E. C. No. 665

ESTIMATES COMMITTEE

(1969-70)

(FOURTH LOK SABHA)

HUNDRED AND TWENTY-NINTH REPORT

DEPARTMENT OF ATOMIC ENERGY

Atomic Power

LOK SABHA SECRETARIAT
NEW DELHI

July, 1970/Asadha, 1892 (Saka)
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CORRIGENDA

to

129th Report of Estimates Committee on the Department of Atomic Energy - Atomic Power.

Page	Para	Line	Correction
(v)	S.No.	16	delete 'Shri'.
1	1.2	Table-ant	for 'US. £' read 'U.S.$'
6	1.10	6	insert '*' against 'Bengal'
17	1.30	1	for 'Fourth' read 'Fifth'
24	1.42	3	for 'majure' read 'majeure'
27	2.4	22	for 'intend' read 'intent'
58	Heading		for 'Indegenisation' read 'Indigenisation'
62	3.25	13	for 'experiemental' read 'experimental'
89	5.4	11	(i) for 'these' read 'then'; (ii) for 'use' read 'uses'
119	6.28	2	delete 'from'
119	6.29	10	delete ' " ' after 'Vienna'
121	6.35	2	delete '*'
121	6.35	3	insert '*' against 'observations'
124	6.39	13	insert '**' against 'firm'
127	6.44	12	for 'Exports' read 'Experts'
129	6.46	5(from bottom)	for '0;5' read '0.5'
135	-	2	for 'Para 1.59' read 'Para 2.59'
145	-	-	(i) delete recommendation at Sl.No.4; (ii) Renumber existing Sl.Nos.5 to 76, as 4 to 75 respectively.

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SECRETARIAT

Shri Avtar Singh Rikhy—*Joint Secretary.*

Shri B. B. Tewari—*Deputy Secretary.*

Shri Y. Sahai—*Under Secretary.*

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*Elected w.e.f. 22-12-69 *vice* Shri G. G. Swell resigned.

INTRODUCTION

I, the Chairman, Estimates Committee, having been authorised by the Estimates Committee (1969-70) to submit the Report on their behalf, present this Hundred and Twenty-Ninth Report on the Department of Atomic Energy—Atomic Power.

2. The Estimates Committee (1969-70) took evidence of the representatives of the Department of Atomic Energy, Ministry of Irrigation and Power and the Planning Commission on the 28th and 29th October, 1969. The Committee wish to express their thanks to the Secretary and other officers of the Department of Atomic Energy and officers of the Ministry of Irrigation and Power (Central Water and Power Commission) and the Planning Commission for placing before them the material and information they wanted in connection with the examination of the estimates.

3. The Committee also wish to express their thanks to all the scientific institutions and the eminent scientists who furnished memoranda on the subject to the Committee.

4. The Report was considered and adopted by the Estimates Committee (1969-70) on the 29th April, 1970.

5. A statement showing the analysis of the recommendations contained in the Report is also appended to the Report (Appendix IX).

NEW DELHI;
July 9, 1970
Asadha 18, 1892 (*S*)

M. THIRUMALA RAO,
Chairman,
Estimates Committee.

CHAPTER I

INTRODUCTORY

A. Importance of Nuclear Power

1.1. In the modern world, the *per capita* consumption of energy is considered to be one of the main criteria for judging the degree of development of a country. In this regard, when the comparison of *per capita* consumption of energy between India and U.S.A. is made, the point becomes clear. The *per capita* energy consumption in U.S. is equivalent to about 10 metric tons equivalent of coal per year and the *per capita* 1966 national income at 4,500 (U.S.$) as compared to 0.2 metric tons of coal and 78$ for India. There is evidence of close co-relation between *per capita* national income and energy consumption.

1.2. India is very much below the *per capita* power consumption of even moderately advanced countries as would be seen from the table below which has been taken from 1967 Statistical Year Book—United Nations. Figures are for 1966.

Country	Per capita national income (U.S.£)	Per capita power consumption (kwh)
U. S. A.	3,842	6,345
Sweden	2,732	6,484
Canada	2,660	7,907
Australia	1,172	3,329
France	2,052	2,202
Germany	2,004	3,040
United Kingdom	1,925	2,703
Israel	1,504	1,740
Italy	1,182	1,730
Japan	986	2,171
Mexico	493	432
Taiwan	245	593
India	92	75

1.3. There are conventional sources of power like hydel or thermal based on fossil fuels, coal, oil and gas. Nuclear power is a newcomer in the field. It was on the 2nd December, 1942 that the first atom was split. This was indeed the birthday of the Atomic Age. The acceptance of atomic energy as a source of power is now an established fact. Ever since the slogan "Atom for Peace" became man's enlightened motto in 1955, nuclear energy has made its mark in almost every field of human activity—industry, agriculture, medicine. Today, nuclear energy is lighting cities, heating homes, driving ships, treating diseases, improving farm crops, aiding industrial processes, proving a dependable servant in some phase of life on every continent. Hence, it has had a profound effect on economic factor in international affairs; it has become the largest single industry in the United States and is playing an ever-increasing role in the economy of many industrially advanced countries; it has created new fields of research and advancement, thus raising new factors of world import and changing the relevance of others, namely, security, welfare and ethics. However, its greatest impact has been in the field of power generation—producing electricity with the help of nuclear reactors. In the modern civilization, which is also called the age of power as it is dependent on a plentiful supply of power, the atomic fission holds great potentiality for generating electric power at competitive rates.

1.4. Energy, or its most versatile form—electricity, is aptly called the modern Aladdin's lamp for economic progress. The break-through which has occurred in the cost of generating electric power by using atomic energy on a large scale is reflected in the current forecast that more than 50 per cent of the new generating capacity, which will be added in the world during the 70s, will be based on atomic energy. Moreover, large agro-industrial complexes if established around low cost energy centres can permit developing areas to utilise these advantages even though the capacity of their grids is small. It is said that atomic power stations would play a very valuable role in the future not only in areas where other sources of energy are expensive but as base load stations working alongside large hydro-electric installations. The significance of all this on India's economy which is so heavily dependent on agriculture is tremendous.

Development of Atomic Power in various countries

1.5. By the end of 1969, there were supposed to be 475 reactors operating in the world. Of these, 105 were power reactors generating nearly 20,000 M.W. of electricity in 15 countries. The other 374 are for research, testing and training purposes in 48 countries. By 1975, the number of power reactors will rise to 283 in 21 countries generating nearly 1,30,000 M.W. of electricity. The growth of nuclear power, which dates from the mid-1950s and only took off in the second half of the 1960s, is still confined mainly to Britain and the United States, with Britain owning more

nuclear generating plants than any other country. But by the end of 1969, U.S.A. has passed the British total, with 24 power stations operating and producing a total of 7,141 MW to Britain's 5,353 M.W. The Soviet Union, for all that it was the first country to start regularly generating nuclear power in 1954 from a small station just outside Moscow, ranks third now, only a nose ahead of France. During this year France will have more installed nuclear capacity than the Russians. When it comes to the mid-1970s, the US will have more than six times the installed nuclear capacity of any other country. While Japan, Canada, Sweden and India which at present occupy 9th, 11th, 12th and 8th position will be ranked as 3rd, 4th, 5th and 13th respectively. A statement showing the number of reactors and the total installed capacity as in 1969 and as is proposed to be in 1975 in respect of certain countries is given in the chart below:

Atomic Power Reactors in USA, UK, Canada, USSR, Japan and France.

Country's name	No. of power reactors in operation in 1969	Total installed nuclear capacity in 1969 (MWe)	No. of power reactors in operation in 1975	Total Installed nuclear capacity in 1975 (MWe)
USA . . .	24	7,140	103	71,200
UK . . .	29	5,350	42	13,000
Canada .	2	225	13	6,500
USSR . .	16	1,700	25	4,000
Japan . .	3	477	17	7,150
France . . .	8	1,650	12	3,700
India . . .	2	380	5	980

B. Power Resources and Future Requirements of Power in the Country

Power Resources

1.6. It is said that our civilisation is energy-based. The wheels of industry and life will come to a grinding halt if we run out of our energy sources, which today consists mainly of fossil fuels—coal, oil and gas. It is called fossil fuels because they are the remains of past organisms preserved through millions of years of geological upheavals.

India's main sources of conventional energy are coal, falling water and oil. Of these coal is the most important source. As regards India's coal reserves, Dr. K. L. Rao, Minister for Irrigation and Power, in an article

contributed to the special issue of the 'Science Today' September, 1969, has assessed our coal reserves and its utilization as follows :—

> "As for utilisation of our coal resources, the present annual production is 70 million tonnes, of which the thermal stations consume about 16 million tonnes. The total requirement of coal for power production by 1973-74 is estimated at about 27 million tonnes, which will be mainly low-grade coal with high ash content. Against this, the proved inferred coal reserves are assessed at 106,000 million tonnes, concentrated mainly in Eastern and Central India."

The representative, of the Ministry of Irrigation and Power during the course of evidence before the Committee stated:—

> "Our country has got tremendous amount of coal by any standard; some are not classified; it is really inferior grade coal; and the only way to utilise that coal effectively is the conversion of this energy into electrical energy."

1.7. In addition to coal, about 2073 million tonnes of lignite are estimated to be available. It may, however, be pointed out that the coal reserves of India are unfortunately restricted to a few coal bearing regions in Bihar—Bengal area. The remoteness of coal fields from many of the centres of consumption places a heavy burden on the transport system, and complicates the problem of consumption of coal as a cheap source of energy in distant parts. For instance, if on an average, the price of coal is Rs. 18 per ton at the mine, it soars to about Rs. 80 per ton in Gujarat or Bombay. Moreover, coal will probably be in great demand for industrial utilisation and in any case its transportation over long distances would be a serious bottleneck as well as uneconomic.

1.8. The economically utiliseable hydro-power potential of the country aggregates to 41·55 million KW, corresponding to about 21,6000 million units of annual output of power.

During the course of evidence, the representative of the Ministry of Irrigation and Power stated that according to the survey the hydro-power resources of the country were 41 million KW., but the survey was not complete and it was going on and it would not be surprising if in future additional sources in the field of hydro-electric energy were to be found.

The Planning Commission in a written reply to a question on this subject has stated as follows—

> "The total hydro-electric potential of the country has been assessed at 41 M. KW. as technically and economically feasible, of this about 15 per cent has been tapped by 1968-69, it is estimated that by the end of Fourth Plan (1973-74) the utilisation will

increase to about 22 per cent of the total hydro-electric potential."

Out of the All-India hydro-potential of about 41 million KW at an annual load factor of 60 per cent, a large part of the hydro-potential (13·5 million KW) is situated in the north eastern part of India (Brahamputra Basin) which is unlikely to consume more than a small fraction of this potential for a long time to come. A good proportion of the balance again is situated right on or close to the coal belt which also is unlikely to be exploited for power generation unless it forms part of some multi-purpose scheme for both irrigation and power. Even if the comparatively less economic hydro-potential were exploited, it would seem most unlikely that more than 18 million kilowatts in terms of installed capacity, would be reached during the next ten years.

1.9. As regards oil, the country's crude resources are insufficient even to meet the numerous higher priority requirements of the transportation and chemical industries and although the vigorous attempts being made to locate oil deposits in the country had met with some success, there is hardly any prospect of indigenous oil production making any appreciable contribution to the long term energy requirements.

In fact, the gap between the requirement and possible availability of oil will be so large that the country will have to depend largely on the new resources of electricity generation.

India's resources of nuclear fuel

1.10. For a self-sufficient atomic energy programme, an adequate supply of nuclear fuel is a pre-requisite. India's reserves of nuclear resources are found in two forms uranium and thorium. As a result of the survey conducted in the country by the Atomic Minerals Division of the Department of Atomic Energy for the search of uranium and thorium deposits and other material of potential interest for atomic energy work, a number of deposits of uranium have been located in Bihar, Rajasthan and Madras.

A mine and a mill has been set up at Jaduguda to treat about 1,000 tons of ore a day which will yield about 180 tons of uranium concentrates per year. Even without further discoveries of uranium, the present supply could enable India to provide from indigenous resources for the first group of stations that might be built, upto a total of 1-1/2 to 2 million KW.

In the longer view, as it now appears, Indian development of nuclear energy must probably depend on the use of thorium. In respect of this

India is very well endowed. These are some 5,00,000 tons of thorium mainly in two deposits. About 2,00,000 tons are contained in a very rich (9 per cent) concentration in the monazite beach sands of Kerala. During the past ten years a second source has been discovered by the Atomic Minerals Division in an even larger deposit in the Ranchi Plateau, partly in Bihar and partly in Bengal. This contains some 3,00,000 tons of thorium in monazite of a concentration of 10 per cent. The 5,00,000 tons of thorium has been described as equivalent to all the world's known uranium in ore containing 0.1 per cent and above.

But while there is no question that ultimately this thorium can be used for the production of nuclear energy, its use requires the solution of a number of problems. Thorium cannot be used directly but must first be used, with other fissionable material, in a reactor to generate U-233. It is believed that the conversion of thorium would best be done in a breeder type reactor but that it is also possible in a thermal-type reactor. When these processes have been developed, especially when suitable breeder-type reactors are commercially available, India will be richly endowed with nuclear fuels.

1.11. The Committee note that the nuclear power is assuming a role of increasing importance in the field of power generation all over the world. They understand that India's resources of coal and hydro-power are adequate for meeting the power requirements of the country in the foreseeable future. However, having regard to the present rate of growth in her population and the steady increase in the per capita **consumption of energy, the position might become difficult after some time. In view of the fact that the coal deposits in India are restricted to a few coalbearing regions in the Bengal, Bihar, and Madhya Pradesh area far away from centres of consumption and the special characteristics of hydro-power which is derived from the seasonal character of rainfall during Indian monsoon, it seems prudent to diversify resources of electricity and take advantage of nuclear power. In the matter of nuclear power, India is said to be fairly well endowed in view of the abundant supply of thorium and availability of uranium also. The Committee are of the view that the question of development of nuclear resources is mainly an economic one and that it would have to fit in with the overall plan for power development taking into account the available resources in the various regions of the country with the object of deriving optimum benefits through integrated operation of hydro, thermal and nuclear stations.**

Future Requirements of Power in the Country.

1.12. When asked whether any survey was conducted regarding the power availability and power requirement on a national basis convering the next 10 years, the Ministry of Irrigation and Power in a written reply

*At the time of factual verification the Department of Atomic Energy have stated that deposits have also been found in Orissa.

stated that the Central Water and Power Commission in connection with the formulation of proposals for power development in the Third Plan had already made a detailed power load survey of the country and assessed the demands covering the 25 year period from 1955-56 to 1980-81. Since 1963, load development in the country was being assessed practically on an annual basis by a Committee set up by the Government, known as the All-India Power Survey Committee. This Committee which comprises the representatives of the Planning Commission, Ministry of Irrigation and Power, Central Water and Power Commission and other Ministries of the Government of India, such as Industrial Development, Finance, Mines and Metals, Department of Atomic Energy, reviews the position from year to year in consultation with the representatives of the State Governments so that the constantly changing pattern of load development could be taken care of. The Fifth Annual Power Survey had already finalised the load demands for the years 1968-69 to 1973-74. The Sixth Annual Power Survey was further reviewing the demands. The Energy Survey of India Committee set up by the Ministry of Irrigation and Power in 1963 and given the following details of the assessed energy needs of the country commensurate with 5 per cent, 6 per cent and 7 per cent growth in the National Income assuming 1960-61 as the base year for the period ending March :—

	For growth in National Income (Million KW)		
	5%	6%	7%
1971 .	18·4	19·2	21·4
1976 .	24·8	28·7	33·9
1981 .	38·0	46·0	55·7

According to the Fifth Annual Power Survey carried out during 1968, the total demand for power in the country was anticipated to be 19·75 million KW by end of 1973-74. The Working Group on Power for the Fourth Plan set up by the Ministry of Irrigation and Power recommended an aggregate installed capacity of 26 million KW by the end of the Fourth Plan with a view to meet the anticipated demand of 18·5 million KW. However, the Planning Commission in their Draft Fourth Five Year Plan had envisaged a targetted installed capacity of 22 million KW by 1973-74.

1.13. The Planning Commission were of the view that the Energy Survey Committee of India had assessed the energy needs of the country on the basis of 5 per cent, 6 per cent and 7 per cent growth in the National Income over the period whereas the growth in National Income had not exceeded 3·8 per cent over the period to-date. It had also been stated

that in the draft outline on the erstwhile, Fourth Plan (1966—71) a target of 20 million KW of installed capacity was adopted but only 17 million KW are likely to be achieved by the end of 1970-71. For the Fourth Plan 1969—74 the growth in the National Income has been adopted at 5·5 per cent. According to the Planning Commission with an installed capacity of about 17 million KW by the end of 1971, 22 million KW by the end of March 1974 is likely to meet the power needs of the country. In a written reply to a question, the Planning Commission has, however, informed the Committee:

> "The Planning Commission however, anticipates certain pockets of shortages and action will have to be taken to identify these pockets and take prompt action to meet the power needs of these pockets."

The representative of the Planning Commission during the course of evidence tendered before the Committee, in addition to the slow industrial growth also laid emphasis on the fact that power supply was a concurrent subject and the States were not coming forward with sufficient funds to meet the needs of the schemes which are to be completed during the Fourth Plan. He further stated that because of paucity of resources the Planning Commission has accorded highest priority for the construction of inter-State lines so that surpluses in certain areas during certain period can meet the needs of the deficit areas during that period. The other factor mentioned by him was about the non-utilisation of the installed capacity. He informed the Committee that today against the installed capacity of 14·5 million KW the peak load was 8 million KW *i.e.* about 55 per cent.

1.14. During the course of evidence, the representative of the Ministry of Irrigation and Power, however, maintained that during the period 1963 to 1969 the plant utilisation had an average of 65 per cent which according to him was not low when compared with—for France it was 62 per cent, for Italy 55 per cent, for Belgium it was 67 per cent and for Austria it was 67 per cent. In this connection, he also pointed out about the statutory regulation regarding the shutting down of the boiler at some time or the other; as for example, if there were 8 boilers, 2 out of them were required to be shut down at some point of time. Then the hydro-electric reservoirs get replenished largely on a seasonal basis and in this connection, the Ministry's representative pointed out that Bhakra Nangal has got potential of generation during certain periods of the year upto one million KW and at certain other periods the average would be 370—380 MW. The Ministry of Irrigation and Power had submitted a detailed note to the Committee on the need for raising the target of installed generating capacity in the country from 22 million KW to 26 million KW at the end of the Fourth Five Year Plan. In the note it had been mentioned that

in mixed systems, a higher utilisation would be achievable through effective hydro-thermal coordination which was proposed to be increasingly resorted to during the Fourth Plan period.

1.15. On the future power requirements of the country, the Chairman, Atomic Energy Commission, during the course of evidence stated that "there has been a very serious difference of opinion as to the size of the total power planned in the Fourth Plan. I think that your Committee could come to our help. I am suggesting this in all seriousness because the Fourth Plan is already on and these decisions should have been taken at least a year and a half or two years ago." He observed that since nuclear power stations take approximately five years to complete we should have firm programme now for meeting needs during the Fifth Plan. Emphasising the need for fixing the target for the Fourth Plan' at a higher level, he stated as follows :—

> "Suppose there is a difference in estimates as to what the load is likely to be in future due to certain set circumstances. We have to consider the penalty that we would have paid for the optimistic forecast. It is well known that power is one of the things which has relation to GNP because it is the basic element that goes into all types of things. A pessimistic forecast is at least ten to twenty times more harmful than what your optimistic forecast is."

1.16. With a view to lay emphasis on the optimistic forecasts about future power requirements, the Chairman, Atomic Energy Commission drew attention of the Committee to its Thirtieth Report on the Ministry of Irrigation and Power (Power) in the year 1962-63 (Third Lok Sabha) wherein it had been stated :—

> "Since the cost of installing 1 KW of electric power is but a fraction of the capital investment required to utilise it, it is obvious that if in any eventuality power generating capacity was underutilised it would entail less overall loss to national economy than would be the case if productive machinery was to be rendered idle on account of power deficit. Past experience, in India and other countries, clearly shows that in a developing economy the demand for power nearly always outruns the available supply. Planning for surplus power is, therefore, essential for achieving an optimum rate of growth in the country. The Committee strongly recommend that power being a primary source of energy should be one step ahead of industrial and other requirements."

Similar views have been expressed by the Chairman, Atomic Energy Commission, in an article* contributed to 'Science Today':

> "The value added through the use of energy is so great that consequences to the national economy as a whole of making a pessimistic forecast can be at least ten times more expensive than of an optimistic forecast.
>
> A recent study made by us has demonstrated that in Kerala State alone the costs to the economy of interruptions and shortages of Power during the period 1961-62 to 1965-66 averaged Rs. 75 million per annum in terms of production lost".

1.17. The Committee regret to note that there is divergence of opinion on the size of the installed generating capacity of power during the Fourth Five Year Plan between the Planning Commission on the one hand and the Ministry of Irrigation and Power and the Department of Atomic Energy on the other. The former i.e. the Planning Commission have fixed the target for the Plan at 22 million kw while the need has been assessed at 26 million kw by the latter. They feel that targets in this respect should have been fixed much before the actual commencement of the Fourth Plan especially when the gestation period for nuclear and hydel projects is 5 years or more. The Committee are unable to appreciate the views of the Planning Commission while fixing the target at 22 million kw that "action will have to be taken to indentify pockets of shortages, which they anticipate" and then take "prompt action to meet the power needs of those pockets". They consider that in the interest of perspective planning and because of relevance of power to the economy of a country, it is desirable to initiate action well in advance rather than wait for the contingency to occur and then take action. In view of the sufficient scope for India's economy picking up momentum and since "the value added through the use of energy is so great that consequences to the national economy as a whole of making a pessimistic forecast can be at least ten times more expensive than of an optimistic forecast", the Committee consider that the question of fixation of power targets for the Fourth Plan merits urgent and thorough consideration. They hope that the differences will be resolved amicably at an early date so that a realistic target is fixed and a firm decision reached about allocation of share of additional power generation to hydel, thermal and nuclear energy.

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*Article on 'Why Nuclear Power for India by Vikram A. Sarabrai, Chairman, Atomic Energy Commission, September, 1969, issue of Science Today' p. 42,

C. Power Reactors

1.18. The Committee desired to know the various types of reactors in use in the world today. Government in a written note have given the following information:—

Types of Reactors in Use

AGR—Advanced Gas-cooled, Graphite Moderated Reactor.

BHWR—Boiling Heavy Water Moderated and Cooled Reactor.

BWR—Boiling Light Water Moderated and Cooled Reactor.

FBR—Fast Breeder Reactor.

GCR—Gas-Cooled, Graphite Moderated Reactor.

HTGR—High Temperature Gas-Cooled Graphite Moderated Reactor.

HWGCR—Heavy Water Moderated Gas-Cooled Reactor.

HWLWR—Heavy Water Moderated Light Water-Cooled Reactor.

HWOR—Heavy Water Moderated Organic Cooled Reactor.

LWGCR—Light Water Moderated Gas-cooled Reactor.

LWGR—Light Water-Cooled Graphite Moderated Reactor.

OMR—Organic Moderated and Cooled Reactor.

*PHWR—Pressurised Heavy Water Moderated and Cooled Reactor.

PWR—Pressurised Light Water Moderated and Cooled Reactor.

SGR—Sodium-Cooled Graphite Moderated Reactor.

SZR—Sodium-Cooled Zirconium Hydride Moderated Reactor.

SGHWR—Steam Generating Heavy Water Reactor.

1.19. When asked which is the type best suited to Indian conditions and likely to prove economical and practical and also whether they agree with the view that "our power programme be based initially on such type of reactors that could operate on natural uranium as fuel and require minimum, initial fuel inventory as well as minimum annual fuel consumption per MW installed", the Chairman, Atomic Energy Commission informed the Committee as follows:—

> "The point is that if we wish to be free from the economic as well as political dependence of outside countries, we must have natural uranium reactors. And according to our estimation, Candu type is one of the best. There are certain variations which one can make for example use light water as a coolant. This might reduce capital cost. The Atomic Energy Commission

*"CANDU"

and its various units are making a detailed study of the variants of Candu design. This type might be even more economically advantageous in the years to come. But we do feel that the natural uranium reactor or reactors, if and when ready for our own equipment plants, then I think that would be the best way to do it. That is, the natural uranium reactor would be the best."

1.20. The Committee also desired to know the time by which Atomic Energy Commission will be able to succeed in their efforts to utilise thorium as nuclear fuel. The Chairman, Atomic Energy Commission explained the position as follows:—

"What is happening is that our resources of U-235 are related to our resources of natural uranium which we can mine and separate. There is a small amount of natural uranium in a large number of granite rocks but it is not economic to go to very low grades. Our resources are therefore restricted to ores which have a certain concentration. Usually 0.05 is the minimum which we believe would be applicable to our work. Our grades are a little better than that. Therefore, our U-235 resources are related to the natural uranium. But we have a rather good—good in our sense, since we are not a rich uranium producing country—workable deposits of uranium at Jaduguda where we are mining almost 900 tonnes daily which will come up to the rated capacity of 1,000 tonnes a day.

As far as thorium is concerned, by itself in its natural form, it cannot be used as a material for running the chain reaction or extracting energy. But if you put thorium in a reactor where reaction is going on because of the U-235 which is the nutrient it will absorb neutrons and will generate another rather important fissile material, U-233, which then can be used as a new nuclear fuel; so that potentially we have got an unlimited source of fissile material. Once we have got the technical knowledge, and the installations for being able to irradiate a large amount of thorium and generating U-233, and then going on to the thorium region, we will be reaching that stage.

* * * *

We have the basic work going on with thorium at the Bhabha Atomic Research Centre at Trombay, but we have collaborative agreements in this field with the USAEC and we are comparing notes with other countries. We are interested in thorium and are following the developments at Oak Ridge for the utilisation of thorium. We are going on with this aspect of our resources also in collaboration with others. The utilisation of thorium would only come in the third phase.

I might add that the use of thorium or the replacement of thorium in our Candu reactor at some stage may be a way of reducing the fuel cost of the Candu reactor. It will not be a breeder reactor but it will extend the fissile inventory in the reactor so that we will be able to utilise, perhaps even before we come to the third stage, the thorium partially and draw more out of the total system which we are planning to do."

1.21. The Committee agree with the Chairman, Atomic Energy Commission, that the reactor system most suitable for the country would be the one for which we would not have to depend on foreign countries for fuel and other nuclear components and which would prove economically advantageous in the long run by making use of thorium which is available in plenty in the country.

D. Atomic Power Programmes in India

1.22. The Atomic Energy Commission was established as an advisory body in 1948 in the Ministry of Natural Resources and Scientific Research. However, an important effort to develop this work was not made until a separate Department of the Government of India with the full powers of a Ministry was established in August, 1954. It is said that the first act that the Department did was to convene a Conference in New Delhi on the Development of Atomic Energy for Peaceful Purposes in India in November, 1954. The Conference was inaugurated by the late Prime Minister, Shri Jawaharlal Nehru, who took the opportunity for making an important policy statement on behalf of the Government regarding the development of atomic energy in India. Referring to peaceful uses of atomic energy the Prime Minister said, "So far as peaceful purposes are concerned obviously we want atomic energy for the generation of power. Power is the most important thing in developing a country's resources. You may judge a country's advance today merely by seeing how much power it produces or uses".

In 1960, the Indian Atomic Energy Commission submitted its first concrete proposals to the Planning Commission for setting up atomic power stations in India. It is stated that amongst the factors that encouraged Government to launch the programme were firstly, the availability of a group of talented, trained and devoted scientists and engineers at Trombay, who had acquired familiarity with the new technology through the construction on their own unaided effort of two research reactors, APSARA and ZERLINA and in collaboration with Canada, the Canada India Reactor (CIRUS); secondly the location of resources of uranium in Bihar and thorium in the monazite sands of Kerala; thirdly, the success of Indian scientists in establishing the technology of the fabrication of uranium fuel elements required for CIRUS; fourthly, the inadequacy of hydel resources

and coal and oil resources in the context of India's long term requirements; fifthly, the limited geographical distribution of coal resources in India; sixthly, the significantly lower fuelling cost of nuclear power stations, particularly if the total real cost of coal including the effect of investment on rail transportation were taken into account; seventhly, the possibility of nuclear power stations operating at high load factor in certain grid systems in India, which would contribute significantly to the economics of nuclear power and last, but not the least, the importance of avoiding absolescence involved in developing the technology too tardily. Any delay in launching the first phase of the development of nuclear power based on natural uranium would, it was recognised, delay the next generation of nuclear stations based on breeder reactors which would be competitive even with thermal stations close to coalfields.

1.23. It has been stated that five successive stages may be identified in the development of the nuclear power programme of India. The first stage of low power and without electrical generating capability was marked by the construction of research reactors. *Apsara* and *Zerlina* (a zero energy assembly) were undertaken by Indian Scientists and Engineers without any foreign collaboration or assistance except that the enriched Uranium required for Apsara was obtained from the United Kingdom and the heavy water for *Zerlina* from the United States of America. The Canada-India Reactor (CIRUS) was the first large research reactor (40 MW thermal) to be built, Canada providing the design and know-how.

1.24. In the second stage the nuclear power programme was initiated with the Tarapur Atomic Power Project. In this project, International General Electric of USA assumed the responsibility of the prime contractor and has built the main station to its own design.

1.25. In the third stage it was decided to develop a family of natural uranium fuelled reactors which would not require the importation of enriched fuel as in the case of Tarapur. After detailed examination, the choice of the system fell on the CANDU reactor developed by Canada using natural uranium as fuel and heavy water as a moderator and coolant.

The ultimate atomic power programme of India would be based on the use of thorium, vast deposits of which are available in the country, but this programme has necessarily to be preceded by a generation of natural uranium reactors which will produce power, and plutonium as a by-product. Following this policy, the construction of three units of heavy water moderated and cooled reactors using natural uranium (Rajasthan Atomic Power Projects I and II and Madras Atomic Power Project—RAPP I & II and MAPP has been undertaken in the third stage described earlier.

1.26. In the fourth stage, it is proposed to build a fast breeder reactor, which will use plutonium and depleted uranium produced in the

first stage reactors as "low cost by-products". As a prelude to the building of this Fast Breeder Test Reactor, our scientists propose to set up a Zero Energy Fast Reactor Facility at Trombay for studying the physics design of large breeders and a Pulsed Fast Reactor at Madras intended to provide high intensity neutron source for cross-section measurement related to the development of breeder reactors and for neutron research. This responsibility it is stated will be undertaken without any foreign collaboration.

The Atomic Energy Commission has entered into agreement with the Commissariat I' Energie Atomique of France. Under this agreement the Commissariat is sharing its experience in the field of fast breeder reactor technology with the Indian Atomic Energy Commission. The detailed studies are expected to be completed in 12 to 18 months. The joint study being undertaken by Indian and French concerns the Fast Breeder Test reactor to be set up at Edaiyur adjoining Kalpakkam. The object of this study is to produce detailed designs and specifications of all plant components as a guide for firm financial estimate for concluding contracts and also for carrying out certain detailed studies and test necessary to define the characteristics of the reactor.

1.27. The expected amount of expenditure to be incurred on this account is estimated at Rs. 175.76 lakhs. India will bear the entire expenditure on the preparation of the project report and on the joint studies. It has been stated that for a small prototype breeder reactor of 40 MW thermal approximately output adequate quantity of plutonium will be available from the Rajasthan and Madras power stations by the mid-seventies. Maximum Indian content of materials and equipment for the project will be aimed at. The construction of the reactor will lie with Indian scientists and engineers. The workshop facilities of the Department of Atomic Energy and Indian industry will have the maximum share in the engineering of the Project and supply of materials and equipment. Moreover, the setting up of ancillary laboratories like Heat Transfer and Liquid Metal Technology Laboratories, Materials Research Laboratories, Fuel Reprocessing, and Refabricating Facilities and, as stated above, a Zero Energy Fast Reactor facility and a Pulsed Fast Reactor facility will be undertaken by Indian scientists and engineers without any foreign collaboration. The Indian programme is planned with a major emphasis on development work in the light of known techniques and of building a base for future research and development in this field, so that by the late *70's large fast breeder reactors on a commercial scale could be installed and operated. Before, however, India can establish commercial scale fast breeder reactors for power generation, to provide self-sustaining base for future atomic energy development of our own fuel resources, it will require a sizeable inventory of plutonium which

*At the time of factual verification the Department of Atomic Energy have desired the substitution of "the late 70's" by "the 80's".

can only come from an installed capacity of approximately 3,000 megawatts of natural uranium thermal reactors.

1.28. In the fifth stage of the nuclear programme U233 bred from thorium would be utilised for maintaining a programme of inexpensive nuclear power plants. This stage could be reached in the 80's.

1.29. When asked to state the broad features of the original programme proposed by the Atomic Energy Commission for the development of nuclear power in India, the Department in a written reply drew the attention of the Committee to the following statements:

The three stage Programme

	TYPE	MW	DATE
I GENERATION	NATURAL	3000	1975
II GENERATION	BREEDER REACTORS		
III GENERATION	URANIUM-233-THORIUM CYCLE		

The original programme at the time of drafting the First Fourth Plan (1966—71) envisaged the setting up of approximately 3,000 Mwe of atomic power capacity by 1975-76 as under:—

1966—71	1200 MWe
Tarapur	380 MWe
Rajasthan	400 MWe
Kalpakkam	400 MWe
1971—76	1800 MWe
Rajasthan or Kakrapara	400 MWe
Kalpakkam	500 MWe
Tarapur	500 MWe
New Site (Southern or Western India)	

1.30. As regards the second unit of the Kalpakkam station, it was proposed by the Atomic Energy Commission for inclusion in the IV Plan. In spite of the fact that its construction was approved by the Planning Commission in October, 1964 and by the Cabinet in June, 1965, it has not been accommodated in the Fourth Plan, apparently owing to the difficult resources position and due to the fact that the Planning Commission are doubtful regarding the capacity of the Madras grid to absorb the power delivered from the station if it were completed before the end of the Fourth Plan.

It has also been stated that the programme proposed by the Atomic Energy Commission included, besides the second unit of the Madras Station, three units of ५०० MW scheduled for completion successively in 1977, 1978

and 1979, so that by the end of the Fourth Plan, 2,700 MW of nuclear power would be installed, including Tarapur, Rajasthan and Madras Atomic Power Project I. This programme would have involved an additional outlay of Rs. 92.00 crores during the Fourth Plan.

1.31. Explaining the strategy of nuclear power, as outlined by Dr. Bhabha, the Chairman, Atomic Energy Commission, informed the Committee as follows:—

> ".....strategy of nuclear power as was outlined by Dr. Bhabha many years ago with a lot of foresight because ten years later now when we look at this again, we will realise with what great insight—what you might say prophetic insight which he had in judging at that stage, out of several technological options for providing nuclear power energy, he chose something which proved successful. There are many other countries which were not successful in the development of nuclear technology. If we look back, it was uranium and heavy water which was made by Dr. Bhabha the cornerstone of the first generation which has permitted us to be free from imported technology or materials. This has great relevance and validity to other political things also. This is a three point programme. Uranium fed into heavy water reactors produce energy. They produce plutonium. This will go in the second stage into the breeder reactor with thorium and develop a new fissile material for use in the Third generation. This is the third generation. Unless you go through these phases and develop a new inventory of plutonium, there will be no hope of going beyond this. The real inexpensive electricity comes at this point. There is no other way and I think the country has to recognise that to develop the indigenous technology we have to go through these processes and take proper measures and here one needs a firm conviction and should go step by step along these lines. Learning to make nuclear power generation less expensive is learning the technology itself.
>
> This programme as is outlined is really not a programme of one or two years. It extends over a period of 10 or 15 years starting from 1964 when Tarapur and Rana Pratap Sagar were first committed to 1980. It is over a period of 16 years. The second stage of the programme cannot survive unless the commitment to it is also made. If we alter our sights for 3 or 5 years because we have a Five Year Plan and we change the very basis on which this commitment is made, then we can just forget about the possibility of reaching there. It is in this context that we feel that there is a great danger in looking at it piecemeal. If you stop the water for six months, you will not

have the plant afterwards. This is the type of situation which we have both in regard to Rana Pratap Sagar and in regard to developing the expertise of our industry both public and private and self-reliance."

He further stated—

"Our plan calls for installation of about 2,800 MW by 1979-1980 which would mean that in addition to 1,000 MW which is under construction or which is already operating by 1974 we should go in for another 1,800 MW which will be sanctioned during the next six years so that that could be completed by 1980. This is the crux of the matter.

Unless we do this there is no possibility of taking advantage of fast breeder reactor technology which according to the best world estimates will be commercially available in about 8 to 10 years' time. Some people are even optimistic that within five years there will be a major break-through in power. The fast breeder test reactor which we are putting up in the next four or five years will give us indigenous technological know-how as well as industrial competence to make these components here itself so that from 1975-80 we can start at least one major unit of the fast breeder reactor. And by 1990 we would be able to run it. All this is a closely knit-plan. If somebody were to tell us that for 2 years there will be no progress, as the Planning Commission draft report says, it would mean literally that until 1973-74 there would be no further approval of a project. If that happens, the whole thing will be completely upset. * * * That includes building of a plutonium inventory. As far as we are concerned that is our aim."

1.32. The Committee desired to know if it will be possible for the Department of Atomic Energy to achieve the target of installation of about 2,800 MW by 1979-80 according to the present development of nuclear power technology and programmes of work and what will be the requirement in terms of money and the number of projects that will have to be set up to achieve the target. It has been estimated that for embarking on breeder reactors 1,000 kgs. of plutonium is required every year and the plutonium produced from Tarapur is 130 kg. and the likely production from Rajasthan Atomic Power Projects I and II and Madras Atomic Power Project I will be 90 kg. each every year.

In a written note it has been stated that depending on the types and sizes of reactors chosen, the balance of 1700 MW yet to be sanctioned will need between Rs. 500 and Rs. 600 crores. According to the present indi-

cations, it should be possible for the Department to carry out this programme if sufficient resources are made available. Plutonium would be required for embarking on breeder reactors in the second stage of the atomic power programme to be completed in the early 80's and for reactors utilising thorium. The plutonium estimated to be produced annually from Tarapur and 2300 MW CANDU type reactors using natural uranium is 1100 kgs. approximately.

1.33. The Committee were informed that the Planning Commission propose discussing these issues to seek clarifications from the Department of Atomic Energy. They have raised the following issues:—

> "The Department of Atomic Energy contemplates stock-pilling plutonium for fuelling these F.B.Rs. in 1980's. According to D.A.E's. estimates, the Tarapur, Rajasthan and Kalpakkam atomic stations would yield annually 130, 180 and 180 kg. of plutonium respectively. Presuming that Kalpakkam Stage II would be completed in 1975 these three stations would yield a total inventory of about 3840 kg. by that time and 490 kg. per year in subsequent years. The Department of Atomic Energy has yet to indicate what programme of Fast Breeder Reactors this inventory of plutonium available by 1980 and that becoming available at the rate of 490 kg. per year can support. It is also not clear as yet the size of outlays that will be required for Fast Breeder Reactor programme".

1.34. In a lecture delivered at Dublin in 1957, Dr. Bhabha had stated as follows with regard to the setting up of breeder power stations:—

> "It seems likely that breeder power stations may begin to operate by about 1965. In order that enough plutonium should be available at that time for fuelling such stations. It is clearly necessary to start on an atomic power programme based on natural uranium reactors very soon.....".

The position of the Atomic Power Projects under construction has been discussed subsequently in Chapters II, III and IV. The Tarapur Project has started flowing commercial power from October, 1969 only. RAPP I and II will be commissioned sometime in 1971 and 1973 respectively. The Madras Project Unit I alone is likely to be commissioned in 1974. Madras Atomic Power Project Unit II has not been included in the draft Fourth Plan. In reply to a question* answered in the Lok Sabha on the 1st April, 1970, it has, however, been stated that it has been decided to add a second unit of 200 MWe capacity to the Madras Atomic Power Station being set up at Kalpakkam. A provision is being made in the Fourth Plan towards advance action for a nuclear power station to yield benefits in the Fifth

*USQ No. 4763 on 1st April, 1970.

Plan. Feasibility studies are also being undertaken to decide upon the setting up of a new plant.

1.35. The Committee note that the atomic energy programme as originally drawn up by the Atomic Energy Department covered a period of 16 years i.e. from 1964 to 1980 to enable the country to avail of the fast breeder reactor technology which is expected to be commercially available by that time. This programme has been altered to synchronize with Five Year Plans and scaled down by the Planning Commission. According to the Chairman, Atomic Energy Commission, this has upset their programme which is a closely knit plan and does not admit of any break-up piecemeal. Their commitment is for a longer period with the aim of building up 'plutonium inventory which will give indigenous technical know-how as well as industrial competence to make the components in the country so that from 1975—80 we can start one major unit of the fast breeder reactor'. The Committee are informed that the Planning Commission are having a dialogue with the Atomic Energy Department with a view to sort out their differences in this regard. The Committee hope that this will be done with expedition and a firm decision reached quickly.

E. Plan Targets and Achievements

1.36. It has been stated that during the first and second Plan periods, the expenditure of the Department of Atomic Energy was not included in the Plan. The Planning Commission were, however, apprised of the broad framework of the atomic energy programme and the capital outlay involved. However, no expenditure was incurred by the Department in the power sector except for an outlay of approximately Rs. 9.00 lakhs on preliminary investigations and site work relating to Tarapur Atomic Power Station. It was only towards the end of the Second Plan period that a decision was taken to include the expenditure of the Department of Atomic Energy in the Third Plan.

Third Plan (1961—66) :

1.37. The allocation of Rs. 51 crores was made in the Third Plan for 'nuclear power' mainly to cover the outlay on the Tarapur Atomic Power Project (TAPP). According to the original targets fixed at the time of the formulation of the Third Plan, one of the two reactor units of 190 MW capacity in the Tarapur Atomic Power Station was to be commissioned by the end of the Third Plan. Work on Tarapur commenced only in May, 1964. The budget provisions made for the two years afterwards totalled Rs. 24.06 crores and the total actual expenditure during the same was slightly higher *viz.* Rs. 25.05 crores. After the conclusion of the agreement with the main contractor, *viz.* Iinternational General Electric Company Limited, the financial target set for the project was attained and the failure to attain higher target set for Tarapur for the original plan was due to delay in the conclusion of the Technical Cooperation and Aid Agreement with the Government of U.S.A.

Rajasthan I and II (RAPP I and II)

By the time of the mid-term review of the Third Plan in 1963, the Cabinet approved in principle the setting up of a nuclear power station at Rajasthan and the inclusion of project in the Third Plan. An outlay of Rs. 10 crores was proposed for the Rajasthan Atomic Power Station during the Third Plan period, which was to be made for the greater part out of the savings from the allocations made for the Tarapur Atomic Power Project. At the same time, it was also proposed to develop one or two sites of nuclear power stations which could be included in the Fourth Plan. Work on Rajasthan Atomic Power Station Unit I commenced in December, 1964. The work on this project only extended for a period of less than one and a half years. As against the budget provisions totalling Rs. 7.53 crores made for the project during the last two years of the Plan, the actual expenditure was Rs. 5.09 crores. The shortfall was mainly due to the fact that the Department of Atomic Energy assumed the actual contract responsibility in respect of Rajasthan Atomic Power Station for the first time. The project had to encounter problems such as shortage of power in Rajasthan, delays in supply of equipment specially indigenous one and delay in the arrival of the delivery items which resulted in shortfall. The late receipt of bills for equipment supplied was also one of the factors. The target of design engineering was generally adhered to the schedule, as also placing of orders for equipment. The contract work was slightly behind schedule.

As regards Rajasthan Atomic Power Station Unit II, it had been stated that this was originally envisaged as a Fourth Plan Project and only some preliminary work was undertaken during the Third Plan.

Madras Atomic Power Station (MAPP)

In October, 1964, the Planning Commission had approved of the setting up of two units of 200 MW each at Madras. In June, 1965, the Cabinet had also approved of the setting up of both the Units subject to arrangement being made for financing the foreign exchange cost of the Project. Owing, however, to the difficulty encountered in making these arrangements, it was decided in mid 1966 to build one unit to begin with.

The break-up of the expenditure made for the development of nuclear power in the Third Plan has been as under:

(Rs. in crores)

(i) Tarapur Atomic Power Project	25·79
(ii) Rajasthan Atomic Power Project—Unit I	5·12
(iii) Rajasthan Atomic Power Project—Unit II . . .	0·07
(iv) Preliminary expenditure on future Atomic Power Stations	0·08
TOTAL .	31·06

Annual Plan (1966-67):

1.38. A total outlay of Rs. 41 crores was included in the Annual Plan for 1966-67 for the Tarapur, Rajasthan and Madras Atomic Power Stations. The actual expenditure amounted to Rs. 48.93 crores *i.e.* 7.93 crores more than the allocation. This excess was mainly due to devaluation.

The work on the construction of Tarapur Atomic Station and Rajasthan Atomic Power Station Unit I proceeded according to schedule during 1966-67. However, there was some delay in the commencement of work on Rajasthan Atomic Power Station—Unit II owing to delay in conclusion of the technical cooperation agreement and financing agreement covering the foreign exchange cost of the project. The work on the Madras Atomic Power Station could not commence as scheduled during 1966-67 as arrangements for financing the foreign exchange cost of the project did not materialise.

Annual Plan (1967-68):

1.39. A provision of Rs. 39.50 crores was included in the Annual Plan for 1967-68 under the scheme 'nuclear power' for expenditure on—

(1) the Tarapur Atomic Power Station.

(2) the Rajasthan Atomic Power Stations—Units I & II.

(3) the Madras Atomic Power Station.

(4) preliminary expenditure on other Atomic Power Stations.

As against this, the actual expenditure during 1967-68 was only Rs. 29.89 crores. The shortfall of Rs. 9.61 crores has been analysed as follows:—

(Rs. in crores)

Tarapur	(—)4·97
Rajasthan Unit I	(—)3·75
Rajasthan Unit II	(—)0·57
Madras	(—)0·38
Preliminary expenditure on future Atomic Stations	(+)0·06
	(—)9·61

The Tarapur Atomic Power Station was scheduled for completion by October, 1968 and the first reactor was to be ready for loading of fuel before December, 1967. However, due to the occurrence of hairline cracks in some stainless steel reactor components, the first reactor could not be ready for loading according to schedule. This postponement accounted for only a part of the total shortfall in expenditure; the other part being due to

larger payments in respect of fuel having been made in 1966-67 though provision therefor was made in 1967-68.

The shortfall in the expenditure on Rajasthan Atomic Power Station—Unit I was mainly due to delay in the manufacture of certain major items of equipment to be supplied by Canadian firms and in the fabrication of certain items in India.

As regards Madras Atomic Power Project I, there was a slight unavoidable delay in getting possession of the land acquired for the Station and consequently civil works could not be commenced according to the original schedule.

Annual Plan (1968-69) :

1.40. A provision of Rs. 25.64 crores was included in the Annual Plan 1968-69 under the scheme 'nuclear power'. As against this, the final requirements of the Atomic Power Stations amounted to Rs. 32.36 crores, *i.e.* an excess of Rs. 6.72 crores. This excess was mainly due to the additional requirements of the Tarapur Atomic Power Station for meeting expenditure on customs duty on import of fuel and use charges on fuel. These were not provided for in the Budget Estimates 1968-69, as information regarding liability on these charges was not available at the time of framing those estimates.

At the time of framing the budget estimates 1968-69, the Tarapur Atomic Power Station was scheduled to go into operation in October, 1968. However, as explained earlier, there was some delay in the commissioning schedule and the station is now expected to go into commercial operation in July, 1969.

The work on the Rajasthan Atomic Power Station Units I & II progressed more or less according to the schedule.

The Madras Atomic Power Station is being set up entirely by Indian engineers/scientists and most of the machinery and equipment required for the station is being fabricated indigenously. As a result of efforts to maximise the indigenous components, certain delays have occurred in ordering and procurement of machinery and equipment. There has also been slight delay in the execution of the civil works on account of the delay in appointment of consultants.

1.41. Explaining the reasons for the difference between the targets and the actual achievements during each of the Plan periods, the Chairman, Atomic Energy Commission, stated as follows:—

> "During Second and Third Plan, the situation was that the Department did have plan provisions but these were not fuly utilised for the reason of the delays which took place. For instance, as explained earlier, Tarapur was delayed for two to

three years for negotiations. There was major spill-over. This condition does not exist now. Today, in the current year, we are short of capital funds. Next year, it will be even less if the present system goes on. Now the situation is that this programme cannot continue to maintain its momentum until the succession of projects are sanctioned in time and one gets the means to implement them. * * * There is this major problem of management at national level between the various agencies. Afterall, the Atomic Energy Department and its groups can only fulfil those aspects of requirements which are not catered to by other major public or private organisations. We are not in the generators field. We should not be setting up a plant for making generators. In these things and for steel, for special metals of various types and for heavy engineering, we must depend on outside organisations. And in this, proper mandate and coordination is quite crucial. As far as I can see, there is scope for our internal improvement and the external coordination has to be tightened up. I think if we have a clear cut mandate not for three or four years but for ten years, we can really make progress. * * * Nobody can make a real attempt at such a major task unless everybody looks at more fundamental way in a long range point of view."

1.42. The Committee note that there have been large scale variations in the budgetary provisions made and the actuals in the Plan targets, although in some cases it was due to force majure **events like devaluation, imposition of customs duty etc., over which the Department of Atomic Energy had no control. The Committee realise that because of the newness of the field of nuclear power development in the country, our dependence on foreign collaboration and foreign finances and introduction of indigenisation in the power projects, there have been shortfalls in the achievement of the targets in the past. They, however, hope that with the experience gained and gradual elimination of dependence on foreign sources in the matter of consultancy, personnel, fuel, equipment etc. and with proper coordination and management at national level between the various connected agencies, the Department will be able to improve its performances in future.**

CHAPTER II

TARAPUR ATOMIC POWER PROJECT (TAPP)

A. Sitting of the Project

2.1. In August, 1958, a decision was taken to include an atomic power station in the western region of India in the Third Five Year Plan. The power unit of the Department of Atomic Energy was set up in August, 1959 with an O.S.D. (Power) and the site for the first atomic power station was selected by this unit. The choice of Tarapur as the site for the first nuclear power station was dictated by the following considerations:—

(a) The inadequacy of conventional sources of power in this region and its distance from coalfields.

(b) The existence of a well-developed power system in this region which would make it possible to operate a nuclear power station at a high load factor.

(c) The pace of industrial development in this region which could ensure the absorption of large blocks of power which a big nuclear power station would deliver.

2.2. As power was intended to be supplied in equal measure to the power systems of Maharashtra and Gujarat, the location of the Station had to be at some point north of Bombay. About 20 alternative sites north of Bombay were accordingly examined in detail. The various Departments of the Government of India including the Geological Survey of India, the Central Water and Power Commission, the Indian Navy and Indian Air Force assisted in the site selection. Tarapur was finally selected on the following technical and economic considerations and this decision was announced by the Prime Minister in Parliament on the 10th August, 1960:—

(1) The suitability of the site from the point of view of drawing cooling water and discharging liquid effluents into the sea.

(2) Good foundation conditions and seismic stability.

(3) Health and safety considerations under all operating conditions.

(4) Electrical considerations effecting the despatch of power.

(5) Access to site, availability of fresh water and construction materials.

(6) Lastly, the availability of a site at Tarapur which would be free from large population within a zone of one mile.

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B. GLOBAL TENDERS

2.3. It has been stated by the Department of Atomic Energy that before India could embark on any programme of nuclear power, it was necessary to acquire as soon as possible the technological know-how in this specialised field and also to have facilities for producing fissile material such as plutonium so as to give flexibility in the later stages of the programme; the country's large thorium reserves could then be exploited usefully. According to them this objective could be met in one of two ways; either, by entering into a foreign collaboration for obtaining the necessary technological know-how and for importing specialised components and materials that may not be available within the country or by calling for a global tender on a fixed price basis without imposing any limitation on the choice of the reactor system and this could provide a general perspective of the world-wide development in the field. For the first atomic power station in the country, at Tarapur, the latter alternative was chosen.

2.4. Global tenders for the Tarapur station were accordingly invited in October, 1960. The tenders were based on enquiry specifications drawn up by the engineers of the Tarapur Project. In response to this invitation of tenders, seven proposals were received at the end of August, 1961, from four countries as under:—

United Kingdom—

1. General Electric Company
2. English Electric, Babcock Wilcox and Taylor Woodrow Group

France—

3. Groupement de Constructeurs Francaise de Centrales Nucleaires (a consortium of French firms)

United States of America—

4. General Electric/International General Electric Co. (CE/IGE)
5. Westinghouse Electric International Co.
6. Atomics International in association with Kuljian Corporation.

Canada—

7. Canadian General Electric Company and Canadian Bechtel.

These proposals covered four reactor systems then in operation or under development in the world:

(a) Natural uranium graphite moderated gas cooled reactors (Proposals 1, 2 and 3)

(b) Slightly enriched uranium, light water moderated and cooled reactors (Proposals 4 and 5)

(c) Natural uranium heavy water moderated, organic cooled concept (Proposal 6)

(d) Natural uranium heavy water moderated and cooled concept (Proposal 7)

The tenders were evaluated in detail by the Project as also by groups of experts from the Atomic Energy Establishment, Trombay (Now Bhaba Atomic Research Centre) and the Central Water and Power Commission. The proposal from the Canadian firm and from the American firm who offered a natural uranium reactor were not complete either in design or cost as no such station had been in operation anywhere in the world. The British and French offers were found to be too expensive. Of the two American tenders, that submitted by the International General Electric which was based on a boiling water reactor using enriched uranium was found to be the most suitable and it was decided that subject to a satisfactory settlement of the terms relating to financing, fuel supply and safeguards, it should be accepted. Before the offer could be finally accepted, it was necessary to make satisfactory arrangements with the United States Government on financing, supply of fuel, safeguards, plutonium buy back and allied matters. As considerable progress on these matters had been made by September, 1962 and there was every possibility of satisfactory conclusion of the inter-governmental agreements a conditional letter of intend was issued to International General Electric Company on September 24, 1962. The definitive contract could, however, be entered into only after satisfactory agreements had been concluded with the U.S. Government and U.S. Atomic Energy Commission.

C. AGREEMENTS

2.5. Three inter-governmental agreements were accordingly executed—

(i) Indo-US Bilateral Agreement for Cooperation tailored for the Tarapur Project, was signed on August 8, 1963. This includes commitment for fuel supply throughout the life of the station and exchange of unclassified information in the fields of research and development including BWR technology and the use of plutonium as fuel.

(ii) US AID Loan Agreement provides for funds for the actual foreign exchange cost of the Project upto a ceiling of $80 million and was signed on December 7, 1963. With the constant effort by the Project to conserve foreign exchange and with the cooperation of the prime contractors, there has been a substantial saving in foreign exchange and $5 million has already been deobligated.

(iii) Fuel Sales Agreement with the U.S. Atomic Energy Commission was negotiated and agreed to in principle in August, 1963. The contract was formally signed on May 17, 1966.

2.6. A definitive contract was thereupon executed on May 8, 1964 between the Government of India and International General Electric. Under this contract, International General Electric have guaranteed the output and efficiency of the station at full power, the quality and workmanship of the various components and also the completion date. The total base price of the station in terms of U.S. dollars and rupees is fixed, subject however to escalation and payments for extra work that may be ordered, for which allowance has been made in the cost estimates. The contract also defines the design basis and spells out in detail the work and services involved along with all the guarantees. It also provides for review and comment of the design and inspection and general supervision of the work by the Project. These details are stated to have proved useful in the administration of the Project.

Choice of Enriched Uranium Reactor

2.7. The Committee desired to know the special considerations which had led to the acceptance of the offer of the International General Electric even though it was against the basic objective of the Atomic Energy Commission of setting up reactors based on natural uranium. The Department of Atomic Energy have justified the setting up of the project on the following grounds:

(i) There were strong economic reasons to do so. The offer of the Company was too attractive in terms of capital outlay to be rejected. The global tender disclosed that among the natural uranium reactor proposals, the French was the best and among the enriched ones, International General Electric's was the best. The relative cost (pre-devaluation basis of the French proposal were Rs. 89·00 crores (inclusive of Rs. 59·30 crores as foreign exchange component) and that of International General Electric's Rs. 60.67 crores (inclusive of Rs. 44·24 crores as foreign exchange component). The initial investment on the French tender (for a slightly smaller station) would have involved over Rs. 28 crores in excess and the foreign exchange requirements over Rs. 15 crores in excess. With an investment of foreign exchange amount equivalent to Rs. 15 crores on pre-devaluation basis, interest at the rate of 6 per cent per annum the yield would have well covered the foreign exchange recurring requirement towards fuel for the life of the station, after allowing for credits for depleted uranium returned to U.S.A. and plutonium if returned to U.S.A.

(ii) The Project had enabled the Department of Atomic Energy to save considerable time that would otherwise had been spent in developing our programme and the Indian scientists and engineers have acquired a great deal of technical know-how and experience with active participation in all stages of construction of the Station, through a well organised and comprehensive programme for training in station operation, imparted by the International General Electric under the contract and through intensive association, in particular with all testing operations.

In addition during the course of evidence the Chairman, Atomic Energy Commission informed the Committee as follows:

"I may say that Tarapur was looked upon by Dr. Bhaba as a project to fulfil two things. One was to demonstrate that atomic power could be generated at a rate which would be competitive with other power available in that area. That was the first demonstration he wanted to show. The second thing was the responsibility for this project is of a very large group of scientists and engineers and they would get involved in it. It must be regarded as an isolated first step, and not really regarded as a major deviation from policy, which means that we should not be dependent on foreign sources and on a situation where outsiders come in and put special conditions on us."

2.8. It may be pertinent to mention that the late Dr. Bhabha, former Chairman of the Atomic Energy Commission had emphasised the development of nuclear power based on natural uranium in the following terms:

"Although the initial capital investment needed for nuclear power stations is higher today than that for thermal power stations of the same size, this additional capital investment must be considered necessary for larger purposes than power production. The major fraction of the nuclear power capacity will be installed in natural uranium power stations, which are *dual purpose stations producing power on the one hand and plutonium on the other.* This plutonium is a concentrated fuel, which is not available from outside as a commercial commodity, and its production is essential in order to enable the country to set up breeder power stations using thorium or depleted uranium for the second stage of its nuclear power programme, which will have to be taken up about five years from now. Such power stations will also be much cheaper in capital cost than the present ones, and the indications are that power from these may even be competitive with power from conventional thermal power stations near the coal-

fields. It will not be possible for India to take advantage of these new developments five years hence, unless steps are taken now to set up dual purpose power stations for producing plutonium....."

The significance of the production of plutonium for the ultimate power programme for India based on the use of natural uranium was further emphasised by Dr. Bhabha in the following terms in his lecture "On the Economics of Atomic Power Development in India and Indian Atomic Energy Programme" delivered on September 6, 1957 in Dublin :

"As far as India is concerned.....the best way of obtaining fissionable material appears to be to produce plutonium as a by-product in atomic power stations working on natural uranium.....It seems likely that breeder stations may begin to operate by about 1965. In order that enough plutonium shuold be available at that time for fuelling such stations, it is clearly necessary to start on an atomic power programme based on natural uranium reactors very soon....."

2.9. The Planning Commission, in their report on the Third Five Year Plan, expressed a somewhat similar view as follows:

"It has been estimated that the thorium reserves in the country are among the largest in the world and are more extensive than those of uranium. In order to utilise thorium, the nuclear power programme in India has to be carried out in three stages, which is time-consuming. The first stage will utilise natural uranium as fuel, producing power and the fissile element plutonium. The second stage will employ reactors using plutonium as fuel and thorium as fertile material, producing power and converting part of the thorium into U-233. The third stage will use U-233 with thorium in breeder reactors, so that while electricity is generated, more U-233 is produced than is burnt up in the process."

2.10. The Committee feel that Government in their enthusiasm to demonstrate that atomic power could be generated at a rate which would be competitive with conventional sources of power in the country, in the setting up of Tarapur Project took a hasty step, not in keeping with the country's long-term objective, in accepting reactor based on enriched uranium. The enriched uranium is required to be imported for the life time of the Station and has thus made the country dependent on foreign resources. The Committee further feel that in view of the contract being on a turn-key basis, it is doubtful if the Tarapur Project has taken the country far enough in attaining the goal of self-reliance in the production of nuclear power.

2.11. The Committee are not convinced that the terms offered by the International General Electric Company were too attractive to be rejected specially when factors like fuel cost, the production of plutonium, achievement of self-reliance, saving in foreign exchange and the country's long-term objective are taken into consideration.

Contract with International General Electric.

2.12. The General Electric Company of U.S.A. and the International General Electric Company (India) collectively called I.G.E., were selected as the prime contractors and the contract was negotiated and executed with them. In September, 1962, a conditional Letter of Intent was issued to I.G.E. The contract with I.G.E. was executed in May, 1964 and became effective in June, 1964.

International General Electric had engaged Bechtel Corporation of U.S.A. and Bechtel India Ltd., for the detailed engineering of the conventional parts of the Station and for handling site construction. The detailed design of the nuclear system had been undertaken by International General Electric themselves at their Atomic Power Equipment Department in Sen Jose, U.S.A.

Foreign Consultants

2.13. In the case of Tarapur Project, U.S. AID had stipulated provision of consultancy with base in USA, as one of their conditions preceding to financing of the Project. Accordingly, amongst the 18 proposals received, the following consultants were appointed with the approval of the US AID—

Kuljian Corporation—USA	} USA based
Nuclear Utility Services with McLain Associates	} USA based
Kuljian Corporation—India	India based

The services have been rendered satisfactorily by pooling together their specialised know-how, experience and personnel resources, with Kuljian Corporation—India co-ordinating the joint effort.

For the entire services which extended for nearly five years, the lump sum fee was as follows:—

Total	Paid so far
(a) $ 285,000	} 95%
(b) Rs. 9,76,190	} 95%

In addition $ 22,000 was fixed and paid towards the cost of setting up, maintaining and running an office at San Jose for one year. (This was extended to about 18 months, without any additional fee).

Due to the extension of the date of station turnover, the Consultants have to continue rendering services till completion of station work. The only payments involved will be for the additional visits of Indian experts to site and also for extension of the stay of the field supervisors, one of whom is from USA; these payments are provided for in the agreements with the Consultants. The additional dollar fees are not likely to exceed $ 6,000.

D. Project Outlay

2.14. In reply to a question* regarding the terms of the contract and the cost of construction of the project answered in the Lok Sabha on the 20th March, 1967, it was stated that the contract was on a 'turn-key' basis, and included designing the station, procurement of equipment and erection of the station. A fixed payment subject only to adjustments on account of changes in labour and materials cost and in certain specified taxes and duties was due to the contractor. The contract had guaranteed the output and efficiency of the station. As regards the cost of the Project, it was stated as follows:—

> "Originally the cost of construction was estimated at about Rs. 48·5 crores, excluding the cost of fuel. The latest revised estimates is approximately Rs. 64.5 crores. The increase in cost is due to the steep rise in Customs Duty, which accounts for an increase of Rs. 6.00 crores and the devaluation of the rupee which accounts for an increase of Rs. 10.00 crores."

2.15. In the brochure 'Tarapur Atomic Power Station' brought out by the Department of Atomic Energy and printed in November, 1968, the project outlay was given as follows:—

On pre-devaluation basis	Rs. in crores
(a) Station base price	40·14
(b) Escalation and contingency	3·70
(c) Capital spares and cost for residential colony, administration, deputation, training, consultancy etc.	5·16
Total Project outlay on pre-devaluation basis	49·00
On post-devaluation basis	
There has been practically no change in the estimated cost of the Project except for adjustments on account of devaluation and increase in customs duty	65·00 (Approximately)

*U.S. Q. No. 4 on 20-3-1967

The fuel charge of the Project has not been included in the Project outlay.

2.16. During the course of evidence, in another document made available at that time, the following information had been given:

Station Outlay	Rs. in crores
First Estimate made in 1964 .	48·77
Revised present estimate	66·00
Causes of rise in the estimate include :	
(i) Effect of Devaluation .	9·70
(ii) Rise in Customs Duty . . .	6·30
(iii) Inerting—an improvement in design . .	0·23
(iv) Additional capital spares	0·56
(v) Ancillary facilities of Meteorological Laboratory, Survey Laboratory.	0·10
(vi) Rehabilitation of Displaced Persons	0·05
(vii) Municipal Services during construction phase . .	0·25
TOTAL .	17·19

This does not include the cost of initial fuel charges which are estimated at 24·61 crores.

2.17. The break up of the expenditure during the various periods of construction of the Tarapur Project upto the end of 1968-69 is as follows:—

	Rs. in crores
(1) Expenditure upto March, 1966 . . .	25·79
(2) Expenditure during 1966-67	36·16
(3) Expenditure during 1967-68 . . .	12·73
(4) Expenditure during 1968-69	11·66
TOTAL . .	86·34

In the Demands for Grants of the Department of Atomic Energy 1970-71, the budget estimates for 1969-70 have been shown as Rs. 4,00,42,000 and the revised estimates have been shown as Rs. 6,58 74,000.

According to the revised budgetary estimates for the year 1969-70 of the Tarapur Project, the total cost of the Station including the fuel cost are likely to be about 92·5 crores exceeding the earlier estimate of Rs. 90·61 crores comprising of estimated cost of Station outlay of Rs. 66·00 crores and the cost of initial fuel charge as Rs. 24·61 crores.

2.18. The Committee are constrained to note that the estimates of the station outlay furnished by the Department have varied from time to time. The Committee would like to emphasise the need to work out reasonably accurate and realistic estimates of the project.

Agreement for Fuel with U.S. Atomic Energy Commission

2.19. The United States of America and India signed a 30-year agreement for co-operation in the development of atomic energy for peaceful purposes in Washington, on the 8th August, 1963. The bilateral agreement commits U.S.A. to supply fuel throughout the life of the station and to exchange with India unclassified information in the field of research and development, including boiling water reactor technology and the use of plutonium as fuel. A commercial fuel sales agreement with United States Atomic Energy Commission was also negotiated and concluded, in principle in August 1963, though the contract was formally signed in May, 1966. Requirements of fuel would be available at a cost applicable to domestic users in the United States. Dealing with the U.S.—India Agreement mentioned above, the Special Issue of 'Nuclear India' published in August, 1963, stated:

> "The fuel, after irradiation in the reactors, will be reprocessed in India to separate the fission products, the residual uranium, which may be returned to the U.S.A. for credit, and the plutonium. It will be possible to re-use this plutonium in the Tarapur reactors, thereby reducing the amounts of enriched uranium which have to be imported from the United States. India can thus retain the plutonium generated in the Tarapur reactors for its own peaceful purpose. If, however, there be some plutonium surplus to India's needs, the United States will have the first option to purchase it at the price then in force in the U.S.A. Moreover, the U.S.A. has guaranteed that such plutonium will be used for peaceful purposes."

According to the agreement, the Tarapur Atomic Power Station would be operated on no other special nuclear material than that furnished by the Government of U.S.A. The parties had agreed that a system of records and reports would be established to assure the complete accountability of any special material which is made available to the Government of India pursuant to this agreement or which would be produced in the atomic power station. This system of records and reports has

been described in the Appendix-I and forms an integral part of the agreement.

2.20. Replying to a question* in the Lok Sabha on the 25th July, 1966, Government had stated that based on the present price and current rate of exchange initial fuel charge would cost Rs. 11.25 crores and replenishments over a period of 25 years were expected to cost about Rs. 1.4 crore on an average per annum.

2.21. In reply to another question** in the Lok Sabha on the 20th August, 1969 with regard to the quantities and cost of nuclear fuel imported for the Tarapur Project, it was stated that 83 tonnes of enriched uranium at a value of Rs. 10.80 crores would be required for the initial fuel charges. 22 tonnes of enriched uranium at a value of Rs. 2·40 crores will be needed annually.

2.22. In the note furnished to the Committee on Tarapur Atomic Power Project, it has been stated that an expenditure amounting to Rs. 24·61 crores (including customs duty on fuel) had been incurred on initial charges on fuel as per following details:

	($ in million)	
(a) Initial fuel including insurance . .	14·375	From US AEC on deferred payment.
Interest charges on fuel (till Station turnover)	1·665	From free resources.
(b) Fuel fabrication base price . .	10·768	From AID Loan.
Escalation on fuel fabrication . . .	10·778	From AID Loan.
$ in million . .	27·586	
Equivalent Rs. in crores—Pre-devaluation basis	14·10	
Post devaluation basis	19·39	
Customs duty on fuel	5·22	
TOTAL IN CRORES . .	24·61	

2.23. When asked as to what will be the annual expenditure on the import of fuel and what will be the estimated total amount required for

*U.S.Q. No. 23 on 25-7-1966.

**U.S.Q. No.4189 on 20-8-1969.

the import of enriched uranium during the life time of the Station, the Committee were informed through a written reply, that the first batch of re-load fuel would be needed in July, 1971 and subsequent batches annually from September, 1972. An annual recurring expenditure of about 2.5 crores starting from 1970-71 on account of enriched uranium is expected. Allowing for credits for plutonium and depleted uranium, the net expenditure will be about 1·7 crores. The expenditure for fabricating the first re-load batch including licence fee to enable future fabrication to be done in India is estimated as under:

	($ in million)
1969-70 .	0·55
1970-71 .	1·73
1971-72	0·66

The fabrication cost for Tarapur fuel is estimated at about Rs. 1·05 crores per annum commencing from 1972-73 (based on a price of Rs. 511 per kilogram of UO_2). The interest charges paid till station turnover amounted to Rs. 1.25 crores. The interest payments likely to be made during the expected life-term of the Station 25 years were estimated at about Rs. 7.00 crores. The fabrication of the second and subsequent re-load fuel batches is proposed to be done at the Nuclear Fuel Complex at Hyderabad. The irradiated fuel residue would be reprocessed in a Reprocessing Plant that was being built at Tarapur. This plant would extract plutonium and residual uranium. When the technology of using plutonium in power reactors is perfected, the station would be able to operate on plutonium fuel wholly or partially, thus reducing the need for importing enriched uranium.

2.24. The Committee consider that the cost of the fuel element for the Tarapur Atomic Power Project is on the high side. They hope that with the setting up of the Reprocessing Plant, which is being built to extract plutonium and residual uranium and the perfection of technology of using plutonium in reactors, the Station will be operated on plutonium fuel wholly or partially and the need for importing enriched uranium will be reduced, which will result in saving of foreign exchange.

2.25. The Committee also note that enriched uranium has to be imported for the working of the Project for the entire life time of the Station. If for any unforeseen circumstances the supply of enriched uranium is cut off or denied due to world postures, the whole Project in that case will be jeopardised. They would, therefore, suggest that Government should explore the possibility of building reserve of enriched uranium to meet such contingencies.

2.26. The Committee are constrained to observe that the cost of the fuel for Tarapur Atomic Power Project, as given by Government on various occasions differ widely. They need hardly stress the importance of furnishing correct information in vital matters of national importance.

U.S. Aid Loan Agreement

2.27. U.S. AID Loan Agreement provided for funds for the actual foreign exchange cost of the Project upto a ceiling of $ 80 million (approximately Rs. 60 crores) and was signed on the 7th December, 1963. The outlay on the Station as indicated in the application for loan to U.S. AID prepared in November, 1962 (as slightly amended at the time of signing the Contract in May, 1964) was as follows —

Station Cost	Dollar part ($ in million)	Rupee part (Rs. in crores)
(a) Station Base Price	59·30	11·91
(b) Escalation and Contingency	5·49	1·09
(c) Capital spares	1·05	..
(d) Independent Consultancy	0·40	0·23
(e) Deputation and training	0·84	..
(f) Other expenses on Station	1·26	3·00
	68·34	16·23
Total cost on pre-devaluation basis		48·77

The cost of the initial fuel charges is as follows :—

	($ in million)	
(a) Initial fuel including insurance	14·375	From US AEC on deferred payment.
Interest charges on fuel (till Station turnover)	1·665	From free resources
(b) Fuel fabrication base price	10·768	From AID Loan.
Escalation on fuel fabrication	0·778	From AID Loan.
$ in million	27·586	
Equivalent Rs. in crores—		
Pre-devaluation basis	14·10	
Post devaluation basis	19·39	
Customs duty on fuel	5·22	
TOTAL Rs. (in croes)	24·61	

The outlay of the Station had now been revised to Rs. 66 crores which according to the Department had been mostly due to devaluation (Rs. 9·70 crores) and rise in customs duty (Rs. 6·30 crores). The credit fee on the loan is three-fourths of one per cent paid half-yearly on the unpaid principal. The first instalment of the loan would be due after 10 years from first disbursement in June, 1964. This forms part of foreign loans for which Government of India had taken the responsibility on repayments. In a note on Tarapur, the Committee had been informed that with the efforts of the Project to conserve foreign exchange and with the co-operation of the prime contractors, there had been a saving in foreign exchange and the loan amount had been reduced to $ 75,000,000.

2.28. The Committee note that due to the efforts made by the Project authorities and because of the cooperation of the prime contractors i.e. International General Electric, a saving of $5,000,000 in foreign exchange could be effected.

E. Delay in the Commissioning of the Project

2.29. The total delay in the commissioning of the Project on the basis of the original target date of October, 1966 has been about 12 months. In this connection, the following dates are of interest:—

Signing of the Contract with IGE—May, 1964.

Contract date—June, 1964.

Start of work at site—October, 1964.

Original target date for full power operation—October, 1968.

Units achieved criticality—February, 1969.

Start of Power Unit I—April, 1969.

Start of Power Unit II—May, 1969.

Flow of commercial power—October, 1969.

Dedication ceremony of the Project performed by Prime Minister—19th January, 1970.

Thus there had been a delay of about one year on the original schedule for commissioning the Plant. Government have stated that with a view to achieve success and timely execution of the Project, the following measures were taken even before the start of the construction:

(i) Arrangement for comprehensive import licences.

(ii) Special customs and port clearance arrangements.

(iii) Priorities and allocations for controlled materials.

(iv) Rail priorities.

(v) Arrangements for speedy transportation of oversize and special consignments.

(vi) Arrangements for construction of a jetty at Tarapur seaface.

(vii) Road access, construction water supply and power arrangements.

(viii) Adequate communication facilities—telephone, telex, wireless, mobile wireless, etc.

(ix) Environmental survey to study normal background radiation in the environment.

(x) Collection of [illegible] meteorological data at the site.

(xi) Project scheduling and adoption of critical path methods for continuous evaluation of progress.

2.30. When asked to state the causes of delay in spite of all preparatory steps taken by the Department, the Chairman, Atomic Energy Commission, during the course of evidence, explained the position as follows:—

"Tarapur involved foreign collaboration and foreign financing. Tarapur involved collaboration and the turn-key job to be done by the I.G.E. but it involved also agreements for the supply of fuel, enriched fuel on a continuous basis with the U.S. Atomic Energy Commission and it also involved financing arrangements under soft loan from the U.S.A. There was also the question of safeguards, because when they agreed to give us the project on a turn-key basis with the financing they had insisted on a basis of safeguards. You must be aware of our national policy that we are very much opposed to discriminatory safeguards which the giver country imposes unilaterally without itself undertaking this discipline. This has been a matter of national policy which has put a great deal of influence on our negotiations and the speed with which we could persuade those who wanted to sell to accept conditions or compromise on a certain basis."

The Committee were also informed that the work continued generally without any procedural delays but there were certain *force-majeure* events over which neither the Project nor the contractors had any control. There were Indo-Pakistani hostilities and critical materials were confiscated in Pakistan. There were also strikes at site, 'go-slow' by the welders and strikes in the vendors shops in the U.S.A. over long periods.

Hairline Cracks and Switchyard Failures

2.31. It has been stated that the first reactor which was scheduled to be loaded with fuel in December, 1967 could not materialise as certain hairline cracks developed in the stainless steel lining of certain reactor components and repairs had to be undertaken. The scheduled programme for 1968-69 consisted of pre-operational testing; loading and critical testing; and power testing. The programme was postponed on account of repairs to hairline cracks. Following the discovery of certain imperfections in the Oyster Creek (U.S.A.) reactor pressure vessel towards the end of 1967, a check was exercised in the case of Tarapur and similar minute imperfections were noticed in the furnace sensitised stainless material used in the station. The repairs were undertaken by the International General Electric under the supervision of their technical experts and also those of the Project, the Bhabha Atomic Research Centre, the Consultants and the Lloyds Register who are specialists in this field.

With the completion of the repairs to the hairline cracks in the reactor, the Station was expected to work on full commercial power by July, 1969, but this did not materialise on account of two major failures of the switchyard, first, on the 28th May and again on the 2nd August, 1969.

2.32. In the Annual Report of the Department of Atomic Energy 1967-68 it had, however, been stated that the Project continued to make steady progress. It had been further stated that work on the Project was on schedule and it was expected that the station would attain full power operation (380 MW) by October, 1968.

2.33. In reply to a question* asked in the Lok Sabha on the 27th March, 1968 about the delay in completing the Project, Government had again stated that the Tarapur Atomic Power Station was expected to be completed according to schedule. It is significant that the position about the hairline cracks in the reactor and non-loading of fuel in the reactor had not been mentioned.

2.34. During the course of evidence, the Chairman, Atomic Energy Commission, informed the Committee as follows:—

> "Recently after it was put up, it has gone into one or two difficulties. Even today the switch yard is not able to accept the full load of 400 megawatts. They are really capable of taking only 250 megawatts. * * * * It is the defective design of the switchyard. Probably it was not experienced in the past in this country in that area at least of accepting and taking care of such big

*U. S. Q. No. 5416 on 27-3-1968.

chunks of power. Even the switchyard construction has run into difficulties."

The position was further clarified by the Tarapur Project Administrator as follows:—

"Unfortunately this was situated on the coast and during the rainy season we ran into a number of difficulties in respect of insulators and isolators. These are being changed. Isolators are still to be changed. We feel that Maharashtra switchyard will not be able to accept for a short time, the entire 400 MW that we are in a position to send out at the present moment. We are sending 250 MW."

2.35. Asked to state about the loss involved as a result of closure of switchyard and whether the same would be borne by the Maharashtra Government, the Chairman, Atomic Energy Commission, during evidence, stated that the loss suffered had not been worked out but significant loss would be suffered and that it was doubtful whether the loss could be recovered from them.

2.36. The Committee were further informed that the Maharashtra State Electricity Board has appointed a high level Committee to look into this problem and it was hoped that within two-months' time *i.e.* by the close of 1969 the switchyard would be put in proper condition. From the following statistics furnished in reply to a question* answered in the Lok Sabha on the 18th March, 1970 regarding production of power from Tarapur during 1969 till February, 1970, it appears that the switchyard is still not able to take entire load and consequently Government would be incurring loss on account of low intake of power :

	Total energy generated at Tarapur (million kilowatt hours)
April 1969	13·099
May 1969	59·078
June 1969	75·847
July 1969	87·927
August 1969	1·429
September 1969	102·501
October 1969	128·373
November 1969	166·126
December 1969	151·487
January 1970	174·407
February 1970	165·243
Total	1,125·517

*U. S. Q. No. 3511 on 18-3-70.

2.37. The Committee note that the repairs to hairline cracks in the stainless steel lining of certain reactor components had been completed by the International General Electric to the satisfaction of the Project Authorities and the warranty period in respect of parts and equipments affected has been suitably extended beyond the normal period of one year.

2.38. The Committee, however, observe that the Department of Atomic Energy in their Annual Report for the year 1967-68 and in reply to a question answered in the Lok Sabha on the 27th March, 1968 did not supply the information about the appearance of cracks in the reactor and the loading of fuel that was due in December, 1967 while mentioning the progress made in the construction of the Tarapur Atomic Power Project.

2.39. The Committee regret to note that after taking a decision in 1958 to have an Atomic Power Station in the western region of India and fixing a target of commissioning one of the two reactor units of 190 MW capacity by the end of the Third Five Year Plan, the Tarapur Atomic Power Station began to flow commercial power in October, 1969 only. Apart from the long time taken in the finalisation of the various agreements necessary for the execution of the Project there has been a delay of about one year in the commissioning of the Project. They consider that a significant loss has been suffered by Government on the following counts:—

(i) The increased cost of the Project and the interest on capital during the extended period of construction;

(ii) The loss of possible profits that would have accrued to the Government, had the project begun to flow commercial power as per schedule i.e. in October, 1968;

(iii) Recurring loss in the cost of production of power;

(iv) Loss on account of lower intake of power by the switchyard and due to its closure.

Payment to International General Electric

2.40. As regards the payments to the main contractors, it has been stated that the budget estimates for 1969-70 provided for rupee payments of Rs. 59.53 lakhs and dollar payments equivalent of Rs. 221.85 lakhs. According to the schedule, the fuel was to be loaded on the Station in December, 1967 and the payments for the same were due in June, 1968 and October, 1968. Pending completion of the repair of cracks of certain reactor components, these payments were proposed to be withheld during 1968-69 under the terms of the contract. It has been stated that as it was anticipated that the repair programme would be completed early in the year

1969, provision was made in the current year's budget estimates. However, in a footnote, Government had stated as follows:

> "Note: At the final grant (1968-69) stage, however, the payment due in June, 1968 was made in view of the acceleration of the repair programme. The provision made for this payment in the Budget Estimate for the current year will be reduced in the Revised Estimate."

2.41. When asked to explain the reasons why the payment was made to the contractors in 1968-69 even before they had completed the repairs as it was not obligatory under the terms of the contract, the representative of the Department, during the course of evidence, stated as follows:—

> "I think there is a little confusion of thought, if I may say so. The payment is not connected with any repairs or anything of that kind. We have to make payments on the occurrence of certain events. In this particular case, 2 payments were due when the fuel was loaded in the Reactor. The fuel should have been loaded in December, 1967 but it was actually loaded in February, 1969; so, the payment that was due in 1967, we made in 1969. These two payments amounted to 3.5 million in U.S. dollars."

The Department of Atomic Energy have further stated in a written reply as follows:

> "The contract is explicit as to when payments are due for Tarapur. Payment No. 39 was due on notice to Government by International General Electric that the Second Reactor is ready for loading of fuel. Payment No. 40 was due on station turnover as defined in the contract. Payment No. 39 was actually paid in March, 1969 after the repairs to the hairline cracks were completed to our satisfaction and notice that the second Reactor is ready for loading of fuel was received. The station turnover was effected on October 28, 1969 and payment No. 40 was made on November 18, 1969."

2.42. When asked what will be the effect of delay on the cost structure of the Project, the Department have stated that as the entire cost of repair had been borne by the contractors in terms of their contract, this will not affect the Project cost. The power cost would not be affected except marginally due to extension in the date of station turnover. In reply to a question* answered in the Lok Sabha on the 24th July, 1968, it had, however, been stated that the loss would include the cost of the Project establishment and the interest on capital during the extended period of construction as well as the loss of possible profits over an equivalent period. The extent of loss that would have to be incurred by Government has not yet been

*U.S.Q. No. 678 on 24th July, 1968.

determined. Further, when asked whether the Project had not lost by the date of extension, looking at it from the commercial point of view, the representative of the Department during the course of evidence stated that a penalty for delay would be imposed on the contractors as provided for in the contract, however, giving them credit for delays which were under *force-majeure* items.

2.43. With regard to the amount of penalty that was going to be deducted from the payment No. 40, it has been stated that an amount of Rs. 143 lakhs had been withheld from payment No. 40 pending determination of damages due from International General Electric due to delay in commissioning the Project and a further amount of Rs. 4.42 lakhs had also been withhheld in respect of works of a minor nature to be done by the contractors after the station turn-over.

2.44. The Committee observe that Government have taken a long time in determining the amount of damages to be recovered from International General Electric on account of delay in the commissioning of the Project. They would like this matter to be settled with expedition.

F. Sharing of Power

2.45. When asked whether any firm agreements had been entered into with the State Governments of Maharashtra and Gujarat for the sale of power to them, the Department of Atomic Energy have, in a written reply, stated that prior to the creation of the two States of Maharashtra and Gujarat, written agreement had been made with the erstwhile Bombay Government for the absorption of Tarapur power at 80 per cent load factor. With the formation of the two States of Maharashtra and Gujarat, an announcement was made by the Prime Minister on the Floor of the Lok Sabha that power from Tarapur would be supplied to the States in equal measure. It was further stated that it had been agreed that in actual operation each State would be entitled to 190 MW from Tarapur during peak load period as well as under emergency conditions. However, sharing of the total output from Tarapur could be varied by mutual agreement depending on system conditions. No firm agreements have been executed so far.

The Chairman, Atomic Energy Commission, during the course of evidence stated as follows:

> "When this power station was decided, on the question of distribution of the power between Gujarat and Maharashtra, there was a very clear-cut announcement that this would be distributed equally between the two States. There was no agreement as such but this was the declared policy of the Government which had been announced publicly. The Central Government has announced while putting up the plant....both the States were supposed to provide a base load. We have asked for 80 per

cent for this power station but in the subsequent calculations we have actually gone to 75 per cent base load. Now this is the nature of the understanding from the very beginning. It was not as I said, a part of written agreement but an announced policy of the Central Government as to how this would be done."

The Tarapur Project Administrator further explained the position as follows:

"Before we started this Tarapur station, we had a written agreement with the erstwhile Bombay Government that they will take power upto 80 per cent of the full load of the Tarapur Station. When the State was bifurcated and two States were formed, we had a similar arrangement and it was announced by the Prime Minister on the Floor of Parliament on 8th August, 1960 that the power will be distributed or will be supplied equally to both the States. It does not mean however that the total power will be equal. In the case of Gujarat, for example, during the night, they are not able to take full load. Maharashtra can easily take it. During the day when the peak period comes, each of the two States will have a share of half the power from Tarapur."

2.46. The Committee were also informed during the course of evidence that there was trouble about the management of the switchyard, as the Gujarat Government after the shutting down of the switchyard had desired that its management should be taken over by the Project authorities. The Chairman, Atomic Energy Commission, stated as follows:—

"Second is about the management of the switchyard. This has now been formally raised by Gujarat Government after the trouble started. The Gujarat Government said that the management of the switchyard was not to their satisfaction. I suggested that the Tarapur Atomic Board should itself look after the switchyard and exercise a better type of supervision. After all we felt concerned with this. Our responsibility was to see that current flows. The views of the Central Power and Water Commission are also similar after discussion with Shri* Mathrani. * * * * * Now we are in the process of negotiation with the Maharashtra Government to see if this can be settled. * * * * * * As far as transmission line is concerned, that is no function of ours. As far as distribution is concerned, it is the function of the State. Power Station and switchyard should be maintained by us because we feel that there is a clear-cut responsibility."

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*Secretary, Ministry of Irrigation and Power.

2.47. The Committee are concerned to note that Government have not so far entered into any written agreement with the Governments of Maharashtra and Gujarat with regard to the sharing of power, although such an agreement used to be there with the erstwhile composite State of Bombay to take power upto 80 per cent of the full load of the Tarapur Station. The Committee consider that the declared policy of the Government regarding sharing of power by both the States in equal measure and taking of power at 75 per cent load factor, announced publicly which according to the Department of Atomic Energy is well understood by both the States is not a satisfactory arrangement. In the light of experience regarding non-acceptance of rates worked out by the Atomic Power authorities by bulk consumers and trouble about the management of the switchyard, the Committee consider that a firm agreement with the beneficiary States on the question of sharing of power, basic assured load, tariff rate, phased programme for erecting transmission lines, switchyard etc. should have been entered into before the Station had begun to flow commercial power. They recommend that steps should now be taken to enter into such an agreement with the concerned States without further loss of time.

2.48. The Committee are also of the view that the Tarapur Project authorities should take over the management of the switchyard. The Central Government has invested hundreds of crores of rupees in all these power projects. With a view to ensure that the power which is produced therefrom is not allowed to go waste and that the Station runs as an economic unit, it is essential that the problems of production, transmission and distribution of power are properly sorted out in advance.

2.49. The Committee need hardly point out the obvious lesson that in the Atomic Power Stations to be put up in future, the Department should ensure that there is a firm written agreement about the sharing of power, rates at which it is to be sold and the management of the switchyard.

G. Demand for Power from Tarapur

2.50. When asked whether it was a fact that there was not enough demand for electricity in the areas adjoining Tarapur Project, Government in a written reply have stated that during monsoon, Maharashtra was endowed with ample hydro power and the lakes over-flow. It had been stated that the question of absorption of power from Tarapur has been discussed at fairly high level and in this connection two studies had been made. One corresponding to an annual generation of 2200 million kwh from Koyna

as per the inter-State agreement and as laid down by the Planning Commission and the other on 3300 million kwh at Koyna. The studies showed that even on the latter basis Tarapur power would be absorbed satisfactorily. It is expected that even during the first year of Tarapur's operation, the absorption of power will be at high load factor, say 75 per cent.

2.51. During the course of evidence, when asked to state how the Tarapur Station was proposed to be utilised during the slack monsoon season and the manner in which the same would affect the economics of power generation, in a folder supplied to the Members of the Committee during the course of evidence, it has been stated as follows:—

"No occasion to close station due to lack of demand.

During monsoon fuelling and maintenance programmes will be carried out.

Power generation economics takes this into account."

2.52. The Committee understand that Maharashtra being endowed with ample hydro power, the lakes are likely to over-flow for a period of three to four months during monsoon. They are also given to understand that reloading of first batch of fuel will be needed in July, 1971 only, which means that there will be no need to reload fuel in the year 1970. Subsequent batches will be required annually from September, 1972. They have also been informed that usual period of fuelling and maintenance programme is four to six weeks which the power generation economics takes into account.

The Committee trust that reloading of fuel and maintenance programme will be phased out in such a way that there will not only be no closure on account of lack of demand but even the closure for maintenance programme will be for the minimum period.

2.53. Since Tarapur Project is a base load Station and the earlier agreement with the erstwhile composite State of Bombay envisaged the utilisation of the Station upto 80 per cent of the full load of the Station instead of the present 75 per cent, the Committee hope that all necessary steps will be taken and alternatives found out to make the maximum use of the power made available by the Station.

H. Cost of Generation and Sale of Power

2.54. It has been stated that the cost of generation of power in Tarapur Station will be about 4.73 paise/kwh, while it is estimated that a thermal station built after devaluation would produce power at a cost of 6.64 paise/

kwh. The original estimated cost of Tarapur power was 3.22 paise/kwh. The increase of 1.51 paise/kwh is explained below:

	Paise/kwh.
Cost of power as assessed in 1962	3·22
Effect of increases in customs duty on plant	0·25
Effect of increases in plant cost due to devaluation	0 09
Effect of increases on fuel cost due to devaluation	0·38
Increase in operation and maintenance cost	0·02
Insurance and Contingencies	0·35
Effect of customs duty on fuel (not included in the original estimate as at the time it was prepared there were special orders exempting uranium fuel elements from customs duty)	0·42
	4·73

In a written reply to a question it has been stated that the cost of generation of power at Tarapur Atomic Power Station was 4.73 paise per kwh calculated on the following basis:

(*i*) Interest on capital	6%
(*ii*) Life	
(*a*) Main Plant	25 years
(*b*) Colony works	50 years
(*iii*) Plant factor	75%
(*iv*) Depreciation on straight line method.	

2.55. The Planning Commission in a written reply to a question on the same subject has stated as follows:—

> "In the case of Tarapur most of the Plant was imported at pre-devaluation prices. It would, therefore, not be reasonable to compare the cost of installing atomic stations in the country with plant and equipment obtained under such circumstances with the cost of installing conventional thermal stations for which plant and equipment is obtained from indigenous sources. Also, in the case of Tarapur and Rajasthan Atomic Stations, the fuel is from imported sources. The cost of nuclear fuel from indigenous sources is very much higher."

2.56. Further, when asked at what rate power was being sold by the existing thermal plants to the State Electricity Boards in Maharashtra and Gujarat, the Atomic Energy Department in a written reply have stated that the information was not available with them. The selling price of power from Tarapur had been fixed at 5.61 paise per kwh and it has been stated in a written reply that this price, according to the Department, had been agreed to by bulk consumers, *viz.* the Maharashtra and Gujarat Electricity Boards. During the course of Committee's Study Tour of Western Zone and during the course of evidence, it was admitted that the State Governments had *not accepted the rate as worked out by the

*At the time of factual verification the Department of Atomic Energy have desired the substitution of "not accepted" by "not formally notified acceptance of".

atomic power authorities and the matter had been referred to the Central Government for *decision in terms of the Atomic Energy Act, 1962. It had also been stated that a marginal profit was expected in the first year of operation and 3 per cent profit was anticipated over the life time of the plant.

2.57. The Committee note that the selling price of power per unit from Tarapur Atomic Power Project has been fixed at 5·61 paise per kwh. This price is stated to have been agreed to by both the bulk consumers, viz., the Maharashtra and Gujarat Electricity Boards. It is presumed that the rate has been got approved with the concurrence of the Central Electricity Authority as required by the Atomic Energy Act.

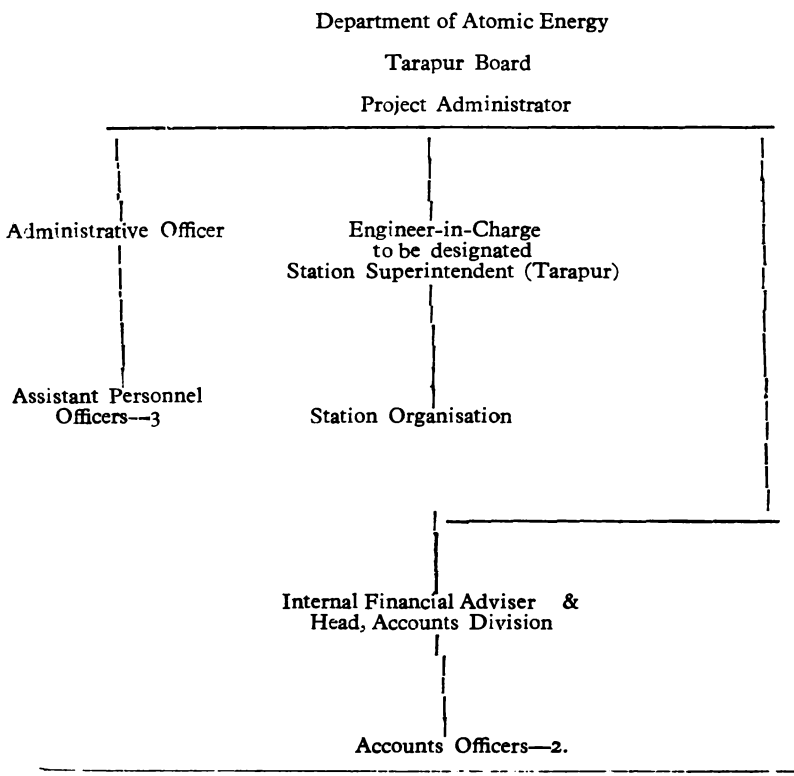
The Committee would, however, like to be informed of the exact cost of generation and the selling price of the power, as approved with the concurrence of the Central Electricity Authority..

I. Organisational set up of Tarapur

2.58. The Organisational set up of Tarapur Board is as follows:

TARAPUR ATOMIC POWER PROJECT

Organisational set up of Tarapur



*At the time of factual verification the Department of Atomic Energy have desired the substitution of "decision" by "concurrence".

The Project Administrator has the authority to deal with all matters covered by and within the terms of the contract with International General Electric Company(IGE). In addition, on matters falling outside the contract, the Administrator has been delegated the powers of the Head of the Department under the Delegation of Financial Power Rules. In respect of matters which are beyond the powers of the Administrator, as thus delegated, the Tarapur Board has been given the authority to give decisions on administrative, financial and technical matters arising in connection with the execution of the contract with International General Electric. Powers of the Board are restricted by expenditure sanction, approved foreign exchange content authorised by the Department of Atomic Energy and the availability of annual budget provisions. The approval of the Department of Atomic Energy is also necessary for any major variation from the contract with the International General Electric that may affect the time schedule or have the effect of increasing the station price by more than Rs. 10.00 lakhs. Basic design changes, matters affecting nuclear hazards, changes in the terms of fuel supply or financing arrangements, major disputes with Contractors, clearance for pre-commissioning and operation of the plant and approval of the procedures from the stand point of nuclear hazards also require the approval of the Department of Atomic Energy.

In respect of matters which lie beyond the competence of the Tarapur Board, all matters which are within the ambit of the delegated financial powers of the Department of Atomic Energy are sanctioned by the Department. In cases, where the proposals involve matters outside such delegated financial powers of the Department, the approval of Member for Finance, Atomic Energy Commission or the Commission itself, as the case may be, is obtained.

2.59. When asked to state the staff strength of Tarapur Atomic Power Project category-wise as on the 1st April, 1967, 1968, 1969 and as on the date of the station turn-over for the operation of station, Government in a written reply supplied the information as given in he table below:

Category of Staff	1-4-67	1-4-68	1-4-69	Station turnover
Administrative	83	106	123	119
Technical .	131	166	239	249
Others	114	157	135	123
	328	429	497	491

A chart showing the position of the staff on station turnover is given in the Appendix-II.

2.60. When asked whether Indian engineers would be able to operate and maintain the Tarapur Project independently in case the engineers of International General Electric were withdrawn and the specific fields in which the foreign scientists would be needed, Government in a written reply stated that the Indian Operations and Maintenance Staff of the Tarapur Atomic Power Project had acquired the necessary competence and could also call upon the expertise in BARC and elsewhere as necessary. It was further stated that as a measure of prudence during the initial stages of operation and maintenance a few experts should be associated.

(a) One reactor operations engineer of General Electric, now at KRB Station in West Germany will be made available for Tarapur for one year. International General Electric had intended to perform these duties through the office of the International General Electric Company located at Bombay. However, in view of our preference, International General Electric have agreed to post the engineer as mentioned above, but they would expect the Government of India to bear a part of his expenses.

(b) One reactor engineer from USA of an analytical type with experience in thermal hydraulic analysis (transient analysis) for a period of six to eight months.

(c) One expert in the field of preventive maintenance for a period of six to eight months.

Further, it was stated that some outside Indian assistance in the conventional field was also being continued for the present. From time to time foreign specialists would also be called in for help in performance audit of the Station. Indian Operation and Maintenance staff will also be sent abroad for training and refresher courses.

2.61. When asked how the staff rendered surplus consequent on the completion of the Project was proposed to be employed, Government in a written reply stated that all the staff would be required for future operation of the Station. Of the 491 persons, 48 are for a common maintenance pool for all Atomic Power Stations.

2.62. The Committee are happy to be informed that the Indian scientists and engineers have acquired sufficient expertise to operate and maintain Tarapur Atomic Power Station independently and that only a limited foreign experts for a minimum period will be required to assist the Indian staff.

2.63. The Committee woud also like to emphasise the need to exchange and rotate senior persons from Tarapur to Kalpakkam and other stations in order to profit from their experience and expert knowledge.

CHAPTER III

RAJASTHAN ATOMIC POWER PROJECT— Units I & II (RAPP I & II)

A. Siting of the Project

3.1. In 1961, the Department of Atomic Energy and the Atomic Energy of Canada undertook a joint study to determine the overall cost of building in India a nuclear power station of the Canadian design (CANDU Type) and worked out details of the components which could be supplied by India and those which had to be imported. The plant was to be built to the design of the Douglas Point Nuclear Power Station then under construction in Canada. The Douglas Point Nuclear Power Station was a natural uranium fuelled and a heavy water moderated reactor. The Planning Commission authorised the Department of Atomic Energy in 1961 to select suitable sites for nuclear power stations in India. The Committee was headed by Shri M. Hayath, Director (Technical), Heavy Electrical Limited and formerly Chairman of Central Water and Power Commission. In accordance with the Report of the Committee submitted in January-February 1962, the following regions were recommended by the Committee in order of preference:

(i) Rana Pratap Sagar near Kotah in Rajasthan.

(ii) Gangabas in Bulandshahr District, U.P.

The two State Governments were addressed to ascertain their willingness to comply with the various conditions which were a prerequisite to the establishment of nuclear power station and the Government of Rajasthan agreed to comply with the conditions. They offered sufficient land free of cost for setting up an atomic power station. It was decided with the approval of the Cabinet in August, 1962 that the second power station in the country should be built in the vicinity of Rana Pratap Sagar in Rajasthan. The Station will use natural uranium as fuel and heavy water as moderator and coolant. It will have a net generating capacity of 400 MWe consisting of 2 units of 200 MWe each. Although the Rajasthan Station was *ab initio* envisaged as a Station consisting of 2 units of 200 MWe each only one unit was included in the Third Five Year Plan. Approval of the Planning Commission for the addition of the second unit was obtained in October, 1964 and that of the Cabinet in June, 1965.

Special features

3.2. Both RAPP-I and RAPP-II are being built by Indian engineers with the assistance of Canadian consultants. In the case of RAPP-II, several components of the nuclear plant will be fabricated in India. The cost of foreign exchange component is about 60 per cent for RAPP-I and will be about 40 per cent for RAPP-II. As regards fuel, only 50 per cent of the first charge of RAPP-I will be imported from Canada. Except for this, all the fuel requirements of the Rajasthan Station will be met entirely from Indian sources. The fuel elements will be fabricated at Trombay and at the new plant being set up at Hyderabad, using natural uranium which would be extracted and processed into uranium concentrates by the Uranium Corporation of India Ltd. The requirement of heavy water to be used in the first unit of this station as coolant and moderator will be obtained on lease from Canada. Additional heavy water for the future stations will be produced at the Heavy Water Plant, proposed to be set up by the Department at the site of the Rajasthan Atomic Power Station, Kota, utilising extra steam generated by the reactors for this purpose.

The Rajasthan Atomic Power Project will employ CANDU type reactor units which use heavy water as moderator and natural uranium as fuel. Reactors of the CANDU type have been found to be very efficient in the use of natural uranium and they also produce substantial quantities of plutonium as a by-product in the spent fuel. Just as coal or oil is to be fed constantly to a thermal power station, in the case of the nuclear power station also nuclear fuel will have to be fed to the reactor and spent fuel removed from it more or less on a continuous basis. From the spent fuel, plutonium is recovered which is a very valuable nuclear material required to fuel advanced breeder reactors which have the potential of using thorium. Reactors of this type have been accepted as the major feature of the first phase of the nuclear power programme of the country.

B. Agreement with Canada

3.3 Two agreements relating to this Station were signed between India and Canada. The first agreement pledged cooperation between the Indian and Canadian Governments specifically for the construction of a nuclear power station in Rajasthan. Under this agreement which was signed in December, 1963, the Department of Atomic Energy would act as the prime contractor and would be responsible for the erection of the station while Canada would provide the design of the station with detailed working drawings and specifications of the station upto the steam raising equipment. The Governments of Canada and India also agreed to exchange information specifically regarding the operation of the Rajasthan Station and the Canadian Station at Douglas Point. The second agreement was between the Department of Atomic Energy and the Atomic Energy of

Canada Limited (AECL) under which the two parties would freely exchange scientific and technical information in regard to the development of heavy water moderated systems.

Initially, the Atomatic Energy of Canada Limited would supply detailed design data including working drawings (which had been valued by the Government of India at $ 5 million) free of cost to India and without deduction from the Colombo Plan or other assistance. The Atomic Energy of Canada Limited were appointed as the consultants for the nuclear portion of the Plant. The consultancy agreement with Atomic Energy of Canada Limited was of a non-commercial nature and provided only reimbursement of cost of time of engineers and overheads. Montreal Engineering Company Limited of Canada (MECo) were appointed the consultants for the non-nuclear portion of the Plant in view of the association of some of their engineers with Atomic Energy of Canada Limited on nuclear power projects. In April, 1964, an agreement was entered into with the Export Credits Insurance Corporation of Canada (ECIC) providing for a loan to cover the foreign exchange component cost of Rajasthan I.

In December, 1966, a supplemental agreement was signed with the Government of Canada. The effect of this was to extend to Rajasthan II the agreement signed in December, 1963 in respect of Rajasthan I. Supplemental agreements covering Rajasthan II were also concluded with Atomic Energy of Canada Limited in January, 1967 and Montreal Engineering Company Limited of Canada in February, 1967, as also with a subsidiary of Montreal Engineering Company Limited of Canada in February, 1967 which, it had been stated was set up in India at the instance of the Department of Atomic Energy with a view to reducing foreign exchange costs. An agreement was concluded with Export Credit Insurance Corporation of Canada in April 1967 to cover the foreign exchange cost of Rajasthan II (later amended in April, 1968).

3.4. When asked to state the reasons for the long time taken in concluding various agreements with the Canadian Government, the Atomic Energy of Canada Limited and the Export Credit Insurance Corporation of Canada, the Chairman, Atomic Energy Commission during the course of evidence stated as follows:

> "Dr. Bhabha's view was that for our ongoing programmes we should certainly take the foreign collaboration and assistance as and when necessary. But that should not be on discriminatory terms. He wanted to negotiate a situation in which if Canada was imposing safeguard on Rajasthan, then India should in turn impose safeguards on the Canadian reactor. This is a ticklish point. This is a fairly equitable way of doing a thing.

This is an unusual thing that in international relations that the aid-giving authority and the people who get it should accept the safeguards from the receiving countries for their own facilities. This was a matter of principle as seen by Dr. Bhabha and the late Prime Minister, Shri Jawaharlal Nehru. We wanted to go in for direct negotiations for coming to a final agreement which would be acceptable to the Canadian authorities as well as us. * * * * *".

In a subsequent note furnished to the Committee, it has been stated that

"The negotiations with the Government of Canada, AECL and ECIC of Canada were protracted due to the differences in approach of the two sides regarding safeguards provisions and need to hammer out a compromise."

3.5. Further asked to state why a period of almost two years was taken in concluding supplementary agreements with various bodies when it was only a matter of extending the existing agreements in respect of Unit I to Unit II, in written reply it has been stated that "the delay in signing the agreement was due to the prolonged discussion with the Government of Canada regardings terms of technical co-operation and financing the foreign exchange cost of the project. The delay was mainly due to need to reach agreement on the safeguards aspects."

3.6. In response to the enquiry as to why no global tender was invited as was done in the case of Tarapur Power Project, the Chairman, Atomic Energy Commission, during the course of evidence stated as follows:—

"According to our assessment, Canada was the one country which had got the most interesting concept of reactor design which had also assisted us earlier in putting up the Canada-India reactor which also uses natural uranium, so that in regard to heavy water moderation as well as in regard to the use of natural uranium as a fuel we did have technical collaboration earlier with Canada and our view was that by working with them, we would be able to get out of this dependence on foreign aid so it was important to judge this more from the point of view of the long-range plan rather than the unit cost of that particular unit.

This was not looked upon purely from the finance point of view, but in relation to the training and self-reliance which we could develop. There are many improvements. In Tarapur, the project manager was not there from our side, but they were there to assist us to build the subsequent plants; but in the Canadian thing in Rajasthan, India had the project manager.

In the case of Tarapur, the project manager was the General Electric Co. This was the case of a country which had earlier collaborated with us under the Colombo Plan in the setting up of the Canada-India reactor; we felt that by doing this and getting on to the thing we would in the quickest way be able to get self-reliance and that was the main reason why it was not looked at from the point of view of open tender. * * * * * * * * * * * * The main purpose of this project was of course to have an atomic power station, but the major purpose was to bring about a situation of self-reliance in future; so, we were not looking at it from the purely price point of view as we did in the case of Tarapur; even here if we had wanted to go in for natural uranium, we would have got a cheaper project than this, but our considerations were to get self-reliance."

3.7. The Committee note that for the setting up of RAPP-I, Cabinet gave approval in August, 1962, but work at site picked up momentum towards the end of 1964. Similarly, for RAPP-II, the Cabinet gave approval in June, 1965 but work at the site commenced in April, 1967. They would like to observe that an unusually long time was taken by Government in negotiating the agreements with the Canadian Authorities.

3.8. The Committee also note that Government's decision to go in for a natural uranium reactor for RAPP is in keeping with their objective to make use of a technology which will enable the country to be self-relient in the future nuclear power production programme based on the use of plutonium and thorium of which India has a larger reserve.

3.9. The Committee cannot, however, resist the impression that the Department of Atomic Energy has taken ad hoc decisions in the setting up of power projects. While, in case of Tarapur, attractive initial capital outlay was the main consideration and global tenders were called for, in the case of Rajasthan it was not looked upon from the financial angle and no global tenders were called for. They, however, hope that the expenditure involved in the setting of the RAPP will be commensurate with the benefits to be derived in the shape of economic gain, self-reliance and technical experience.

C. Cost Structure of the Project

3.10. Asked to state the original estimates of the total cost and the revised estimates of the two units and the reasons for the increase, Govern-

ment in a written reply have furnished the following information:

Project	*Original estimates of the total cost*	The revised estimates of the total cost 1967)	*Increase*
		(Figures in Rs. crores)	
RAPP-I.	33·42	52·50	19·08
RAPP-II	30·00	58·16	28·16

It has been stated that increase in the cost was mainly due to extraneous factors, like devaluation (Rs. 10.22 crores), increase in customs duty (Rs. 3.33 crores), increased escalation in price (Rs. 5.53 crores) in case of RAPP I. With regard to RAPP II, it is said that in addition to above factors, a further increase had resulted due to increased indigenisation of equipment. The Committee are informed that second revised estimates of costs were currently being made in the context of the delay in the completion of the station.

The actual expenditure so far incurred upto 1968-69 on RAPP-I & I is as follows:—

Project	Estimated total outlay	Actual expenditure upto 1968-69	Budget Estimates 1969-70
		(Figures in Rs. crores)	
RAPP-I. .	52·50	41·75	7·03
RAPP-II .	58·16	8·47	7·26

3.11. The Committee are concerned to note that the orginal estimates of the total cost of RAPP I and II have risen from Rs. 33·42 and 30 crores to Rs. 52:50 and 58·16 crores respectively and are further likely to be pushed up in view of the delay in the completion of the project. They fear that the increased cost of this proect is bound to affect ultimately the cost of generation of power per unit. They would like to sound a note of warning that Government should take concerted measures to keep down the cost so that the Nuclear Power Project does not become an uneconomic proposition and the power generated can compete with conventional sources in price level.

D. Indegenisation in Equipment and Machinery

3.12. The Committee are given to understand that the foreign exchange component of Unit I of the RAPP is about 60 per cent whereas in the case of Unit II of RAPP it is 40 per cent. As regards fuel, only 50 per cent of the first charge of RAPP I will be imported from Canada. Except for this, all the fuel requirements of the Rajasthan Station will be met entirely from Indian sources. The fuel elements will be fabricated at the new plant being set up at Hyderabad, using natural uranium which would be extracted and processed into uranium concentrates by the Uranium Corporation of India, Ltd.

3.13. It is stated that with the experience gained on Rajasthan-I, it was decided to manufacture the bulk of nuclear components in India, utilising the detailed designs obtained from Atomic Energy of Canada Limited and some Canadian suppliers in respect of similar components used in Rajasthan Unit I. In a written reply to a question about the content of indigenous material and equipment that had been/would be used in the nuclear and conventional operation of the RAPP I and II, the following information has been given:

	Total estimated cost of machinery and equipment	Estimated cost of indigenuos material & equipment
	(Figures in rupees crores)	
RAPP I	26·82	6·33
RAPP II	26·81	12·17

It is stated that certain items of equipment required for the electrical switchgear, transmission equipment, pumps, compressors etc. for the water system are being manufactured in India.

The area of Canadian consultancy of RAPP II has considerably been reduced and so far as nuclear equipment is concerned, the services of the Canadian consultants, will be utilised to a limited extent only for inspection of the nuclear equipment manufactured in India. The major items of conventional equipment in respect of Unit II, including the turbine generator and auxiliaries were, however, included in the list of equipment to be imported as at that time Indian manufacturers were not able to meet the required time schedule.

3.14. In reply to a question whether any of our public sector undertakings or private sector ones are supplying those components and whether they are supplying them regularly or not, the Director, Bhabha Atomic Research Centre stated as follows:

> "We placed orders with Bhopal but there were delays. For instance the main transformer has been delayed. It is now due in

another month or so. On the other hand, certain Canadian firms have also let us down. For instance the Turbo set was delayed by more than a year. We also had delays on equipment like cranes, etc. There has been quite a problem with Rajasthan Unit No. II. We require for each of these stations fairly substantial amounts of quality carbon steel. An order was placed with HSL for certain flat products but had to be transferred to a firm abroad because the material did not come up to our specifications. * * * * * * * As far as steel is concerned, there have been many problems in getting it, specially thicker varieties. Thicker sizes have laminations and we cannot use this material for nuclear purposes. This is our problem."

3.15. Replying to another question whether there is any other difficulty apart from adequacy of funds, in fulfilling the targets, the Chairman, Atomic Energy Commission, during the course of evidence, stated as follows:

"After all, the Atomic Energy Department and its groups can only fulfil those aspects of requirements which are not catered to by other major public or private organisations. We are not in the generators field. We should not be setting up a plant for making generators. In these things and for steel, for special metals of various types, and for heavy engineering, we must depend on outside organisations. And in this, proper mandate and coordination is quite crucial. As far as I can see, there is scope for our internal improvement, and the external coordination has to be tightened up. I think if we have a clear cut mandate not for three or four years but for ten years, we can really make progress. One of the problems was of Bhopal. They said 'you are asking us to go into all these troubles. But what assurance you will give for orders'. Unless I have the concurrence of the Planning Commission and other Ministries here that these power plants are considered to be good and are required, I am not able to think that we shall have in ten years four more generators. I know these are required, but I must have a mandate. I cannot say this to Bhopal. This is where the problem lies."

3.16. As regards coordination among Government Departments, the Chairman, Atomic Energy Commission, stated:

"As regards the second point, namely, coordination, nationally, I agree with the Chairman and the view here that there is tremendous scope for the improvement of our own national management of these things. I have no doubt that our overall

performance nationally is poor. This coordination is there on paper, but when it comes to delivering the goods, there are so many different agencies which are involved that it is very difficult to get, in fact, that type of accountability which I feel should be there. This is a wider aspect of a national organisation which I cannot myself comment upon. But I would share your view that in this country, if we want to undertake this major project, economise and get on with the job, we would require a much greater coordination than what exists. I have no doubt about it."

3.17. The representative of the Planning Commission, while explaining the position about the turbine for Kalpakkam Project, stated that it would be certainly an advantage if the lump-sum fee that the Heavy Electricals, Bhopal had to pay for the technological documentation etc., could be spread over large number, because that would bring down the price of the turbine. He added that even if were to go in for one turbine, there would still be a saving of foreign exchange worth about a crore of rupees.

3.18. In reply to a question whether tenders were invited from private as well as public sectors about the supply of conventional equipment including turbine generator and auxiliaries for RAPP II, the Department of Atomic Energy in a written reply have stated as follows:—

"Tenders were invited in all cases and quotations were evaluated, keeping in view the technical capability of the firm, as well as the price, and delivery schedules quoted. The turbo-generator was decided to be imported, not only to meet the time schedules, but also as much more engineering would have been involved in incorporating indigenous equipment."

3.19. The foreign exchange cost of the turbine generator is stated to be Rs. 422.66 lakhs. The order for this turbine generator was placed with a Canadian firm in September, 1968 and the date of shipment, though fixed as September, 1970 had been further delayed by a year. The Chairman, Atomic Energy Commission, while explaining, during the course of evidence, about the conditions for entering into foreign collaboration has *inter alia* stated :

"* * * * but in Canada particularly, the industry there itself was new with some of those nuclear components just as in India. There have been many major delays in the supply of Canadian equipment to Rajasthan."

3.20. The Committee note that for RAPP I and II, the Department of Atomic Energy had initially placed orders with the Hindustan Steel Ltd. for certain flat products using quality carbon steel, but these orders

had to be transferred to a firm abroad as the material forthcoming from H.S.L. did not conform to the prescribed specifications. The Committee would like Government to look into the matter so that the requisite variety of steel for nuclear power stations could be supplied from indigenous soucres, thereby achieving self-reliance and saving valuable foreign exchange.

3.21. The Committee further note that orders for machinery and equipment placed on Heavy Electricals India Limited, Bhopal and Heavy Engineering, Ranchi had also not been fulfilled. They are distressed to learn that none of these public undertakings were able to deliver the goods.

3.22. The Committee are convinced that to a considerable extent the delay in the execution of the Project has been caused by lack of coordination amongst the various Ministries/Departments concerned which they deprecate. They consider that in important matters like these, close coordination and cooperation of all Departments concerned is absolutely necessary and recommend that proper procedures should be laid for expeditious despatch of work especially where several Departments/ Ministries are concerned.

E. Delay in execution of Project

3.23. In reply to a question* answered in the Lok Sabha on the 23rd August, 1965, Government had stated that the first unit of Rajasthan Atomic Power Project was expected to go into commercial operation during the later part of 1969 and the second unit before the end of the Fourth Plan, if suitable arrangements could be completed at an early date for financing the foreign exchange component.

In reply to another question** answered in the Lok Sabha on the 27th March, 1968, it was stated that the expected date of full commissioning in respect of unit I was 1970-71 and in respect of unit II was 1971-72 respectively. However, during the course of evidence in October, 1969, it was stated that completion of construction and criticality of reactors I and II would be in early 1971 and 1973 respectively and the commercial operation of the stations would be six months thereafter after testing.

3.24. Asked to state why the work on Unit I could not be completed by the due date, Government in a written reply has stated that the original schedule for completion by 1969 was deliberately tight and ambitious taking into consideration the first that even in Canada the first large reac-

*U. S. Q. No. 487 on 23-8-1965.

**U. S. Q. No. 5416 on 27-3-1968.

tor of the same type was also under construction. The following four reasons have been given for the delay in the completion of the Projects:—

(i) Protracted negotiations in finalisation of the various agreements. Cabinet gave its approval for Unit I in 1962 and the work at site picked up momentum only towards the end of 1964. Cabinet approved Unit II in June, 1965 but the work at site commenced in April, 1967.

(ii) Serious delay in the supply of equipment and machinery both by the Indian and Canadian suppliers.

(iii) Part of the delay is also related to work which had to be executed by Government Department, following Government procedures. In this connection, they pointed out that the main station at Tarapur was entrusted to a single private contractor (IGE) whose procedures were far more flexible and less time consuming.

(iv) Technical improvements had become necessary in order to make it run smoothly and with economy.

3.25. With regard to technical improvements, the Chairman, Atomic Energy Commission, during the course of evidence stated that:—

"The Douglas Point Plant was based on a Power Station of 20 MW running in Canada since 1962 or 1963 and large number of people from India had observed its operation at that level. .. The question of extrapolation involved scaling of the size from 20 MW to 200 MW. Canada undertook its operation in 1960 and the Project was scheduled to be completed by about 1965 but it was delayed for 2 years with the result that the operational experience came along only in the following years."

To a question as to why Government went in for a plant which was still in an experiemental stage in Canada, the Chairman, Atomic Energy Commission replied:

"This is the only natural uranium reactor which will make us self-reliant."

When asked whether it was desirable to make changes in the design of the Station and how far it was advisable for the Department to spend

huge amounts in learning these things while building, the Chairman, Atomic Energy Commission, stated as follows:—

> "I would like to point out that unless our engineers and scientists also come into the situation and know the development process, we shall be always trailing behind and will have to rely on outside help. I think we have at some stage to acquire self-confidence of being able to tackle a problem or defect and make the plant work. And I think in the process of economic development as I put it, we have to take this type of challenges in order to develop the competence for being able to do all the things that we shall be required to do.***** Let us look at the other way. Take other fields. We never got over the purchase and this business of importing any worthwhile technology. And in this particular case, I would say—what it costs, if we assume that it has meant two years delay? I would say that the interest would be perhaps three crores a year and therefore in two years, 6 crores.**** We can take up Tarapur. But it is not two years or three years. Tarapur plant was a well proved style. The best natural uranium design was the Canadian. Do we go far changes at this stage or not? If we had not gone, then our entrie programme of plutonium production would have been delayed by so many years."

3.26. The Committee regret to note that the Rajasthan Atomic Power Units I and II which were originally scheduled to be commissioned in 1969 and 1970-71 will now go into commercial operation by 1971 and 1973. This would mean that while the gestation period in respect of Tarapur Atomic Power Project was five years, in the case of Rajasthan Atomic Power Projects Unit I and II is seven years.

3.27. The Committee have a feeling that Government were rather hasty in taking up the RAPP without proper assessment of the technological development and infra-structure of the industry inside the country and the requisite skill and expertise in the particular field obtaining even in Canada. As a consequence, the project has been delayed for non-delivery of equipment in time. Moreover, several changes had to be made in the design during the process of construction of the nuclear and conventional portion of the project. They consider that a poor country like India can ill afford to pay a heavy penalty to the tune of rupees six crores owing to the aforesaid reasons.

F. Cost of Power Generation

3.28. In reply to a question* answered in the Lok Sabha on the 18th December, 1967, the estimated capital cost and the annual average cost

*U, S, Q. No. 4724 or 18-12-1964,

of production per kwh of the Rajasthan and Tarapur Projects were given as below:—

	Estimated capital cost (Figs. in $ Rs. crores)	Net capacity	Estimated annual cost of production (Paise/Kilowatt Hour)
Tarapur Atomic Power Station . . .	82·69	380 Mwe	4·50
Rajasthan Atomic Power Station . . .	110·66 (excluding cost of $ heavy water)	400 Mwe	5·71 (Provisional

3.29. The Department of Atomic Energy have, however, stated in a written note furnished to the Committee that:—

> "On present indications, the cost of generation of power in the Rajasthan Station would be approximately the same as at Tarapur *i.e.* 4.73 paise/kwh and might not be subject to more than 10 per cent variation as a result of any increase in the capital cost or the cost of fuel elements that might come to light in the future."

3.30. In a note furnished to the Committee, the Planning Commission have stated that the costing of energy generation from Rajasthan Atomic power Station has been estimated by the Department of Atomic Energy as follows:—

	Rs.
1. Capital cost per kw	3,150
2. Fixed cost (paise/kwh)	4·38
3. Fuel cost (paise/kwh)	0·34
4. Total production cost excluding profit (paise/kwh)	4·72

The Planning Commission do not, however, agree with the above estimate. According to them, the fixed charges should come to 5·5 paise as against 4.38 paise/kwh. They have further stated that in the case of Rajasthan Atomic Power Station, the Project Report has indicated that the fuel charges per unit would be 0·62 paise whereas in the above table, the fuel cost has been shown to be 0·34 paise/per unit. In the Project Report, the uranium price was Rs. 302 kg. and burning rate presumed to be 9,000 MWD/tonne and thermal efficiency 28·8 per cent. The cost

of fuel has since gone up and the cost of imported fuel is now indicated to be Rs. 512 per kg. and that produced in Nuclear Fuel Complex Rs. 475/kg. The fuel cost per unit generated at Rajasthan would be considerably higher than 0·62 paise indicated in the Project Report. It is not understood how the fuel cost has now been indicated to be 0·34 paise per unit and the Department of Atomic Energy have been requested to clarify this.

3.31. The Committee are surprised to note the wide variations in the estimated cost of generation of power by RAPP as furnished by the Department of Atomic Energy from time to time. According to the Planning Commission the cost of generation of power in RAPP should be considerably higher. The Committee need hardly stress the desirability and importance of working out the cost of generation of energy in advance as a firm estimate in this regard has an important bearing not only on the economics of the plants but also on the willingness of the consumer States to purchase it at reasonable rates.

G. Demand for Power in Rajasthan.

3.32. During the Committee's visit to Kota in August, 1969, they gathered the impression that there was already surplus power available in and around Kota. In the Ranapratap Sagar Hydel Power Project which consisted of four units generating 43 MW each, only one unit was then working on account of lack of demand. Apart from that certain factories *e.g.* the Sriram Fertilizers Factory, Sriram Rayon etc. were producing their own power having installed Captive Thermal Power Stations.

As regards the estimated demand of power in Rajasthan in 1971 when Unit I of the RAPP is likely to be completed and for a period of ten years thereafter, the Ministry of Irrigation and Power in a written reply have stated that at present the load demand in Rajasthan is of the order of 200 MWe. It was expected to rise to 390 MWe by 1971-72 and further to 583 MWe at the end of 1973-74. On the basis of an increase of 12 per cent annual growth rate, the load demand at the end of 1978-79 would be 1,030 MWe. When further asked to state whether it would be possible to utilise in full the additional 200 MW of power that would be available from Unit I by 1971 and another 200 MW of power that would be available from Unit II by 1973, the Ministry of Irrigation and Power have stated:—

> "Taking into account the retirement of obsolete plants, (for the conventional generation schemes), the installed generating capacity expected to be available in Rajasthan at the end of

Fourth Plan perid would be above 582 MW resulting in a firm capacity of 300 MW. As against this the load demand at the end of 1973-74 is expected to be 583 MW. There is, therefore, a scope for full utilisation of power available for the nuclear power station at Ranapratap Sagar. However, in order to enable the station to work as a base load station, some off-peak surplus power available in Rajasthan may have to be exported to Delhi, Haryana and Punjab in the Northern region which will have a deficit of about 500 MW at the end of 1973-74."

3.33. In reply to another question whether there was well-developed power system in Rajasthan which would make it possible to operate the nuclear power station at the optimum load factor, the Ministry of Irrigation and Power had stated that facilities for full utilisation of the nuclear power from RAPP were underway. A 220 KV single circuit transmission lines from RAPP to Udaipur and a 220 KV double circuit line from RAPP to Kota and thence on to Jaipur was already under construction and would serve to receive the full output from RAPP. It has been further stated that, however, to enable RAPP to operate as a base load sation off-peak surplus power would have to be exported to Delhi and Punjab; and accordingly an inter-State 220 KV line between Jaipur and Delhi is also being planned. According to the Ministry of Irrigation and Power, the following measures would be called for on the commissioning of the Rajasthan Project to sort out and solve the problems of distribution of power :

(i) Re-inforcing transmission and distribution system.

(ii) Getting firm commitments from and executing formal agreements by the RAPP with the State Electricity Boards/Electricity Supply Undertakings of the neighbouring States of Rajasthan, Punjab, Haryana, Delhi and Madhya Pradesh.

The Ministry of Irrigation and Power have, however, admitted—

"Although industrial development in the Region may not be at a fast enough pace, the inherent characteristics of the power system in this region are ideal for location and economic operation (at high load factors) of nuclear power stations when operated in an integrated manner with other hydro power stations which could take the peaks."

3.34. The Chairman of the Atomic Energy Commission during the course of evidence before the Committee has also expressed similar views that with the existing pattern of the industry in Rajasthan, there might not

be so much consumption of power immediately and has explained the position as follows:—

> "....this whole region is now regarded as a grid with the whole series of things, this at the southern end and Bhakra-Nangal and some other stations at the northern end. With these new lines which are being constructed and those which are already existing, the proposal is to have the most optimum distribution of power through this grid from one area to the other taking into account the load and the peaking demands. The fact that the Ranapratap Sagar Dam has also got a hydel power station with good peaking capacity being borne in mind, the establishment of the base load station of nuclear power in that area according to our estimation is intrinsically sound. It may be that with the existing pattern of industry there, there may not be so much consumption of electricity immediately; but Kota has developed rather well as an industrial unit. In my discussion with the Rajasthan Government I have been told that there are many projects in Rajasthan, particularly dealing with lift irrigation as well as electro-thermic process for production of phosphorous from the phosphatic rocks that they have found near Udaipur, so that the industrial development of that area which has been hampered so far by the non-availability of inexpensive electricity and firm supplies can now go ahead. So, the Ranapratp Sagar Hydel capacity together with the base load capacity of the nuclear power station would be used. So, this is essentially sound and would benefit this area and also firm up the whole grid as it now stands."

3.35. The representative of the Planning Commission pointed out that the power intensive industries that are already being set up are (i) zinc smelter which was being doubled during the Fourth Plan; (ii) the Copper Complex at Khetri. They have also stated that in the Fourth Plan stress had been laid on the connecting up of the inter-State grids in order to utilise to the maximum extent the power generated in a particular power supply system.

Agreement for Absorption of Power from RAPP

3.36. In reply to a question whether any firm agreement had been reached with the Rajasthan Government regarding the absorption of the power to be produced by RAPP I and II and the price at which the same would be sold to the State Electricity Board, Government in a written reply have stated as follows:

> "So far as the Rajasthan Atomic Power Station is concerned, there is no indication yet from the Government of Rajasthan regard-

ing the minimum off-take of power by them and the optimum load factor. The Rajasthan State Electricity Board has proceeded with the installation of the double circuit 220 KV transmission line from Rajasthan Atomic Power Station to Kota and then to Jaipur. The tariff for sale of power from the Rajasthan Atomic Power is yet to be fixed and an arrangement with the Rajasthan State Electricity Board and the Electricity Boards of other beneficiary States in the Region cannot be entered into at present."

Government have also stated that no firm agreement had been signed with regard to absorpotion of power to be produced by RAPP I and II.

The following question was asked:

"(a) Has any firm agreement been reached with the Rajasthan Government regarding the absorption of the power to be produced by RAPP I and II and the price at which it will be sold to the State Electricity Board? If so, please furnish a copy thereof.

(b) What is the estimated difference in the cost of generation of power and its supply?

(c) Please clarify as to who would bear the loss?"

Government in reply sent in January, 1970 have stated as follows:

"(a) No firm agreement has been signed with regard to absorption of the power to be produced by RAPP I and II. In this connection, please refer to reply to Point No. 3... (reply quoted on pre-page).

(b) & (c). Does not arise in view of reply to (a) above."

3.37. The Committee regret to note that no written agreement has so far been executed regarding the basic assured load, tariff rate, phased programme for erecting transmission lines, switchyard, etc. by the Atomic Energy Department with the Government of Rajasthan or the neighbouring States. They apprehend that in the absence of any written agreement several complications might arise when the Atomic Plant is on stream.

3.38. The Committee note that RAPP was set up with a view to meet the future power requirements of Rajasthan and neighbouring States with a hope that there will be faster industrialisation in the region and that it will absorb the power generated therefrom in due course of time. The Committee also note that at present there is hardly any infrastructure to absorb the power expected to be generated at maximum load factor.

3.39. The Committee suggest that with a view to operate the Station at the optimum load factor, the following steps should be taken well in advance so that by the time the power starts flowing from the Station, there is sufficient demand for the power and it works as an economic unit:

(i) Reinforcement of the transmission and distribution system;

(ii) Execution of formal agreements between RAPP and Rajasthan and other beneficiary State Governments *re*: utilisation of power, etc.

(iii) Timely development of the industries like copper complex at Khetri, zinc smelter and production of phosphorus at Udaipur and the setting up of other industries in and around Kota.

H. Requirements of Heavy Water

3.40. During evidence, in a folder supplied to the Members of the Committee, the following information regarding the production of heavy water was given :—

(i) Requirements for RAPP I-II, MAPP-I . 210 tonnes each

(ii) No imports so far

(iii) Balance of requirements beyond indigenous supply will be obtaind on lease from abroad.

(iv) Indigenous availability

Esisting	Nangal	15 tonnes/year
Future	Kota	100 tonnes/year
	Baroda	67 tonnes/year

(v) Progress on Kota and Baroda plants

Kota	Site selection and survey completed
(Estimated cost Rs. 19·5 crores)	Process calculations completed RAPP preparatory work in hand to enable start of main construction early 1970
Baroda	Project sanctioned
(Estimated cost Rs. 16·0 crores)	Agreements signed Land acquisition started.

3.41. The following additional material was furnished through a written note :

"The proposed plant at Baroda which will be attached to the Gujarat Fertilizer Plant will use the Ammonia—Hydrogen Exchange Process developed in France and will have a capacity of 67.2 tonnes per annum.

The Project is estimated to cost Rs. 15.1 crores with a foreign exchange components of Rs. 7.75 crores".

3.42. In reply to a question* answered on the 18th March, 1970, it has been stated that the requirement of heavy water for RAPP I and II and MAPP I will be 230 MT and that the present production of heavy water in the country is of the order of 14 tonnes per annum.

Heavy Water is required as a coolant and moderator in CANDU type reactors. As regards the urgency of setting up plant for heavy water, it has been stated in reply to a Question** in the Lok Sabha on the 23rd August, 1965, as follows :—

> "The second unit of the Rajasthan Atomic Power Station and the two units of the Madras Atomic Power Station will each require approximately 200 tonnes of heavy water, which if imported will cost Rs. 15 crores. The Department has put up a proposal to build a heavy water plant without foreign consultancy at an estimated cost of Rs. 21 crores with a foreign exchange component of Rs. 9 crores. This will save Rs. 6 crores foreign exchange on heavy water for these three reactors alone. The plant has however not yet been sanctioned by Government and any further delay in its sanctioning willl lead to delay in the coming into operation of the three power reactors. This proposal was put up by the Department to Government as far back as March, 1965. Unless this heavy water is produced in India, all the three power stations, will be under international safeguards."

Heavy Water Pilot Plant at Bhabha Atomic Research Centre

3.43. The Heavy Water Pilot Plant at Bhabha Atomic Research Centre was set up in 1963 to obtain technical data and study operational problems and not to produce heavy water of any particular concentration. A total expenditure of Rs. 8.35 lakhs has been incurred for equipment required specifically for this research plant. The foreign exchange component of this expenditure is Rs. 5.19 lakhs. It is claimed that the working of this Pilot Plant has yielded valuable process information for setting up the large scale plant at Kota which will be set up without any collaboration from foreign countries and will be based on know-how developed indigenously. The official witness, however, stated during the course of evidence regarding heavy water production that "we are running into difficulties regarding this. We have visualised a technique for supply of heavy water by certain plants. But this is not attainable immediately because of the lack of technical know-how. This has to be attained first".

3.44. As severe criticism about the working of this plant had appeared in a Bombay Weekly, the Chairman of the Committee specifically desired

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*U. S. Q. No. 3512 on 18-3-1970

**U. S. Q. No. 487 on 23-8-1965.

to have a detailed note on the working of this plant, expenditure involved therein under various heads, its output and its effect on the setting up of the Heavy Water Plant at Kotah. The Director of Bhabha Atomic Research Centre, however, did not send any reply. Subsequently, however, the Committee received a reply to some of the points mentioned in the articles in the set of replies furnished by the Department of Atomic Energy which was found to be inconclusive.

3.45. A comparative statement of the Demands for Grants of the Department of Atomic Energy giving budgetary provisions in respect of heavy water for the years 1965-66, 1966-67, 1967-68, 1968-69, 1969-70 and 1970-71 are given in Appendix III. A statement giving the actuals and budgetary provisions in respect of Kota Heavy Water Plant is as below:

Year	Budget Estimates	Actuals
1965-66		43,184
1966-67	2,25,00,000	1,82,351
1967-68	50,00,000	3,199
1968-69	2,00,00,000	1,05,120
1969-70	2,00,00,000	
1970-71	3,18,00,000	..

3.46. The Committee are constrained to observe that inspite of the realisation of urgency by Government in regard to the production of heavy water indigenously to meet the requirements of the two units of Rajasthan Atomic Power Project as also that of Madras Atomic Power Project, nothing substantial has been done in the matter so far.

3.47. They regret to note that unduly long time was either taken by Government to sanction the proposal of the Department of Atomic Energy to build a heavy water plant or the Department itself has taken a long time to start the construction of the Heavy Water Plant at Kota. The Committee note with concern that Heavy Water Pilot Plant of the Bhabha Atomic Research Centre which was set up as early as in 1963 to provide technical know-how for the large scale Kota Heavy Water Plant at Kota has failed in its objective and has been the prime factor contributing to the delay in the setting up of the Kota Plant. The Committee feel that with a view not only to conserve foreign exchange but also obviate "International Safeguards" which are imposed in obtaining heavy water from abroad, Government should lay down a reasonable target date by which the construction of heavy water plants are completed and production thereof started.

3.48. The Committee are not able to appreciate as to why excessive provisions for crores of rupees have been made for heavy water in the budget estimates from year to year when actually a fraction of the amount could be spent. They feel that lack of planning and development of technical know-how in this regard and failure on the part of Government to achieve the fixed targets within a scheduled time has led to this over-budgeting.

I. Organisational set-up of RAPP

3.49. The two units of the Project (RAPP I and RAPP II) are under the same Board of Management that governs the functioning of the organisation. The organisational set up is shown in Appendix IV. The staff strength of the RAPP as on 1st July, 1969 is given in Appendix V. The Committee were informed that there were 16 foreigners working on this Project who were the representatives of the Canadian Consultants, responsible for design of the nuclear and conventional portion of the Project. These representatives are stationed at site to ensure that the plant was built as per specifications. The Committee were also informed that no foreign personnel would be required for the operation or maintenance of these stations when they were commissioned. The personnel who manage Unit II of the Project would be drawn from the staff at present employed for construction of Rajasthan Atomic Power Project I and II.

3.50. After the commissioning of the Project, the operation and maintenance staff requirements are likely to be as follows:—

Scientific	64
Technical	284
Administrative and Auxiliary	

3.51. The Committee note that after the commissioning of the Units I and II of the Rajasthan Atomic Power Project, no foreign personnel will be required to operate or maintain the Station.

3.52. The Committee also note that the scientific and technical staff likely to be required for the operation and maintenance of the Rajasthan Project after the Station has turned over will be 348 whereas in case of Tarapur, the number of persons is 249 only. The Committee consider that requirements of the staff for the Rajasthan Station may be examined with a view to keep it as low as possible to ensure that the Station is run as an economic unit.

CHAPTER IV

MADRAS ATOMIC POWER PROJECT (MAPP)

A. Siting of the Project

4.1. The demand for power in Tamil Nadu has been steadily increasing on account of progressive industrialisation as well as rapid spread of the use of electrical energy for agricultural production and rural electrification. Though there has been augmentation in installed generating capacity in successive years, the demand has been outstripping the generating capacity. The Madras system is very largely fed from hydro electric power stations, the effective capacity of which is undependable due to the vagaries of the monsoon. As a result, for many years in summer months it has become necessary for power cuts to be imposed with disastrous impact on the economy.

The Site Selection Committee appointed in 1962 found Kalpakkam the most suitable site in this region for locating an atomic power station of about 400 MWe. Consequently, it was proposed that the 200 MWe units of the CANDU type be constructed at Kalpakkam generally similar to the ones in Rajasthan. This proposal was approved in principle by the Atomic Energy Commission in 1963, and was accepted by the Planning Commission for inclusion in the Fourth Plan, in October, 1964. In June, 1965, the Cabinet approved the proposal, subject to the requisite foreign exchange being arranged in consultation with the Department of Economic Affairs. However due to difficulties encountered in procuring comprehensive credits to meet the entire foreign exchange component of the project cost, it was decided to phase construction of the two units at Kalpakkam by two years. In early 1967, a separate project report, seeking approval to proceed with the construction of the first 200 MWe unit, was approved and expenditure sanction was issued by Department of Atomic Energy in December, 1967.

B. Special Characteristics

4.2. The Madras Atomic Power Station will employ CANDU type reactor units which has heavy water as moderator and natural uranium as fuel. Reactors of the CANDU type have been found to be very efficient in the use of natural uranium and they also produce substantial quantities of plutonium as a by-product in the spent fuel. The availability of deposits of natural uranium in Bihar is one of the important factors in launching

the power programme with natural uranium reactors. Whereas in Rajasthan, cooling water is drawn from the Rana Pratap Sagar reservoirs, in the case of the Madras Atomic Power Station cooling water will be drawn from the sea. It is stated that such reactors can be constructed with a high degree of indigenous manufacturing and fabricating capacity. The Chairman of the Atomic Energy Commission while speaking about the advantages of this technology, stated as follows:—

> "The advantages of this technology from our point of view is that this is the first time when we have no outside interference or outside control in regard to the whole operation; in the sense that it would be fed with natural uranium mined in Jaduguda and processed in Hyderabad and the heavy water being obtained from our own sources. The other materials which came out afterwards, plutonium and other things, will be entirely subject to Indian determination with no outside interference."

In a written note Government have explained the special features of the Madras Atomic Power Project as distinct from Rajasthan Atomic Power Project as follows—

(a) Sub-soil water level in the Kalpakkam area is very high and therefore a special technique had to be adopted for construction of sub-structures.

(b) The reactor building will be constructed in prestressed concrete and is being designed for the maximum pressure expected in the event of worst conceivable accident (maximum credible accident, in the technical terminology). A supression pool has also been introduced (as in the Tarapur Atomic Power Project) as part of the postaccident safety system.

(c) Seawater intake poses a special problem particularly in view of the large extent of littoral drift in the east coast and cyclone conditions that prevail in this region at certain times of the year.

Building of self-reliance

4.3. In the setting up of Kalpakkam Project a major step towards self-liance has been taken. There will be no foreign collaborator in respect of this Project. Under the general agreement with Atomic Energy of Canada Limited the Department of Atomic Energy has secured rights to exploit the basic designs obtained from Canada for the Rajasthan Reactors and any other Atomic Power Stations to be constructed in the country. In a written note Government have stated that with the experience gained in building research reactors and other nuclear plants at Trombay and in

the construction of Rajasthan and Tarapur Atomic Power Stations it has not been found necessary to have any foreign technical collaboration for the Madras Station. The Department itself is taking on full responsibility for design, engineering, procurement and construction of this station. It has, however, been stated that as it is not the policy of the Department to undertake the design and engineering of the conventional portion of the station, two firms of Indian consultants have been appointed to undertake this part of the work.

The fuel for the Project will be manufactured indigenously and the cost of the initial fuel charge will be Rs. 1.70 crores only. The cost of annual replacement will be Rs. 0:81 lakhs only.

Heavy water for the Project will also be manufactured indigenously and for the purpose plants with larger capacity are being set up. Heavy water to a limited extent is already being produced in the country.

Specialised personnel required for the Project are available with the Department of Atomic Energy. Others are recruited from various other organisations or the open market and given training where necessary. Engineers from the Madras Atomic Power Project have been sent to the Rajasthan Atomic Power Project and have been attached to the various sections there and given "on the job" training. It has been further stated that this programme will be continued through the commissioning and operating stages also. The Rajasthan Atomic power Project will also provide facilities for the training of operating and maintenance personnel of the Madras Atomic Power Project.

It has been stated that the scientists and engineers of the Atomic Energy Department have assumed responsibility for the fabrication of almost the entire nuclear part of the station. A very substantial portion of the conventional part including the turbine generator and auxilliaries will also be of Indian manufacture. When asked to state what proportion of the machinery and equipment required for the Madras Atomic Power Project will be indigenous, Government in a written note have stated that approximately 57 per cent of the expenditure on machinery and equipment required for the Project will be of indigenous items. Only certain special items of equipment, components and raw materials will be imported. The Chairman of the Atomic Energy Commission during the course of evidence further stated:—

> "We are not having any foreign consultancy at Madras at all, but in relation to the importation of certain specified items of materials and hardware, we have brought it down to about 20 per cent. This is the degree of Indianisation that has been possible. As public sector projects in steel and engineering develop further, it should be possible to reduce this 20 per

cent further. In Rajasthan I and II, all items of engineering, design, purchase, inspection, field engineering, etc. come to about 12.5 per cent of the total project cost. In Madras, it would come to only 5 per cent."

4.4. In reply to a question* answered in the Lok Sabha on the 3rd December, 1969, it has been stated that the total saving in foreign exchange as a result of indigenisation was estimated to be of the order of Rs. 15 crores. The cost of items required to be imported would be of the order of Rs. 10 crores. These cover some conventional material not yet manufactured in India.

4.5. The Committee are glad to learn that in setting up the Madras Atomic Power Project, India for the first time will be having no foreign collaborator and that Indian scientists and engineers have acquired sufficient expertise and skill to undertake this task on their own.

4.6. The Committee also note that a serious attempt has been made to build self-reliance for our future nuclear power production programme regarding the use of indigenous fuel and heavy water, greater degree of indigenisation of equipment and machinery etc.

C. Delay in construction of Madras Atomic Power Project—I

4.7. In reply to a question‡ asked in the Lok Sabha on the 23rd August, 1965, Government stated that "the Station has been authorised very recently and financing arrangements have yet to be completed. Preliminary work at the site is being taken in hand and the Station is expected to be completed before the end of the Fourth Plan, *i.e.* by 1970-71".

Replying to another question** asked in the Lok Sabha on the 27th March, 1968, Government stated that the Station was expected to be ready by 1972-73.

4.8. In a written note furnished to the Committee, it has been stated that

"The aim is to commission the first Unit of the Station by 1973-74. Commercial operation for the Station should be possible within about 6 months after the reactor attains criticality. This date, however, is dependent on a number of factors, the outcome of which is difficult to predict at this stage of the Project. On the basis of the present indications and subject to various assumptions materialising and to full and timely coordination

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*USQ No. 2409 on 13-12-1969.

‡USQ 487 on 23-8-1965

**USQ 5416 on 27-3-1968.

from the various agencies, *e.g.* private industry, public sector undertakings, the State Government and availability of foreign exchange in requisite amounts at appropriate stages, it is expected to be completed by 1973-74."

4.9. In reply to a question* asked in the Lok Sabha on 11-3-1970, it was stated:—

"While there may be a delay of about one year in the schedule of the Project, the progress cannot be termed as unsatisfactory, viewed in the context of the optimisation of indigenous production capacity xx xx xx . The progress of the Project is thus naturally dependent on the timely and satisfactory performance of a number of industries, organisations and agencies, both in the Public and Private Sectors."

4.10. As regards uncertainty about the time schedule for the completion of the Project, Government have stated that one of the items governing it is the turbo-generator. A letter of intent was placed with the Heavy Electricals India Ltd., Bhopal, for the supply of turbo-generator on 13-9-1967. Since that date, Heavy Electricals have been negotiating with the U.K. collaborators on getting a suitable design for the turbine. It has further been stated that due to merger taking place in U.K. heavy electrical industries, these negotiations have taken a longer time than envisaged. During July-August, 1969, discussions had concluded and the agreement was expected to be executed soon. The generator will now be produced at Hardwar by Bharat Heavy Electricals on a sub-contract basis with Heavy Electricals India Ltd., Bhopal. The Department have stated that the delivery time of 36 months has been mentioned by the Bharat Heavy Electricals in oral discussions for the supply of turbo-generator.

4.11. During evidence when asked to state whether it was not due to lack of planning or difficulties in getting indigenous clearance about import licences for materials or equipment, that even after 10 years of industrial oriented schemes in the country we were importaing components and materials, the Chairman of the Atomic Energy Commission stated as follows:—

"The current policy of the Government is that we will not import anything which can be substituted by something which is available here.

Hindustan Steel may have facility of making plates. But unless those plates are a part of the programme for that year or next year, that is not a thing which I can substitute because it is not an alternative source. It is precisely on this basis that Bhopal generator involved an extensive delay in starting. According to the policy of the Government as it is decided, we shall pay a price.

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*USQ 2480 on 11-3-1970.

I do not think there is any real conflict.

When we are talking of big orders on an enterprise like the Bhopal it is not as if we just rely on normal procedures. Many issues arise. To import certain components in order to fabricate this generator, we try to meet here and sort out this problem in consultation with the Ministry of Industry. Problems arise about price; on this particular generator it would be heavy. After all, we do not want the Department of Atomic Energy to pay a heavy price. On the other hand, Bhopal can come and say 'I do not know about the third order. Even to meet the first order, I have to incur certain tooling design expenses, etc.' The Government tells us not to wait, and we fix the price. So it is not as if we rely on normal procedures when we are dealing with a development effort like trying products for atomic plant as much indigenously as possible. We take up problems. We try to get together and sort out the problem with whatever happens to be the governmental Department; certainly the Finance Ministry in matters relating to foreign exchange etc. But there is also a desire on all sides to say that if they have to meet the maximum requirements of the Department of Atomic Energy by way of their own production they in turn want their enterprise to be helped. We have set a common objective which we try to fulfil through the coordination of various Departments."

4.12. The Committee note that the probable date of completion of the Project has been revised thrice since it was taken in hand in 1965. From 1970-71, the date has now receded to 1973-74. Constant shifting of target dates indicates lack of realistic planning.

4.13. The Committee are glad to be informed that the valuable competence in nuclear power technology gained by Indian scientists and engineers at Tarapur and Kota will enable them to build the Kalpakkam Atomic Power Station on their own without any foreign collaboration or financial aid. In fact, this is said to be the first nuclear power project which is being handled by Indians utilizing resources from within the country and with indigenous component to the extent of 80 per cent. A large number of agencies, namely, Ministries of Industrial Development and Company Affairs, Foreign Trade, Finance, D.G.S. & D., D.G.T.D., public undertakings like Heavy Electricals, Bhopal, Bharat Heavy Electricals, Hardwar and Hindustan Steel Ltd., and industries in the private sector are involved in this project and hence the timely completion of the project will depend on the cooordination and cooperation of all the parties concerned. It is a challenging job calling for pooling of resources and the cooperative and

concerted efforts of the various agencies. The Committee hope that Government will keep a constant watch on the progress of the project with a veiw to ensure that all hurdles and bottlenecks in the way of its smooth execution are sorted out and possible delays eliminated.

D-Capital outlay of the Project

4.14. The cost structure of the Madras Atomic Power Project showing the foreign exshange component and the break-up of the expenditure is given in Appendix VI. The total estimated capital outlay of the Project is 61.78 crores out of which the estimated cost of the Unit I is Rs. 60.08 crores and the cost of fuel is Rs. 1.70 crores. However, in reply to a question* in the Lok Sabha on the 18th December, 1967, the estimated capital cost of the Project Unit I has been given as Rs. 69.28 crores. In a written note the Planning Commission have also stated that the cost of Kalpakkam (200 MW) stage I has been indicated to be Rs. 69.28 crores in an estimate framed by the Department of Atomic Energy in 1966-67.

4.15. During evidence when asked whether the construction cost of the Madras Atomic Power Project will be lower than the other Projects, the Chairman, Atomic Energy Commission, stated as follows:—

> "If you talk in absolute terms, it will not be lower. There are two reasons for it. One is, here, some time has elapsed between the other projects and this. And there has been the normal inflation and the escalation of prices which have gone on for two years. The other thing is, in this particular project, we are for the first time introducing major indigenous components like turbo-generator sets. There, I believe it is at the cost of 2½ crores which is additional, arising from building this turbo-generator set for the first time at Bhopal. Additional economy in foreign exchange would result when we come to the second, the third and the fourth stage. Here, there is a much greater degree of Indian components, and unfortunately, when we do these things, for the first time, the labour, technology, tooling, and so on have not yet been standardised, and therefore, the initial cost is sometimes 15 to 20 per cent higher than the imported cost. The price, in absolute terms, is not less.
>
> * * * * * The third reason is that the use of salt water intake is going to cost more than the soft water coolant system.
>
> * * * * *
>
> In that region, the trouble was that there is not sufficient fresh water supply all the year round for doing this. If one wanted

*USQ No. 4724 on 18-12-1967.

to have it there, this was essential. The water intake system is essentially meant to supply both Madras Atomic Power Project I and Madras Atomic Power Project II. This is rather a problem of economics. If only Madras Atomic Power Project I is sanctioned, Madras Atomic Power Project II may not be proceeded with; it means that the total impact of the single water supply system will fall just on half the unit, and this is why we have been pressing that these two units should be completed as an integral part of one station, without too much time elapsing between the two."

4.16. The Committee note with concern the big difference in the figures regarding capital outlay of the Project as given to the Lok Sabha in 1967 and as furnished to them. The Committee feel that unless concerted and speedy action is taken to complete the project by the scheduled date, the estimated capital cost is further likely to go up with the passage of time.

E. Budget Estimates and Performance

4.17. The budget estimates for Unit I of the Madras Atomic Power Project and the actual expenditure incurred against budget estimates for 1965-66 to date is given below:—

Madras Atomic Power Project Unit I		Figures in Lakhs of rupees
	(1)	(2)
1965-66	(i) Budget Estimate	50·00
	(ii) Revised Estimate	12·00
	(iii) Actuals	1·34
1966-67	(i) Budget Estimate	158·00
	(ii) Revised Estimate	25·71
	(iii) Actuals	22·59
1967-68	(i) Budget Estimate . . .	150·00
	(ii) Revised Estimate . . .	122·00
	(iii) Actuals	111·56
1968-69	(i) Budget Estimate	350·00
	(ii) Revised Estimate	199·01
	(iii) Actuals	174·00
1969-70	(i) Budget Estimate	434·00
	(ii) Actuals up to end of July 1969 . .	28·06

4.18. During the years 1965-66 to 1969 (upto 1st September, 1969), budgetary provision had been made for Rs. 11.42 crores and the actual amount spent was to the extent of Rs. 3.64 crores only.

A small provision has also been included for unavoidable preliminary works connected with the Madras Atomic Power Station Unit II and ancillary facilities like High and Low Level Waste Management facilities for the Madras Atomic Power Station. Provision made for 1969-70 for Madras Atomic Power Project II is as follows:—

Madras Atomic Power Project-Unit 2

(1)		(2)
		(Rs. in lakhs)
1969-70	(i) Budget Estimate . . .	20·00
	(ii) Actuals up to end of July 1969 . .	5·41

4.19. When asked to state the reasons for the shortfall or saving in expenditure with reference to budgetary provision, the Department in a written reply *inter alia* have mentioned the following factors as mainly responsible for the same:—

1. Inability to secure a comprehensive credit from France as was originally expected and the consequent decision to stagger the two units of the Projects with a phasing of two years and belated issue of sanctions consequent on these changed conditions.
2. The need for protracted negotiations in connection with the appointment of consultants for engineering the conventional portion of the Plant. Since Indian consultants are being used for the first time on such an assignment, they have also been taking time to get familiar with the problems involved.
3. Difficulties or delays encountered in locating and promoting suitable sources of indigenous supply for specialised materials and components which would, in the normal course, have been imported, and which involve very rigid specifications and a high degree of development effort.
4. Procedural delays involved in the processing of orders against certain foreign credits in terms of the credit arrangements with those countries.
5. Difficulties encountered by outside agencies such as Heavy Electricals India Ltd., Bhopal, in finalising the terms and condi-

tions with their collaborators for obtaining know-how for the manufacture of the turbine.

6. Delays and difficulties in procuring materials and equipment from abroad on account of circumstances beyond our control such as strikes, (*e.g.* the strike in the Canadian Nickel Industry which supplies the bulk of nickel in the world market).

7. The civil works involved in the construction of the reactor and turbine building are of a highly sophisticated nature. The reactor building is being built in pre-stressed concrete in India for the first time. The contractor to be chosen for the work must have a suitable organisation and an adequate comprehension of the requirements of the work, which is for a nuclear containment. A team consisting of senior engineers of the Department and representatives of the consultants had therefore to inspect the various works executed by the tenderers and study their organisational arrangements in detail before making a recommendation on the selection of the contractor.

4.20. The Committee regret to note the wide gap in the budget estimates and the actuals. During the years 1965-66 to 1969 (upto 1st September, 1969) while budgetary provisions had been made for a sum of Rs. 11·42 crores, the actual amount spent was to the extent of Rs. 3·64 crores only. The Committee hope that Government would in future frame a more realistic budget estimates as far as possible having regard to the various factors likely to affect the progress of the project.

F. Cost of generation of Power

4.21. When asked to state the estimated cost of generation of power from Kalpakkam Project and how the same would compare with the Tarapur and Rajasthan Projects, the Department in a written note have stated that on present indications the cost of generation of power in the Rajasthan Unit would be approximately the same as at Tarapur *i.e.* 4.73 paise kwh and may not be subject to more than 10 per cent variation as a result of any increase in the capital cost or the cost of the fuel element that may come to light in the future. The cost of generation of power from Kalpakkam is expected to be of the same order as from the Rajasthan Atomic Power Project, though it is likely to be slightly higher as a result of the higher capital cost of the Station resulting from greater degree of indigenisation.

4.22. As against this, the Planning Commission have in the note furnished by them to the Committee stated that "In the case of Kalpakkam atomic station, the project report indicates, based on the present estimated cost of Rs. 69.28 crores, the cost per unit generated would be 7.25* paise per kwh." The estimates were prepared in the year 1966-67.

*At the time of factual verification the Department of Atomic Energy have pointed out that "7.25 p. is sale price and not cost of generation".

4.23. The Committee are concerned to note that the Department of Atomic Energy has not been able to workout so far a firm estimate of the cost of generation of power. They hope that the cost of generation of power will be worked out on a realistic basis at an early date so that the consumers know what they will be expected to pay for the electricity flowing out of the Kalpakkam Atomic Power Project.

G. Agreement for Sale of Power to Tamil Nadu

4.24. The Committee enquired whether any firm agreement had been reached with the Tamil Nadu Government for the sale of power to them, and if no agreement had been entered, when it is likely to be done. The Department in a written note have stated that a firm undertaking had been given by the State Government that the entire energy output from this station, less the power requirements of the station would be purchased by the State Government. It was added that this had been agreed to in formal exchange of letters between the two Governments. In reply to another question, Government have stated that although actual agreement for the sale of power can be entered into only after the tariff for power to be sold from Madras Atomic Power Station is worked out and approved by the Central Electricity Authority, there was an undertaking from the State Government that they would purchase all the power available from the Madras Atomic Power Station irrespective of the final cost figures.

4.25. However, during evidence the Chairman, Atomic Energy Commission, further clarified the position as follows:—

> "Sir, let me say that there is an undertaking with the Tamil Nadu Government which was finalised in Delhi that they will absorb the power from the station provided the base load is 75 per cent. No firm figure of price was mentioned because this was not available at that stage. We cannot, therefore, interpret it as saying that they have agreed to take it irrespective of the price. If the price is exorbitant, they will have something to say. The overall estimated schedule for nuclear power is likely to be on a certain cost, and these undertakings are related to that type of estimate. If there is very wide variance in these estimates, it will seem to me that people will have something to say about."

4.26. It has been pointed out that as in the case of Maharashtra—Gujarat region, there is large hydro capacity in Madras also which is fed from monsoons. It is stated that advantage would be taken during that period for the annual maintenance of the Atomic Power Station.

4.27. There is yet another problem about the demand for power that would be available from Kalpakkam. The Department in a written note

have stated that the decision to establish the Madras Atomic Power Station was taken after taking into account the assessed forecast in the Annual Electric Power Survey conducted by the Central Electricity Authority on demand for power in the Tamil Nadu area and the scheduled capacity which would become available by 1970-71. According to them a clear deficit of over 400 MW generating capacity was expected. They have further stated that the assessment made by the Working Group on Power set-up by the Ministry of Irrigation and Power to formulate development programme for the Fourth Plan confirms this position. Even after taking into consideration the benefits from all existing and sanctioned schemes including Unit I of the Madras Atomic Power Station, there would still be deficit of about 500 MW in Tamil Nadu by 1973-74.

4.28. The Ministry of Irrigation and Power in their written reply to a question have pointed out that power load being handled by Madras Grid is 1050 MW which is the optimum capacity of the Grid to absorb power at present. The power available from Madras Grid for distribution was 944 MW by the end of 1968-69 with an installed generating capacity of 1470 MW. The balance of power was being imported from the neighbouring States to meet the demand. The following additional benefits are likely to accrue in the State during the Fourth Plan :—

Apart from 200 MW from Stage I of Kalpakkam Atomic Power Station.

	MW
1. Parambikulam Aliyar (Hydro)	155
2. Pandiar Punapuzha (Hydro)	100
3. Kodayar (Hydro)	100
4. Ennore (Thermal)	440
5. Basin Bridge (Thermal)	30
6. Neyveli (Thermal)	200
7. Kundah Stage IV (Hydro)	110

4.29. During the course of evidence it became clear that with the commissioning of Neyveli, where 500 MW plant had already come into operation there was surplus power in Tamil Nadu at present. The representative of the Planning Commission when asked whether the Commission had taken into consideration the demand of power in that State while sanctioning the Kalpakkam stated as follows :—

> "The other point that we should keep in mind is the base load factor. Now the nuclear or a thermal power station for that matter must have a base load. For example, in the northern region if you fix up the base load station of 400 or 600 M.W., we have to know as to what is likely to be the base load in

future if we fix it at 80 to 85 per cent. I think this base load would be desirable. Base load stations operations utilise the hydro-electric power for peaking purposes. Similarly in Madras, for example, at the moment we have a thermal base load stations of 600 MW which comes from Neyveli. If Ennore is also going in for 400 MW that means it comes to 1000 MW.

** ** ** ** **

In Neyveli 500 MW Plant has already come into operation."

The representative of the Planning Commission admitted that because of surplus power only one Unit of 200 MW at Kalpakkam has been sanctioned* and they were going slowly. The situation here also is the same as in the case of Rajasthan Project.

4.30. In reply to a question as to whether any demand from Andhra Pradesh for supply of power from Kalpakkam has been received, the Department of Atomic Energy in written note have stated that:—

"The original decision of the Central Water and Power Commission was that 100 per cent of Madras Atomic Power Project—Unit I power should go to Tamil Nadu. In September 68 the Government of Andhra Pradesh wrote asking for a share in the power generated from the Kalpakkkam Station. The Department replied in their letter of December 2, 1968 that there was already an understanding between the Government of Tamil Nadu and this Department on this subject and if the Government of Andhra Pradesh came to an Agreement with the Government of Tamil Nadu for sharing the power from Kalpakkam, his Department would have no objection.

The question also came up for discussion in a meeting held in the room of Union Minister of Irrigation and Power on 6th August, 1969. The Minister proposed that as a general principle, power from nuclear power stations should be shared by the neighbouring States. He suggested that the power from Kalpakkam should be shared 50:50 between the Government of Tamil Nadu and the Government of Andhra Pradesh."

The Ministry of Irrigation and Power in reply to the question gave the following reply:—

"Although Tamil Nadu has agreed to take all the power available from Kalpakkam Nuclear Power Station, Mysore and Andhra Pradesh States are also claiming some power supply from this

*At the time of factual verification the Planning Commission stated "While considering the revised plan of Atomic Energy Commission subsequently, a decision was taken for going ahead with 400 MW at Kalpakkam, of which the first unit was expected to go into operation in 1973-74. This has accordingly been incorporated in the revised Fourth Plan document".

station on the plea that it is financed centrally. It will certainly be of advantage if the station is operated in an integrated manner with the neighbouring power system as such operation will ensure a high load factor of 75 per cent at which the station is expected to work.

If in case it is decided to allocate power to the neighbouring States also from Kalpakkam, it should be on the basis of power shortages. The preference should be given to the State which can absorb power at very high load factor."

4.31. The Committee understand that in and around Madras there will not be much demand for nuclear power during the monsoon season on account of over-flowing of reservoirs in that region. In this respect, Kalpakkam and Tarapur stand on the same footing. The Committee also understand that in Madras there are two monsoons and the usual period which the power generation economics takes into account is 4 to 6 weeks only. The Committee trust that maintenance programme of the Station will be properly phased out and all other necessary steps taken by Government to ensure that there is no closure of the Station on account of lack of demand and alternatives found out to make the maximum use of the power made available from the Kalpakkam.

4.32. The Committee feel that the Madras Atomic Power Project is beset with a number of problems which must be attended to right now rather than kept pending till the power begins to flow from the Station. In the first place, no written agreement has been entered into as to the rate at which the power will be purchased by the Tamil Nadu Government. Secondly, there is an urgent need to work out the economics of running the station at high base-load factor. The problem has assumed seriousness because the State Government has not entered into any written agreement about the assured base-load at which they will take the power. Running the Kalpakkam Station at a maximum base-load factor may pose a problem and in the long run it may not run at optimum load. Thirdly, the neighbouring States of Andhra Pradesh and Mysore want to have a share in the power from Kalpakkam as according to them the project has been constructed out of the finances of the Central Government. It is, therefore, desirable that a firm settlement amongst the claimants is reached in the matter. The Committee are of the opinion that there is need to lay down a definite policy by the Government about the sharing of benefits by States in respect of those projects which have been constructed solely from the finances of the Central Government.

4.33. The Committee apprehend that failure to find an early solution to the problems may lead to a situation which may have serious repercussions. The Committee trust that a satisfactory solution will be found to the various problems mentioned above without further loss of time.

H. Organisational set up of the Project

4.34. The organisational set up of the Madras Atomic Power Project is shown in the chart at Appendix VII.

The strength of the staff as on September 1, 1969 is given below :

(As on 1-9-1969)

(i) Engineering, Scientific and Technical . . .	247
(ii) Administrative and Auxiliary (including Accounts, Purchase, Stores, Security, Transport, Hospital, Fire Service other general purpose staff)	268
	515
(iii) Daily rated and casual labour	388
(iv) Contractors' labour .	1,500

4.35. The Committee hope that the strength of the staff, both engineering, seientific and technical and others has been assessed keeping in view the actual requirements of the Project and that Administration will ensure that there is no over-staffing right from the very beginning.

4.36. The Committee suggest that Government may examine whether it would be desirable to keep a separate pools of erection and construction staff and staff required for normal operation and maintenance of the Project so that when the work is over expenditure on the former category of staff would not automatically become part of the operational staff thus burdening the undertaking with over-staffing and making it uneconomical.

CHAPTER V

ORGANISATION

A. Department of Atomic Energy

5.1. The Department of Atomic Energy was established as a Ministry of Government of India by a Presidential Order dated the 2nd August, 1954 and since its inception continues to be under the charge of the Prime Minister. It is stated that the Department is an independent Ministry with a Secretary at its head, who advises and assists the Minister-in-charge. The Department is located at Bombay.

Functions

5.2. The Department is vested with the responsibility of carrying out all the traditional functions of a Ministry which, besides (i) assistance to the Minister in the formulation of policy, (ii) implementation of that policy, and (iii) obtaining the grants of Parliament required therefor, include the following functions :—

(a) Assistance to the Minister in the disposal of Parliamentary business;

(b) Discharge of statutory responsibilities, i.e. the administration of the Atomic Energy Act;

(c) Administrative and financial co-ordination of its activities—scientific, industrial, logistic and developmental;

(d) Relations with foreign countries, State Governments, local bodies, other Ministries of the Central Government;

(e) Personnel planning and administration;

(f) Financial control;

(g) Watching the progress and performance of the various units of the Department responsible for the implementation of its programmes.

5.3. The scientific activities of the Department are carried out by units such as the Bhabha Atomic Research Centre, the Atomic Minerals Division, and establishments of the Indian Space Research Organisation as also by institutions for which it is administratively responsible, e.g. Tata Institute of Fundamental Research, Physical Research Laboratory, Saha Institute of Nuclear Physics, etc. Its industrial activities include the generation of nuclear power, the activities of the various commercial undertakings of the

Department, namely Indian Rare Earths Ltd., Electronics Corporation of India Ltd., etc. The Department is also undertaking the manufacture of fuel elements and of heavy water. Its logistic activities include the search for atomic minerals, the development of uranium mines, the purchase of stores and equipment required for the projects of the Department, acquisition and management of land, civil engineering support, etc. Developmental activities of the Department include not only the development activities of production units, for example some of the Dvisions of the Bhabha Atomic Research Centre, but also the encouragement of units, both in the public and private sector, to participate in the gradual indigenisation of equipment required for carrying out the programme of the Department.

It is further stated that the Department of Atomic Energy exercises certain special powers with regard to the making of appontments, the purchase of stores and equipment, construction of buildings etc.

B. Atomic Energy Commission

Setting up of the Commission

5.4. The Atomic Energy Commission was initially constituted in 1948 under the late Department of Scientific Research Notification No. F-402/DSR/48 dated the 10th August, 1948. Between 1948 and 1958, the Commission consisted of Dr. H. J. Bhabha, (Chairman), Dr. S. S. Bhatnagar and Dr. K. S. Krishnan. This Commission was reconstituted *vide* Department of Atomic Energy Resolution No. 13/7/58-Admn. dated the 1st March, 1958 as amended by Resolution No. DAE/C-1-H dated the 6th March, 1962. Giving the genesis of the new Commision, the Resolution states:—

> "The Department of Atomic Energy was established in August 1954 and since these research and development in the peaceful use of atomic energy have made important and rapid strides and a greatly expanded programme is envisaged for the future, in the couse of which India should be able to produce all the basic materials required for the utilisation of atomic energy and build a series of atomic power stations, which will contribute increasingly to the production of electric power in the country. These developments call for an organisation with full authority to plan and implement the various measures on sound technical and economic principles and free from all non-essential restrictions or needlessly inelastic rules. The special requirements of atomic energy, the newness of the field, the strategic nature of its activities and its international and political significance, have to be borne in mind in devising such an organisation. After careful consideration, the Government

of India have decided to establish an Atomic Energy Commission with full executive and financial powers, modelled, more or less, on the lines of the Railway Board."

Functions of the Commission

5.5. The functions of the Commission as indicated in the Resolution setting up the Commission are as follows:—

"The Atomic Energy Commission shall be responsible:—

(a) for formulating the policy of the Department of Atomic Energy for the consideration and approval of the Prime Minister;

(b) for preparing the budget of the Department of Atomic Energy for each financial year and getting it approved by Government; and

(c) for the implementation of Government's policy in all matters concerning atomic energy.

Within the limits of the budget provision, approved by Parliament, the Commission shall have the power of the Government of India, both administrative and financial, for carrying out the work of the Department of Atomic Energy."

Demarcation of functions as between the Commission and Department of Atomic Energy

5.6. It was noted that Commission was entrusted with the responsibility not only for formulating the policy in respect of all matters concerning atomic energy but also for implementing the same and was vested with powers of the Government of India, both administrative and financial, for carrying out the work. Since this appeared to cover the whole field, the Chairman, Atomic Energy Commission was asked to state the reasons for the existence of separate Department of Atomic Energy.

In reply he stated:

"Commission is approached regarding policy, review and sanctioning of project within the budget of the Department and the Department is like any other normal Ministry of the Government. In this case the Department can derive its sanctioning and its review by a special body. It has been invested with the powers. As I said these powers provide an opportunity by which it is able to do the sort of thing for which otherwise the departments would have to go up to higher levels before they could do that thing. Here the Commission itself takes the responsibility within the constraints of the finances, annual budget and other things."

5.7. Answering another question, the Chairman of the Commission stated that the Commission had separate staff of its own on full-time basis headed by a Secretary. The Headquarter of the Commission is at Bombay. The Department of Atomic Energy, according to him, had himself as Secretary, one Additional Secretary and three Joint Secretaries—two at the Headquarters in Bombay and one at Madras.

5.8. During evidence a point was raised that in view of the fact that there are no clear cut demarcation of functions between the Commission and the Department of Atomic Energy there was the possibility of overlapping of functions and duplication. The Chairman of the Commission replied: ".....the danger of overlapping of powers.....are safeguarded.....by making the Secretary *ex-officio* Chairman of the Commission and he is given the power to overrule the other Members of the Commission."

Amplifying this point further Government have, in a subsequent written note furnished to the Committee, stated:

> "Clause 5 of the Resolution states that within the limits of the budget provision, approved by Parliament, the Commission shall have the powers of the Government of India, both administrative and financial, for carrying out the work of the Department of Atomic Energy" and it may, at first sight, appear that as a result there might be an overlapping of powers between the Commission and the Department and that the two might find themselves at cross purposes. This danger is safeguarded against by two provisions built into the constitution of the Commission: first, according to Clause 3(b), the Secretary of the Department is the *ex-officio* Chairman of the Commission, and, secondly, according to Clause 6(b) the Chairman has the power to overrule the other members of the Commission. The Member for Finance, however, shall have the right to ask that any financial matter, in which he does not agree with the Chairman, be referred to the Prime Minister and the Finance Minister. It follows that the Commission cannot take any decision with which the Chairman, that is the Secretary of the Department, does not agree. On the other hand, Clause 5 empowers the Commission acting as a whole, and, therefore, with the explicit or implicit concurrence of the Chairman, to make decisions relating to the business of the Department of Atomic Energy, some of which might lie beyond the competence of a normal Ministry. This, in fact, is one of the main reasons for having such a Commission."

The note goes on to justify the exercise by the Commission of the powers of Government of India thus:

> "The Commission has the responsibility for preparing the budget of the Department of Atomic Energy for financial year and getting it approved by Government. The procedure for getting the budget accepted by the Ministry of Finance for presentation to Parliament has already been laid down with the concurrence of that Ministry.
>
> The Commission is in a position to exercise the powers of the Government of India, both administrative and financial, as (a) its Chairman is Secretary in the Department of Atomic Energy and (b) the Member for Finance is *ex-officio* Secretary to the Government of India in the Department of Atomic Energy for financial matters. The implementation of work of the Department of Atomic Energy is again the responsibility of the Chairman as Secretary to the Government of India. As regards the transaction of its day-to-day business, the Secretary, with the concurrence of the Member for Finance, can exercise the full powers of the Government of India, subject to the approval of Government at higher levels where necessary, for example, approval of the Minister concerned or of the Cabinet as in other Ministries. The powers exercisable by the Commission collectively, or by the Chairman and Member for Finance in consultation with each other, are further subject, as will be evident from para 5 of the Resolution, to budget provision. In determination of the level of budget provisions, both the Department of Expenditure and the Planning Commission exercise a control function."

5.9. At the instance of the Committee, Government have furnished to the Committee a note indicating the position of the Atomic Energy Commission in certain foreign countries. According to this note, the Atomic Energy Commission in U.S.A. is a part of the executive branch under the President while the Atomic Energy Authority of U.K. is a statutory public corporation for which the Minister of Technology, who has a general responsibility for promoting and controlling the development of Atomic Energy, is responsible. The Atomic Energy of Canada Ltd. is a Government company. In France, the Atomic Energy Commission is, in law, under the authority and control of the Premier but the powers of the Premier in this respect have been delegated to the Minister of State responsible for Scientific Research and for Atomic Energy, who participates very actively in the examination of the budget presented by the Commission.

5.10. The Committee are not convinced by the justification given for the existence of a separate Department of Atomic Energy when the Atomic

Energy Commission itself has been vested with the administrative and financial powers of the Government of India, besides being responsible for formulating the policy of the Department of Atomic Energy, preparation of the budget of the Department and getting it approved by Government, and implementing the Government's policy in all matters concerning atomic energy. The Committee consider that the two bodies, which cover the same field and yet have separate secretariats, should have a clear-cut demarcation of duties and functions so as to avoid duplication and overlapping.

Composition of the Commission.

5.11. The Resolution of the 1st March, 1958, as amended on the 6th March, 1962 contains the following provisions regarding the composition of the Commission:

"(a) The Commission shall consist of full-time and part-time members and the total number of members shall not be less than three and not more than seven.

(b) The Secretary to the Government of India in the Department of Atomic Energy shall be the *ex-officio* Chairman of the Commission.

(c) A member of the Commission shall be the Member for Finance, who shall also be *ex-offcio* Secretary to the Government of India in the Department of Atomic Energy in financial matters.

(d) The Director of the Atomic Energy Establishment, Trombay, shall be a member of the Commission in charge of research and development."

It is noted from the information furnished to the Committee that, including the Chairman and the Member for Finance, the membership of the Commission has varied from three to five. It is also noted that while during the first ten years (1948—58), all the three members of the Commission were scientists, the number of scientists on the Commission in the following years has been as follows:—1958—62—two out of three members 1962-65—one out of four members 1965—one out of five members; and 1966 to-date—two out of five members with the exception of a part of 1966 when there was only one scientist out of four members.

Another notable feature of the composition is that right from the inception of the first Commission in 1948, the scientist members of the Commission were generally those holding some position in the Government departments or research establishments run by Government.

5.12. The present composition of the Commission is indicated as follows:—

Dr. Vikram A. Sarabhai	Chairman
Shri H. N. Sethna	Member for Research and Development
Shri P. N. Haksar	Member
Dr. I. G. Patel .	Member for Finance
Shri J. R. D. Tata .	Member

Shri J. R. D. Tata has been continuing as a Member of the Commission since 1962. Dr. V. A. Sarabhai joined the Commission in 1966 and after a brief spell as Member became its Chairman towards the middle of 1966. Shri H. N. Sethna became Member in 1966 by virtue of his appointment as Director, Bhabha Atomic Research Centre and is continuing since then. Shri P. N. Haksar, who is Secretary to the Prime Minister, was appointed as Member of the Commission in 1967. Dr. I. G. Patel, who is Secretary, Department of Economic Affairs, Ministry of Finance, was appointed to the Commission in 1968.

5.13. The Resolution setting up the Commission provides that Secretary to the Government of India in the Department of Atomic Energy shall be the *ex-officio* Chairman of the Commission. In regard to the manner of appointment of other members, their tenure of membership and remuneration etc., the Resolution is silent. Government was therefore asked to state the procedure being observed by them in regard to appointment etc. of members of the Commission, other than its Chairman. They have stated that the Director, Bhabha Atomic Research Centre is a Member of the Commission in-charge of research and development and that the term of office of the Member for Research and Development is co-terminous with his appointment as Director, BARC (formerly Atomic Research Establishment, Trombay) and as such he is a continuing Member. In regard to the Member for Finance Government have stated that he shall also be *ex-officio* Secretary to the Government of India in the Department of Atomic Energy in financial matters. It is added that the Member for Finance is also a continuing Member. In regard to other members of the Commission it is stated that they are appointed "by the Prime Minister on the recommendation of the Chairman, Atomic Energy Commission for a term of one year and are eligible for re-appointment."

5.14. In the course of discussion during evidence, a point was raised that, apart from the Chairman of the Commission and one other member,

who was at the same time Director of Bhabha Atomic Research Centre, there was no scientist as Member of the Commission though, under the Resolution setting up the Commission, there was scope for adding two more Members on the Commission. It was pointed out that some of the subjects on which research was being conducted under the Commission were the same on which other scientific institutions run by Government were also carrying on research. The Chairman of the Commission was asked to state whether, to avoid overlapping and unnecessary duplication of effort and also to avoid complete dependence on one or two men, it would not be desirable to have some outstanding scientists experienced in scientific research on the Commission. In reply he stated that "there is no hard and fast rule" regarding the composition of the Commission and that "it would be advantageous to have them". According to him: "There has not been in the past any prejudice against outsiders. In fact, I myself was an outsider who was a member. The composition has changed from time to time. In principle, your point is well taken." He assured the Committee that he had no objection to the suggestion for two more outstanding scientists being added to the Commission as Members. He, however, maintained that the idea was to have a compact and small body which might "look at things with a major policy angle" and that they had found it very much more meaningful to have specialised Committee where "outside people" were associated for "specific things".

5.15. The Committee note that the activities of the Commission in the field of atomic energy are fast expanding and now include not only research and development of peaceful uses of atomic energy but also training of scientists, survey and prospecting for and mining of rare earths, running of industrial enterprises e.g. Indian Rare Earths Ltd., Electronic Corporation of India Ltd., setting up of atomic power plants, generation of atomic power and its sale etc. Besides, the area of Commission's activities, include fields which appear only remotely connected with its own field e.g. space research. The Committee consider that it is hardly possible for the Commission, as at present constituted, to lay down policies and programmes in all these fields as also to supervise the administration of the programmes. In view of the fact that the Commission consists of, besides the Chairman, only four part-time Members, it is inevitable that all the work of the Commission should devolve on the Chairman of the Commission. The Committee feel that this arrangement does not yield the desired results and recommend that Government should rationalise the functions of the Commission and suitably reorganise its composition with a view to include a few whole-time functional Members.

5.16. The Committee note that as at present constituted the Commission has a preponderance of non-scientist members. They consider that the Commission as the policy making body at the highest level should also include a few eminent independent scientists either on a full-time or part-

time basis so as to induct more expertise in the Commission and make it more broad-based and useful. The Committee have, no doubt, that such a step would be generally beneficial and would lead to better programming and appraisal of research and development work in the field of atomic energy.

5.17. The Committee also note that the same persons have been continuing as Members of the Commission year after year. They need hardly stress the desirability and advantage of inducting fresh experienced persons as members of the Commission from time to time.

Position of Chairman

5.18. The position and powers of the Chairman of the Commission are spelt out in para 6 of the Resolution setting up the Commission thus:

> "(a) The Chairman in his capacity as Secretary to the Government of India in the Department of Atomic Energy shall be responsible under the Prime Minister for arriving at decisions on technical questions and advising Government on matters of atomic policy. All recommendations of the Commission on policy and allied matters shall be put up to the Prime Minister through the Chairman.
>
> (b) The Chairman shall have the power to overrule the other members of the Commission, except that the Member for Finance shall have the right to ask that any financial matter, in which he does not agree with the Chairman, be referred to the Prime Minister and the Finance Minister.
>
> (c) The Chairman may authorise any member of the Commission to exercise in his behalf, subject to such general or special orders as he may issue from time to time, such of his powers and responsibilities as he may decide."

5.19. During evidence, it was pointed out to the Chairman of the Commission that the power given to the Chairman of the Commission (except the Finance Member in respect of financial matters) may not be conducive to members taking on independent opinion. The Chairman of the Commission explained:

> "It identifies the responsibility. But it does not say that this is something one should use in any unreasonable way. It just identifies, as I should say, a clear-cut responsibility and accountability in that situation. The Chairman or the Secretary has to stand by all the decisions because he has been given this power of over-ruling. If he does not do it, he takes upon himself full accountability as the Chief Executive of the Com-

mission. As I said, although the history of the Commission which has now gone on for many years, there has not been a single occasion when this power has been invoked. I think it itself speaks for the manner in which the Commission has been functioning."

5.20. Asked to state the reasons for having a rule which had not been exercised even once, the Chairman of the Commission stated:

"It clearly brings out accountability. It prevents an *alibi* being made. One often hears some Chief Executive who says I would have done this or that, the Board decided differently and all that. This provision prevents anybody saying like that."

Member for Finance.

5.21. As already stated, clause 3 of the Resolution setting up the Commission provides that a member of the Commission shall be the Member for Finance, who shall be *ex-officio* Secretary to the Government of India in the Department of Atomic Energy in financial matters. Under clause 6(b) of the Resolution, the Member for Finance has the right to ask that any financial matter, in which he does not agree with the Chairman of the Commission, be referred to the Prime Minister and the Finance Minister. Clause 7 of the Resolution provides that the Member for Finance shall exercise the powers of the Government of India in financial matters concerning the Department of Atomic Energy except in so far as such powers have been or may in future be, conferred on or delegated to the Department.

5.22. During evidence, the Chairman of the Commission further explained what he called the 'system of in-built financial control' thus:—

"Clause 7 stipulated that no proposal with financial implications could be sanctioned within the Commission without the prior concurrence of Member for Finance. This was changed in 1962 to provide for this concurrence only in respect of those things which are not delegated to the Ministry."

He further stated:

"Last thing I would like to mention is that the system of internal financial advice that is practised in the department is similar to what was recommended for public enterprise, with some slight modifications. The responsibility for taking final decisions rests squarely on the head of the Department, namely, the Secretary, and Secretary arranges that in important cases where the internal financial advice is not accepted, he must make a report of this to the Commission. The role of the

Atomic Energy Commission would be that of a Board of Directors in a corporation and they would deal with important matters and Member (Finance) will have a special responsibility. Rules are framed to give effect to the system of working outlined above."

5.23. In a subsequent written note furnished to the Committee, Government have stated that the position of the Member for Finance in the Atomic Energy Commission is "not dissimilar to that of the Financial Commissioner (Railways)." The note further says:—

"It was considered desirable that the Commission should include a Member for Finance, who would be intimately associated with all its deliberations, to enable him to arrive at a fully informed appraisal of the financial implications of its policy and programme, seen in correct perspective. As the Atomic Energy Commission was vested by the Resolution with full executive and financial powers, it was logical that the Member for Finance should also be *ex-officio* Secretary to the Government of India in the Department of Atomic Energy in financial matter, just as the Financial Commissioner (Railways) is also an *ex-officio* Secretary to the Government of India."

5.24. Referring to the question as to how far the existing arrangement facilitates efficient financial control in the Department and the Commission, the note states:—

"The arrangement enables the Member for Finance to acquire full familiarity with the policy and programme of the Commission —in fact, a much greater familiarity than, for instance, the Secretary in the Department of Expenditure, Ministry of Finance could have with the plans and programmes of the various Ministries for the control over whose expenditure he is responsible. Such close familiarity with the work of the Department should ensure efficient financial control.

The correct functioning of 'Finance' as an independent agency is ensured by the appointment of an independent Secretary as Member for Finance. After the re-organisation of the Commission in 1962, for example, Shri Jagannathan, the then Financial Commissioner (Railways) was appointed as the Member for Finance. He continued to be the Member for Finance when he was later appointed Secretary in the Department of Economic Affairs. The officer who succeeded him as Secretary, Department of Economic Affairs is at present Member for Finance in the Atomic Energy Commission. Secondly, the Member for Finance has the right, under the constitu-

tion, to ask that any financial matter in which he does not agree with the Chairman be referred to the Prime Minister and the Finance Minister. Thirdly, the Commission has the power of the Government of India for carrying out its programme within the limits of the budget provisions. The convention established provides not only for the Member for Finance assuming a special responsibility for the budget of the Department, but also for the Department of Expenditure, after discussion between Secretary (Expenditure) and the Member for Finance, Atomic Energy Commission, exercising a general scrutiny over the budget proposals of the Department of Atomic Energy and suggesting reductions wherever possible in the provisions asked for on the basis of the resources position and in the light of past performance and capacity to spend. The final budget figure, in other words, has to be a mutually agreed one. It may also be relevant to mention that the Plan outlays of the Department of Atomic Energy which are initially scrutinised by the Member for Finance are also subject to the approval of the Planning Commission."

5.25. The Special* Secretary, Department of Economic Affairs, Ministry of Finance who was concurrently Member for Finance on the Atomic Energy Commission, replying to a question from the Committee, in a communication addressed to the Committee in December, 1969 stated: "On the whole, I do not feel that my charge including the work relating to the Atomic Energy Commission is an unduly heavy one."

5.26. The Committee feel that the present arrangement is not conducive to proper financial control over an Organisation which has an annual estimated budget of the order of Rs. 93 crores during the current financial year. They are of the opinion that there is need for a whole-time Member for Finance in the Atomic Energy Commission. In this connection, the Committee would like to draw the attention of Government to their recommendation re reorganisation of the Commission made earlier in this Chapter.

C.—Project Organisation

Rajasthan and Madras Boards

5.27. The project organisation of Tarapur Atomic Power Project has been dealt with in Chapter II. Rajasthan and Madras Atomic Power Projects which are under construction are being managed by Management Boards set up for each of these Projects. Powers have been delegated

*Now Secretary, Department of Economic Affairs, Ministry of Finance, Government of India.

to the Rajasthan Project Administrator/Chairman of the Madras Board. In respect of matters falling beyond his powers, the Project Administrator/ Chairman obtains the approval of the Board. Approval of the Department or the Commission is also obtained where necessary.

5.28. The powers and functions of the Rajasthan and Madras Boards are broadly as follows :—

(1) The power to give decisions on all administrative and financial and technical matters *without exceeding* (a) the expenditure sanction, (b) the approved foreign exchange component of the expenditure sanction, and (c) the annual budget and in particular the provision made for pay and allowances; without *involving* (a) major changes in the basic designs *outlined* in the joint Indo-Canadian Study Report on CANDU Reactors, and (b) lowering of standards of nuclear safety. In respect of Rajasthan Atomic Power Project, any modifications of agreements with the Canadian Consultants requires the approval of the Department of Atomic Energy.

(2) The Boards specifically *require the clearance of the Department for* (a) pre-commissioning and commissioning of the Station from the stand-point of nuclear hazards and (b) the creation of posts carrying a scale ending at Rs. 1,800 or above.

(3) The Boards (a) approve tenders exceeding Rs. 25 lakhs in value and (b) sanction excesses over sub-and detailed heads in the expenditure upto Rs. 10.00 lakhs of 20 per cent whichever is less, provided the expenditure sanction as a whole is not exceeded.

5.29. The composition of the Rajasthan and Madras Boards is indicated as under :—

Rajasthan Atomic Power Project	Madras Atomic Power Project
Chairman	
Shri H. N. Sethna, Director, DARC/PPED.	Shri H. N. Sethna, Director, BARC/PPED.
Representative of the Department with special responsibility for administrative and financial matters	
Shri R. Bhaktavatsalu, Additional Secretary, Deptt. of Atomic Energy.	Shri R. Bhaktavatsalu, Additional Secretary, Deptt. of Atomic Energy.

Rajasthan Atomic Power Project	Madras Atomic Power Project
Three Scientists/Engineers who are not members of the Project	
Dr. Brahm Prakash, Director, Metallurgy Group, BARC	Dr. Brahm Prakash, Director, Metallurgy Group, BARC
Shri A.S. Rao, Director, Electronics Group, BARC	Shri A. S. Rao, Director, Electronics Group, BARC
Shri V. N. Meckoni, Head Reactor Engineering Division, BARC	Vacant
Two additional members	
Vacant	Shri N. S. Siva, Joint Secretary, Deptt. of Atomic Energy.
Vacant	Vacant

It is noticed that the Boards consist of seven members each including the Chairman, out of which only five are in position on each of the Boards. It is also noticed that four out of five members of the two Boards are common.

5.30. While conceding that both the Rajasthan and Madras Power Projects being in the development stage it would be advantageous to have a few common Members in the two Boards, the Committee feel that the very idea of having separate Boards for management is defeated when the Boards have common membership to the extent of four out of a total of five members in position. They accordingly recommend that the two Boards should be reconstituted with the Project Head as one of the Members.

Power Projects Engineering Division

5.31. It is stated that prior to June, 1967 each of the Atomic Power Projects was independently organised and related itself to the Atomic Energy Department through its own Board. However, the work relating to these Projects involved not only construction work at site but also the

work relating to design on the nuclear and the conventional side, identification of indigenous manufacturing capability and the planning and procurement of materials. It was also recognised that the expertise gained in the construction of a Power Project could be utilised in subsequent Projects. In view of these, it was considered by Government that a new organisation for Power Projects which would permit deployment of men and specialised equipment from one Project to another, would be an advantage. Moreover, through common membership of the important supervisory staff of the new organisation for Power Projects and the Reactor Engineering Division and other Divisions of the Bhabha Atomic Research Centre, the full back up of the facilities created at Bhabha Atomic Research Centre, and the trained personnel that are available, is ensured. Accordingly, the Department of Atomic Energy has set up in 1967 a Power Projects Engineering Division (PPED) for undertaking the responsibility for the establishment of atomic power projects on behalf of the Department. Power Projects Engineering Division was constituted as a new Division of a permanent character entrusted with the responsibility of engineering, not only the current but also future power stations and of development works connected therewith, Government have therefore organised it as a Directorate.

5.32. The precise functions of the Power Projects Engineering Division are stated to be as under :—

(i) Coordination with Research and Development

(ii) Development of indigenous capability

(iii) Design and construction of plants

(iv) Training of personnel

(v) Procurement of equipment

On matters of policy concerning developmental contracts with industry, consultancy, foreign collaboration, etc., approval of the Chairman is obtained by the Power Projects Engineering Division.

5.33. The Power Projects Engineering Division is headed by a Director. It has two construction groups for Rajasthan and Madras Projects, a Design Group, a Commissioning and Operation Group and Internal Financial Adviser. The Design Group of the Power Projects Engineering Division has a separate Head who is under the Director of Power Projects Engineering Division. The PPED is organised into the following sections :

(i) Nuclear Design

(ii) Conventional Design Co-ordination

(iii) Procurement

(iv) RAPP Project Engineer (Liaison)

(v) MAPP Project Engineer (Liaison)

(vi) Administration

5.34. The present strength of the Power Projects Engineering Division is 353.

The expenditure on the Power Projects Engineering Division is met out of the funds provided for the various power projects under construction. The allocation of the expenditure to the various projects is fixed each year on the basis of the work done by the Division for each of the projects. The expenditure allocation is approved by the Management Boards of the projects concerned while approving the annual budget. Government have informed the Committee that the present allocation of expenditure of the Division is as follows: Rajasthan Unit I-50 per cent; Rajasthan Unit II-30 per cent; and Madras Unit I-20 per cent.

5.35. In reply to the question as to how long would the present arrangement continue and how the expenditure would be met after the power projects in hand were completed, Government have stated:

> "Activities and capital assets of relevance to the long term programme of setting up nuclear power stations, as distinct from those immediately in hand, would be carried by PPED, and allotted over a period of time to future power stations."

5.36. The Committee hope that the constitution of Power Projects Engineering Division in Atomic Energy Department for undertaking the responsibility for the establishment of atomic power projects will lead to better coordination and economy and ensure better pooling of resources and expertise and experience. They have, no doubt that experienced engineers and scientists will be rotated among the three Power Projects according to the needs of the situation.

Atomic Power Authority

5.37. Government were asked whether they visualised any separate Central Authority for managing the atomic power stations after the construction work was over. They have in reply stated that it is proposed to set up an Atomic Power Authority for the purpose. According to them, the proposed Atomic Power Authority will be a constituent unit of the Department of Atomic Energy for the management of atomic power stations during their operational phase. The Authority will be responsible for the generation and supply of electricity, maintenance of stations, preparation and consolidation of budgets, management of personnel, etc. The budget will require the approval of the Department of Atomic Energy for incorporation in the Department's Annual Budget. All changes affect-

ing nuclear hazards and safety will require the prior approval of the Department. The Authority will be a Departmental Undertaking but sufficient flexibility in day to day working will be achieved by delegating to it most of the Department's powers except those which are specifically reserved.

5.38. The Committee note that a separate Atomic Energy Authority as a constituent unit of the Atomic Energy Department is soon going to be set up for managing the nuclear power plants in the country after the construction work was over. They hope that the proposed Authority will be a forward looking body able to run the Power Plants efficiently and economically.

D. Liaison Offices

Liaison Offices in Foreign Countries

5.39. The Department of Atomic Energy is maintaining a Liaison Office in Canada and a Technical Liaison Mission in France. The Liaison Office in Canada was set up in 1964 and consists of one Indian Liaison Officer with special experience in nuclear energy. The expenditure of the Liaison Office in Canada was about Rs. One lakh during 1967-68 and Rs. 1·43 lakhs during 1968-69. The present sanction for this office expires in 1972. The Technical Liaison Mission in France was set up in June 1967 and consists of two Indian Engineer Officers with special experience in Nuclear Energy and one Senior Clerk. The expenditure on the Mission in France was Rs. 2·16 lakhs during 1967-68 and Rs. 2·96 lakhs during 1968-69.

5.40. Government was asked to indicate the advantages of maintaining these offices in foreign countries on a regular basis and to state whether the work performed by them could not be attended to by our Embassies and Consular and Trade Representatives in those countries. They have, in a written note furnished to the Committee, justified the existence of these offices as follows :

"(i) *Liaison Officer in Canada* :

The Liaison Officer in Canada has an important role to play *vis-a-vis* the Atomic Energy Canada Ltd., who are the consultants for the Rajasthan Atomic Power Project on the nuclear side, and with Montreal Engineering of Canada Ltd. (MECO) on the conventional side of the Rajasthan Atomic Power Station. The latter assists the Project in the procurement of Canadian equipment which is financed by a loan from the Export Credits Insurance Corporation (ECIC). The Liaison Officer has to ensure that the interests of the Project are fully safeguarded in the procurement of equip-

ment and ECIC for their part require a representative of the Government of India to countersign suppliers' bills passed by MECO. He also assists in preparing the annual estimates of outlay on Canadian equipment included in the Budget in consultation with the consultants. He has a part to play in the promotion of indigenisation of equipment by obtaining relevant information from Canada on the one hand and on the other, assisting in securing the approval of the Canadian consultants of the designs and specifications of equipment proposed to be manufactured in India. He also assists in securing shop drawings wherever possible from Canadian manufacturers. He audits the bills of the Consultants based on cost of time. He has also been delegated powers to approve of tenders and of deviations in orders etc. up to specified limits.

The exercise of these functions requires a full time officer. Owing to the highly specialised nature of his duties they are best entrusted to a technical officer who has been fully trained in the Department of Atomic Energy.

(ii) *Technical Liaison Mission in Paris*

The main function of the Mission is to locate European suppliers of raw materials and components required by the important projects of the Department of Atomic Energy like the Atomic Power Projects, Heavy Water Plants, Fuel and Electronic Complexes etc. Over a five year period, the purchase of these projects are estimated to average over Rs. 7·00 crores per annum and at least 50 per cent of these will be from European sources. For wider national interest many of these projects are to be set up expeditiously and without any foreign collaboration. Thus the benefits of contacts generally provided through a collaborator would not be available. Also, for the same reasons, a high percentage of indigenous content is aimed at and equipments are not purchased on turn-key basis and instead a large number of components and raw materials of special specifications are imported for indigenous fabrication. The information supplied by the Mission is of great relevance to decisions regarding design and specifications of equipment the manufacture of which is attempted in India. The responsibilities of the Mission also cover the following areas :—

(a) Maintenance of contacts with suppliers;

(b) Follow-up on enquiries initiated from India;

(c) Negotiations for conclusion of contracts in consultation with the Indian user elements;

(d) Follow up on delivery, quality control, inspection etc.

(e) Arrangements for financing, insurances, shipping etc. and

(f) Contacts with Industry and attendance at technical conferences, trade fairs etc. to keep Indian users posted with latest developments.

The nature of duties as explained above can only be performed by a resident Mission. In view of the volume and specialised nature of imports, the frequency and level of contacts that will be necessary to push the purchase programme at the required pace, there was no alternative to establishing a separate Mission with engineers having specialised knowledge and familiarity with technology of atomic power reactors and other nuclear installations.

In this connection it may be mentioned that a commission of 2 to 5 per cent is usually paid to overseas agencies for ordering and shipment of imported materials. The saving in this commission would off-set many times the foreign exchange expenditure to be incurred on the Liaison Mission."

5.41. The Committee suggest that Government should review the position regarding the continuance of Liaison Offices in Canada and France on a regular basis after the expiry of the present sanction.

Liaison Office at Delhi

5.42. The Department of Atomic Energy as also the Atomic Energy Commission are located at Bombay. The Department is maintaining a Branch Secretariat at Delhi. It is stated that the Branch Secretariat at Delhi is a regular Secretariat Office handling the work relating to Atomic Minerals Division and only incidentally discharges such liaison functions at Delhi as are required. The number of officers and staff working in the Branch Secretariat at Delhi is 26 and the expenditure on Pay and Allowances of staff during 1968-69 was Rs. 1·41 lakhs.

Location of the Department at Bombay

5.43. As stated earlier, the Department of Atomic Energy is located at Bombay. The seat of Government and venue of meeting of Parliament being at Delhi, the officers of the Ministry are required to pay frequent visits to Delhi in connection with official work. During 1968-69, the expenditure on travelling and daily allowance to officers visiting Delhi/Bombay was about Rs. 54,000. In addition during that year (1968-69) the expenditure on transmission of telex messages between New Delhi office and Headquarters Bombay was about Rs. 42,000.

5.44. Government were asked state the reasons for keeping the Headquarters of the Department of Atomic Energy at Bombay when a sizeable part of its activities had shifted to areas far removed from that city. They have in reply stated as follows :—

"Historically, the national centre for applied research in nuclear technology was nurtured at Trombay and Tata Institute of Fundamental Research, the national centre for fundamental research in nuclear physics and mathtematics at Colaba, by a common Director, who assumed responsibility also for creating a Department at the Ministry level, which could give this programme the closest administrative and financial support. Though now the activities of the Department have ramified in different directions—nuclear power and its ancillary industries, electronics, space research etc. and its activities have spread over the face of the country, the direction and support from Bombay—scientific and technical as well as administrative and financial—has by no means become a historical anachronism, but continues to be a living reality. The Bhabha Atomic Research Centre at Trombay is still the only centre in which all the disciplines relevant to the development of nuclear science and technology have been firmly and adequately established and is, therefore, the only centre able to provide the leadership and guidance for the development of the atomic energy programme. Recognising the need for intimate association of all forms of expertise, scientific, technical, administrative and financial, in the management of the projects of the Department, this responsibility has been entrusted to Boards in which officers of the Department are closely associated with the scientific and technical officers of the Bhabha Atomic Research Centre as well as Projcet Engineers, who are themselves mainly drawn from that Centre. This obviates the necessity for references in the traditional manner and facilitates the settlement of many difficult issues expeditiously across the table, not only in formal meetings of the Board or its various sub-committees, but also through informal consultations. This is rendered possible by the presence of the Secretariat at Bombay. Contacts with other Ministries are maintained through the Branch Secretariat at Delhi (which besides dealing with matters relating to the Atomic Minerals Division, functions as a liaison cell), as also through visits of officers stationed at Bombay to Delhi as and when the need arises.

It may be pertinent to recall that on several occasions in the past, Government have stressed the desirability of decentralisation of the departments of the Government of India. The Department

of Atomic Energy is probably the only Ministry which has followed this suggestion.

Further, it cannot be said that relative to the location of the various centres of the activities of the Department, Delhi is more central than Bombay. Of the total number of about 15,000 employees working under the Atomic Energy Commission, approximately 10,900 do their work in Bombay or its neighbourhood."

CHAPTER VI

MISCELLANEOUS AND GENERAL

A. Training of Technical and Scientific Personnel

6.1. The Department of Atomic Energy in their publication 'Nuclear Power in Developing Countries' have stated that "If the most important bottle-neck in our programme is to be named, it is of trained scientists and engineers with experience to take over independent responsibility for design and construction of sophisticated plants. Even with an inventory of about 2,500 scientists and engineers in the Commission's establishments, we find ourselves seriously stretched to undertake all the tasks which we can now identify for reaping a return for the investment which has been made in the last 20 years in Atomic Energy." When asked to state whether adequate technical personnel—scientists and engineers are available in the country to man the atomic power projects, it has been stated:

> "There are adequate technical personnel, scientists and engineers to man the Atomic Power Projects available in the country. However, the number required for the future may not be sufficient from the point of view of quality when the Atomic Energy Programme begins to expand. The number of engineers and scientists being produced in the country is very large, the percentage of properly trained personnel gets smaller each year."

6.2. Asked to indicate how they propose to meet the requirements of technical personnel, the Department have stated that Bhabha Atomic Research Centre training programme which started as far back as 1957 has proved sufficient and satisfactory for the present needs. 1,604 trainees have completed the training course at Bhabha Atomic Research Centre in the various disciplines from 1957-58 to 1968-69. During the year 1969-70 the number of trainees admitted for training were 160. They have further stated that it will be essential to have more Indian Institutes of Technology and Regional Engineering Colleges of high quality to meet further requirements of technical personnel. The Indian Institutes of Technology have been producing the best type of engineers. According to them engineers and metallurgists must first be trained properly in conventional fields. It is basically the application of normal engineering to problems which arise in nuclear reactors. All the engineers should have a broad training in all fields and their specialisation with respect to nuclear power can always be given at Bhabha Atomic Research Centre.

6.3. To a suggestion made during the course of evidence as to why the Department of Atomic Energy has not followed the model of the United States and Canada where the research is done by the private sector and specifically the universities and afterwards it is handed over to the Government, the Chairman, Atomic Energy Commission, stated that U.S.A. is spending 3 to 4 thousand million dollars and a small part of it is given as developmental grants to universities and other companies. Government itself runs a very major establishment like the Oakridge National Laboratory but its management is given over to a university or a private company. The Union Carbide manages the Oakridge National Laboratory. There is the Chicago Laboratory. There are big laboratories with budgets several times the budget of the Indian Atomic Energy Commission. He further explained the position as follows :

> "Today we are faced with a situation in which the type of things which we require for atomic energy both in the form of training, equipment, design and development facilities are not prevailing as in advanced countries, in industry or in universities. In consequence, at the present time it has become a necessity for us to give facilities to Universities rather than the university being able to come to help us. A typical example is the 5 crore rupees cyclotron project in Calcutta. This is a thing which we would like to run as an Inter-University project where we provide the funds for setting it up and the entire construction will be done by the Bhabha Atomic Research Centre and some members drawn from the University. Once the facilities are ready, it will be under an autonomous unit. It will be available to all the universities to use it for research and production of isotopes. If once we succeed in this, we too will be able to get the universities taking a major role. But at the moment we have found that if we are to depend on outside bodies for doing some of the basic things, we really could not be able to go ahead and we cannot get the results in time."

6.4. Replying to the further point that training programme should have been entrusted to various other institutions in order to derive the maximum advantage in men and facilities available in the country as is being done in other countries, the Chairman, Atomic Energy Commission explained the position as follows :—

> "I think the point is important and relevant. Atomic Energy requires a special background in certain special things. Now there are some universities and particularly the I.I.Ts. having a special programme for teaching nuclear science and nuclear engineering. We are having our main cadre from people who had taken General Science in the university. We found that by putting them under a very specific programme of

somewhere about 9 months to 12 months they will be in a better position to work. There are two advantages. After the training the man is assured of being absorbed in the Atomic Energy Department. Supposing the University is going in for a very high degree of specialisation of the type that we are talking of, the man has only one employer really in the country and if he is not chosen he would jeopardize his career. So in the state of affairs which exists today, I think it is perhaps in the interest of the student that in his university career he does no specialise too narrowly in one direction. On the other hand, if this is the case, the Department of Atomic Energy must pick up a student, thus giving him the guarantee that he will be absorbed. That will largely be the rationale for you. But I would hope that with the development of I.I.Ts. and other places and with the development of industry catering to their needs, we should have a greater contribution of the Universities and I.I.Ts."

6.5. The Committee note that the training programme conducted by the Bhabha Atomic Research Centre has proved satisfactory and adequately meets the present manpower requirements of the Atomic Energy Department. The Committee are, however, informed that there are not sufficient men to meet the likely needs for future atomic power programme. They feel that training programme need to be broad-based and with that end in view, fundamentals of the nuclear physics, its theory and practice, should be taught in universities as part of B.Sc. (Hons.) and M.Sc. courses and nuclear technology and engineering should form part of engineering degree course. The best students amongst them should be selected and given training at Bhabha Atomic Research Centre.

6.6. The Committee also feel that the Atomic Energy Department should establish closer liaison with institutions of advanced learning like the MATSCIENCE, Madras, Indian Institute of Science, Bangalore and certain universities which have been selected as centres for research and advanced studies in science, with a view to make use of the scientific personnel coming out of these institutes. They are further of the opinion that it will be desirable to associate leading scientists with the training programme.

6.7. The Committee trust that the Atomic Energy Department periodically review their manpower requirements so that they recruit and impart training to only such number of engineers and scientists as can be usefully and purposefully employed and not become redundant after some time.

B. Nuclear Fuel Complex

6.8. Fuel requirement for the initial loading of Tarapur Atomic Power Project (enriched uranium oxide canned in zircaloy) has been imported from the United States. The first reload requirement for Tarapur Atomic Power Project will also be imported. As regards the Rajasthan Power Reactors, (2×200 MWe), the position is that while half the initial fuel load (natural uranium oxide) for Rajasthan Atomic Power Project-I has been imported from Canada, the other half amounting to 30 tonnes of contained UO_2 will be fabricated at Trombay.

The Nuclear Fuel Complex being set up at Hyderabad will supply (i) the further replacement fuel and zircaloy requirements for Tarapur Atomic Power Project and Rajasthan Atomic Power Project-I, (ii) the initial and replacement requirements for Rajasthan Atomic Power Project-II, and (iii) the entire zircaloy and fuel requirements (initial and replacement) for Madras Atomic Power Project and other CANDU type stations as may be set up in the future.

6.9. The projected Nuclear Fuel Complex at Hyderabad will cover the entire range of operations from raw mineral concentrates to finished fuel element assemblies and other reactor components for power reactors of different designs. The development of the detailed flow sheets and the engineering of these processes for full scale production have all been carried out by the scientists and engineers of Bhabha Atomic Research Centre, Trombay through research and development work and pilot plant operations.

6.10. The capital outlay as estimated in the Project Reports for the various constituent plants is stated to be as under:

	Capital Outlay (including Civil Works)	Foreign Exchange (component)
	(Rupees in lakhs)	
1. Uranium Oxide Plant . . .	118·46	22·00
2. Zirconium Plant	710·56	311·70
3. Ceramic Fuel Fabrication Plant . .	152·87	75·00
4. Special Materials Plant . . .	37·33	6·97
5. Enriched UO_2 Plant . . .	83·81	17·81
6. Enriched Uranium Fuel Fabrication Plant	41·70	15·46
7. Common Plant Facilities . . .	239·57	19·53
TOTAL . . .	1,384·30	468·47

6.11. In deciding upon the capacity of the various plants constituting the Nuclear Fuel Complex, a careful assessment of the requirements of uranium oxide fuel, and zircaloy (a zirconium based alloy with 1·5 to 1·7 per cent tin) components for the initial inventory as well as for replacement requirements has been made. Provision has also been made for the expansion of these facilities as required. A township common to Nuclear Fuel Complex and Electronics Corporation of India Ltd. to house about 900 employees, is under construction near the Complex site. With the commissioning of the Nuclear Fuel Complex, the recurring foreign exchange saving is estimated at Rs. 5·50 crores per year at the rated out-put. The Complex will afford employment opportunities to about 250 engineers and scientists, 1,200 technicians and about 200 administrative and auxiliary personnel.

6.12. During the course of evidence, when asked to state when the plant would come into production and whether it was working according to the schedule, the representative of the Department informed the Committee that as far as the enriched plant was concerned, it was expected to come into operation in time for the second reload *i.e.* in early 1972. It was further stated that one plant which was part of the zircaloy plant was likely to be delayed by about three to five months. Giving further details about the delay, the Chairman, Atomic Energy Commission, explained the position as follows:

> "Some of these plants were thought of quite early in the mid sixties. For instance, when I took over in the middle of 1966, a Committee had been round the various parts of the country to identify the site where this plant could be put up and we had a report about it by the end of 1966. The negotiations with the Andhra Government have been finalised for locating this complex in Andhra Pradesh. After that, detailed engineering and other things were done and it was put up to the Commission with the various references made. For the whole thing to start in right earnest, a period of two and a half years was provided * * * * * and * * * there is likely to be a slip of one of the plants to the extent of three to five months."

When further asked whether he was satisfied with the time-lag between the location of the site and the commissioning or commencement of the work, he informed the Committee as follows:—

> "I am not satisfied, but I think in future we have to have a totality of administrative practice of taking into consideration the financial approval which calls for better project management. I am not satisfied personally with our project management, which is not only internal but outside also. It is not a criticism

of anybody, but it is a combination of factors operating within Government such as the D.G.T.D. clearance, finance and the whole complex of things which are to be settled before you get on really with the job, while is generally cumbersome.

He suggested the following remedial measures to bring down the time-lag :

"My own feeling is that in the planning and designing stage, we should have many things decided to a much greater extent before we start the actual construction. Because, otherwise, once you start construction and get a team of people coming in, and if the plant is not ready, you run into other problems, which come up continually. So, at the time you start construction, all the concerned parties should know pretty well, not in every detail, but in broad terms, exactly what is involved and what they have to do. This type of project replanning and scheduling is a thing which we have to do more rigorously in the future."

Consultants

6.13. In the Annual Report of the Department of Atomic Energy for the year 1967-68 it has been stated that a firm of consultants has been recently appointed for the design and engineering of civil works and services, and for preparation of the detailed shop layout for the constituent plants in consultation with the Bhabha Atomic Research Centre engineers. The engineering report is expected soon from the consultants and plant construction is scheduled for completion about two years thereafter. In reply to a question* answered in the Lok Sabha on the 2nd April, 1969, it has been stated that no tenders were invited for the appointment of consultants. M/s. M. N. Dastur and Company were selected on the basis of their experience in the field of metallurgical and metal industries. The details of the agreement have been stated as follows :

"The consultants are entitled to a payment of fixed fee of Rs. 26 lakhs (inclusive of travelling expenses) provided the construction and erection work is completed within 30 months. Beyond this period an additional fee (not a fine) of Rs. 12,000 per month is payable to cover the extra expenditure incurred by the firm on the continued maintenance of staff required to assist the Project. The main responsibility of the Consultants includes the preparation of the engineering report, development of the plant and shop layouts, designs and specifications for structural designs of services including electricity etc. and utility systems, design supervision and Project coordination."

*U.S.Q. No. 4059 on 2-4-1969.

6.14. Government were asked to furnish details of the terms and conditions of the contract with M/s. Dastur and Co. and the present position of implementation of the same by the contractor. In a note supplied in January, 1970, Government have invited attention to the folder supplied during evidence in October, 1969 wherein the following information has been given :

"Consultants responsibilities
in N.F.C.
General Layout
Shop Layout
Civil & Structural Designs
Design of External/Internal
Services
Fees Rs. 26·00 lakhs fixed
Payable in 30 months
plus
Rs. 12,000 per month
if required beyond this period
Design work, preparation of tender documents
drawings likely to be completed
by April, 1970."

No details of the agreement entered into with the consultants and the latest position about the progress of the work have been given.

6.15. The Committee feel that Government have taken a long time in commencing the work on Nuclear Fuel Complex although the decision to set it up was taken as far back as in 1966. They are constrained to observe that lack of proper project planning and scheduling and lack of coordination amongst the various Ministries/Departments concerned have been the main factors responsible for delay in the commencement of the work on this Complex.

6.16. The Committee hope that the Government would now take all necessary steps to ensure that the Complex is completed according to schedule to meet the requirements of fuel for three Atomic Power Projects and to avoid dependence on foreign resources and to save the much needed foreign exchange.

6.17. The Committee note that in appointing M/s. M. N. Dastur and Co., the Department did not call for any tenders. According to them, they made an *ad hoc* selection "on the basis of the adequacy of experience in handling similar projects". From the sketchy information furnished to the

Committee in January, 1970, they are not in a position to comment on the justification of the terms and conditions of the agreement entered into with the consultants, and whether the progress so far made is according to the schedule.

C. Nuclear Powered Agro-Industrial Complexes

6.18. In reply to a question* answered in the Lok Sabha on the 2nd April, 1969, it has been stated that a study conducted by the Oakridge National Laboratory of U.S.A., in which scientists from India also participated, indicate the possibilities to improve the country's food production by bringing large areas under cultivation by using ground or desalted water. It has been further stated that to follow up this study with particular reference to Indian conditions, the Atomic Energy Commission set up a working group towards the end of 1967. The working group has submitted a preliminary report which is under examination. The final report is still awaited.

6.19. It has also been stated in the Report that some of the details given in the report may need revisions based on detailed study. Also some important items have not been adequately covered. The transport, storage and marketability of raw materials and products have to be looked into in much more detail. Since large finances are required to be raised for such complexes, the raising of finance is an important factor as also decisions regarding locations of complexes.

6.20. The basic theme of the preliminary study is that low cost energy could play an important role in the country's economy both in the field of agriculture and industry. India is predominantly an agricultural country and its agriculture is mostly monsoon-dependent. Nuclear power offers immense potential for lifting of underground water for irrigation and for desalting water which could be used for agriculture purposes. In the industrial field if power costs are reduced to less than 2·2 p/kwh for chemical processes, energy will increasingly substitute some of the raw materials. Cheap power can be made use of for producing gasoline from coal, production of fertilizers, aluminium and electro-chemical industry producing electrolytic caustic soda.

It has been further stated that there are certain difficulties in adding large block of power to the grids in India. If one single 1,000 MW unit in one station is added to any of the present grids, it might be difficult to integrate such a station into the grid and to find consumers for such a large block of power. Moreover, if this power is to be transmitted over long

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*S. Q. No. 870 on 2-4-1969.

distances, transmission costs will nullify the advantage of low energy cost. It is, therefore, necessary for the power producers to start or promote energy-consuming industries in the vicinity of these large blocks of power resulting in a nuclear powered agro-industrial complex.

6.21. The study group has brought out interesting findings regarding the economic viability of agro-industrial complexes based on nuclear power of about 1,000—1,200 MWe in the Kutch-Saurastra area and the Western Indo-Gangetic plain.

Kutch-Saurastra

6.22. In the Kutch-Saurashtra area, a nuclear-powered agro-industrial complex producing 4,70,000 tonnes per year P_2O_5 along with 55,000 tonnes per year of aluminium and 150 million gallons water per day from a desalination plant would require an investment of about Rs. 600 crores. The return on the investment on the industrial portion would be about Rs. 71 crores. The desalted water would provide for additional food production of 1,92,000 tonnes of maize, 3,90,000 tonnes of potato and 46,400 tonnes of groundnut. The foodgrains produced would meet the requirement of 1 million people with the potato and groundnut available to supplement food intake substantially. Income from the farm sector would be about Rs. 14 crores.

Western Indo-Gangetic Plant

6.23. The agro-industrial complex visualised in the Western Indo-Gangetic plain requires an investment of Rs. 430 crores for production of 6,36,000 tonnes per year of plant nutrient, 50,000 tonnes per year of aluminium and enough power to energise tubewells for assured irrigation of 7,20,000 hectares. Additional food produced would be 4.5 million tonnes of cereals and 7,00,00 tonnes of pulses enough to meet the requirement of 22;5 million people. The income from the industrial portion is estimated at Rs. 57 crores and the farm portion Rs. 213 crores.

6.24. The proposed agro-industrial complex starts off with the assumption that there is today in India the potential for the establishment of 500 MW nuclear stations in several areas of the country. As such conditions do not really exist in the country, the Committee has desired to know if the scheme was at all feasible. The Department in a written note has stated that study made by the Working Group demonstrate that there is scope for the establishment of 500 MW nuclear stations in the country. The study also shows that by simultaneous planning consumer industries along with large scale units for generating electricity, great economic advantage can be gained. According to them the whole programme is workable, in Western U.P., for example, and is therefore not hypothetical, if resources are available.

6.25. From the preliminary report of the Working Group set up by the Department of Atomic Energy in 1967 on the the Nuclear-Powered Agro-Industrial Complexes, it is evident that the Agro-Industrial Complexes envisaged in the study in Kutch-Saurashtra area and Indo-Gangetic plains are based on the following assumptions :—

(i) Setting up of nuclear power projects of about 1600-1200 MW capacity in these two areas.

(ii) Availability of power at rates of two paise per KW for fertilizers and 2·6 paise per KW for Aluminium.

(iii) Raising of resources to the tune of Rs. 1,030 crores in a period of 5 to 10 years.

The scheme would appear to be hypothetical as it is based on assumptions which are unfounded. The Committee, therefore, consider that the question of setting up Nuclear-Powered Agro-Industrial Complexes is not at present feasible in the context of the present progress made in the field of nuclear power development and due to lack of resources.

D. India and International Atomic Energy Agency

6.26. It has been stated that largely due to the early start which India made in atomic energy and also largely due to Dr. H. J. Bhabha's own personal role in the field of atomic energy as one of the outstanding experts, India claimed in the International Atomic Energy Agency a special position. In the Charter of the Agency there is a provision whereby India can have a certain non-elective seat on the Board of Governors. India is a founder Member and since the inception of the International Atomic Energy Agency India has been continuously designated a member on its Board of Governors as the country most advanced in the science and technology of atomic energy in the South Asia region. During the course of evidence, the Chairman, Atomic Energy Commission, informed the Committee as follows:—

> "The main thing that the Agency has done is to have a very intensive scheme of scholarships, fellowships, technical discussions in panels, and holding of symposia on issues as also arranging a world conference of peaceful uses of atomic energy and so on. We are one of the countries which, from the beginning has participated very actively. In fact amongst all the developing nations of the world, India has been able to make contributions in collaboration and so on and so forth. There has been sharing of information based more on professional considerations than on commercial considerations."

6.27. It has also been stated in reply to a question *in the Lok Sabha on the 13th August, 1969 that the International Atomic Energy Agency will establish a computer-based system called International Nuclear Information System (INIS) at Vienna by 1970 and India will also be entitled to obtain the special information.

6.28. India is contributing a sum of Rs. 15,54,000 annually to the International Atomic Energy Agency according to from the budgetary estimates made in the years 1969-70 and 1970-71.

6.29. When asked to state who represented India at the International Atomic Energy Agency, the Chairman Atomic Energy Commission during the course of evidence informed the Committee that "for the time being we have got Shri C. V. Trivedi, our Ambassador in Vienna who is accredited to Austria. Also he is a Governor on the Board of Governors. For instance, if any delicate issue, relating to the atomic policy came, the Chairman, Atomic Energy Commission, Dr. Bhabha used to go there to attend the meetings. I also have attended these meetings. But the routine type of contact is left with the Mission—our Embassy in Vienna."

6.30. From the information furnished to the Committee, it is seen that during 1964-65, 1967-68 and 1968-69, the Chairman, Atomic Energy Commission, was abroad for 110, 70 and 78 days respectively in connection with official business.

6.31. The Committee note that India is contributing as much as 15·54 lakhs of rupees annually to the International Atomic Energy Agency. They trust that our association with International Atomic Energy Agency is fruitful and commensurate with the expenditure involved.

6.32. The Committee understand that the Chairman, Atomic Energy Commission, is required to go abroad to participate in important activities of the International Atomic Energy Agency and attend conferences and seminars organised by that Agency and the U. N. Organisation regarding peaceful uses of Atomic Energy. As the Chairman, Atomic Energy Commission, is also Secretary of the Department of Atomic Energy he has under his administrative control a large number of Research Centres and Institutes, Departmental Undertakings and Atomic Power Stations, a large number of complicated problems are bound to arise necessitating his decision and personal guidance.

The Committee feel that in view of the fast developing activities of the Department in several directions simultaneously, the whole time presence and attention of the Chairman will become imperative. They, therefore, suggest that his visits abroad should be confined to the absolute minimum requirements.

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*SQ 528 on 13.8.1969.

E. Economics of Nuclear Power

6.33. At a power symposium with reference to a remark that nuclear power was rich man's electricity, Shri Homi J. Bhabha declared: "No power is costlier than no power." The Chairman, Atomic Energy Commission during evidence explained this remark as follows—

> "When we look at the relevance of nuclear power, we have to put it in the context of relevance of power itself. Nuclear power is only a means of achieving an economic source of power.... In a developing nation if you deny the people power, that is a costliest thing you can do. It is a dramatic way of putting it."

Shri Bhabha may have succeeded in silencing his detractor, but he could not for all times smother the controversy over power costs which is still raging. In a memorandum submitted to the Committee by an eminent scientist, it has been suggested that the "Choice between nuclear, hydro electric and thermal power production should be made solely on the basis of economic reasons and not because of some false sense of prestige of setting up atomic power projects all over India."

Information regarding capital outlay of the hydel, thermal and nuclear power stations was asked for separately from the Department of Atomic Energy, Ministry of Irrigation and Power and the Planning Commission so as to have a comparative idea.

Views of the Planning Commission.

6.34. In a note furnished to the Committee by the Planning Commission, they have given the estimated cost of energy generation from Tarapur, Rajasthan and Conventional Thermal Stations as has been indicated to them by the Department of Atomic Energy as follows:—

	Tarapur Atomic Power Station	Rajasthan Atomic Power Station	Typical Thermal Station
	Rs.	Rs.	Rs.
1. Capital cost per KW installed .	1850	3150*	2000
2. Fixed cost (Paise/KWH) . .	2·687	4·38	3·34
3. Fuel cost (Paise/KWH) . .	2·04	0·34	3·30
4. Total production cost excluding profit (Paise KWH) . .	4·727	4·72	6·64
5. Profit at 3% (Paise/KWH) .	0·885	1·44	0·91
6. Total selling price (Paise/KWH) .	5·61	6·16	7·55

The following assumptions have been made:—

(1) The thermal plant costs are for a typical station of 200 MW size with maximum indigenisation and includes interest during construction.

(2) An interest rate of 6 per cent, a plant life of 25 years for the main plant and 50 years for colony and other civil works; and a plant factor of 75 per cent have been assumed in all cases.

(3) O & M costs have been assumed at 3/4 per cent, insurance of property at 1/8 per cent and contingency at 1/2 per cent of capital value in each case.

(d) The cost of coal at pit-head has been assumed at Rs. 30 per tonne and fuel cost has been calculated on the basis of the coal cost of Rs. 60 per tonne. This is the cost at which coal is available at distances of 670 to 1,000 km. from collieries.

6.35. Commenting on the co-relative comparison between the three different sources of power as estimated by the Department of *Atomic Energy, the Planning Commission has made the following observations:—

"In case of Tarapur and Rajasthan, the fixed charges are represented to the extent of full 11·475 per cent. This is because in their calculation they have not allowed for the full interest charges on the loan capital whereas in the cost of conventional thermal stations, full interest charges have been allowed. If the same method as used for conventional stations were used for Tarapur and Rajasthan Stations, the corresponding fixed charges in case of Tarapur and Rajasthan would be 3.4 paise and 5.5 paise as against 2.687 paise and 4.38 paise respectively indicated by the Department of Atomic Energy in the earlier table. * * * * The cost of generation in hydro station is very much cheaper than either from conventional thermal stations or nuclear power stations and therefore needs no comparison."

It has already been stated in Chapters III and IV relating to Rajasthan Atomic Power Project and Kalpakkam Atomic Power Project that according to the Planning Commission the cost of generation of energy for both the stations would come to much more than estimated by the Department of Atomic Energy.

6.36. During evidence, the representative of the Planning Commission expressed to the Committee his views in this matter as follows:—

"Today we have to consider all types of power generation and come to most economical product mix. At the moment we have the Rajasthan Ranapratapsagar power plant under construction and in the plan we have also included Kalpakkam unit

*At the time of factual verification the Department of Atomic Energy have pointed out that "Department of Atomic Energy has allowed for full interest charges on the entire capital cost depreciated year by year. Planning commission have evidently not followed our calculations".

No. 1 for 200 MW. As we have stated in the Plan Document, this is a matter for continuous review.

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So, at the moment, we are in close contact with the Atomic Energy Commission. As a matter of fact, there has been a continuous dialogue and we hope that we will go into details taking into account the regional requirements. Particularly, in the northern region, one has to see as to whether it would be desirable to exploit the hydro-electric potential or whether it would be more economical to go in for a nuclear power station on a large scale."

Pointing out the problems of manufacturing generating equipment and other components, he stated that the matter was being reviewed. He maintained:—

"We would like to go ahead with the programme of product-mix so that in far away places instead of transporting coal reserve over a longer distance, * * * * * * We can go in for plutonium from uranium as the cost of generation of power from it might go down..... Tarapur has just gone into operation—only a few months back. Now Rajasthan has yet to go into operation. Certainly when these two stations go into operation, we would know as to what would be the problems and other details regarding operation of the Atomic Power Station".

Another point that he made was:—

"The other point that we should keep in mind is the base load factor. Now the nuclear or a thermal power station for that matter must have a base load. For example, in the northern region if you fix up the base load station of 400 or 600 M.W., we have to know as to what is likely to be the base load in future if we fix it at 80 to 85 per cent load factor. I think this base load would be desirable base load stations operations utilise the hydro-electric power for peaking purposes."

Views of the Ministry of I and P

6.37. The Ministry of Irrigation and Power have in a written reply stated that hydro stations have now to be considered in two separate categories (a) conventional energy sources located on main rivers—at dams, waterfalls and escarpment sites—based on the product of available discharges in the rivers and the head and (b) "pumped-storage" developments, which are not based on larger river discharge, but rely on utilising off-peak, surplus thermal/nuclear energy to pump up waters from small tail pools to high level reservoirs, for re-use during the peak hours (these

are considered wherever economic thermal/nuclear energy surpluses are available and reservoirs for a few hours supply can be easily constructed). Capital costs of hydel development, as is well-known, vary from site to site. The capital costs of recently completed schemes range from Rs. 1,000 to Rs. 1,500 per kw installed (the average being about 1,230). Keeping the expected rise in prices in materials, labour and equipment in mind, the capital costs per kw of new hydro plants in respect of which detailed estimates are not available may be tentatively assured to be of the order of Rs. 1,800 to Rs. 2,000. Pumped storage developments have yet to be initiated in this country, but on the basis of preliminary studies it is expected that they can be executed at costs of about Rs. 700 per kw. The actual capital cost/kw installed of thermal power stations recently completed where the plant and equipment are imported is Rs. 1200 to 1300. The cost of thermal schemes under construction is estimated to vary between Rs. 1500 to 1800/kw with the increasing component of indigenous manufacture the capital costs today are around Rs. 1700 to Rs. 1900 per kw. The investment cost per kw. of nuclear plant in the country would by and large be around Rs. 3000 per kw in future.

6.38. Tendering evidence before the Committee, the representative of the Ministry of Irrigation and Power stated that India's per capita consumption of energy was very low and when compared with other advanced countries of the world we are having the lowest position. In view of this, he emphasised that it would be necessary to take adequate action in all the fields wherever we could lay hands on the resources for utilisation in the most economic manner.

As regards nuclear power, he stated that we had made a beginning and it had a role to play. He emphasised that it had to be decided what would be the best mix of various forms of energy which in this country would give the most economical energy production. A decision would have to be taken as to the quantum of atomic energy that should be induced into our national economy on the basis of such optimum mix-studies. When asked to state the period when nuclear power would have an important role to play, he stated:—

> "Cost of unclear energy will be lower and lower as the units become bigger and bigger. That is one of the points in nuclear generation. At the moment, although with some difficulty, we are able to instal about 200 M.W. but then again not all the systems can take to 200 M.W. It will create certain problems in operation, transmission, distribution etc. I may put it this way. It may be between 1980 and 1985, by that time, we may say, more of development would have taken place in the field of thermal and hydro-electric sources and then that would be the time we will be in a better position to assess the real economics of nuclear power."

Views of the Department of Atomic Energy

6.39. The Department of Atomic Energy in a written reply have furnished the following information regarding the capital cost of an atomic, thermal of hydro station:—

atomic, thermal or hydro station Capital outlay per KW installed.	Rs.
Tarapur Nuclear	1850
Rajasthan Nuclear	3150*
Madras New thermal Station	2000
Hydro	1500**

*Includes first half charge of fuel

Firm capacity is only a fraction of installed capacity in storage hydel e.g. at Bhakra Eirm capacity is 365 MW installed capacity is 1050 MW.

All figures include interest during construction.

The Department has further stated that the cost would vary depending upon the time at which the project is taken up, the extent to which indigenous equipment is utilised and the size of the station. According to their present estimate, the capital cost of a thermal power station in the 200 MW range and with a higher degree of indigenisation of equipment would be of the order of Rs. 2,000 per kw.

6.40. The Chairman, Atomic Energy Commission, in the course of evidence stated: "Today power in this country is atleast twice as expensive as in other developed nations." He emphasised that our goal should be clear-cut and it should be to provide power in the most economic way and if things are looked upon from that point of view, the question will not be to choose "either/or" between these three forms of power. He stressed that we should have a maximum of all the three sources of power as these types of power generations have special characteristics. According to him, hydel power was site bound and subject to seasonal character of the rainfall during the monsoons. Vagaries of the monsoons have put out of gear India's economy on many occasions in the past.

6.41. Further, according to him, the average load on hydel stations during the year was only 30 to 50 per cent of the installed capacity.

Another feature of the load in each grid was large range of variations. In the northern grid, for instance, while the peak load was 1430 MW but the minimum load was only 600 MW. For about 50 per cent of the time, the load was less than 1/3rd of the installed capacity. This illustrated the vast scope for economy of capital expenditure and of reducing cost of power through an improvement of the load factor. The Chairman, Atomic Energy Commission, maintained that the capital cost of hydel station was not as small as is generally believed if comparison was made on a like-to-like basis.

6.42. With regard to thermal power, the Chairman, Atomic Energy Commission, stated that the coal in this country was concentrated in certain areas and haulage of coal to distant places would involve transportation cost on a major scale.

Further, the mining costs were labour intensive and therefore coal price fluctuates every now and then. He maintained that a conventional station based on coal would be most inexpensive when coal was available nearby; but at places which were 400 to 500 miles away from the coal-fields, it will not be so. Nuclear power, however, according to him, was practically independent of geographical factors, the only requirement being that there should be a reasonably good water supply. No combustion products were created by nuclear plants and consequently it was a clean source of power which does not contribute to air pollution. As to the economic of nuclear power, he stated that nuclear power was economical only if it was run at a large load factor. A nuclear station which was capital intensive, generated electricity least expensively only if it gets a fairly constant load factor somewhere around 65 or 70 per cent and was not subjected to big ups and downs. Thus, according to the Chairman, Atomic Energy Commission: "It is the combination of good base load station and a good peaking source like hydro electricity which provides the most economic solution". He further stated:

> "We can make this analysis: over a period of years how can you balance the initial capital costs with the overall operating costs to get the most economical system taken over 25 years period. This process has already been applied by us. We have some figures which we can discuss. You come out always with the combination of all the things as the most economical system. We are convinced through studies that any one who says that it is either the one or the other is not reflecting the hard facts of economic reality as we seem to be able to project today. This is one factor which we would like to emphasize to this Committee. When we talk of the relevance of nuclear power, we feel that we should consider two aspects: we should consider not only its economic considerations as of

now but we should also see what is likely to happen to the future of India if you have to avoid it. The most dramatic aspect can be demonstrated by asking this question: suppose we decide that there is going to be no nuclear power station, what is likely to be the future of India 10 or 20 years from now? It is in this context that the striking advantage of nuclear power comes out. * * * * * * * * * The nuclear power station also produces plutonium. It is one of the most important fissile material of the present day which has, of course, got its signifinance for power generation. * * * * * * It is absolutely essential for the country to have a series of thermal reactors which using uranium, could produce plutonium which ten years from now can make nuclear power inexpensive. Today it is on the border line. Ten years from now, if you develop this programme properly, you can get into a stage where plutonium will be available from our sources without any restriction from outside. This could be used in the most economical way for breeder reactor which will give us inexpensive electricity and which will enable us to go into the path of utilisation of thorium. None of these things is possible unless we have the reactor of our own and develop a net-work of stations which will provide inexpensive electricity and at the same time develop the technological base and the full fissile inventory which would be needed for future."

Power Economy Committee

6.43. It is stated that the Planning Commission are in constant dialogue with the Department of Atomic Energy and are reviewing the role that should be assigned to the nuclear power and in this context they would like to watch the operational efficiency of the Tarapur Project which is under operation and of the Rajasthan Atomic Power Project which is under construction at present. Further, in order to utilise more efficiently the available resources in the country for generation, transmission and distribution of power and bring down the costs of development, a High Power Committee consisting of experts in the field of electricity development has been constituted by the Ministry of Irrigation and Power in May, 1969. The terms of reference for the Committee are:—

(i) to review the pattern of utilisation of available plant capacity during the past 5 years and their operational efficiency and fuel consumption, to consider the scope of improving economy in power generation together with specific measures for attaining them;

(ii) a review of the economic of power generation from different sources hydro, thermal and unclear—under prevailing condi-

tions and expected future trends to indicate the factors which must prevail in the choice of of schemes for expansion of generation and supply in each region of the country in future;

(iii) to review the conditions of power supply including reliability, voltage fluctations and the extent of transmission losses, to be followed by specific suggestions to improve the conditions of supply and reduce transmission losses to the minimum extent possible; and

(iv) to review the causes of delay in the execution of the power projects, to suggest measures for improving the manner of implementation of power projects and reducing construction periods.

6.44. The Committee note that the cost of power generation from conventional sources i.e. thermal and hydro and from the three Atomic Power Stations at Tarapur, Kota and Kalpakkam has been variously estimated by the Planning Commission, Ministry of Irrigation and Power and the Atomic Energy Department. They feel that with the present constraint on our financial resources there is need that the choice between nuclear, hydro and thermal power production should be made after a study of their relative economics both short term as well as long term. This is possible only after it is known what the cost of generation of power would be from each of the systems. The Committee note that the Ministry of Irrigation and Power has already constituted a High Power Committee of Exports inter alia "to review the economics of power generation from different sources—hydro, thermal and nuclear—under prevailing conditions and expected future trends to indicate the factors which must prevail in the choice of schemes for expansion of generation and supply in each region of the country in future". The Committee would like that the above expert body also goes into the cost structure of the Atomic Power Plants at Tarapur, Kota and Kalpakkam with a view to determine the unit cost of generation of power from each one of them. They trust that the expert Committee would be submitting its Report at an early date and that Government would no doubt keep its recommendations in view while deciding the programme for nuclear power stations.

F. Selection of site—Report of the Slection Committee

6.45. At the time of taking up India's second nuclear power station, the Planning Commission authorised the Department of Atomic Energy to select suitable site for a nuclear power station in the area of Delhi-U.P.-Punjab-Rajasthan. For the purpose, a Committee for selection of suitable sites for locating nuclear power station proposed to be constructed during

the Third and the Fourth Five Year Plans was constituted in August 1961 as follows:—

(1) Shri M. Hayath,
Director (Technical),
Heavy Electricals
India Ltd.,
New Delhi. — *Chairman*

(2) Shri K.P.S. Nair,
Member (Hydro Electricity),
Central Water & Power
Commission,
New Delhi.

(3) Shri A. S. Rao,
Head, Electronics & Health
Physics Group,
Atomic Energy Establishment, Trombay.

(4) Shri V. N. Meckoni,
Head, Reactor-Engineering Division
Atomic Energy Establishment,
Trombay.

(5) Dr. A. K. Ganguly,
Senior Research Officer,
Health Physics Division,
Atomic Energy Establishment,
Trombay. — *Members*

(6) Shri R. P. Mehta,
Electrical Engineer,
Reactor Engineering Division,
Atomic Energy Establishment,
Trombay.

(7) Shri G. R. Udas,
Senior Geologist,
Atomic Minerals Division,
Department of Atomic Energy,
Bombay.

The terms of reference of the Committee are:—

(i) to select a suitable site for nuclear power station of the CANDU type, 200 MWe, in the general area of Delhi-Punjab-Rajasthan-Uttar Pradesh. The site should preferably be capable of having a second unit of 200 MWe added at a later date.

(ii) to select about six other suitable sites for nuclear power stations in the rest of India so as to have a list available for use, whenever the need arises, for locating further nuclear power stations in the country during the Third and Fourth Five Year Plans. At least one such site should be in South India, preferably in the Madras State. These sites should be placed in order of suitability.

6.46. It has been stated that siting of a nuclear power station is governed by usual technical considerations applicable to conventional power stations plus by considerations due to the special design and operational features of a nuclear reactor. The latter involves health and safety aspects which are not present in conventional power plants but which require careful evaluation in the case of the nuclear power plants. The following technical requirements of a site for location of a CANDU type nuclear power station were taken into account:—

1. *Cooling water*:—Availability of cooling water is one of the prime consideration for selection of a site. The temperature of the water available for cooling effect the efficiency of the plant; the lower the temperature the higher is the efficiency. The water should be free from silt and should be reasonably soft as otherwise the cost of auxiliary plant for treatment of water will be high.

2. *Electrical system*:—The station should be located such that it is possible to make power supply available to the whole of the area served most economically and with minimum of new transmission lines. Nuclear power stations on account of their high capital costs but low operating costs, can work economically as base load stations. Load factors of 80 per cent or more are desirable and such high load factors can only be achieved of the stations work as part of an integrated grid and are assigned the base load, the system peaks being taken by other stations.

3. *Seismic conditions*:—The nearness of the epicentres of past earthquake as well as the vicinity of a seismically active region have to be given due consideration.

4. *Population distribution*:—The site should be such that it is possible to have; (a) an exclusion area of 0;5 mile radius around the reactor. Only plant operations will be permitted within this area; (b) a sterilised area of 3 miles radius around the reactor. Further growth of population and public utilities will be restricted in this area. Existing population in

the area should be small enough so as to enable easy rehabilitation in case of emergency; (c) an outlying area of 10 miles radius in which there are no centres of population of 10,000 or greater. It is preferred that large cities of population 100,000 or greater do not lie within 25 miles of the site.

5. *Foundation*:—Nuclear Power Stations impose very heavy loading on the foundations. Since normal soils cannot have such high bearing capacities, it would be preferable to have foundations on solid rock so as to avoid expenditure on piling or raft foundation. The total area required for location of the plant is approximately 600′ × 600′.

6. *Water utilisation*:—Enough water should be available to effect dilution in case of an accidental release of activity in water so as not to affect appreciably its ultimate utilisation.

7. *Geology*:—Sites where compact rock foundations are available at reasonable depths would be preferred for Nuclear Power Stations.

8. *Access to site*:—The site should be easily accessible by broad-gauge railway and/or reasonably good road.

9. *Construction power supply*:—During construction of the power station, 4,000 to 5,000 KW of power would be required.

10. *Agriculture and Diary Products*:—It is preferred that there are no large agricultural or diary areas in the immediate vicinity of the sterilised area.

11. *Fisheries*:—Large scale commercial fishing should preferably be absent in matters.

12. *Meteorology*:—The site should not be subject to storms or frequent calm conditions. The frequency and strength of inversion preferably be low.

13. *Subsoil water*:—Lower water table as well as a lower movement of the subsoil water is preferred.

The following two sites in the Delhi-Punjab-Uttar Pradesh-Rajasthan region were recommended by the Committee in their Report submitted in January-February, 1962 in order of preference:—

(i) Rana Pratap Sagar near Kotah in Rajasthan;

(ii) Gangabas in Bulandshar District, Uttar Pradesh.

The Committee also recommended the following sites in order of merit:—

(i) Kalpakkam near Mahabalipuram in Madras State;

(ii) Billigundlu in Hoganekkal in Madras State;

(iii) Somasila near Srisilam in Andhra Pradesh; and

(iv) Sangam near Mekadatu in Mysore State.

The sites at Billigundlu and Sangam would, it was stated by the Committee, only be possible on the assumption that the hydro-electric schemes of Honganekkal and/or Mekadatu were implemented, and the site at Somasila was dependent on the hydro-electric scheme at Srisilam being implemented.

6.47. The Committee desired to know if the recommendations of the Hayath Committee Report will hold good for setting up future projects also, the representative of the Department of Atomic Energy explained the position as follows:—

> "We have already taken up the Kalpakkam and Ranapratap Sagar out of those. The Report also gave a number of sites, some in U.P., Punjab and Western India. We are now to bring the report up-to-date because lot of time has passed and we have got to examine it * * * * * has already given you a full idea of the type of investigation we have done on the northern region and we have come to certain conclusions. As soon as we complete this, we will go to western region and make a similar analysis and find out what are the most suitable places and also whether it would be most economical to have nuclear power stations there."

The Chairman, Atomic Energy Commission, explained the position further as follows:—

> "The Hayath Committee had made a preliminary analysis of the possible sites where power stations could be set up. * * * We feel that since the Committee came about, there has been a major change and development in the country, and it is necessary for Atomic Energy Commission to look at other sites in those areas where, on *prima facie* consideration, atomic power would be economically advantageous compared to the generation of power from coal which is to be taken from at a distance."

6.48. The Committee note that Government are aware of the need to look afresh in the matter of selection of sites for nuclear power stations apart from sites recommended in the Report of the Hayath Committee submitted in January-February, 1962. More than 8 years have now elapsed and Government have since acquired experience in building Atomic Power Stations. The Committee hope that in addition to the technical

considerations which govern the setting up of a nuclear power station due notice will be taken of the following points :—

(i) Need for a rational policy in the national interest so that power generated reaches the areas of demand.

(ii) Need for rationalisation and strengthening of grids and continuous research to reduce loss in transmission over long distance.

6.49. They would also recommend that if atomic power is to be subsidized in the national interest, this should be done with the prior approval of Parliament.

NEW DELHI;
July 9, 1970
Asadha 18, 1892 (*Saka*).

M. THIRUMALA RAO,
Chairman,
Estimates Committee.

APPENDIX I

(*Vide* Para 2.19)

The parties have agreed that the system of records and reports for the Tarapur Atomic Power Station will consist of the following elements:—

A. With respect to records, information covering the following will be included:—

1. Receipts of all nuclear materials*;
2. Internal movements of all nuclear materials;
3. any removal of nuclear materials including shipments, known losses and unaccounted for quantities;
4. inventories of all nuclear materials on hand at the end of each accounting period, showing form, quantity and location; and
5. Reactor-operating data necessary for determining and reporting on the production and consumption of any nuclear materials and the use of the Tarapur Atomic Power Station.

B. With respect to reports, information covering the following will be included:—

1. all receipts and removals of nuclear materials;
2. any production and consumption of nuclear materials;
3. any known losses and unaccounted for nuclear materials;
4. all inventories of nuclear materials; and
5. the operation of the Tarapur Atomic Power Station including unusal incidents; and significant modifications made or to be made in the plant or in the fuelling programme.

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*The term "Nuclear material" as used in this Annexure means both source material and special nuclear materials.

"*Special Nuclear Material*" means (1) plutonium, uranium enriched in the isotope 233 or in the isotope 235 and any other material which the United States Commission pursuant to the United States Atomic Energy Act determines to be special nuclear material; or (2) any material artificially enriched by any of the foregoing.

"*Source material*" means (1) uranium thorium or any other material which is determined by either Party to be source material; or (2) ores containing one or more of the foregoing materials in such concentration as either Party may determine from time to time.

Routine reports covering the foregoing elements shall be submitted to the Government of the United States of America and the Government of India on a monthly basis. Any losses of nuclear materials, however, or any unusual incidents or major changes in the fuelling programme will be reported as soon as the loss has been discovered or the change has been scheduled.

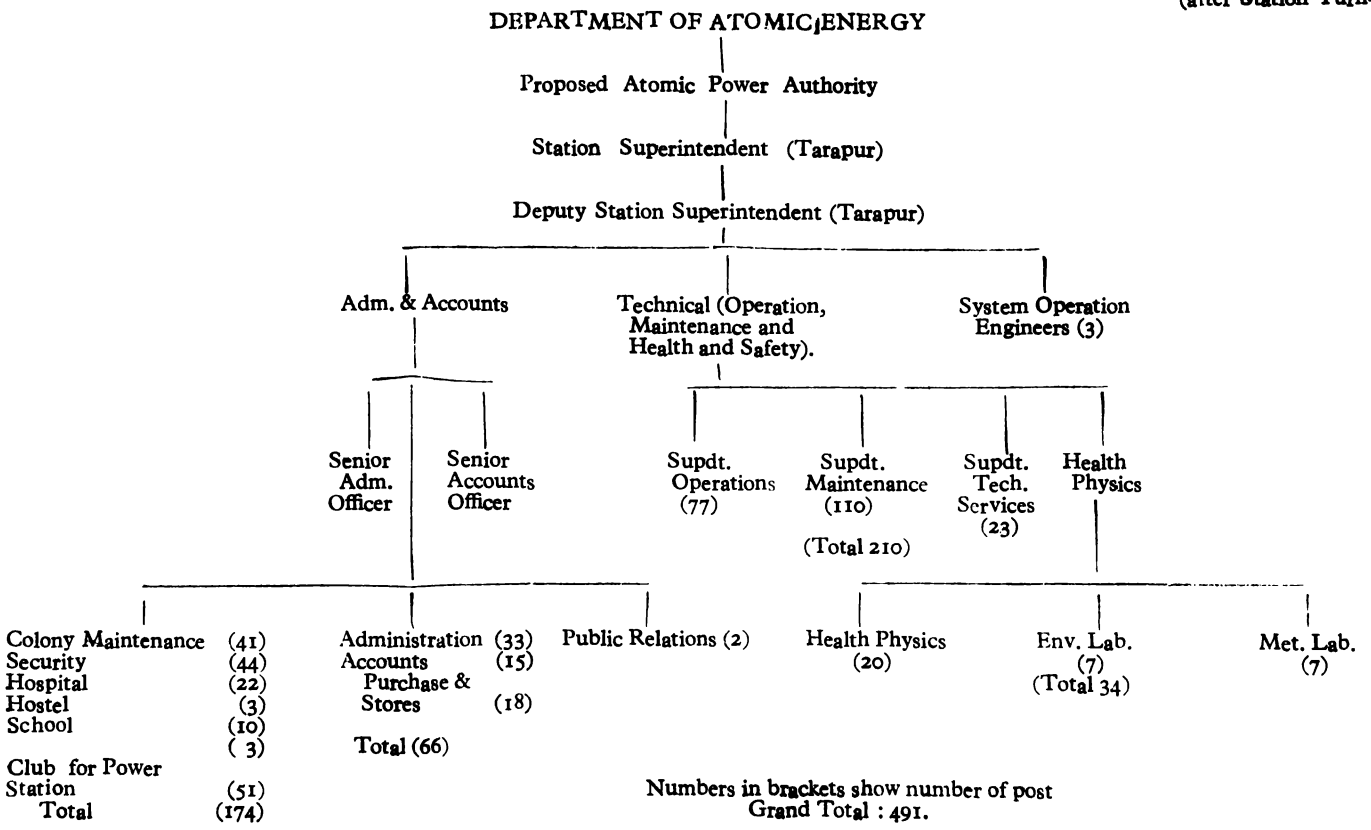
The Parties further agree that if any special nuclear material which is made available to India pursuant to this Agreement or produced in the Tarapur Atomic Power Station is placed, in accordance with this Agreement, in any facilities in India other than the Tarapur Atomic Power Station, then the principles of the agreed-upon system referred to in Paragraph B.2 of Article VI of this Agreement and set forth in this annexure will be applied to such a situation.

The records and reports will include such details as may be relevant to the achievement of the objectives of Article VI and may be modified by mutual agreement.

In the event of unusual incidents, special reports may be requested, including such amplifications and elucidations as each party considers relevant to the achievement of the objectives of Article VI.

APPENDIX II

(*Vide* para 1·59)



APPENDIX III

(*Vide* para 3:45)

A comparative statement of the Demands for Grants of the Department of Atomic Energy giving Budgetary Provisions in respect of heavy water for the years 1965-66, 1966-67, 1967-68, 1968-69, 1969-70 and 1970-71 are as follows :—

	Actuals, 1965-66	Budget Estimates 1966-67	Revised Estimates 1966-67	Budget Estimates 1967-68
	Rs.	Rs.	Rs.	Rs.
Heavy Water	43,184	2,25,00,000	2,000	50,00,000
	1966-67	1967-68	1967-68	1968-69
Heavy Water	1,82,351	50,00,000	3,00,000	2,00,00,000
	1967-68	1968-69	1968-69	1969-70
A.2(3).—Heavy Water Plant No. I	3,199	2,00,00,000	23,50,000	2,00,00,000
Plant No. II	..	..	..	1,00,000
	1968-69	1969-70	1969-70	1970-71
A.2(3)—Heavy Water Plant	..	..	..	
A. 2 (3).—Office of the Heavy Water Projects Board	..	..	6,00,000	5,40,000
A. 2 (3) (2).——Heavy Water Plant at Kota.	*1,05,120*	*2,00,00,000*	*1,40,00,000*	*3,18,00,000*
A. 2 (3) (3).—Heavy Water Plant at Baroda.	..	1,00,000	3,60,00,000	2,00,00,000
A.2(3)(4).—Heavy Water Plant III		..	..	1,00,000
A. 2 (3) (5).—Purchase of Heavy Water.	..	..	75,00,000	75,00,000
TOTAL—Heavy Water Plant	1,05,120	2,01,00,000	5,81,00,000	5,99,40,000

APPENDIX IV

(*vide* para 3·49)

Organisational set up of the Rajasthan Atomic Power Plant

CHIEF PROJECT ENGINEER

Supdt. Engineer (Civil)	Supdt. Engineer (Electrical)	Supdt. Engineer (Mechanical)*	Supdt. Engineer (Reactor)	Supdt. Engineer (Instrumentation)	Station Supdt. (Operation & maintenance)	Chief Adm. & Accts. Officer
Planning, construction & co-ordination, Reactor Building 1 & 2, Turbine Building 1 & 2, Service & Adm. Buildings & Stack, Concrete testing Lab, Permanent Township housing construction & maintenance & road improvements for over-dimensioned crom-ponents-transpot.	Power Plant erection, Power Plant auxiliaries erection, power supply & services.	Mechanical equipment erection including main piping. Boilers, circulating water & process water pumps and all station piping & miscellaneous steel, Workshop Garage, Water-Supply & over-dimensiond components transport to site.	All nuclear installations, component assembly shop coolant tube processing.	Incoming inspection and calibration, instrument installation, construction, testing & system calibration.	Commissioning including preparation of procedures & programmes, training of operation and maintenance personnel and operation and maintenance of station after commissioning.	Administration, Account, Security, Stores, Medical Fire Fighting. Welfare & Public Relation and School.

*NOTE : —General co-ordination with all technical wings will be done by SE(M) for which he is designated as General Superintendent also. Inspection and Quality Control, Site Planning comprising of field design, scheduling, PERT, budget, Archieves and saftery engineering are also attached to him.

APPENDIX V

(Vide para 3.49)

Strength of various categories of staff in RAPP Staff strength as on 1-7-1969

A. *Gazetted Officers*:

			Site Strength
Chief Project Engineer	1	Mech. Engineers	75
Engineering/Scientific Officers	165*	Elec. Engineers	35
		Civil "	34
Admn./Accounts Officers	11	Chemical "	6
General Maintenance/Auxiliary Services (*viz.*Hospital, Stores, Fire, Security, School, WPRO)	15	Electronic/Instrumentation etc.	15
Total 'A'	192*		165*

(*includes 9 PPED Engineers under training)

B. *Non Gazetted Establishment*:

(i) *Regular*	
(a) *Technical*:	
1. Supervisory staff (*viz.* Foreman, SAS, A/Fs, Chargehands)	95
2. Tradesman A to E	121
3. Semi-skilled (Helpers)	5
(b) *Non Technical*:	
1. Supervisory staff (like Accountants, Clerks, Nurses, Fire, Security Stores, Drivers and Stenographers)	410
2. Class IV Staff (Chowkidars, Fireman, Office Helpers etc.)	88
Total 'B' (i)	719
(ii) *Work-charged*	
(a) *Technical*:	
1. Supervisory staff	138
2. Tradesman A to E	602
3. Semi-skilled (Helpers)	552
(b) *Non- Technical*:	
1. Drivers	8
2. Class IV staff (Chowkidars, Bus Helpers, Stores Helpers etc.)	98
Total 'B' (ii)	1398

Total 'A'+'B' =192+2117 = 2309 Total 'B' (i) & (ii) = 2117

APPENDIX VI

(*Vide* para 4.14)

GOVERNMENT OF INDIA

DEPARTMENT OF ATOMIC ENERGY

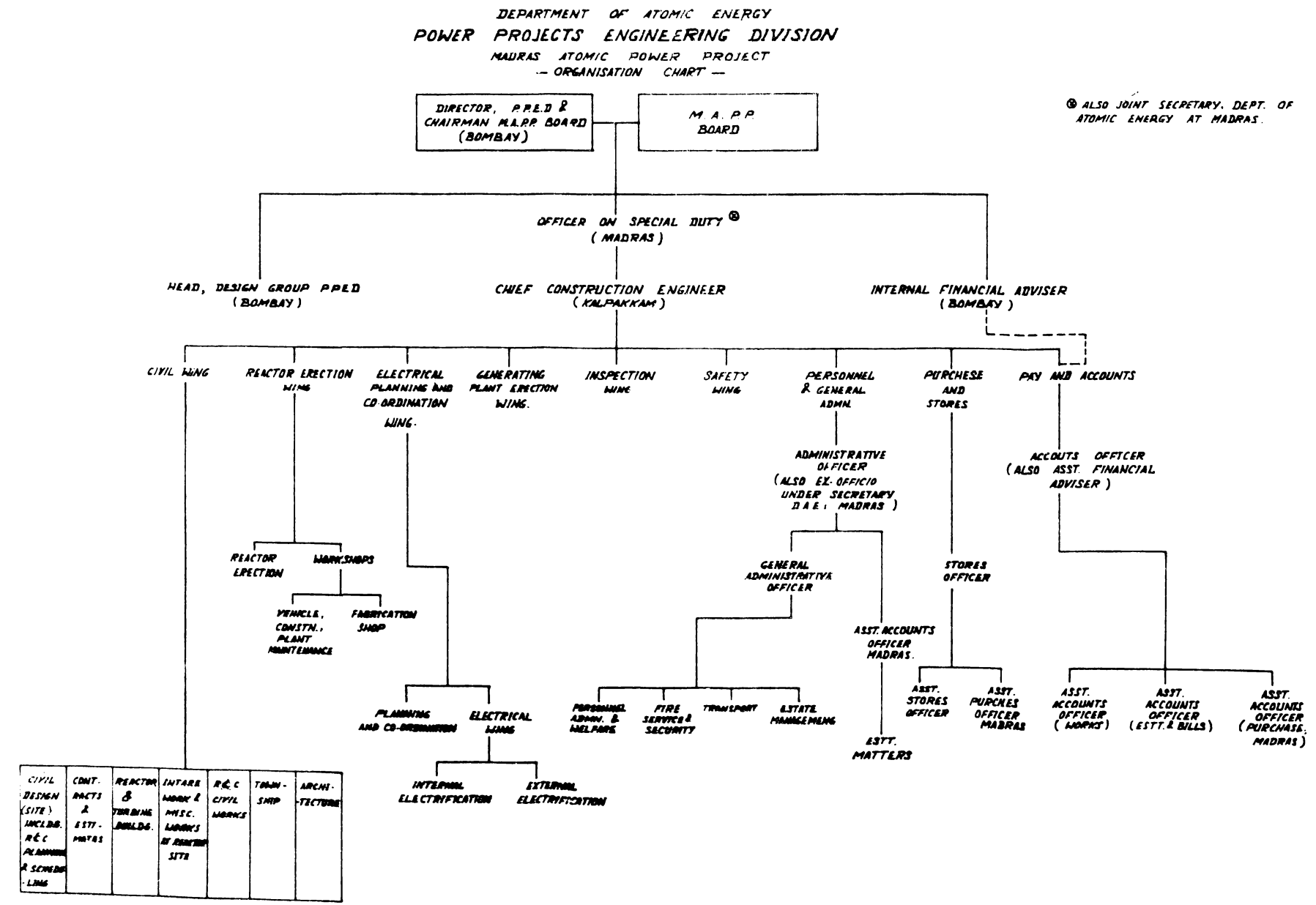
Madras Atomic Power Project

Expenditure Against Financial Sanction for MAPP-I

(In rupees)

Sl. No.	Description	Total	Foreign Exchange component	Rupee Component	Expenditure from beginning to August 1969
1	2	3	4	5	6
1	Site and improvement	30,00,000	..	30,00,000	25,58,079
2	Building and structures	5,09,90,000	57,70,000	4,52,20,000	24,85,447
3	Reactor boiler & Auxiliaries	12,06,00,000	4,71,50,000	7,34,50,000	2,15,342
4	Turbine Generator and Auxiliaries	8,87,71,000	94,07,000	7,93,64,000	20,352
5	Electricity Power System	2,52,92,000	89,05,000	1,63,87,000	28,136
6	Instrumentation & Control	3,17,50,000	1,18,50,000	1,99,00,000	96,718
7	Common Process & Service	2,25,34,000	60,96,000	1,64,38,000	5,37,112
8	Construction Plant	2,85,50,000	62,50,000	2,23,00,000	99,93,276
9	Engineering	1,60,00,000	30,00,000	1,30,00,000	14,68,499
10	Inspection	50,00,000	25,00,000	25,00,000	..
11	Field Engineering	15,00,000	..	15,00,000	..
12	Field Management and Superintendence	1,10,00,000	..	1,10,00,000	40,82,046
13	Purchasing	5,00,000	..	5,00,000	..
14	Foreign Travel & Living	31,00,000	15,00,000	16,00,000	..
15	Field Accounting	5,00,000	..	5,00,000	..
16	Freight and Insurance	90,00,000	75,00,000	15,00,000	14,982
17	Commissioning	56,00,000	21,00,000	35,00,000	..
18	Housing	1,50,00,000	..	1,50,00,000	1,03,05,037
19	Customs Duty	3,00,00,000	..	3,00,00,000	2,27,074
20	Contingency	6,46,00,000	1,15,00,000	5,31,00,000	..
21	Escalation	6,14,00,000	1,26,00,000	4,88,00,000	..
22	Increase due to devaluation	61,50,000	..	61,50,000	..
23	Fuel	1,70,00,000	..	1,70,00,000	..
24	Suspense Transactions	..	..	..	10,30,873
25	Book Debits	..	..	..	32,91,000
	TOTAL	61,78,37,000	13,61,28,000	48,17,09,000	3,63,53,973

APPENDIX VII
(Vide Para 4.34)



APPENDIX VII

APPENDIX VIII

Summary of Recommendations/Conclusions contained in the Report

Sl. No.	Reference to para No. of the Report	Summary of Recommendations/Conclusions
1	2	3
1.	1.11.	The Committee note that the nuclear power is assuming a role of increasing importance in the field of power generation all over the world. They understand that India's resources of coal and hydro-power are adequate for meeting the power requirements of the country in the foreseeable future. However, having regard to the present rate of growth in her population and the steady increase in the *per capita* consumption of energy, the position might become difficult after some time. In view of the fact that the coal deposits in India are restricted to a few coal-bearing regions in the Bengal, Bihar, and Madhya Pradesh area far away from centres of consumption and the special characteristics of hydro-power which is derived from the seasonal character of rainfall during Indian monsoon, it seems prudent to diversify resources of electricity and take advantage of nuclear power. In the matter of nuclear power, India is said to be fairly well endowed in view of the abundant supply of thorium and availability of uranium also. The Committee are of the view that the question of development of nuclear resources is mainly an economic one and that it would have to fit in with the overall plan for power development taking into account the available resources in the various regions of the country with the object of deriving optimum benefits through integrated operation of hydro, thermal and nuclear stations.
2.	1.17.	The Committee regret to note that there is divergence of opinion on the size of the installed generating capacity of power during the Fourth Five Year

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		Plan between the Planning Commission on the one hand and the Ministry of Irrigation and Power and the Department of Atomic Energy on the other. The former *i.e.* the Planning Commission have fixed the target for the Plan at 22 million k.w. while the need has been asssessed at 26 million k.w. by the latter. They feel that targets in this respect should have been fixed much before the actual commencement of the Fourth Plan especially when the gestation period for nuclear and hydel propects is 5 years or more. The Committee are unable to appreciate the views of the Planning Commission while fixing the target at 22 million k.w. that "action will have to be taken to indentify pockets of shortages, which they anticipate" and then take "prompt action to meet the power needs of those pockets". They consider that in the interest of perspective planning and because of relevance of power to the economy of a country, it is desirable to initiate action well in advance rather than wait for the contingency to occur and then take action. In view of the sufficient scope for India's economy picking up momentum and since "the value added through the use of energy is so great that consequences to the national economy as a whole of making a pessimistic forecast can be at least ten times more expensive than of an optimistic forecast", the Committee consider that the question of fixation of power targets for the Fourth Plan merits urgent and thorough consideration. They hope that the differences will be resolved amicably at an early date so that a realistic target is fixed and a firm decision reached about allocation of share of additional power generation hydel, thermal and nuclear energy.
3.	1.21.	The Committee agree with the Chairman Atomic Energy Commission that the Reactor system most suitable for the country would be the one for which we would not have to depend on foreign countries for fuel and other nuclear components and which would prove economically advantageous in the long run by making use of thorium which is available in plenty in the country.

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4.	1.28.	The Committee agree with the Chairman Atomic Energy Commission that the Reactor system most suitable for the country would be the one for which we would not have to depend on foreign countries for fuel and other nuclear components and which would prove economically advantageous in the long run by making use of thorium which is available in plenty in the country.
5.	1.35.	The Committee note that the atomic energy programme as originally drawn up by the Atomic Energy Department covered a period of 16 years *i.e.* from 1964 to 1980 to enable the country to avail of the fast breeder reactor technology which is expected to be commercially available by that time. This programme has been altered to synchronize with Five Year Plans and scaled down by the Planning Commission. According to the Chairman, Atomic Energy Commission, this has upset their programme which is a closely knit plan and does not admit of any break-up piecemeal. Their commitment is for a longer period with the aim of building up 'plutonium inventory which will give indigenous technical know-how as well as industrial competence to make the components in the country so that from 1975—80 we can start one major unit of the fast greeder rector'. The Committee are informed that the Planning Commission are having a dialogue with the Atomic Energy Department with a view to sort out their differences in this regard. The Committee hope that this will be done with expedition and a firm decision reached quickly.
6.	1.42.	The Committee note that there have been large scale variations in the budgetary provisions made and the actuals in the Plan targets, although in some cases it was due to *force majure* events like devaluation, imposition of customs duty etc. over which the Department of Atomic Energy had no control. The Committee realise that because of the newness of the field of nuclear power development in the country, our dependence on foreign collaboration and foreign

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		finances and introduction of indigenisation in the power projects, there have been shortfalls in the achievement of the targets in the past. They, however, hope that with the experience gained and gradual elimination of dependence on foreign sources in the matter of consultancy, personnel, fuel, equipment etc. and with proper co-ordination and management at national level between the various connected agencies, the Department will be able to improve its performances in future.
7.	2.10.	The Committee feel that Government in their enthusiasm to demonstrate that atomic power could be generated at a rate which would be competitive with conventional sources of power in the country, in the setting up of Tarapur Project took a hasty step, not in keeping with the country's long-term objective, in accepting reacter based on enriched uranium. The enriched uranium is required to be imported for the life time of the Station and has thus made the country dependent on foreign resources. The Committee further feel that in view of the contract being on a turn-key basis, it is doubtful if the Tarapur Project has taken the country far enough in attaining the goal of self-reliance in the production of nuclear power.
8.	2.11.	The Committee are not convinced that the terms offered by the International General Electric Co. were too attractive to be rejected specially when factors like fuel cost, the production of plutonium, achievement of self-reliance, saving in foreign exchange and the country's long-term objective are taken into consideration.
9.	2.18.	The Committee are constrained to note that the estimates of the station outlay furnished by the Department have varied from time to time. The Committee would like to emphasise the need to work out reasonably accurate and realistic estimates of the project.
10.	2.24.	The Committee consider that the cost of the fuel element for the Tarapur Atomic Power Project is on the high side. They hope that with the setting

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		up of the Reprocessing Plant, which is being built to extract plutonium and residual uranium and the perfection of technology of using plutonium in reactors, the Station will be operated on plutonium fuel wholly or partially and the need for importing enriched uranium will be reduced, which will result in saving of foreign exchange.
11.	2.25.	The Committee also note that enriched uranium has to be imported for the working of the Project for the entire life time of the Station. If for any unforseen circumstances the supply of enriched uranium is cut off or denied due to world postures, the whole Project in that case will be jeopardised. They would, therefore, suggest that Government should explore the possibility of building reserve of enriched uranium to meet such contingencies.
12.	2.26.	The Committee are constrained to observe that the cost of the fuel for Tarapur Atomic Power Project as given by Government on various occasions differ widely. They need hardly stress the importance of furnishing correct information in vital matters of national importance.
13.	2.28.	The Committee note that due to the efforts made by the Project authorities and because of the cooperation of the prime contractors *i.e.* International General Electric, a saving of $ 5,000,000 in foreign exchange could be effected.
14.	2.37.	The Committee note that the repairs to hair-line cracks in the stainless steel lining of certain reactor components had been completed by the International General Electric to the satisfaction of the Project Authorities and the warranty period in respect of parts and equipments affected has been suitably extended beyond the normal period of one year.
15.	2.38.	The Committee, however, observe that the Department of Atomic Energy in their Annual Report for the year 1967-68 and in reply to a question answered in the Lok Sabha on the 27th March, 1968

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		did not supply the information about the appearance of cracks in the reactor and the loading of fuel that was due in December, 1967 while mentioning the progress made in the construction of the Tarapur Atomic Power Project.
16.	2.39.	The Committee regret to note that after taking a decision in 1958 to have an Atomic Power Station in the western region of India and fixing a target of commissioning one of the two reactor units of 190 MW capacity by the end of the Third Five Year Plan, the Tarapur Atomic Power Station began to flow commercial power in October, 1969 only. Apart from the long time taken in the finalisation of the various agreements necessary for the execution of the Project there has been a delay of about one year in the commissioning of the Project. They consider that a significant loss has been suffered by Government on the following counts :— (i) The increased cost of the Project and the interest on capital during the extended period of construction; (ii) The loss of possible profits that would have accrued to the Government, had the project begun to flow commercial power as per schedule *i.e.* in October, 1968; (iii) Recurring loss in the cost of production of power; (iv) Loss on account of lower intake of power by the switchyard and due to its closure.
17.	2.44.	The Committee observe that Government have taken a long time in determining the amount of damages to be recovered from International General Electric on account of delay in the commissioning of the Project. They would like this matter to be settled with expedition.
18.	2.47.	The Committee are concerned to note that Government have not so far entered into any written agreement with the Governments of Maharashtra and Gujarat with regard to the sharing of power, although

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		such an agreement used to be there with the erstwhile composite State of Bombay to take power upto 80 per cent of the full load of the Tarapur Station. The Committee consider that the declared policy of the Government regarding sharing of power by both the States in equal measure and taking of power at 75 per cent load factor, announced publicly which according to the Department of Atomic Energy is well understood by both the States is not a satisfactory arrangement. In the light of experience regarding non-acceptance of rates worked out by the Atomic Power authorities by bulk consumers and trouble about the management of the switchyard, the Committee consider that a firm agreement with the beneficiary States on the question of sharing of power, basic assured load, tariff rate, phased programme for erecting transmission lines, switchyard etc. should have been entered into before the Station had begun to flow commercial power. They recommend that steps should now be taken to enter into such an agreement with the concerned States without further loss of time.
19.	2.48.	The Committee are also of the view that the Tarapur Project authorities should take over the management of the switchyard. The Central Government has invested hundreds of crores of rupees in all these power projects. With a view to ensure that the power which is produced therefrom is not allowed to go waste and that the Station runs as an economic unit, it is essential that the problems of production, transmission and distribution of power are properly sorted out in advance.
20.	2.49.	The Committee need hardly point out the obvious lesson that in the Atomic Power Stations, to be put up in future, the Department should ensure that there is a firm written agreement about the sharing of power, rates at which it is to be sold and the management of the switchyard.
21.	2.52.	The Committee understand that Maharashtra being endowed with ample hydro power, the lakes

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		are likely to over-flow for a period of three to four months during monsoon. They are also given to understand that reloading of first batch of fuel will be needed in July, 1971 only, which means that there will be no need to reload fuel in the year 1970. Subsequent batches will be required annually from September, 1972. They have also been informed that usual period of fuelling and maintenance programme is four to six weeks which the power generation economics takes into account.
		The Committee trust that reloading of fuel and maintenance programme will be phased out in such a way that there will not only be no closure on account of lack of demand but even the closure for maintenance programme will be for the minimum period.
22.	2.53.	Since Tarapur Project is a base load Station and the earlier agreement with the erstwhile composite State of Bombay envisaged the utilisation of the Station upto 80 per cent of the full load of the Station instead of the present 75 per cent, the Committee hope that all necessary steps will be taken and alternatives found out to make the maximum use of the power made available by the Station.
23.	2.57.	The Committee note that the selling price of power per unit from Tarapur Atomic Power Project has been fixed at 5.61 paise per kwh. This price is stated to have been agreed to by both the bulk consumers, *viz.*, the Maharashtra and Gujarat Electricity Boards. It is presumed that the rate has been got with the Concurrence of the Central Electricity Authority as required by the Atomic Energy Act.
		The Committee would, however, like to be informed of the exact cost of generation and the selling price of the power, as approved with the Concurrence of the Central Electricity Authority.
24.	2.62.	The Committee are happy to be informed that the Indian scientists and engineers have acquir[illegible]

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		sufficient expertise to operate and maintain Tarapur Atomic Power Station independently and that only a limited number of foreign experts for a minimum period will be required to assist the Indian staff.
25.	2.63.	The Committee would also like to emphasise the need to exchange and rotate senior persons from Tarapur to Kalpakkam and other stations in order to profit from their experience and expert knowledge.
26.	3.7.	The Committee note that for the setting up of RAPP-I Cabinet gave approval in August, 1962, but work at site picked up momentum towards the end of 1964. Similarly, for RAPP-II, the Cabinet gave approval in June, 1965 but work at the site commenced in April, 1967. They would like to observe that an unusually long time was taken by Government in negotiating the agreements with the Canadian Authorities.
27.	3.8.	The Committee also note that Government's decision to go in for a natural uranium reactor for RAPP is in keeping with their objective to make use of a technology which will enable the country to be self-reliant in the future nuclear power production programme based on the use of plutonium and thorium of which India has a larger reserve.
28.	3.9.	The Committee cannot, however, resist the impression that the Department of Atomic Energy has taken *ad hoc* decisions in the setting up of power projects. While, in case of Tarapur, attractive initial capital outlay was the main consideration and global tenders were called for, in the case of Rajasthan it was not looked upon from the financial angle and no global tenders were called for. They, however, hope that the expenditure involved in the setting up of the RAPP will be commensurate with the benefits to be derived in the shape of economic gain, self-reliance and technical experience.

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29.	3.11.	The Committee are concerned to note that the original estimates of the total cost of RAPP I and II have risen from Rs. 33.42 and 30 crores to Rs. 52.50. and 58.16 crores respectively and are further likely to be pushed up in view of the delay in the completion of the project. They fear that the increased cost of this project is bound to affect ultimately the cost of generation of power per unit. They would like to sound a note of warning that Government should take concerted measures to keep down the cost so that the Nuclear Power Project does not become an uneconomic proposition and the power generated can compete with conventional sources in price level.
30.	3.20.	The Committee note that for RAPP I and II, the Department of Atomic Energy had initially placed orders with the Hindustan Steel Ltd., for certain flat products using quality carbon steel, but these orders had to be transferred to a firm abroad as the material forthcoming from H.S.L. did not conform to the prescribed specifications. The Committee would like Government to look into the matter so that the requisite variety of steel for nuclear power stations could be supplied from indigenous sources, thereby achieving self-reliance and saving valuable foreign exchange.
31.	3.21.	The Committee further note that orders for machinery and equipment placed on Heavy Electricals India Limited, Bhopal and Heavy Engineering, Ranchi had also not been fulfilled. They are distressed to learn that none of these public undertakings were able to deliver the goods.
32.	3.22.	The Committee are convinced that to a considerable extent the delay in the execution of the Project has been caused by lack of coordination amongst the various Ministries/Departments concerned which they deprecate. They consider that in important matters like these, close coordination and cooperation of all Departments concerned is absolutely necessary and recommend that proper procedures should be laid for expeditious despatch of work especially where several Departments/Ministries are concerned.

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33.	3.26.	The Committee regret to note that the Rajasthan Atomic Power Units I and II which were originally scheduled to be commissioned in 1969 and 1970-71 will now go into commercial operation by 1971 and 1973. This would mean that while the gestation period in respect of Tarapur Atomic Power Project was five years, in the case of Rajasthan Atomic Power Projects Unit I and II is seven years.
34.	3.27.	The Committee have a feeling that Government were rather hasty in taking up the RAPP without proper assessment of the technological development and infra-structure of the industry inside the country and the requisite skill and expertise in the particular field obtaining even in Canada. As a consequence, the project has been delayed for non-delivery of equipment in time. Moreover, several changes had to be made in the design during the process of construction of the nuclear and conventional portion of the project. They consider that a poor country like India can ill afford to pay a heavy penalty to the tune of rupees six crores owing to the aforesaid reasons.
35.	3.31.	The Committee are surprised to note the wide variations in the estimated cost of generation of power by RAPP as furnished by the Department of Atomic Energy from time to time. According to the Planning Commission the cost of generation of power in RAPP should be considerably higher. The Committee need hardly stress the desirability and importance of working out the cost of generation of energy in advance as a firm estimate in this regard has an important bearing not only on the economics of the plants but also on the willingness of the consumer States to purchase it at reasonable rates.
36.	3.37.	The Committee regret to note that no written agreement has so far been executed regarding the basic assured load, tariff rate, phased programme for erecting transmission lines, switchyard, etc. by the Atomic Energy Department with the Government of Rajasthan or the neighbouring States. They apprehend that in the absence of any written agreement

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		several complications might arise when the Atomic Plant is on stream.
37.	3.38.	The Committee note that RAPP was set up with a view to meet the future power requirements of Rajasthan and neighbouring States with a hope that there will be faster industrialisation in the region and that it will absorb the power generated therefrom in due course of time. The Committee also note that at present there is hardly any infra-structure to absorb the power expected to be generated at maximum load factor.
38.	3.39.	The Committee suggest that with a view to operate the Station at the optimum load factor, the following steps should be taken well in advance so that by the time power starts flowing from the Station, there is sufficient demand for the power and it works as an economic unit: (i) Reinforcement of the transmission and distribution system; (ii) Execution of formal agreements between RAPP and Rajasthan and other beneficiary State Government *re*: utilisation of power, etc. (iii) Timely development of the industries like copper complex at Khetri, Zinc smelter and production of phosphorus at Udaipur and the setting up of other industries in and around Kota.
39.	3.46.	The Committee are constrained to observe that in spite of the realisation of urgency by Government in regard to the production of heavy water indigenously to meet the requirements of the two units of Rajasthan Atomic Power Project as also that of Madras Atomic Power Project, nothing substantial has been done in the matter so far.
40.	3.47.	They regret to note that unduly long time was either taken by Government to sanction the proposal of the Department of Atomic Energy to build a heavy

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		water plant or the Department itself has taken a long time to start the construction of the Heavy Water Plant at Kota. The Committee note with concern that Heavy Water Pilot Plant of the Bhabha Atomic Research Centre which was set up as early as in 1963 to provide technical know-how for the large scale Kota Heavy Water Plant at Kota has failed in its objective and has been the prime factor contributing to the delay in the setting up of the Kota Plant. The Committee feel that with a view not only to conserve foreign exchange but also obviate "International Safeguards" which are imposed in obtaining heavy water from abroad, Government should lay down a reasonable target date by which the construction of heavy water plants are completed and production thereof started.
41.	3.48.	The Committee are not able to appreciate as to why excessive provisions for crores of rupees have been made for heavy water in the budget estimates from year to year when actually a fraction of the amount could be spent. They feel that lack of planning and development of technical know-how in this regard and failure on the part of Government to achieve the fixed targets within a scheduled time has led to this over-budgeting.
42.	3.51.	The Committee note that after the commissioning of the Units I and II of the Rajasthan Atomic Power Project, no foreign personnel will be required to operate or maintain the Station.
43.	3.52.	The Committee also note that the scientific and technical staff likely to be required for the operation and maintenance of the Rajasthan Project after the Station has turned over will be 348 whereas in case of Tarapur, the number of persons is 249 only. The Committee consider that requirements of the staff for the Rajasthan Station may be examined with a view to keep it as low as possible to ensure that the Station is run as an economic unit.

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44.	4.5.	The Committee are glad to learn that in setting up the Madras Atomic Power Project, India for the first time will be having no foreign collaborator and that Indian scientists and engineers have acquired sufficient expertise and skill to undertake this task on their own.
45.	4.6.	The Committee also note that a serious attempt has been made to build self-reliance for our future nuclear power production programme regarding the use of indigenous fuel and heavy water, greater degree of indigenisation of equipment and machinery etc.
46.	4.12.	The Committee note that the probable date of completion of the Project has been revised thrice since it was taken in hand in 1965. From 1970-71, the date has now receded to 1973-74. Constant shifting of target dates indicates lack of realistic planning.
47.	4.13.	The Committee are glad to be informed that the valuable competence in nuclear power technology gained by Indian scientists and engineers at Tarapur and Kota will enable them to build the Kalpakkam Atomic Power Station on their own without any foreign collaboration or financial aid. In fact, this is said to be the first nuclear power project which is being handled by Indians utilizing resources from within the country and with indigenous component to the extent of 80 per cent. A large number of agencies, namely, Ministries of Industrial Development and Company Affairs, Foreign Trade, Finance, D.G.S.&D., D.G.T.D., public undertakings like Heavy Electricals, Bhopal, Bharat Heavy Electricals, Hardwar and Hindustan Steel Ltd., and industries in the private sector are involved in this project and hence the timely completion of the project will depend on the coordination and cooperation of all the parties concerned. It is a challenging job calling for pooling of resources and the cooperative and concerted efforts of the various agencies. The Committee hope that Government will keep a constant watch on the progress of the projects with a view to ensure that all hurdles and

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		bottlenecks in the way of its smooth execution are sorted out and possible delays eliminated.
48.	4.16.	The Committee note with concern the big difference in the figures regarding capital outlay of the Project as given to the Lok Sabha in 1967 and as furnished to them. The Committee feel that unless concerted and speedy action is taken to complete the project by the scheduled date, the estimated capital cost is further likely to go up with the passage of time.
49.	4.20.	The Committee regret to note the wide gap in the budget estimates and the actuals. During the years 1965-66 to 1969 (upto 1 September, 1969) while budgetary provisions had been made for a sum of Rs. 11.42 crores, the actual amount spent was to the extent of Rs. 3.64 crores only. The Committee hope that Government would in future frame a more realistic budget estimates as far as possible having regard to the various factors likely to affect the progress of the project.
50.	4.23.	The Committee are concerned to note that the Department of Atomic Energy has not been able to work out so far a firm estimate of the cost of generation of power. They hope that the cost of generation of power will be worked out on a realistic basis at an early date so that the consumers know what they will be expected to pay for the electricity flowing out of the Kalpakkam Atomic Power Project.
51.	4.31.	The Committee understand that in and around Madras there will not be much demand for nuclear power during the monsoon season on account of over-flowing of reservoirs in that Region. In this respect, Kalpakkam and Tarapur stand on the same footing. The Committee also understand that in Madras there are two monsoons and the usual period which the power generation economics takes into account is 4 to 6 weeks only. The Committee trust that maintenance programme of the Station will be

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		properly phased out and all other necessary steps taken by Government to ensure that there is no closure of the Station on account of lack of demand and alternatives found out to make the maximum use of the power made available from the Kalpakkam.
52.	4.32.	The Committee feel that the Madras Atomic Power Project is beset with a number of problems which must be attended to right now rather than kept pending till the power begins to flow from the Station. In the first place, no written agreement has been entered into as to the rate at which the power will be purchased by the Tamil Nadu Government. Secondly, there is an urgent need to work out the economics of running the station at high base-load-factor. The problem has assumed seriousness because the State Government has not entered into any written agreement about the assured base-load at which they will take the power. Running the Kalpakkam Station at a maximum base-load factor may pose a problem and in the long run it may not run at optimum load. Thirdly, the neighbouring States of Andhra Pradesh and Mysore want to have a share in the power from Kalpakkam as according to them the project has been constructed out of the finances of the Central Government. It is, therefore, desirable that a firm settlement amongst the claimants is reached in the matter. The Committee are of the opinion that there is need to lay down a definite policy by the Government about the sharing of benefits by States in respect of those projects which have been constructed from the finances of the Central Government.
53.	4.33.	The Committee apprehend that failure to find an early solution to the problems may lead to a situation which may have serious repercussions. The Committee trust that a satisfactory solution will be found to various problems mentioned above without further loss of time.
54.	4.35.	The Committee hope that the strength of the staff, both engineering, scientific and technical and

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		others has been assessed keeping in view the actual requirements of the Project and that Administration will ensure that there is no over-staffing right from the very beginning.
55.	4.36.	The Committee suggest that Government may examine whether it would be desirable to keep a separate pools of erection and construction staff and staff required for normal operation and maintenance of the Project so that when the work is over expenditure on the former category of staff would not automatically become part of the operational staff thus burdening the undertaking with over-staffing and making it uneconomical.
56.	5.10	The Committee are not convinced by the justification given for the existence of a separate Department of Atomic Energy when the Atomic Energy Commission itself has been vested with the administrative and financial powers of the Government of India, besides being responsible for formulating the policy of the Department of Atomic Energy, preparation of the budget of the Department and getting it approved by Government, and implementing the Government's policy in all matters concerning atomic energy. The Committee consider that the two bodies, which cover the same field and yet have separate secretariats, should have a clear-cut demarcation of duties and functions so as to avoid duplication and overlapping.
57.	5.15.	The Committee note that the activities of the Commission in the field of atomic energy are fast expanding and now include not only research and development of peaceful uses of atomic energy but also training of scientists, survey and prospecting for and mining of rare earths, running of industrial enterprises *e.g.* Indian Rare Earths Ltd., Electronic Corporation of India Ltd., setting up of atomic power plants, generation of atomic power and its sale etc. Besides, the area of Commission's activities, include fields which appear only remotely connected with its

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		own field e.g. space research. The Committee consider that it is hardly possible for the Commission, as at present constituted, to lay down policies and programmes in all these fields as also to supervise the administration of the programmes. In view of the fact that the Commission consists of, besides the Chairman, only four part-time Members, it is inevitable that all the work of the Commission should devolve on the Chairman of the Commission. The Committee feel that this arrangement does not yield the desired results and recommend that Government should rationalise the functions of the Commission and suitably recognise its composition with a view to include a few whole-time functional Members.
58.	5.16.	The Committee note that as at present constituted the Commission has a preponderance of non-scientist members. They consider that the Commission as the policy making body at the highest level should also include a few eminent independent scientists either on a full-time or part-time basis so as to induct more expertise in the Commission and make it more broad-based and useful. The Committee have no doubt, that such a step would be generally beneficial and would lead to better programming and appraisal of research and development work in the field of atomic energy.
59.	5.17.	The Committee also note that the same persons have been continuing as Members of the Commission year after year. They need hardly stress the desirability and advantage of inducting fresh experienced persons as members of the Commission from time to time.
60.	5.26.	The Committee feel that the present arrangement is not conducive to proper financial control over an organisation which has an annual estimated budget of the order of Rs. 93 crores during the current financial year. They are of the opinion that there is need for a whole-time Member for Finance in the Atomic Energy Commission. In this connection, the Com-

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		mittee would like to draw the attention of Government to their recommendation *re* reorganisation of the Commission made earlier in this Chapter.
61.	5.30.	While conceding that both the Rajasthan and Madras Power Projects being in the development stage it would be advantagious to have a few common Members in the two Boards the Committee feel that the very idea of having separate Boards for management is defeated when the Boards have common membership to the extent of four out of a total of five members in position. They accordingly recommend that the two Boards should be reconstituted with the Project Head as one of the Members.
62.	5.36	The Committee hope that the constitution of Power Projects Engineering Division in Atomic Energy Department for undertaking the responsibility for the establishment of atomic power projects will lead to better coordination and economy and ensure better pooling of resources and expertise and experience. They have no doubt, that experienced engineers and scientists will be rotated among the three Power Projects according to the needs of the situation.
63.	5.38.	The Committee note that a separate Atomic Energy Authority as a constituent unit of the Atomic Energy Department is soon going to be set up for managing the unclear power plants in the country after the construction work was over. They hope that the proposed Authority will be a forward looking body able to run the Power Plants efficiently and economically.
64.	5.41	The Committee suggest that Government should review the position regarding the continuance of Liaison Offices in Canada and France on a regular basis after the expiry of the present sanction.
65.	6.5.	The Committee note that the training programme conducted by the Bhabha Atomic Research Centre has proved satisfactory and adequately meets the

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		present manpower requirements of the Atomic Energy Department. The Committee are, however informed that there are not sufficient men to meet the likely needs for future atomic power programme. They feel that training programme need to be broad-based and with that end in view, fundamentals of the nuclear physics, its theory and practice, should be taught in universities as part of B.Sc. (Hons.) and M.Sc. courses and nuclear technology and engineering should form part of engineering degree course. The best students amongst them should be selected and given training at Bhabha Atomic Research Centre.
66.	6.6.	The Committee also feel that the Atomic Energy Department should establish closer liaison with institutions of advanced learning like the MATSCIENCE, Madras, Indian Institute of Science, Bangalore and certain universities which have been selected as centres for research and advanced studies in science, with a view to make use of the scientific personnel coming out of these institutes. They are further of the opinion that it will be desirable to associate leading scientists with the training programme.
67.	6.7.	The Committee trust that the Atomic Energy Department periodically review their manpower requirements so that they recruit and impart training to only such number of engineers and scientists as can be usefully and purposefully employed and not become redundant after some time.
68.	6.15.	The Committee feel that Government have taken a long time in commencing the work on Nuclear Fuel Complex although the decision to set it up was taken as far back as in 1966. They are constrained to observe that lack of proper project planning and scheduling and lack of coordination amongst the various Ministries/Departments concerned have been the main factors responsible for delay in the commencement of the work on this Complex.

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69.	6.16.	The Committee hope that the Government would now take all necessary steps to ensure that the Complex is completed according to schedule to meet the requirements of fuel for three Atomic Power Projects and to avoid dependence on foreign resources and to save the much needed foreign exchange.
70.	6.17.	The Committee note that in appointing M/s. M. N. Dastur and Co., the Department did not call for any tenders. According to them, they made an *ad hoc* selection "on the basis of the adequacy of experience in handling similar projects". From the sketchy information furnished to the Committee in January, 1970, they are not in a position to comment on the justification of the terms and conditions of the agreement entered into with the consultants, and whether the progress so far made is according to the schedule.
71.	6.25.	From the preliminary report of the Working Group set up by the Department of Atomic Energy in 1967 on the Nuclear-Powered Agro-Industrial Complexes, it is evident that the Agro-Industrial Complexes envisaged in the study in Kutch-Saurashtra area and Indo-Gangetic plains are based on the following assumptions :— (i) Setting up of nuclear power projects of about 1000—1200 MW capacity in these two areas. (ii) Availability of power at rates of two paise per KW for fertilizers and 2.6 paise per KW for Aluminium. (iii) Raising of resources to the tune of Rs. 1,030 crores in a period of 5 to 10 years. The scheme would appear to be hypothetical as it is based on assumptions which are unfounded. The Committee, therefore, consider that the question of setting up Nuclear-Powered Agro-Industrial Complexes is not at present feasible in the context of the present progress made in the field of nuclear power development and due to lack of resources.

1	2	3
72.	6.31.	The Committee note that India is contributing as much as 15.54 lakhs of rupees annually to the International Atomic Energy Agency. They trust that our association with International Atomic Energy Agency is fruitful and commensurate with the expenditure involved.
73.	6.32.	The Committee understand that the Chairman, Atomic Energy Commission, is required to go abroad to participate in important activities of the International Atomic Energy Agency and attend conferences and seminars organised by that Agency and the U.N. Organisation regarding peaceful uses of Atomic Energy. As the Chairman, Atomic Energy Commission, is also Secretary of the Department of Atomic Energy he has under his administrative control a large number of Research Centres and Institutes, Departmental Undertakings and Atomic Power Stations, a large number of complicated problems are bound to arise necessitating his decision and personal guidance. The Committee feel that in view of the fast developing activities of the Department in several directions simultaneously, the whole time presence and attention of the Chairman will become imperative. They, therefore, suggest that his visits abroad should be confined to the absolute minimum requirements.
74.	6.44.	The Committee note that the cost of power generation from conventional sources *i.e.* thermal and hydro and from the three Atomic Power Stations at Tarapur, Kota and Kalpakkam has been variously estimated by the Planning Commission, Ministry of Irrigation and Power and the Atomic Energy Department. They feel that with the present constraint on our financial resources there is need that the choice between nuclear, hydro and theremal Power production should be made after a study of their relative economics both short term as well as long term. This is possible only after it is known what the cost of generation of power would be from

1	2	3
		each of the systems. The Committee note that the Ministry of Irrigation and Power has already constituted a High Power Committee of Experts *inter alia* "to review the economics of power generation from different sources—hydro, thermal and nuclear—under prevailing conditions and expected future trends to indicate the factors which must prevail in the choice of schemes for expansion of generation and supply in each region of the country in future". The Committee would like that the above expert body also goes into the cost structure of the Atomic Power Plants at Tarapure, Kota and Kalpakkam with a view to determine the unit cost of generation of power from each one of them. They trust that the expert Committee would be submitting its Report at an early date and that Government would no doubt keep its recommendations in view while deciding the programme for nuclear power stations.
75.	6.48.	The Committee note that Government are aware of the need to look afresh in the matter of selection of sites for nuclear power stations apart from sites recommended in the Report of the Hayath Committee submitted in January—February, 1962. More than 8 years have now elapsed and Government have since acquired experience in building Atomic Power Stations. The Committee hope that in addition to the technical considerations which govern the setting up of a nuclear power station due notice will be taken of the following points :— (i) Need for a rational policy in the national interest so that power generated reaches the areas of demand. (ii) Need for rationalisation and strengthening of grids and continuous research to reduce loss in transmission over long distance.
76.	6.49.	They would also recommend that if atomic power is to be subsidized in the national interest, this should be done with the prior approval of Parliament.

Analysis of recommendations/conclusions contained in the Report

I. CLASSIFICATION OF RECOMMENDATIONS

A. Recommendations for improving the organisation and working:
Serial Nos. 24, 55, 56, 57, 58, 59, 60, 61, 62.

B. Recommendations for effecting economy:
Serial Nos. 20, 50, 51, 54, 63, 66, 72.

C. Miscellaneous Recommendations:

Serial Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 25, 26, 27, 28, 29, 30, 31, 33, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 52, 53, 64, 65, 67, 68, 69, 70, 71, 73, 74, 70.

II. Analysis Of the Recommendations Directed Towards Economy

Sl. No.	S. Nos. as per Summary of Recommendations (Appendix VIII)	Particular
1	2	3
1.	20	Re-loading of fuel and maintenance programme for Tarapur Power Station should be phased out in such a way that there will not only be no closure on account of lack of demand but even the closure for maintenance programme will be for the minimum period.
2.	50	Re-loading of fuel and maintenance programme for Kalpakkam Power Station should be phased out in such a way that there will not only be no closure on account of lack of demand but even the closure for maintenance programme will be for the minimum period.
3.	54	Need to examine whether it would be desirable to keep a separate pool of erection and construction

1	2	3
		staff and staff required for normal operation and maintenance of the Project so that when the work is over expenditure on the former category of staff would not automatically become part of the operational staff.
4.	63.	Position regarding the continuance of liaison offices in Canada and France need to be reviewed.
5.	72	The Committee suggest that Chairman, Atomic Energy Commission's visits abroad should be confined to the absolute minimum requirements.

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39.	The Secretary, Establishment Department, The High Commission of India, India House, Aldwych, LONDON, W.C.-2.	59

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