CHAPTER I

The Beginnings of Self-Reliance in Defence Production: 1947-1964

India's quest for self-reliance began in its struggle against colonial rule. The whole experience of freedom struggle, starting from the many revolts and oppositions put up to British colonization even before 1857 forms the ideological basis for what in post-Independence India came to be termed as self-reliance. With the formation of the Indian National Congress in 1885, Indians began their first journey of liberation from their colonial yoke to become a free and independent nation. In this journey, the urge to do everything including the creation of modern nation-state, its management and future development, formed the core of what later came to be termed as 'self-reliance'. The aim was to achieve self-reliance in the realms of polity, economy, industry, agriculture, and defence. In this sense the search for self-reliance in economy or defence is a living struggle both internally and externally.

Nehru, the first Prime Minister of independent India, explained what self-reliance meant. He said, "In our external and internal domestic policy, in our political policy, or economic policy, we do not propose to accept anything that involves in the slightest degree, dependence on any other authority".1 This urge to be free from foreign dependence as far as possible, found its concrete

expression in the Indian planning process and began to be used as the goal of all planning from beginning of the Third Five Year Plan. The Fourth Five-Year Plan clearly stated, "self-reliance not only means freedom from dependence on foreign aid but also involves the establishment of an acceptable minimum standard of living for the masses and a continuous rise in this standard. With self-reliance, therefore, has been linked the capacity for self-sustaining growth. This means that the objective is not only to take the country towards freedom from dependence on external aid for its economic development, but also to generate domestic capacities that will enable it to have a steady and satisfactory rate of economic growth without dependence on external aid."^2

**Nehru's Concept of Defence**

To understand the quest for self-reliance in defence production, it is important to understand what is meant by defence. Jawaharlal Nehru said about defence,

"What is the equation of defence? ....Well, one thinks immediately about defence forces - army, navy, air force. Perfectly right. They are the spear-points of defence...What are they based on? The more technical armies and airforces get, the more important becomes the industrial and technological base of the country. You may import a machine or an aircraft or some other highly technical weapon and you may even teach somebody to use it, but that is very superficial type of defence because you have not got the technological background for it ....Therefore, apart from the army, navy and so on, you have to

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have an industrial and technological background in the country. Supporting all this is the economy of the country. If the country's economy is not sound, it is a weak country...The equation of defence is your defence force plus your industrial and technological background, plus, thirdly, the economy of the country and fourthly, the spirit of the people. ... In other words, the real strength of a country lies in her industrial resources. The strength of the defence forces and every thing connected with them depends on the development of these resources. If not, then, defence is just a superficial thing which can be kept up by borrowing money but has no basic strength of the defence forces and everything connected with them depends on the development of these resources.¹³

Nehru, therefore, clearly understood that the task of building an industrial base for defence was not an easy one. He followed this goal in terms of four broad policy directions:

(i) A broad-front licencing strategy, involving a massive import of foreign technology through the wide ranging net of foreign collaborations.

(ii) The rapid creation of a broad-based general purpose structure of R & D through a wide network of high quality science laboratories in the public sector.

(iii) The rapid creation of specific mission-oriented institutions for R & D in selected areas where generation of local technology is necessary.

Enormous increase in scientific and technical manpower to service the industrial system, based on imported technology as well as the R & D structure through a rapid expansion and upgrading of the system for higher education.  

In pursuit of this goal of self-reliance, India adopted a policy of "selective disengagement" from the international economic system, which involved her in a programme of import-substitution so as to develop a capacity to produce as many items at home. The "selective" approach to this industrialisation was guided by:

(i) the import-substitution strategy based on import of technology rather than development of indigenous technology;

(ii) the import substitution relied in substantial measure on external resource mobilization; and

(iii) the reliance on foreign investments, which were limited, given the poverty of the country.

According to Baldev Raj Nayar, "one could say that technology policy in the 1950s and 1960s was solely determined by foreign exchange considerations, though the foreign exchange constraint was itself the result of the initial decision to go in for a gigantic import-substitution programme".  

Domestically, Nehru did two things to create an independent technology base. First, at his initiative, the Indian Parliament adopted the Science Policy Resolution in 1958. Second, he increased the budgetary allocations for this

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purpose and created basic R & D institutions. Thus while in 1948-49, only Rs.11 million were allocated for R & D in the Central budget, this amount rose to Rs.46.8 million in the 1950-51 budget.6 At the institutional level, the Department of Scientific Research was created which was later expanded in 1951 into the Ministry of Scientific Research and Natural Resources to organize and direct scientific research for national development.7 The R & D infrastructure created was of two types; first, general purpose R & D agencies; second, mission-oriented agencies.

The pre-eminent agency in the general purpose type of R & D institutions was the Council of Scientific and Industrial research (CSIR), while in the second category of mission-oriented agencies there are for example, the Department of Atomic Energy; the Indian Council of Agricultural Research; the Defence Research and Development Organization (DRDO); and the Indian Council of Medical Research (ICMR). Specifically defence R & D and production are carried out in the various Ordnance Factories (OFs), the many mission-oriented Defence Public Sector Undertakings (DPSUs) and Defence Research and Development Organization (DRDO) for the Army, Navy, and Air Force. In the following pages, an enumeration of the various technological developments that took place for the three services from these R & D agencies, OFs and DPSUs from 1947 to 1962-63 is first attempted, and then an analysis of the defence production in this period is done with a view to find out how far India has progressed or failed in its quest for self-reliance in defence production.

Ordnance Factories (OFs)

At the time of the transfer of power, there were 16 Ordnance and Clothing factories in India under the control of the Director of Ordnance Factories. The Mathematical Instrument Factory had also been placed temporarily under the Director of Ordnance Factories. After independence, the programme for the attainment of self-sufficiency in defence production was handicapped by various factors. Firstly, the manufacturing particulars, which used to be obtained from the UK, were no longer available for the manufacture of new equipment. Secondly, no work relating to research and development of armament stores took place in India. In fact, no encouragement was given to any institution in this field as the whole subject was considered highly confidential. Thirdly, there was also the problem of shortage of highly skilled workers, drawing officers and design staff and rate-fixing and estimating staff. Thus the OFs had to undertake considerable pre-production work like training schemes for highly skilled personnel. Fourthly, there was the problem of how to retain the labour force so that the technique and know-how were not lost, as at the end of the war and at the dawn of independence new military orders would not be forthcoming. Thus, to keep the factories going in full capacity, the OFCs had to accept considerable civilian orders.8

Free India required a highly advanced industrial base for manufacture of items such as explosives. The existence of a highly advanced chemical industry would be most helpful. A good mercantile service and well organized ship

building industry and or an advanced air force were essential. All these required that the Ordnance factory set up be packed with well developed engineering, scientific and industrial potential in the country. The industrial development of the country was not only important for improving the living standards of the people but also for the defence of India.

**Developments in OFs in 1948-49**

The Ordnance Factories came under the direct control of the Ministry of Defence from 1st December 1947. The Ministry of Defence encountered several significant initial problems in the creation of a post-independence defence production capacity in the Ordnance Factories. First, there were very few Indians in the high-skilled labour force. In fact, as of 1st April 1948 "most of the trained engineering and supervisory staff in the Ordnance Factories consisted of Europeans ... and a serious staff situation was thus created."  

Though relatively the number of Indian officers in gazetted ranks in the Ordnance Factories had increased vis-a-vis the situation in 1939, when there were only two Indian Officers. As of 1948, ".... all except 83 are Indians out of a total of 2,668. We have just completed recruiting further 50 Indian officers who will after a period of training be available for replacing Europeans who may be leaving.... Every effort is being made to give adequate training to Indian officers and supervisory staff. A certain number have been deputed to foreign countries and more will be sent from time to time."  


acute need to increase production and prior to doing this "...most of the machinery and plant required to be renewed and replaced". It was also necessary to rationalize and modernize the machinery in the Ordnance Factories. Plans were prepared "for progressive modernization of plants in the factories, for the re-starting of two factories which were on a "care and maintenance basis" and for the establishment of some new factories".

1949-50

In 1949-50, apart from the normally planned programme of Ordnance Factories, "a great deal of experimental work" had been carried out "in connection with the establishment of manufacture of new stores for the three services". Thus, two factories were re-started, the Jerry Can Factory at Wadala and the Barrel Factory at Bhusawal and taken over as Ordnance Factories in 1949. Added to this, Ordnance Factories were re-started also in Khamaria and Kanpur. The Ministry of Defence was also planning during 1949-50 to establish a Prototype-cum-Machine Tool Factory Plant. This factory would provide specialised machine tools for feeding other Ordnance Factories; "...but its main purpose is to assist in the development of new manufactures by providing a place where prototypes can be produced and tried." A training school had been attached to this factory to impart instruction to workmen in skilled crafts. Apart from this, the creation of a defence industrial base required

11. Ibid,
12. Ibid,
14. Ibid,
creating a system of training. In this regard the Ordnance Factories were suffering from a shortage of trained technicians. To meet this shortage, Ordnance Factories had to begin different training schemes for Assistant Works Managers, Apprentices, Boy Artisans, Draughtsmen and Workmen. Added to this, about 20 officers of the Ordnance Factories were sent abroad for technical training in connection with the newly created Prototype-cum-Machine Tools Factory.\textsuperscript{15}

1950-51

In the past, the Ordnance Factories catered exclusively to the needs of the Army. From 1950 onwards, its role was expanded to fulfill even Naval and Air Force needs. Progress has been somewhat slow "...as development of new lines of armament production usually involves large capital outlay and we have not available the necessary technical know-how in many cases."\textsuperscript{16} As regards production of basic armaments ammunition and explosives, there was an increase over the previous year. For example, the targets for rifles and Small Arms Ammunition (S.A.A.) had been fully met. Manufacture of certain items of new production had been established thereby reducing imports.\textsuperscript{17} The two factories commissioned the previous year, i.e. the Jerry Can Factory at Wadala and Barrel Factory at Bhusawal have begun producing at maximum capacity. Civil orders to the tune of Rs.1.7 crores had been executed in 1950-51 and works on components of 950 Road Rollers was completed during the year. The

\begin{itemize}
  \item \textsuperscript{15} Ibid, pp.13-14.
  \item \textsuperscript{16} GOI, MoD, \textit{Annual Report} (New Delhi, 1951), p.22.
  \item \textsuperscript{17} Ibid, p.23.
\end{itemize}
Ordnance Factories also carried out a lot of experimental work by way of "extensive repair work to different types of ammunition from war stocks" and "....manufacture of spares for vehicles...."\(^{18}\) Some new projects were carried out. The first one was near Bombay at Ambernath. This factory had the uniqueness of having a modern Artisan Training School which began functioning on 1st October 1950. The second project was a factory near Jabalpur which is went go into production in the Autumn of 1951. Apart from this a lot of planning efforts were made to create factories to produce batteries, parachutes and several security items. To aid production by Ordnance Factories for the civilian market, a civil production cell at the Headquarters of the Director General of Ordnance Factories was established so as to locate suitable manufacturing capacity with trade. Thus, the year 1950-51 saw spectacular results in the Ordnance Factory system.\(^{19}\)

1951-52

Production was definitely affected by the fact that for a number of items basic raw materials of vital components were not available in the country and thus had to be imported and by the lack of sufficient skilled technical labour. These two lacunae no doubt effected production and this problem was "...only partially overcome by using substitute materials, concentrating on factory technical training schemes...."\(^{20}\) As regards experimental work and new

\(^{18}\) GOI, MoD, n.16, p.23.

\(^{19}\) Ibid, pp.23-25.

projects, the year saw as regards the former, work on new items of production including spares for vehicles, teleprinters etc., and modification work of vehicles for specialist roles.\footnote{21} As regards the latter, i.e. new projects, the Machine Tool Prototype Factory reached the final stages of completion and the factory was designed for the manufacture of machine tools for Ordnance Factories and prototype of new weapons. The Artisan Training School attached to this factory accepted the second batch of 100 students for a 3-year course of technical instruction.\footnote{22}

1952-53

The year witnessed many efforts to establish indigenous production in a number of warlike stores though nothing spectacular had been achieved. One significant thing to be noted about arms production is the time factor between the date a new weapon or store is ordered and the date it is finally produced. In this matter, though India had a shortage of skilled technical labour and lack of specialized know-how, it managed to produce arms, ammunition and stores in the time planned.

Some of the outstanding developments during the year were the establishment of a new Machine Tool Prototype Factory at Ambarnath. It was opened in January 1953 by Prime Minister Nehru and was stated to be "probably the most modern of its type and will help to meet a long felt need for the early

\footnote{21} Ibid,  
\footnote{22} Ibid,
production of prototypes of new equipment". The Factory was expected to "give a great fillip to development and production of new items of equipment". Attached to this Factory was a training school which was considered one of the finest in the country. In the year 1952-53 the intake of the school was 100 and this factory was expected to provide technically trained workers for both the Ambarnath factory and others.

1953-54

The raising of human resource potential of the technically trained officers of Ordnance Factories was continued in 1953-54. The lack of technically trained personnel was one great lacuna Indian Ordnance factory system suffered from 1947 onwards and for its remedy the sending of selected officers either directly abroad, or be trained in India continued in a small affordable measure in 1953-54. It was under this scheme that in 1953-54 some 11 Ordnance factory officers were sent to UK for training while some received training in Germany under an Indo-German Technical Collaboration Scheme. However, there were some lacunae in the Ordnance Factories' system needing drastic change if they were to rise to the needs of the Services. There was "...non-availability of manufacturing particulars" which constituted one of the principal bottlenecks in the establishment of manufacture of new equipment.


25. Ibid.

This resulted in the factories having to undertake considerable development and pre-production work and to establish manufacture from first principles.27 Moreover, there was a "...shortage of highly skilled workers, drawing, office and design staff and rate-fixing and estimating staff".28 The only way to get over these two problems was to intensify the training programmes. The Government appointed a Committee with Sardar Baldev Singh as its Chairman to examine the overall working of Ordnance Factories.

At the level of new projects in the defence production field, "a project for the manufacture of modern types of ammunition was expected to be completed. Other major projects under contemplation included the manufacture of certain types of military explosives.29 Second, the contract setting up Bharat Electronics Limited at Jalahalli was signed between the Government of India and M/s Compagne Telegraphie Sansfil of France on 11th December 1952. The total project cost was estimated at Rs.9.5 crores including Rs. 2.5 crores as working capital and the factory was to manufacture electronic, radio and radar equipments. The factory was to go into production by 1956-57.30

Thirdly, Hindustan Aircraft Limited (HAL) produced HT-2, the first Indian Designed trainer aircraft; upto December 1953, 10 production aircraft of this type had been produced in addition to 10 pre-production aircraft. The production was planned to reach the peak rate of five aircraft per month by

27. Ibid, p.19.
28. Ibid,
30. Ibid,
June-July 1954. HAL was also engaged in the developing a "prototype for the HT-10, an advanced trainer aircraft". Apart from this HAL was also producing railcoaches for the civilian sector at the rate of 11 per month.

1954-55

At the level of Ordnance Factories working towards self-reliance, some progress was made. The significant developments in that direction were, firstly, the efforts directed towards the production of new equipment resulted in the manufacture in Ordnance Factories of no less than 30 new items and many more were in different stages of development. Secondly, the newly established Machine Tools Prototype Factory at Ambarnath continued its production of machine tools according to plan. Thirdly, a large number of machines from German Reparations had also been repaired and installed in a number of factories thus increasing the productive capacity. Fourthly, a new type of ammunition for the Air Force was perfected. Fifthly, construction work of the Bharat Electronics Limited was in progress. Sixthly, as far as creating a technically trained pool of skilled labour which could carry the burden of an evolving self-reliant defence production base, the year saw the deputing of 80 officers/technicians of the Ordnance Factories for training in Europe. Also about 11 training schemes were going on which provided managerial training for workers and managers. Seventhly, HAL designed and developed the HT-2 a basic trainer aircraft.

Added to this, work relating to production of Vampire Jet Fighters was also going on and HAL began overhauling various types of aircraft engines of a civilian nature.
1955-56

The Committee set up in 1954 under the Chairmanship of Sardar Baldev Singh submitted its report and most of its recommendations regarding the modernisation of the Ordnance Factories and changes to be made in organizational and management techniques were accepted. A Defence Production Board was established to coordinate research, development and design activities of the three Services with production in Ordnance Factories and to secure effective liaison with civil industry for meeting defence requirements.\(^{31}\)

The Machine Tool Prototype Factory at Ambarnath showed good progress in the production of machine tools. However, as regards production of prototypes, the factory had yet to realise its goals as "....the manufacture of prototypes of weapons cannot begin to function satisfactorily unless and until a great deal of coordination is established between the various General Staffs of Defence Services, the Defence Science Organization, and the Ordnance Factory. Such coordination is rapidly being attained and the next few years should see an increase in the utilization of the prototype parts of this factory."\(^{32}\)

As regards the new projects, most of the plant and machinery required for a project to manufacture modern types of ammunition for use by the Air Force had been received and the regular production of certain types of this ammunition had begun. Similarly, two major projects as well as several other


\(^{32}\) Ibid, pp.15-16.
smaller projects to modernize, increase and establish production of various items in Ordnance Factories were in different stages of consideration and implementation.\(^{33}\)

In HAL, the production revenues steadily increased from Rs.56.40 lakhs in 1946-47 to Rs.560 lakhs in 1955-56. As regards aircraft manufacturing capability, the year saw the production of Vampire Jet Fighters and negotiations for the establishment of manufacture of Gnat Fighter Aircraft and Orpheus engines. HAL also manufactured airframes and Aero-Engine repair and overhaul work for IAF, Indian Navy and Civil Airlines. As regards the HT-2 aircraft, its sale abroad was encouraged by a demonstration tour in December 1955 in Burma, Thailand, Cambodia and Malaya.\(^{34}\)

**1956-57**

Significant developments took place in the areas of upgradation of technological capability. Ordnance Factory production for Army, Navy and Air Force and training i.e. developing human resources for managing the defence production industrial base.

At the level of upgrading the Ordnance Factories' technological capability, a statistical quality control unit was established under the Director General of Ordnance Factories in October 1955 and started functioning from January 1956. Its task was to carry out investigations into the production problems and find ways to effect improvements in some of the production processes which are beneficial both from the point of view of the technique of

\(^{33}\) Ibid, p.17  
\(^{34}\) Ibid, p.19.
production as well as from the point of view of the cost of manufacture. The results during the first year were encouraging as far as improving the production processes and techniques.

As regards building a human resource base of highly trained manpower in 1956-57 "one non-Gazetted Officer was sent to West Germany on deputation for higher technical training. Three Gazetted officers and eight non-Gazetted officers were also sent to the UK for training in higher arms production subjects. Also the Ministry of Defence was exploring possibilities of sending gazetted as well as non-gazetted personnel and skilled workers to West Germany for practical training."

1957-58

The year saw two defence industrial projects of specific items going at full swing along with an overall modernization of Ordnance Factories. The 1957-58 Ministry of Defence Annual Report says that "....since the issue of the last report, seven projects have been sanctioned for modernization/expansion of existing production facilities in Ordnance Factories. Certain modernization schemes and plans for meeting our requirements have been worked out and/or are in the advanced stage of finalization. The modernization and expansion of steel making facilities in Ordnance Factories is also now under active consideration." As regards developing technically skilled manpower base for self-reliant defence production the Principal Artisan Training School at


Ambarnath offered technical courses in engineering trades, workmen, designers and instructors.

1958-59

This year saw a considerable increase in various ammunition and stores produced by the Ordnance Factories. The total value of stores issued to the services between April to September 1958 was 11 per cent higher than that of the corresponding period in 1957-58. The foreign exchange saved in April-September 1958 was about Rs.60 lakhs. And the value of production in the Ordnance Factories during 1957-58 was 40 per cent higher than the year 1956-57 and the foreign exchange saved during this period was of the order of Rs.4.24 crores".37

The most significant aspect to be noted regarding the quest for an indigenous arms production capability is that "...as many as 32 new items have been manufactured in the Ordnance Factories. A number of further new items of weapons and ammunition is in the process of development. It is hoped to commence bulk production after satisfactory establishment of their manufacture."38

1959-60

In terms of the overall output of Ordnance Factories inclusive of civil trade consumption was of the order of Rs.20 crores during the past year i.e. 1958-59, Rs.18 crores in 1957-58 and Rs.14 crores in 1956-57. As far as the


38. Ibid,
value of goods produced for the Armed Forces as well as civil sector upto December 1959 was of the order of Rs.15 crores and the expectation was to reach a total target of Rs.26 crores for the overall 1959-60 years. This increase in production was due to the fact that some new production units had gone into full capacity production. Another factor which contributed to this was the introduction of new and improved methods and techniques of production which have led to overall cost reduction without addition of labour strength. As regards increasing the scope of production, the year saw the Government of India signing some 10 contracts of collaboration with firms of which eight were foreign.39

The expanding scope of indigenisation process can be seen by the ever increasing annual investments in various Projects in the figures given below:40

<table>
<thead>
<tr>
<th>Year</th>
<th>Cost (Rs. in Crores)</th>
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<tbody>
<tr>
<td>1956-57</td>
<td>.34</td>
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<td>1957-58</td>
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<tr>
<td>1958-59</td>
<td>1.49</td>
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<tr>
<td>1959-60</td>
<td>19.32</td>
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The above figures clearly indicate the rising levels of investment into the Ordnance Factories in developing greater self-reliant and self-sufficient defence production base. The foreign exchange savings made by the Ordnance Factories due to reduction of reliance on imports which was itself a result of greater

degree of indigenous production capability both at the level of a higher skilled labour and evolution of more sophisticated techniques of production into the Ordnance Factory system. Thus, while in 1957-58 the Ordnance Factories conserved foreign exchange worth Rs.16 crores, by December 1959 already about Rs. 6.61 crores worth of foreign exchange had been conserved. The total figure would obviously go up by the end of the 1959-60 term ending July.41

The total value of civil trade done during 1958-59 was of the order of Rs.3.50 crores.

1960-61

The year 1960-61 saw the signing of six agreements with Governments and firms abroad for the licenced manufacture in India of certain Defence equipments/stores. It was hoped that this would result in saving considerable foreign exchange.

Added to these agreements of obtaining licences the year saw sanctioning of a number of new production projects for expansion of existing facilities or creating new facilities in Ordnance factories.

At the level of production, there was an increase in the volume of production which was due to the greater utilization of existing manpower, plant and machinery as well as inclusion of new items of arms, ammunition and allied equipments for manufacture. Another factor that contributed to increased production was the encouragement given by the Directorate General of Ordnance Factories to the Ordnance Factories to adopt modern techniques of production which resulted in a reduction in the cost of production. One can get a fair idea

41. Ibid, p.28.
of both the increase in production volumes and decrease in cost of production in the figure given below.\textsuperscript{42}

<table>
<thead>
<tr>
<th>Year</th>
<th>Value of Production (Rs. Crores)</th>
<th>Volume of Production (taking prodn. in 1956-57 as base at 100)</th>
<th>Cost of Production (taking cost during 1959-60 as 100)</th>
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<tr>
<td>1956-57</td>
<td>14.08</td>
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<tr>
<td>1957-58</td>
<td>18.08</td>
<td>128</td>
<td>120.5</td>
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<tr>
<td>1958-59</td>
<td>19.57</td>
<td>139</td>
<td>113.0</td>
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<tr>
<td>1959-60</td>
<td>..</td>
<td>170</td>
<td>100.0</td>
</tr>
</tbody>
</table>

The value of production by Ordnance factories targeted in 1959-60 was of the order of Rs.26 crores. The actual production reached Rs.25.14 crores. Similarly the total output from April to November 1960 amounted to Rs.17 crores. The target for 1960-61 was set at Rs.29 crores. The year 1959-60 saw the production of 838 Shaktiman 3-ton trucks against the targeted number of 1,200. The target for 1960-61 was set at 1,200 with a 50 per cent indigenous content. As of December 31st 1960, 1,264 trucks had been assembled. As regards production for civil trade in 1959-60 goods worth Rs. 3.45 crores were manufactured. By November 1960 the value of civil trade had gone up to Rs.2.03 crores.\textsuperscript{43}

1961-62

As far as signing of new collaborative agreements and launching of new projects is concerned, 11 agreements were signed with Governments as well as


\textsuperscript{43} Ibid, p.53-55.
firms of foreign countries for manufacture in India under licence of various
defence stores and equipments which was hoped to save considerable foreign
exchange. Also two agreements were signed with foreign firms for supply of
defence stores and equipments. Three new projects for manufacture of various
types of products were undertaken. They were a vehicle factory at Avadi; a
clothing factory at Avadi; and an electrical factory at Chandigarh. Added to
these three projects, two projects sanctioned the previous year were progressing
i.e. an Alloy and Special Steels Plant.44

In the area of vehicle production the Ordnance Factories had already
established the manufacture of 3-ton, 1-ton and 8 Cwt. vehicles to meet the
requirements for light and medium vehicles. With the establishment of the
Heavy Vehicle Factory at Avadi along with the Artisanal Training School, the
production of heavy vehicles was expected to begin in a big way. Specifically
the figures for the number of 3-tonners, 1-tonner and 8 Cwts Vehicles are as
follows: 1,000 Shaktiman, 3-Ton trucks wish an indigenous content of 48.8% as
against 39.3% in 1959-60; 1,190 1-ton Nissan trucks with an indigenous content
of 30 per cent were produced in the current year. As regards the 8 Cwt Nissan
Patrol, a licence agreement in this regard was signed in December 1961.

Finally, regarding the Komatsu Tractors, a total of 131 such tractors of
different types were produced with different rates of indigenization shown in the
figure for 1961-62.

The Ordnance Factories also manufactured attachments for these tractors totalling 88 in number with an indigenous content of 70 per cent. These tractors are mainly for civilian use. This indigenization definitely led to savings in foreign exchange.\(^{45}\)

The improvements affected in the production techniques and processes since the acceptance and implementation of the recommendations of Sardar Baldev Singh Committee on Ordnance Factories in 1955 and Creation of Statistical Quality Control Units in more Ordnance Factories resulted by 1961-62 in rising volume of production but a simultaneous fall in cost of production, therefore saving valuable foreign exchange. The figure below would clearly show the volume of production and the index of cost of production.\(^{46}\)

\(^{45}\) Ibid, pp.36-38.

\(^{46}\) Ibid,
<table>
<thead>
<tr>
<th>Year</th>
<th>Value of Production in Rs. crores</th>
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<tr>
<td>1960-61</td>
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The estimates are that the volume of production in 1961-62 would be of the order of Rs. 40 crores.

1962-63

1962-63 period is significant as far as defence production is concerned as it is the year when the Sino-Indian border war broke out. The war situation created an emergency which necessitated a complete re-appraisal of the activities of the whole Defence Production Organization due to the sudden spurt in requirements for stores and equipments in the Services. Certain steps were taken immediately to meet the requirements. Firstly, at the level of Ordnance Factories, they began to work round the clock; introduced modern techniques of manufacture; accelerated the commissioning of new projects which had been sanctioned for the past many years; chalking out plans for creating new ordnance factories and transferring to the civil sector more components for manufacture. Secondly, at the organizational level of planning and executing
defence production plans the 1962 emergency saw the Defence Production Organization working in close liaison with other ministries. Whatever technical assistance was required was offered to the Ministry of Economic and Defence Coordination for harnessing the full industrial capacity of both the civilian industries and defence industries.47

As regards signing of joint venture agreements and launching of new projects for developing a more self-reliant defence industrial base, two things have to be noted. First, eight collaboration agreements between April and November 1962 were signed with foreign countries and firms, and second new projects costing Rs.7 crores were sanctioned during the year bringing the total cost of projects sanctioned for expansion of Ordnance Factories during the last four years to over Rs.56 crores. These projects have definitely augmented the overall capacity of Ordnance Factories enhancing substantially the production capacity of the Ordnance Factories.48

As regards production, the total value of Ordnance factory production in 1961-62 amounted to Rs.41.45 crores against the targeted Rs.40 crores.49

1963-64

The first half of the financial year 1963-64 itself saw an increase of about Rs.32 crores in the value of issues from the Ordnance Factories compared to the issues for the same period in 1962-63. The total value of issues in 1963-64

49. Ibid, p.32.
amounted to Rs.51.71 crores while that of 1962-63 was Rs.19.84 crores.50

As regards the constantly increasing volume of production the figures are given below from 1958-59 to 1962-63.51

<table>
<thead>
<tr>
<th>Year</th>
<th>Army</th>
<th>Navy/Air Force</th>
<th>Civil Indentors (including Border Roads Development Board)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1958-59</td>
<td>14.31</td>
<td>2.08</td>
<td>3.26</td>
<td>19.65</td>
</tr>
<tr>
<td>1959-60</td>
<td>19.94</td>
<td>1.75</td>
<td>3.68</td>
<td>25.37</td>
</tr>
<tr>
<td>1960-61</td>
<td>24.24</td>
<td>1.66</td>
<td>7.45</td>
<td>33.35</td>
</tr>
<tr>
<td>1961-62</td>
<td>33.27</td>
<td>2.55</td>
<td>6.06</td>
<td>41.88</td>
</tr>
<tr>
<td>1962-63</td>
<td>55.83</td>
<td>3.07</td>
<td>5.00</td>
<td>63.90</td>
</tr>
</tbody>
</table>

It is in the field of production of new items that the 1963-64 period saw the culmination of many projects indigenous pushed from 1948-49. The significant achievements by 1963 were as follows:

(i) establishment of manufacture of 7.62 mm semi-automatic Ishapore Rifle, including ammunition for it;
(ii) establishment of manufacture of improved carbines replace sten guns;
(iii) modification of Light Machine Guns and Bolt Action Rifles to take new rimless 7.62 mm ammunition;

51. Ibid,
(iv) establishment of production of a new Heavy Mortar with longer range and its ammunition;

(v) establishment of production of new anti-tank ammunition;

(vi) establishment of production of anti-aircraft guns and ammunition."

Apart from this, the year saw development of many other weapons and equipments by the Ordnance Factories. They are as follows:-

(i) the successful development of a suitable mountain gun with significantly higher range has begun to be produced.

(ii) the establishment of a new Cordite Factory at Aruvankadu for the production of semi-solvent propellants for rockets. The factory was commissioned by March 1964.

(iii) A plant set up at Khamaria for production of a new type of ammunition for the Air Force. The Plant was expected to be commissioned by April 1964.

(iv) As regards the production of vehicles, the expected production of Shaktiman 3-ton trucks was targeted at 4,300 pieces by March 1964. The Shaktiman Project had been on for 4 years in July 1963 and by the end of December 1963, 3,994 trucks has been produced. The indigenous content had reached 61%.

(v) Similarly, the Nissan 1-Ton truck project had by December 1963 produced 4,420 trucks. In the year 1963-64 ending March 1964, the total

52. Ibid, pp.57-58.
number produced was expected to go up to 5,200. The indigenization content was up to 35%.

(vi) The Nissan Patrol Jeep project by December 1963 had a manufacture of 1,847 pieces. This was expected to rise by March 1964 to 2,100 with an indigenous content of 28%.

vii) Clothing and other equipments too form a very expensive part of the production which need to be supplied with weapons. In this area too, we were totally dependent on imports at the time of independence. But over the years and particularly in the light of the emergency plan launched in the context of the Sino-Indian War even in this area, the Ordnance Factories achieved a degree of self-reliant production capability. Thus, production of snow and ski equipment, winter and cotton garments increased considerably during 1963-64. The same increase was seen in the case of supply-dropping parachutes, line-gear and saddlery. A new clothing factory was set up at Avadi producing 1-lakh garments per month. Production commenced from October 1963. A project for production of one piece Beret at the Ordnance Clothing Factory, Shahjahanpur was sanctioned in 1964.

viii) Added to the above, in January 1962 the Ordnance Cable Factory at Chandigarh was sanctioned. The factory commenced production of field cables from 8th September 1963 and it was expected to meet one of the vital communication requirements of the Army.53

53. Ibid, pp.57-59.
As far as new projects are concerned, in the fields of arms and ammunition and the manufacture of Heavy Engineering Equipment, several developments took place. First, six new factories were being established for augmenting the production of small arms and ammunition. Second, the construction work of the ammunition factory at Varangaon was going on. Third, similar work was in progress for the setting up of the engineering unit at Ambajhan. Fourth, basic work was going on for setting up the High explosives Factory at Burla. Fifthly, work on establishing three factories including a second small arms factory at Tiruchirapally. Lastly, a factory was being erected at Avadi near Madras for production of tanks and other heavy engineering equipment. As regards development of human resource base four more Artisan Training Schools are being established at Ambarnath, Khamaria, Ishapaore and Nagpur.

1964-65

The year 1964-65 is a significant year as it represents the end of the Nehru era. The Indian defeat sent shock waves down the Indian defence establishment and in 1963-64 a comprehensive five year modernization plan was drawn up at an estimated cost of Rs.33.2 crores with a foreign exchange component of Rs.15.2 crores. The modernization plan covered the fields of metal making and shaping; optical; filling and explosives; certain special equipments for armament production.

As far as production of arms and ammunition is concerned, during the current year, production of a number of new items was established for all three Services. Some of the important items going to be productionized were a Tank
Gun, a Heavy Mortar and 30 mm ammunition for the Air Force. A new mountain gun of Indian design and of high performance.

Added to this designs and production were established for other weapons and ammunition. In particular the ammunition for the new Heavy Mortar. A fuze already under production has been successfully adopted for one of the new items of equipment in lieu of the complicated fuze prescribed by the original designers. At Khamaria with the production of a new type of aircraft ammunition in mid-1964, bulk production of electrically fired ammunition was established for the first time. Production of solvent less cordite for rockets has been established at the new Plant which was commissioned at Aruvankadu in March 1964.

As regards the production of vehicles is concerned, the year saw a total estimated target of 1,131 3-Ton Shaktiman pieces. The total production last year i.e. 1,030 pieces. The indigenous content was 70% by January 1965. Similarly the estimated output of Nissan 1-Ton Truck for 1964-65 was put at 3,798 pieces while the number produced last year i.e. 1963-64 was 2,933 pieces. The indigenization percentage had come to 70% by 1964-65. Lastly, as regards the Nissan Patrol Jeeps 1964-65 estimates put at 1,125 pieces with an indigenous content of 31% last year saw the production of 1,080 pieces.54

As far as the production of clothing and other equipment in 1964-65 is concerned, the production of snow, winter and cotton garments of all types was considerably speeded up during the year. There was an increase of 300% in the capacity of the clothing Factory at Avadi. Thus, production of clothing was

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over the capacity and certain developments were made in the field also that symbolize rising self-reliance. Firstly, bulk production of a new type of man-dropping parachute will commence after the completion of on-going user trials. Second, production was also established of a special type of pack plaster for paradropping of jeeps. Third, the Everest Expedition in 1965 was assisted by the Ordnance Factories by manufacturing mountaineering clothing and equipment of all sorts e.g. sleeping bags, high altitude tents, eider down suits, ice axes, crampons, pitons, and carabiners. Fourth, field cable production from the Ordnance Factory at Chandigarh exceeded capacity.55

As far as new projects in the areas of arms, ammunitions, and heavy engineering equipments is concerned, they were as follows:

First, a factory for small arms ammunition manufacture at Varagaon was to be commissioned on 15th October 1964. Second, the Bhandara Factory work was nearing completion and production had commenced at its two plants in December 1964. Third, a team of US Consultants was studying the engineering aspects of the new Ordnance Factory at Ambajhari. Its report was expected towards the middle of 1965 and the factory was expected to go into production at the end of 1966. Fourth, various plants and machinery was being acquired for the Filling Factory at Chandrapur and the factory was expected to start production at the end of 1966. Fifth, the Small Arms Factory at Tiruchirapalli was being established exclusively by the Ordnance Factories Organization without any foreign assistance. Sixthly, a new Vehicles factory was being established at Jabalpur with a team of consultants from West Germany finalising

55. Ibid,
the project report. Seventhly, a High explosives Factory was being established at Burla and also a propellant manufacture factory at Panvel were being put into the next 5-year Defence Plan due to lack of resources that was estimated at around Rs.62 crores.56

DEFENCE PUBLIC SECTOR UNITS (DPSUs)

HINDUSTAN AERONAUTICS LIMITED (HAL)

1948-49

Originally, Hindustan Aircraft Limited located at Bangalore was a private Limited Company in which the Government owned two-thirds share represented by a capital investment of Rs.1,16,66,600 and the Mysore Government having one-third share i.e. a capital a Investment of Rs.58,33,300. In 1942 the Company was taken over from the private company and handed over to the US Army Air Corps for War purposes.

HAL has been serving as an overhaul, assembly and conversion depot since the termination of the War. From April 1946 to December 1948 for a period of almost 2 years, HAL did 87 aircraft conversions, 260 aircraft overhauls and 804 aero-engine overhauls. Both during the war and since its termination, the factory perhaps one of its kind in the East, rendered inestimatable service to the Royal Indian Air Force (RIAF) and civil operators in keeping Indian aircraft flying. Apart from this the Company also catered in some little measure to the aeronautical needs of some countries in the Far East, Saudi Arabia, Ceylon etc.57

56. Ibid, p.54.
As far as the profits and losses in the year 1946-47, the Company incurred a loss of Rs.6,02,704 due to the termination of the World War II. However, in 1947-48 after a reorganization of the Company and also due to increased demands from RIAF as well as civil operators, the financial situation improved. Thus in 1947-48 HAL recorded a profit of over Rs.20 lakhs whereby emoluments and amenities for the workers were improved. In the year 1948-49 again a higher profit is expected.58

As regards production, HAL with an agreement with the Percival Aircraft Company of UK began to produce for the RIAF, 30 Prentice Trainer aircraft from raw materials apart from assembling 15 aircrafts from components and 5 from detailed parts imported from the UK. The first assembled Prentice Percival is expected to fly very shortly. Further orders from RIAF are expected for the Prentices.

As regards indigenous R & D based development, HAL began to go beyond assembly right from the start, though in a small way. A Design and Development Section under an Indian expert was added to the factory in 1948-49. This new section helped in designing certain indigenous types of aircraft. It is developing 3 trainers - one primary, one basic and the third one advanced trainer. The first was to be used by Flying Clubs, Private individuals and National Cadet Corps; the second and third will be used by the RIAF. The flying tests for the proto-type of the primary trainer were to begin in mid-1950. As regards manufacture for the civilian sector, HAL manufactured 5 rail coaches

and was scheduled to produce 100 rail coaches of special design for the Railways. 59

1949-50

The year 1949-50 saw HAL entering the arena of production in a significant way. First, five Prentice aircraft fitted with engines and ten without engines were assembled and two of them have successfully completed their trials and were the fully manufactured by the factory. Second, the work on developing a prototype of a Trainer aircraft was making good progress and the first prototype will be ready for air-testing by August 1950. Third, arrangements were made for producing a fighter aircraft whose production process will start little later on a large-scale. Lastly, the overhaul and repairs work continued and in 1949-50, 112 major aircraft overhauls, and 440 aero-engine overhauls were undertaken besides miscellaneous work on a large number of aircraft, aero-engines and overhaul accessories. The experience HAL gained led to a reduction of overhaul costs. 60

At the level of production for the civilian market work was going on satisfactorily. Fifty coaches were delivered by the end of January 1950 and fourteen more were to be completed before the end of March 1949. The Ministry of Railways has put an order of 150 rail coaches. The sales turnover by March 1949 of Rs.0.75 crores but by March 1950 the turnover was expected to be Rs.2 crores. The overall profits and losses were as follows: 61

61. Ibid,
### Yearly Profit and Loss

<table>
<thead>
<tr>
<th>Year</th>
<th>Profit</th>
<th>Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>1945-46</td>
<td>Rs. 16.38 lakhs</td>
<td></td>
</tr>
<tr>
<td>1946-47</td>
<td>Rs. 6.00 lakhs</td>
<td></td>
</tr>
<tr>
<td>1947-48</td>
<td>Rs. 9.3 lakhs</td>
<td>...</td>
</tr>
<tr>
<td>1948-49</td>
<td>Rs. 14.5 lakhs</td>
<td>...</td>
</tr>
<tr>
<td>1949-50</td>
<td>Rs. 8.8 lakhs</td>
<td>...</td>
</tr>
</tbody>
</table>

As of 1949-50 - 6,250 employees were working in its fold.

**1950-51**

A prototype of the Primary Trainer Aircraft HT-2 took shape. Various tests were being carried out for checking the adequacy of the strength of the components and the aircraft was expected to fly in March 1951. Second, components and details for 15 Prentice Aircraft which had previously been imported were assembled in the factory. Apart from this, parts for another 15 Prentices, manufactured within the factory, were in various stages of erection. Third, satisfactory progress had been made in the manufacture of fighter aircraft. Fourth, as regards overhaul and repairs, they still continued to be a great part of the Factory's activities.62

As far as HAL's contribution to civilian industry, the year 1950-51 saw a further increase in volume of production. Significant achievements were made in two areas. First, an entirely new type of work attempted during the year was the building of all-metal Double and Single Decker Bus Bodies for the State Transport Authorities of West Bengal, Delhi and Bombay. The first few were

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built mainly from imported materials but arrangements were made for manufacture of kits out of indigenous materials. Second, HAL completed the first order from Railways of 100 railcoaches by July 1950. Added to this 44 coaches of an improved type are expected to be delivered by March 1951. Overall, the year 1950-51 saw a total sales worth Rs.240 lakhs against Rs.185,186 and Rs 130 lakhs in the past three years. Administrative control of Ordnance Factories was passed from Ministry of Industry and Steel to the Ministry of Defence in December 1950.

1951-52

As regards the developmental projects undertaken during the year, the first prototype of an `all-metal' primary trainer HT-2 was completed. The aircraft was test flown on 13th August 1951, but it crashed unfortunately on 11th December 1951 while doing its 28th test flight. Work on the second prototype of the HT-2 was completed by February 1952 and the aircraft had its first successful test flight on 18th Feb 1952.

1952-53

The second prototype of the HT-2, the first `all-metal' Indian designed and manufactured primary trainer aircraft successfully completed all its test flights and received Type Certificate of Air worthiness from the Ministry of Communications. 6 pre-production HT-2 aircraft were also manufactured and delivered to the IAF in time for participation in the Republic Day Celeberations.

63. Ibid, pp.41-42.
64. Ibid, p.42.
A programme for the manufacture of this aircraft was drawn up which was expected to meet both civil and Air Force requirements of the country in respect of the primary trainer aircraft.

Added to this, the design work on the HT-10 an advanced trainer aircraft also proposed to be manufactured by HAL for the IAF had been completed and the first prototype was expected to be ready within two years.

1953-54

During the year 1953-54 HAL produced HT-2 the first Indian Designed trainer aircraft. Upto December 1953, 70 production aircraft of this type have been produced in addition to 10 pre-production aircraft, six of which were produced in 1952 and 4 this year. The production was planned to reach the peak rate of five aircraft per month by June-July 1954.

The second project was the HF-10 prototype development work i.e. an advanced trainer too was progressing according to schedule.

As regards production for civil sector, HAL's peak output rate per month of rail coaches reached 11 per month during 1952-53 and continues to remain 20--- in 1953-54.

1954-55

HAL produced 42 HT-2 aircrafts. HT-2 was a basic trainer designed and developed indigenously by HAL. The Company was producing HT-2 at the rate of 2 per month. Work on the Vampire Jet Fighters for IAF was progressing satisfactorily. Overhauling of various IAF engines was going on. The aero-engines overhauled were - Centaurs; P & WR 1830; Gypsy Major; Gypsy Queen 70; and Gypsy Queen 32.

65. GOI, MoD, n.26, p.21.
As regards HAL's production for the civil sector, HAL produced 15 rail coaches per month as well as kits for single and double decker bus-body for the transport departments.  

1955-56

As of December 1955 HAL completed its 15th year of existence. In regard to progress one can see that the production revenue steadily increased from Rs.56.40 lakhs in 1946-47 to Rs.560 lakhs in 1955-56. During the same period the strength of the labour force increased from 3,600 to 10,000. As far as aircraft manufacture in 1955-56, HAL's production of Vampire Jet Fighters for IAF was progressing satisfactorily. Apart from this, negotiations were going on for the establishment of the manufacture in HAL under licence, of the GNAT Fighter Aircraft and the Orpheus jet engine. HAL aero-engine repair and overhaul work for IAF, Indian Navy, Indian Airlines and Civil Airlines was going on. At the civilian commercial side, HAL produced 169 rail coaches and 300 single Decker Bus Kits by March 1956. Besides, this, they supplied 4 lakh lbs. of castings for a High Speed Lathe to Hindustan Machine Tools. To sell the HT-2 Trainer abroad, HAL put forth a demonstration show in November and December 1955 in Burma, Thailand, Cambodia and Malaya.  

1956-57

As far as manufacture of aircrafts is concerned as of 1956-57, 4 major


67. GOI, MoD, n.31, pp.18-19.

38
projects were in progress. They were:

(i) HT-2 Basic Trainer aircraft
(ii) Gnat
(iii) Orpheus Jet Aero-Engines
(iv) Dr. Kurt Tank's Project to design and develop a modern aircraft for India.

By December 1956, HAL had produced 122 HT-2 aircrafts. Second, as far as the GNAT programme, Indian government entered into a licence agreement with M/s Holland Aircraft Ltd., UK. Third, as regards the Orpheus Jet Aero-engine the Government of India entered into an agreement with M/s Bristol Aero Engines Ltd. UK for the production of Orpheus Engine. Lastly, HAL employed a team of aeronautical experts under the world famous aeronautical expert Dr. Kurt Tank to design for India a modern aircraft.68

On the commercial civilian side, HAL had a peak production of 18 rail coaches per month. Of the Model 407 during 1956-57. However, HAL decided to manufacture integral type of rail-coaches similar to those produced at the Integral Rail Coach Factory at Perambur but of a slightly different design. Production was to take place along with Machinenfabrik Augustburg Nerenberg (MAN), a West German firm collaborating with HAL. The programme aimed at producing 300 integral type rail coaches during the first five years and after that annually producing around 300 coaches.69

Apart from this various facilities were being established at the factory for the manufacture of light alloys and forgings specially required for jet aircraft and

68. GOI, MoD, n. 5 p. 23.
69. Ibid,
engines. Finally, training schemes of various sorts were put into operation. After an all-India recruitment, a basic engineering course of six months was provided at HAL and then these apprentices were sent for practical training to the Artisanal Training School of the Machine Tool Prototype Factory at Ambarnath. 70

1958-59

Apart from on-going projects, the significant highlight of the year was the development of an ultra light aircraft i.e. the Pushpak. It made its first flight successfully on 24th September 1958. The aircraft was awaiting Type Certificate. 71

1959-60

Work in HAL was proceeding in two divisions i.e. Aircraft and Aero-Engines Divisions and the Rail Coach Division. As far as the Aero-Engine Division is concerned, work on Gnat aircraft and Orpheus Jet Engine under licence agreements with M/s Folland Aircraft Ltd., UK and M/s Bristol Aero Engines Ltd., UK respectively made substantial progress.

Work on the development of the HF-24 modern military aircraft was progressing satisfactorily. Work on a Basic Jet Trainer for the Indian Air Force had been undertaken. From April to November 1959, 8 more Pushpak aircraft have been produced. The development of a five cylinder piston aero-engine of an estimated horsepower of 90 to 95 for the Puspak aircraft was undertaken without any foreign assistance.

70. GOI, MoD, n. 36, p. 22.
71. GOI, MOD, n. 37, p. 35.
Development tests on the engine were being conducted. Development of a light Four-seater aircraft which could also be used for pest control and agricultural spraying and in certain military roles had also been embarked upon. Flight trials were going on. Also work on a six-Cylinder piston engine of an estimated horsepower of 190 for the Four Seater Aircraft had been undertaken. The development of a logistic air support type aircraft had been undertaken and a prototype was expected to be ready for flight trials during 1960. As regards railcoach manufacture, HAL from April to November 1959 had produced 57 conventional type and 83 Integral type rail coaches. 72

1960-61

Work on developing the first prototype of HF-24, i.e. a modern military aircraft was nearing completion. The prototype was expected to make its first flight in the first half of 1961. Second, the manufacturing programme of the Gnat was going on smoothly. Third, from April 1960 to December 1960, 4 HT-2 and 4 Pushpak aircraft were produced. Fourth, the Company undertook the design and development of a Basic Jet Trainer aircraft for the IAF during the year. Fifth, the progressive manufacture of the Orpheus aero-engines at HAL commenced during the year. Sixth, it was decided to manufacture 'Dart' aero-engines at HAL under licence with M/s Rolls Royce of UK. The Company took preliminary work for manufacture of engines. Seventh, work also began on the design and development of a piston aero-engine. Two prototypes of this

72. GOI, MoD, n.39, p.38.
engine were made and the engines were undergoing extensive tests. The engine had been installed on the Pushpak aircraft manufactured by HAL and was flight tested. Lastly, Overhaul and repair work of different types of airframes, piston engines and aircraft and piston engine accessories had been going on according to the requirements of the Defence Services. The serviceability of the IAF maintained at outstations was kept at a high level. Repair and overhaul of jet engines also began to be taken up by HAL. 73

1961-62

The year saw many developments in the field of aircraft and aero-engines. First, the prototype of Supersonic jet aircraft, the HF-24 Mk I, designed and developed by HAL made its first flight successfully on 17th June 1961. While the prototype was undergoing further development test flights, steps had been taken simultaneously for its service production. Second, the manufacture of Gnat aircraft from imported raw materials commenced. Third, from the beginning of the HT-2 programme, HAL had manufactured 160 aircraft including 2 aircraft completed during the early part of 1961-62. Due to lack of orders, the HT-2 production line has been virtually closed down. Fourth, HAL produced 12 Pushpak aircraft and right from the beginning of this programme HAL has received orders for 40 aircraft. By 31st March 1962, HAL produced 38 aircraft of which 37 had been delivered. Fifthly, the second prototype of Krishak aircraft completed all the flight tests required. Sixthly, as regards the first prototype Logistic Air Support type of aircraft, it carried out its flight trials in September 1960 as a result of which certain improvements were being

73. GOI, MoD, n. 42, pp. 62-63.
incorporated. HAL was considering the possibility of installing after consulting
the Air Force, a turbo-prop power plant in place of the piston engine for
improving the performance of the aircraft for high altitude flying. Seventhly,
work progressed on HAL's efforts at developing a Basic Jet Trainer aircraft for
the Air Force. Eighthly, HAL started manufacture of the Orpheus aero-engines
from imported raw materials during the year. Ninethly, a four cylinder piston
engine for the Light aircraft was under development by HAL. Lastly, as regards
overhaul work and contribution to the civil sector, work on overhaul of various
types of airframes, piston engines and accessories was proceeding as planned.
HAL completed the successful first major overhauling and inspection of the first
Canberra Jet bomber aircraft. The value of the overhaul work and investigation
of defective engines was about Rs.260.00 lakhs. As regards rail coach
manufacture, HAL produced 245 Intergral Railcoaches Class III Broad Gauge
including one-day-cum-sleeper Type Coach. HAL had produced 592 Integral
Rail Coaches by March 31, 1962.\textsuperscript{74}

1962-63

HAL's development needs to be noted in four directions i.e. design,
development, manufacture and overhaul of aircrafts; engine manufacture; future
programmes and civilian products.

As far as designing, manufacturing and overhauling aircraft is concerned,
five major programmes were in operation. First, a prototype, the first of its
kind, of HF-24 Mk I, had been undergoing development test flights since 1961.
The second prototype made its flight on 4th October 1962 and it was also

\textsuperscript{74} GOI, MoD, n.44, pp.46-48.
undergoing development test flights. Simultaneously, steps were being taken to bring the Hf-24 Mk I into production. Secondly, work on production of a jet trainer was in progress, and it was hoped that the first prototype would be completed before the end of 1963. Third, the Gnat programme was continuing. Fourth, as of November 30th 1962, 48 Pushpak aircrafts had been produced against a total order of 70 aircraft received by HAL. Fourth, HAL had also developed successfully a four seater light aircraft named 'Krishak', and lastly, a Logistic Air Support was undergoing test trials before production. 75

As far as engine manufacture is concerned work relating to the manufacture of Orpheus 701 Jet engine which powers the Gnat aircraft had been satisfactory. Next, the manufacture of the Dart RDa-7 engine was undertaken at HAL under licence agreement with a UK firm. This engine powered the AVRO 748 aircraft being manufactured at the Aircraft Manufacturing Depot, Kanpur.

HAL was given the task of manufacturing Alouette helicopters. It was also undertaking the manufacture of heavy earth moving equipment in collaboration with M/s Le Tourneau Westinghouse. 76

1963-64

During this period, the main work of the Company was concentrated on the overhaul and conversion of the surplus Douglas C-47 aircraft. Seond, HAL undertook assembly and manufacture of the Prentice trainer aircraft in accordance with the recommendations made by visiting Technical Mission from the United Kingdom in 1946. It is to be noted that the first HAL assembled Prentice flew in April 1948.

76. Ibid, pp.30-31.
Second, HAL entered into licenced collaboration with several foreign firms for assembly/manufacture of the following: Vampire Fighters; Vampire Trainers; Gnats; Orpheus and Dart engines. Third, as far as HAL’s own indigenous development work, it designed and developed - HT-2 a Basic Trainer aircraft; Pushpak and Krishak which are light aircraft and Basic Jet Trainer respectively. HAL was trying to develop a supersonic HF-24 aircraft for IAF.77

Third, HAL was assigned the responsibility of executing certain projects:
First, the Alouette Helicopter project in collaboration with Sud Aviation of France; secondly, Artopuste Engines in collaboration with Turbomecca of France; Heavy Earth Moving and Mining Equipment with M/s Le Togrneau Westinghouse Company of USA; Light Alloys and Forgings in collaboration with HighDuty Alloys Ltd., UK.

On the civilian side HAL produced 113 Integral type Coaches. As regards the financial balance sheet, HAL earned a net profit of Rs. 94,39,794 during the year 1962-63 after providing for depreciation, gratuity and production bonus. As far as the value of production in 1961-62 it was Rs. 11.55 crores. In 1962-63 this amount increased to Rs. 14.68 crores.78

1964-65

The various on-going projects were as follows:- First, the HT-23 Basic Jet Trainer Project, begun by HAL in 1948, was completed in 1953. Second, 

78. Ibid,
the project for assembly, and manufacture of the Prentice aircraft. Third, production of Vampire Jet Fighter aircrafts. Fourth in 1957, HAL decided to manufacture under licence the Gnat fighter. Fifth, HAL from 1957 entered into collaboration with a foreign firm to produce Orpheus Jet Engines. Sixth, in 1959 the Aircraft Manufacturing Depot at Kanpur produced the AVRO-748 aircraft. Seventh, HAL also produced the Dart engines for the AVRO-748 aircraft. Eighth, in 1962, the Alouette helicopters and their engines were added for manufacture under licence. Ninth, HAL also successfully designed light aircraft e.g. HT-2, Pushpak and Krishak. Tenth, HAL has designed the Basic Jet Trainer named KIRAN at Bangalore and it had its inaugural flight in December 1964. Eleventh, HAL was to design development and manufacture of the supersonic jet fighter HF-24. The first two HF-24 aircraft manufactured at Bangalore were handed over to Indian Air Force in May 1964. Twelfth, the Government of India and USSR entered into an agreement whereby HAL could licence manufacture MiG-21s in March 1964 at upcoming factories in Nasik, and Koraput. Work was also going on to establish an Electronics Factory at Hyderabad. Lastly, by the end of 1964 the manufacture of AVRO-748 aircraft had been completed in HAL (Kanpur) Division. Two AVRO-748s had joined Squadron Service with IAF. The AVRO-748 II series aircraft had been handed over to the Indian Airlines Corporation for trials.79

These are the various developments that took place in HAL from 1948-49 to 1964-65 in regard to the various projects, civilian projects, profits/losses,

production values and overall developments as regards India's search for self-reliance in defence production, especially in the case of HAL in regards to aircraft manufacture.

**BHARAT ELECTRONICS (P) LTD (BEL)**

**1956-57**

Bharat Electronics Limited (BEL) contributed significantly towards fulfilling the needs of the Armed Forces in respect of radio, radar, electronic equipment and associated components. BEL was established in 1954 April in collaboration and technical support of Compagine Generale-De-Telegraphie Sans Fil, Paris, France.

The Company began its production in December 1955 and was later engaged in an effort to manufacture (1) general purpose communication receivers (ii) 400 Watts transmitters for 1956-57 and 1957-58, (iii) Crystals and orders were placed for machinery required for its production; (iv) and valves - as radio valves are essential to radio industry.80

The Company employed 900 staff and more than 80 trainees were undergoing training as radio mechanics for employment in the Company.81

**1957-58**

BEL's production was focused on two key areas (i) Wireless and Radar equipment; (ii) Radio manufacturing equipments. It was to produce these equipments that in June 1957 the Government sent a deputation consisting of representatives of the Defence Ministry, Army, Air Headquarters, Defence

Science Organization and Bharat Electronics Ltd., to France and UK to examine and report on the suitability of wireless and radar equipments manufactured by Compaigne Generale De Telegraphic Sans Fils, Paris, France. BEL was also to take up the production of equipments suitable for use by the Army and Air Force. The deputation studied in U.K. various equipments on offer by firms for use by Services and manufacture by BEL.\(^2\)

**1958-59**

In 1956-57 the production level of electronic equipment was to the tune of Rs.6 lakhs, whereas the production value in 1957-58 was about Rs 28 lakhs. As regards the current year i.e. 1958-59, the value of production in the first six months itself touched Rs.23 lakhs. The kinds of electronic equipment being produced were the following: (i) Medium Power IF Communication Transmitters (ii) General Purpose Communication Receivers (iii) HF & UHF Mobile and Portable Transreceivers (iv) Rawin Transmitters for meteorological observation, (v) Studio consoles and Pre-Amplifiers for All-India Radio (vi) Components like crystals, transformers, coils and chokes.\(^3\)

As regards production by the BEL factories, a number of steps were taken to accelerate production and overcome the various difficulties encountered at the initial stages. First, a delegation was sent to UK and the Continent in June 1957 to study and examine certain technical aspects of wireless and radar equipment with special reference to the possibilities of their progressive manufacture at BEL. Second, the question of production at BEL was also considered by the

\(^2\) GOI, MoD, n.36, p.23.

\(^3\) GOI, MoD, n.37, pp.35-36.
Electronic Panel of Defence Production Conference which was called by the Ministry of Defence in May 1958 to devise ways and means of attaining self-sufficiency in the production of Defence equipment.

It was after all these factors that the BEL's Board of Directors approved of a general production programme of the Company upto 1961-62. Efforts were being made to include items of equipment other than those manufactured by M'S Compagnie Generale-De-Telegraphic San Fil, Paris the French collaborators of BEL in the production programme of the Company. An agreement was concluded by BEL with a foreign firm for manufacturing certain type of equipment required by the Defence Services.84

1959-60

The Factory production was increasing steadily as is evident from the following figures.

<table>
<thead>
<tr>
<th>Year</th>
<th>Rs. in Lakhs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1956-57</td>
<td>5.97</td>
</tr>
<tr>
<td>1957-58</td>
<td>27.88</td>
</tr>
<tr>
<td>1958-59</td>
<td>64.80</td>
</tr>
</tbody>
</table>

The production target fixed for 1959-60 was of the order of a total value of Rs.100.70 lakhs worth of electronic equipment. The following were to be the equipments that are going to be produced (i) RU 536 General Purpose communication HF Receivers; (ii) ET 402 B HF Transmitters; (iii) ET 902 A2/B HF Transmitters (iv) Testing Boxes (ET 402) (v) Rawin Transmitters; (vi)

84. Ibid, p.36.
MF 743 VHF Manpack Sets; (vii) MF 833 Mobile VHF Transreceivers; (viii) RB 501 ISB Receivers (ix) Consoles AIR (x) SAFI 456 HF Transreceivers (xi) Pre-Amplifier AIR (xii) Power Supply AIR (xiii) MF 7543 VHF Transreceivers (xiv) Battery Chargers (xv) Mounting Shelf AIR. Apart this equipment required for the Defence Services, BEL also produced civil equipment worth Rs.33.65 lakhs by 30 September 1959.

To increase the production levels further, BEL entered into agreements with various firms: (i) An Agreement was entered into in 13 January 1959 with a British firm for manufacturing certain equipment. (ii) Another agreement was signed between BEL and a Dutch firm on 11th May 1959 for securing technical assistance for production of valves for civil and Defence requirements. The Dutch firm was to supply all the necessary equipment and machinery for establishing production according to the latest techniques adopted to suit the Indian conditions. In the initial stages, 18 standardized types of valves were to be taken up for production and new types were to be gradually added. The capacity of the plant will be 1.8 million valves of the miniature type. Production would be substantially increased by double shift working if the demand warrants such a step. The valves are expected to be produced by BEL by the end of 1960-61. (iii) An agreement was entered into by the Government with a British firm on the 15th August 1959 for manufacturing UHF Multi-channel equipment etc. The equipment was required mainly for the Railways and its manufacture was entrusted with BEL. Negotiations are going on with other firms for licenced manufacture of their equipment in BEL.85

85. Goh, MoD, n 34, pp. 40-41.
1960-61

The profits for the year 1959-60 came to Rs.7.04 lakhs. For 1960-61 a production target of Rs.176.28 lakhs had been fixed and the value of production for the first 7 months during 1960-61 was approximately Rs.84.46 lakhs. Production of valves was expected to begin in 1961.

An agreement was signed on 26th October 1960 between BEL and M/s Nippon Electronic Company of Japan for the manufacture of medium wave broadcast transmitters.86

1961-62

The production pattern87 was as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Value of Production planned Rs.crores</th>
<th>Value of Production Achieved Rs.crores</th>
<th>Percentage of Savings in increase over 1956-57 figures</th>
<th>Foreign Exchange Rs.crores</th>
</tr>
</thead>
<tbody>
<tr>
<td>1956-57</td>
<td>0.39</td>
<td>0.06</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>1957-58</td>
<td>1.36</td>
<td>0.28</td>
<td>366%</td>
<td>0.22</td>
</tr>
<tr>
<td>1958-59</td>
<td>0.71</td>
<td>0.65</td>
<td>983%</td>
<td>0.59</td>
</tr>
<tr>
<td>1959-60</td>
<td>1.08</td>
<td>1.10</td>
<td>1733%</td>
<td>1.04</td>
</tr>
<tr>
<td>1960-61</td>
<td>1.75</td>
<td>1.72</td>
<td>...</td>
<td>0.77</td>
</tr>
</tbody>
</table>

86. GOI, MoD, n.42, pp.63-64.
87. GOI, MoD, n.44, p.48.
The production target for 1961-62 was fixed at Rs.2.29 crores and this target was expected to be reached by the end of March 1962. By 28th February 1962, the value of production which includes work in progress totalled Rs.187.73 lakhs. The foreign exchange savings on equipment completed up to 28th February 1962 was of the order of Rs.108.11 lakhs.\(^{88}\)

Two major agreements of collaboration was signed by BEL. A project for the manufacture of transistors was taken up by the company in collaboration with M/s Phillips of the Netherlands. Actual production was to begin from August-September 1962. Second, a licence agreement was signed with a foreign firm for the manufacture of fire control radars in the factory.

As far as production targets, the target set for 1962-63 was of Rs.2.75 crores. The company made a profit of Rs.7.04 lakhs in 1959-60 and Rs.11.85 lakhs in 1960-61.\(^{89}\)

1962-63

The factory commenced production in January 1956 and its production had been increasing since then as shown by the following figures:\(^{90}\)

\(^{88}\) Ibid, p.49.

\(^{89}\) Ibid, pp.49-50.

\(^{90}\) GOI, MoD, n47, p.27.
<table>
<thead>
<tr>
<th>Year</th>
<th>Value of Production Planned Rs.crores</th>
<th>Value of Production Achieved Rs.crores</th>
<th>Savings in foreign Exchange Rs.crores</th>
</tr>
</thead>
<tbody>
<tr>
<td>1956-57</td>
<td>0.39</td>
<td>0.06</td>
<td>...</td>
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<tr>
<td>1957-58</td>
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<td>1.08</td>
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</tr>
<tr>
<td>1960-61</td>
<td>1.75</td>
<td>1.72</td>
<td>0.77</td>
</tr>
<tr>
<td>1961-62</td>
<td>2.29</td>
<td>2.43</td>
<td>1.77</td>
</tr>
</tbody>
</table>

As of 31st December 1962, the production of valves and capacitors by BEL was of the order of Rs.188.28 lakhs resulting in foreign exchange savings of Rs.93.04 lakhs as completed equipment. The following equipments were under production: (i) HM-100/150 VHF Multichannel Equipment; (ii) MF 843/844 Transreceiver (iii) MF-723 Transreceiver (iv) MF 753A Transreceiver (v) Audio oscillators (vi) VT Volt Meter (vii) General Purpose Amplifier (viii) Radar (ix) Safi-456 D and (x) Tape Recorders and Tape Decks. The rate of production of valves stood at two million per year, and the total number of valves produced up to 31st December 1962 was 1.35 million. Production of crystals was stepped up to meet the urgent requirements of the Defence Services. Production of transistors commenced in September 1962. Because of the increased needs of the services following the Emergency a revised programme was drawn up representing an increase in the value of production to Rs.7 crores during 1963-64 and Rs.11 crores during 1964-65.
The Company made a net profit of Rs.7.04 lakhs in 1959-60; Rs.11.85 lakhs in 1960-61 and Rs.20.33 lakhs in 1961-62.\(^91\)

1963-64

BEL entered into agreements with - M/s Pye Telecommunications Ltd., England; M/s Phillips of Holland; M/s Marconi of England; M/s Siemens of Germany and M/s Nippon Electricals Co. of Japan. Also an agreement was signed with M/s Contraves of Switzerland for the manufacture of some types of radar equipment. By 31st March 1963, as many as 54 items of equipment were brought under production and progressive manufacture of 14 more items was taken up.\(^92\)

The year 1962-63 saw production to the tune of Rs.302.74 lakhs as against Rs.243 lakhs in the preceding year. As regards 1963-64 the initially planned production value was to the tune of Rs.4.2 crores. However, following the assessment of larger needs and requirements of the Services, the target for 1963-64 was revised to Rs.7 crores. As of 31st October 1963 (including work in progress) was Rs.2.9 crores. The Company made a profit (net) of Rs.46.86 lakhs in 1962-63 as against Rs.20.33 lakhs in 1961-62 and Rs.11.85 lakhs in 1960-61.\(^93\)

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91. GOI, MoD, n.75, p.27.
92. Ibid, pp.27.28
93. Ibid, p.63.
As of the present BEL manufactures over 70 different types of equipment ranging from the tiny transmitter for upper air observation to high power transmitters and sophisticated radars and also components such as valves, transistors, capacitors and crystals. Bharat Electronics Limited designed and developed various items of electronic equipments; instruments, accessories and appliances which had gone into production. BEL began to produce components essential for the rapid development of the Electronics industry.

It set up facilities for the following: (i) Receiving Valves (ii) Germanium Semi-conductors (iii) Silver Mica and Ceramic Capacitors (iv) Piezo-Electric-Crystals. In addition BEL established facilities for repair and production of transmitting tubes. The production capacity of the components division was nearly Rs.1.8 crores per annum. Proposals were approved for producing - silicon semi-conductors, as an extension of the existing plant for the manufacture of Germanium Semi-conductors and for manufacturing of transmitting tubes relating to civil and defence needs, both under licence. Proposals were also under consideration for producing of magnetrons and X-ray tubes. Annual production value of BEL was expected to reach Rs.4 crores in the next 3 or 4 years.

By 1963-64 the value of production was Rs.6.21 crores. The value expected in 1964-65 was about Rs.7.5 crores including defence equipment of the value of Rs.5.1 crores in which the value of assembly from imported kits was expected to be less than Rs.1 crore. The plan for 1965-66 envisaged value of production of Rs.10.5 crores including defence equipment of the value of Rs.7.5
crores. Profits touched Rs.22.33 lakhs in 1962-63, Rs.46.86 lakhs and in 1963-64 Rs.53.61 lakhs. 94

These are the developments that took place in Bharat Electronics Limited (BEL) from its beginning to 1964-65. It clearly shows that the first steps towards a defence production self-reliance in the field of supply of electronic equipment to the armed forces.

*Defence Research and Development Organization (DRDO)*

Prior to the establishment of Defence Research and Development Organization (DRDO) on 1st January 1958, research and development was going on in the field of armament production from 1948-49 but under other institutions.

The Second World War demonstrated the value of scientific research and made the newly independent government realize that it was vital to create an R & D Organisation for the country. It was with this specific intention that the Defence Science Organization was created in July 1948. Added to it were the Defence Science Policy Board and Defence Science Advisory Committee.

The Defence Science Organization focussed on fundamental aspects of science and their application to various branches. No major development is possible without guidance from professional scientists dealing with fundamental problems. Of course this is not done independently, but by a close liaison on the one hand between the Defence Science workers and technical development workers and on the other between Defence Science workers and Scientific

workers in civil institutions such as universities, National Laboratories etc. The Defence Science Policy board is an institution concerned with the wider aspects of Defence Science and Policy, and interpretation of military and scientific thought and in planning defence, research and development as a whole, taking into account the industrial resources of the country. The Defence Science Advisory Committee considered the technical and scientific aspects of the service requirements, keep close contact with research and development in the service (technical) establishments, initiate basic research in relation to defence Science in Scientific Laboratories, in the Universities and Research institutions in collaboration with them to keep in touch with the scientific and industrial development in the country generally. Panels or sub-Committees for specialised subjects such as ballistics, electronics, explosives, chemical warfare were to be established under the auspicious of the Defence Science Advisory Committee. Apart from these three institutions there were also Technical Development Establishments of the three Services i.e. Army, Navy and Air Force attached to them. They were responsible for the day to day development work in stores and equipment and with research work connected with it.95

In April 1949 the first Defence Science Conference was held with representatives from Universities technical development organizations, research institutions, ordnance factories and all other branches of the Armed Forces connected with R & D. Also the first Defence Science Laboratory (part of Defence Science Organization) was housed in the National Physical Laboratory building in Delhi in 1949 with a Block Grant of Rs.15 lakhs spread over three

95. GOI, MoD, n.9, p.9.
years. A Scientific Advisor to the Ministry of Defence was appointed in July 1948 whose task was to guide the Defence Science Policy Board. He was in UK for a seven week tour in October 1949 to visit the Military Establishments and study the working of the Defence Research Organisations.\(^96\)

The number of scientists joining the Defence Science Organization increased from 30 in 1950-51 to 52 in 1954-55. Apart from this the idea of creating a Defence Science Service came up in 1951 and by 1953-54 the constitution for it was drawn up and the rules of recruiting civilian scientists to it was also formulated. The creation of such a Service was hoped to lead to a much closer integration of the scientific work in different establishments and an effective utilization of the available scientific effort. Two Defence Science Conferences were held in Delhi, one in April 1949 and the second in April 1952. An Institute of Armament Studies was established at Kirkee for studying performance of weapons and ballistics. Other Defence Science Organizations Labs. were established in Bombay and Cochin for Naval research.

The Technical Development Organization with its many establishments in the three Services already had by 1957-58 (when DRDO was created) 500 research projects on armaments, vehicles, general stores, instruments and electronics running and had the already indigenized over a hundred formerly imported items with indigenous substitutes.\(^97\)

The creation of Defence Research and Development Organization (DRDO) on 1st January 1958 brought in certain changes in the R & D

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96. GOI, MoD, n.13, p.12.
organizational structure. The Scientific Advisor to the Ministry of Defence will be assisted by a Chief Scientist and a Chief Controller. The Inspection functions of the various Technical Development Establishments were, however, retained by the Controller General of Defence Production. 98

Organizationally, the Chief Controller was responsible for coordinating research and development programmes with the services and for the efficient functioning of Technical development Establishments; and the Chief Scientist was responsible for coordinating research in experimental establishments, liaison with universities, National Laboratories and research institutions and also for contacts with commonwealth countries in matters of defence research. DRDO took into its structure, the Defence Science Organization, and the Directorate of Technical Development Production (Air) which was concerned with R & D of air crafts in the country. 99

DRDO, apart from undertaking all R & D and design relating to the three Services including armaments, ammunition, electronics, aircraft, vehicles and engineer stores, and coordinating all R & D as expanded its areas of R & D into weapons evaluation, guided weapons study and radar equipment development. DRDO's research laboratories spread all over the country are the following: the Defence Science Laboratory, Delhi; the Naval Chemical and Metallurgical Laboratory Bombay and the Naval Physical Laboratory, Cochin. 100

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98. GOI, MoD, n.36, p.19.
100. Ibid, p.31.
Apart from these changes that came into defence research with the formation of DRDO there were other changes such as constituting a Defence Minister's (Research and Development) Committee replacing the previous Defence Production Board. This Committee was to consider all policy matters and was presided over by the Defence Minister, the Scientific Adviser, all three Chiefs of Staffs of the Services, senior Secretariat Officers and Financial Adviser attended its meetings. A Research and Development Advisory Committee, with distinguished civilian scientists, senior service officers and defence scientists as members, replaced the old Defence Research Policy Board. Then there was the Psychological Research Wing of DRDO, and the Institute of Armament Studies, Kirkee, specializing in performance of weapons and armaments and imparting advanced technical training in defence technology to technical officers of the three Services. The Defence Science Service continued as part of DRDO. By 1958-59 nearly 15 patents were taken out or renewed by DRDO.101

In 1960-61 a review was carried out of R & D activities of the past three years by DRDO. In the field of explosives research, DRDO developed several new indigenous stores replacing formerly imported ones.102 In the field of aircraft development, good progress was made in the production of AVRO-748 and other aircraft projects like Light Communication Aircraft, design and development of jet engine and various other aeronautical, armament, electrical and aviation electronics projects.103

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103. Ibid, p.60.
In the year 1961-62 a number of new establishments/laboratories were added to DRDO in new fields of defence research, such as the Defence Food Research Laboratory, an Institute of Nuclear Medicine and Allied Sciences; a Defence Research and Development Laboratory for R & D in the field of special weapons; a Terminal Ballistics Research laboratory for study of blast and fragmentation phenomena; a solid state physics laboratory for research in the field of transistors and semi-conductors; an Engineering Research and Development Establishment; an Institute of Work Study, and a Defence Electronics Research Laboratory for technique oriented research in electronics as against equipment oriented research for which a Development Establishment already exists.\textsuperscript{104}

In the field of explosives during 1961-62 indigenous development of propellants for various types of ammunition used in small arms, guns, mortars and rockets had been undertaken resulting in considerable savings in foreign exchange. Apart from this, in the field of aircraft development the first prototype of supersonic HT-24 was flown successfully. The prototype of Light aircraft Kanpur I, and its improved version Kanpur II were also test flown. 'Aimed' or 'applied' research was another area in which work was carried on multifarious subjects e.g. fundamental research work on shaped charges for better armour penetration; on deterioration of shock wave and fragmentation phenomena. Similarly in the field of operational research, some problems were taken up such as: problems of mountain/snow warfare; theory of war gaming

\textsuperscript{104}. GOI, MoD, n.44, p.41.
and its application; cost of missiles versus fighter aircraft and of anti-tank guided missiles versus other anti-tank weapons; calculation of kill probabilities of the different targets by aircraft bombardment and comparative destruction of different anti-aircraft weapons.\textsuperscript{105}

In the field of armaments, studies were conducted to improve efficiency in the use of ignition accelerators, development of infra-red guidance system, stability of projectiles (liquid filled base heavy) relationship between maximum rangemuzzle velocity and standard ballistic coefficient and bomb sights for aircraft. Progress in the applied research field included development of indigenous propellants for use in small arms and various types of ammunition. In the field of related instruments work included the universal sight for field branch artillery, infra-red instruments for operation at night. As regards aircraft development, the aeronautical branch besides carrying out design and development work assisted HAL and other agencies with technical advice and carried out technical trials for the evaluation of equipment developed by DRDO with particular reference to HF-24 Jet engines.\textsuperscript{106}

As of 1963-64 the on-going weapon projects were the following: the mountain gun project, semi-automatic rifle; a self-loading pistol lighter and easier to handle than the existing pistol; anti-tank grenade; a new type of anti-tank mine; and equipment for clearing mine fields. Among the fire control instruments two indigenous designs may be mentioned: a universal sight for guns and an universal mortar sight; each of these replaces a number of sights in

\textsuperscript{105. Ibid, pp.42-44.}
\textsuperscript{106. GOI, MoD, n.75, pp.28-29.}

62
current use. DRDO also developed know-how in Ordnance Factories to manufacture several types of conventional ammunition which were previously imported for e.g. a high velocity tank gun, rocket launcher and rockets and a recoilless anti-tank gun. Some experimental work on rocketry was successfully initiated; a number of two staged rockets were fired at Hyderabad; work on development of rocket propellants carried out at Explosives Laboratory. The realization had dawned on DRDO that in view of the urgent need to expand its activities a separate Armament Research & Development Center should be formed. The limited facilities in rocketry, propellants and weapons development were expanded at this center.\textsuperscript{107}

In the field of communications despite the limited resources of DRDO, several things have been developed for e.g. a light weight forward area VHF communication set, a ground-to-air communication set; single-channel, twin channel and multi-channel VHF air-borne trans-receivers. The line Communication equipment developed for production includes a field carner system capable of a number of telephone conversations simultaneously, a switch board of 40 lines required for field units and generating sets of various types including a precision generator for anti-aircraft gun and radar. A metallic mine detector of very much reduced weight and improved performance was designed for production. Among other items which were in the advanced stage of finalisation specialist signal vehicles and a smaller field switchboards.

In radar technology, a beginning was made in two major projects, one concerned with the development of a local warning radar for the Army and the second covering the development of a field artillery radar.

\textsuperscript{107} GOI, MoD, n.77, pp.74-75.
As regards the area of field engineering equipment which provides the essential mobility to the Army DRDO has developed some items. A high altitude pre-fabricated portable hut, collapsable assault boats, pontoons, motor boat bridging and a marine prodder were produced.\textsuperscript{108}

In 1964-65, in the field of armaments, the development of a mountain gun and an anti-tank mine were two of the important achievements, during the year. Full scale `proving trials' for these indigenously developed mountain guns were conducted along with standardization trials for the shells used by these guns have been conducted. Apart from this, projects for the development of gun and mortar sights and the telescope for the sniper were completed. An infra-red sniper scope for the Infantry and an infra-red telescope for the Navy were under development. Other important projects where substantial progress was made are the following: an anti-tank missile; a charge line mine clearing mine fields; new techniques relating to preparation of rocket propellants. In the field of electronics a beginning was made in a third establishment on the development of missiles. The following projects were completed successfully during the year - light weight VHF set for ground to air; carrier apparatus; switch board field; light weight portable secondary battery; a forward area HF set; a single vehicle shelter. In the field of radar, the system engineering of a local warning radar was successfully completed and also a field Artillery radar for the Army. In the field of aeronautics, the first phase of the design and development of a reheat

\textsuperscript{108} Ibid, pp.75-76.
system for aero-engines installed on HF-24 aircraft was successfully completed. Two reheated engines were undergoing trials on a prototype aircraft.\textsuperscript{109}

Apart from DRDO's role in defence production one has to look into what has been the precise contribution of other defence industries - Mazagon Docks Limited (MDL), Garden Reach Workshops Limited, Calcutta (GRTSEL), and Praga Tools.

The Mazagon Docks Limited (MDL) was acquired by the government in April 1960. The Company was engaged mainly in ship repair and shipbuilding along with manufacture of Diesel Oil Engines and engineering work. Its direct contribution to armament production, though very low had a very large indirect role in sustaining the warships and naval armament produced by way of repairs, and also shipbuilding. In 1960-61 the Navy asked the MDL to construct a 500-ton Water Boat and Inshore Minesweepers and a Destroyer costing approximately Rs. 6.4 crores.\textsuperscript{110} As of 1964-65 two Mine sweepers, two 150 men ferries, and a non-propelled Bucket Dredger for the Indian Navy were produced. The Defence Minister visited UK in November 1964 and the British government agreed to make available to the Government of India a special Defence Credit off 4.7 million to meet the external costs of the construction of the Leander Class Frigates. An agreement with Vickers Armstrongs and Marrino for the construction of Frigates was concluded on 22nd December 1964 and entrusted to Mazagon Docks. According to the bulding programme, the first

\textsuperscript{109} GOI, MoD, n.94, pp.66-67.
\textsuperscript{110} GOI, MoD, n.42, p.65.
Frigate was expected to be completed by the end of 1971.\footnote{111}

The Garden Reach Workshops Limited (GRSEL), Calcutta was incorporated under the Indian Companies Act in 1934 with the British India Steam Navigation Company and River Steam Navigation Company of the United Kingdom for undertaking marine repairs and services to their ironships and vessels. It was acquired by the government of India by agreement on 19 April 1960. The main activity of GRSEL is ship repairing, ship construction and general engineering manufacturing lines. For its production it collaborated with well-known ship builders of UK, Germany, Holland, and Japan and specialized in the design and construction of shallow draft vessels including Tugs, Light Naval Craft, River steamers, Fiats, Water Boats, Batges, Pontoons etc.\footnote{112}

As far as its contribution in 1960-61 is concerned the company was constructing a Seaward Patrol Craft for the Navy. In 1962-63 though no direct arms production took place by GRSEL in the process of producing a destroyer, certain foundations for creating an armament production capability was obtained. A proposal for construction of the Kasara Basin into an impounded wet dock is under consideration of Ministry of Defence. If this is done the Company would be in a position to undertake more ship repair and ship building work including construction of Destroyers.\footnote{113}

The last defence industry under analysis for possible contribution to defence production capability is Praga Tools Limited whose administration was

\footnote{111. GOI, MoD, n.94, pp.60-61.}
\footnote{112. Ibid,}
\footnote{113. GOI, MoD, n.75, p.30.}

66
transferred to the Ministry of Defence (Department of Defence Production) in December 1963 to enable utilization of the capacity available for Defence Production. The company specializes mainly in production of small tools and precision instruments e.g. lathes, drilling machines, grinders, forgings for crankshafts of diesel engines of various types. Its products were various tools and machines and precision instruments required to produce the big arms for navy, air force and army.\footnote{Ibid.}