

Mr. Baines

10th June, 1963.

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NATIONAL INSTITUTE FOR RESEARCH IN NUCLEAR SCIENCE

GENERAL PURPOSES COMMITTEE

FIVE-YEAR EXPENDITURE FORECAST 1964/5 to 1968/9: FINAL TEXT

Note by the Secretary

The five-year forecast of expenditure for 1964/69 was considered by the Committee on 18th February, 1963 and approved by the Governing Board on 28th March, 1963, but the verbal text was to be further revised and approved by the Chairman.

A copy of the forecast in its final form, as submitted to the Minister for Science, is now attached for information.

17th May, 1963.

NATIONAL INSTITUTE FOR RESEARCH IN NUCLEAR SCIENCE

FIVE-YEAR EXPENDITURE FORECAST 1964/5 to 1968/9

1. The forecast of the expenditure needed for the Institute's work, excluding the Atlas computer, in the years 1964/5 to 1968/9 is given in the following table:-

(£ million)

	<u>1964/5</u>	<u>1965/6</u>	<u>1966/7</u>	<u>1967/8</u>	<u>1968/9</u>
(a) <u>Present Programme</u>					
(i) High energy and nuclear physics	7.9	7.3	7.5	7.6	7.5
(ii) Research using nuclear reactors	0.2	0.3	0.4	0.4	0.5
Total of the present programme	8.1	7.6	7.9	8.0	8.0
(b) <u>Future Schemes</u>	0.1	1.1	1.9	1.9	2.4
<u>Treasury proposals</u>	7.0	7.1	7.3	7.4	-

The Treasury proposals shown in the table were made recently after some discussion of the interpretation of the 2% pattern of growth agreed between the Treasury and the Minister for Science in July, 1962. It is clear from these figures that the Institute cannot work within these proposals without cutting back a major part of their present programme. It should be emphasised here that although some of the expenditure under "Future Schemes" is forecast for completely new items on the programme, arising for example from a major scientific breakthrough, a large part represents natural and healthy developments which can be expected to spring directly from the present programme. If the subject is to develop at all, these growth points must be encouraged.

2. INCREASED REQUIREMENTS OF THE PRESENT PROGRAMME

Three parts of the present programme will need more money than has been forecast previously: these are the proper exploitation of Nimrod for experiments, the construction of the Electron Laboratory, and the use of nuclear reactors for university research.

(a) Exploitation of Nimrod

The ingenuity and complexity of techniques for recording and analysing experimental data are always increasing, but in high energy physics they have increased with unexpected rapidity since the "2% formula" was agreed. This is the main reason for the increased forecast for exploitation of Nimrod. Three examples illustrate the point: automatic measuring machines now need to be applied to the powerful spark chamber technique, having been under development for some time for the older (but still very important) bubble chamber technique. The university bubble chamber groups are now well established with machines provided by D.S.I.R., but it is now clear that they will need more advanced equipment which the Institute will have to provide because most of their experimental data will come from Nimrod. Computer techniques are now beginning to be incorporated in electronics apparatus for particle detection. For these and similar developments the Institute estimate an increase rising from

£0.25m in 1965/6 to £0.4m in 1967/8 since the five-year forecast, of 19th November, 1962, referred to in this note as the previous forecast. These sums are intended to provide for 28 rising to 63 additional staff, to develop and operate the new apparatus, and include about £0.2m in each year for minor capital equipment. The Institute consider this to be a minimum increase for proper exploitation of Nimrod; it does not allow for the maximum possible exploitation, but has been put at a deliberately reduced level for reasons of economy. An important factor in the need for this increase has been the vigour with which the university physicists have directed their preparations for research on Nimrod. Experimental proposals of the highest quality are being made by fourteen research groups.

(b) The Electron Laboratory

Now that the Electron Laboratory is under way much better estimates have been made for the construction of the electron synchrotron (NINA) and its buildings. The present estimates for the machine itself are very close to those which were made nearly two years ago, but the buildings were underestimated by £0.6m. The building scheme has been examined most carefully but it seems impossible to reduce it. The increase of £0.6m in the capital budget was partly offset by slower build-up of staff and a consequent reduction in the current expenditure.

It seems clear now that the Electron Laboratory and NINA can be built in four years rather than five which seemed necessary two years ago. In view of the considerable delay which occurred in the authorisation of the project, it is essential that it is pressed forward as quickly as possible, but a redistribution of the budget over four years does inevitably mean a substantial increase in the early years of construction. In 1964/5, for example, the total expenditure will have to be increased from £1.5m to £2.3m and this leads to a large increase in the Institute's total forecast for that year. It will be necessary to commit substantial expenditure on the basis of the new forecast by July, 1963 if the accelerated programme is undertaken.

(c) Research using Nuclear Reactors

A programme of university research at the A.W.R.E. "Herald" reactor has now begun, and the cost of its early stages has been estimated on a realistic basis. Proposals have also been made for experiments at A.E.R.E. reactors. There is, therefore, a better basis on which to forecast the future cost of this part of the Institute's activities than at the time of the previous five-year forecast, which included only £0.15m for reactor work in each of the years 1964/5 to 1967/8, whereas the present forecast is that the cost will rise from £0.2m in 1964/5 to £0.5m in 1968/9. The later figures are very tentative. In 1968/9 a token amount has been included for the hire of space in a possible new national or European high-flux reactor.

As with the accelerator work, first-class research programmes are being worked out by universities, stimulated and co-ordinated by the Institute but in this case using existing publicly-owned facilities. The Institute regard this as a very important part of their work, but wish to emphasise again that it is not concerned with nuclear physics. Several disciplines are involved covering a wider range than the specialised fields of nuclear and high-energy physics, and the "nuclear science" aspect is simply the provision of sources of radiation in nuclear reactors. The work is only just getting under way, and needs a more rapid growth of financial support than high energy physics during the next few years.

3. INCREASED REQUIREMENTS FOR FUTURE SCHEMES

The needs now forecast for future schemes have increased since July, 1962 even more than those for the present programme. They no longer make a difference only in the last year under consideration as they did then. The

following table shows also that this change had been appreciated in part by the time the 1963/4 - 1967/8 forecasts were finally revised in November, 1962:-

Future Schemes (£ million)

	<u>1964/5</u>	<u>1965/6</u>	<u>1966/7</u>	<u>1967/8</u>	<u>1968/9</u>
(a) As in the Minister's letter of 13th July, 1962.	-	-	-	0.8	-
(b) Previous forecast 1963/4-1967/8	-	(0.03)	0.6	1.1	-
(c) Present forecast 1964/5-1968/9	(0.04)	1.1	1.9	1.9	2.4

The sums shown are an attempt to forecast the amount required for new schemes not yet approved or committed in principle. Consequential non-capital expenditure has been included in the present forecast. It is emphasised that these figures are forecasts only, and particularly susceptible to the effects of future developments in physics. Possible examples of the larger schemes are included in Table III, where they are identified by the letter C in the margin. As has been stated above, some such schemes, although uncommitted now, would be natural developments from the present programme if it is as successful as it ought to be, while others would be completely new items on the programme. An example of a scheme arising from the present programme would be a capital addition to a present accelerator, which would greatly increase its energy or output of particles. An example of a completely new item on the programme would be the "second major site" which has always figured in the Institute's forecasts.

It cannot yet be decided what schemes will be finally submitted for consideration, but neither sort of scheme can be neglected if the subject is to develop healthily.

Two of the possible future schemes require some comment.

- (a) The possible large electrostatic generator would be for research in nuclear structure, a field in which the requirements are at present under study by a special committee appointed by the D.S.I.R. One possible recommendation is for a new national facility, with a large machine which can be supplied commercially, so that expenditure could fall as early as is shown.
- (b) The high-flux reactor, which was included in the previous forecast with token expenditure in the last year, is treated similarly in this forecast. While it seems likely that some national or European high-flux research reactor will be built, the policy remains to be decided. The Institute would not necessarily bear or share in the capital cost. On the other hand some form of this project might be pushed ahead very quickly, and indeed as is mentioned in para. 2(c) a token amount of expenditure on hiring space in such a reactor has been forecast in 1968/9.

4. Expenditure on the Atlas Computer Laboratory has been treated hitherto as rather separate from the other Institute expenditure. To complete the forecast, the Atlas figures, and appropriations in aid, (much of which will come from payments for Atlas time) have to be taken into account:-

(£ million)

	<u>1964/5</u>	<u>1965/6</u>	<u>1966/7</u>	<u>1967/8</u>	<u>1968/9</u>
Total excluding Atlas, from the table in para. 1	8.2	8.7	9.8	9.9	10.4
Atlas Computer Laboratory	1.5	1.1	0.8	0.7	3.1
NIRNS total (gross)	9.7	9.8	10.6	10.6	13.5
Appropriations in aid	0.3	0.8	0.8	0.8	0.8
NIRNS total (net)	9.4	9.0	9.8	9.8	12.7

The forecast has been made on the basis of price levels in December, 1962. In the following tables it is given in the same form as the previous five-year forecast: it is first analysed according to the kinds of expenditure which form separate sub-heads of the Atomic Energy Vote; then the amounts of capital expenditure on large and small schemes are forecast separately and the large schemes are listed. Tables I and II show a shadow cut which has been applied before arriving at the final forecast. The shadow cut is made up of two parts, of which the first is an allowance of £0.5m in 1964/5 and of £0.1m in 1965/6 for delays in the present programme. The balance of the shadow cut applies to the future schemes, both the major ones such as the possible schemes listed in Table III and the smaller ones included under heading 2 of Table II, and is to allow for the probability that some such schemes will not be approved, and that others will be delayed. The Institute consider that the substantial cuts which have been applied allow fully for these uncertainties and delays, and that the forecasts represent their essential needs.

TABLE INATIONAL INSTITUTE FOR RESEARCH IN NUCLEAR SCIENCE1964/69 Five-Year ForecastSummary of Expenditure - £M

	<u>1964/65</u>	<u>1965/66</u>	<u>1966/67</u>	<u>1967/68</u>	<u>1968/69</u>
Salaries, Wages etc.	1.6	1.9	2.0	2.2	2.3
Administrative Expenses	0.2	0.2	0.3	0.3	0.3
Stores, Materials and Services for Establishments	2.4	2.8	3.0	3.4	3.6
E.M.R. by Universities and Industry	0.2	0.2	0.3	0.2	0.3
Reactor Support (excluding Plant)	0.2	0.2	0.3	0.3	0.4
Purchase, Construction etc. of Land, Buildings, Plant and Machinery, etc.	5.7	4.8	5.2	4.9	7.5
	10.3	10.1	11.1	11.3	14.4
<u>Less</u> Shadow cuts	0.6	0.3	0.5	0.7	0.9
<u>Gross Expenditure</u>	9.7	9.8	10.6	10.6	13.5
Appropriations in Aid	0.3	0.8	0.8	0.8	0.8
<u>Net Expenditure</u>	9.4	9.0	9.8	9.8	12.7

NATIONAL INSTITUTE FOR RESEARCH IN NUCLEAR SCIENCE1964/65 Five-Year ForecastCapital Expenditure - £MSummary

	<u>1964/65</u>	<u>1965/66</u>	<u>1966/67</u>	<u>1967/68</u>	<u>1968/69</u>
1. <u>Schemes over £100,000 in total cost</u>					
A	3.9	1.9	0.7	-	-
B	0.4	0.2	0.4	1.3	0.7
C	0.1	1.0	1.7	0.7	3.4
	4.4	3.1	2.8	2.0	4.1
2. <u>Schemes under £100,000 in total cost</u>					
A	0.2	0.1	0.1	-	-
B	1.1	1.6	2.0	1.6	2.1
C	-	-	.3	1.3	1.3
	1.3	1.7	2.4	2.9	3.4
Totals 1 and 2 above					
A	4.1	2.0	0.8	-	-
B	1.5	1.8	2.4	2.9	2.8
C	0.1	1.0	2.0	2.0	4.7
	5.7	4.8	5.2	4.9	7.5
<u>Less Shadow Cuts</u>	0.6	0.3	0.5	0.7	0.9
<u>Net Capital Forecasts</u>	5.1	4.5	4.7	4.2	6.6

Key: A Firm Commitment
 B Committed in principle
 C Not committed

TABLE III

NATIONAL INSTITUTE FOR RESEARCH IN NUCLEAR SCIENCE

1964/69 Five-Year Forecasts

List of Capital Schemes over £100,000

		<u>Date of</u> <u>likely</u> <u>Commitment</u>	<u>Est.</u> <u>Total</u> <u>Cost</u>	<u>1964/5</u>	<u>1965/6</u>	<u>1966/7</u>	<u>1967/8</u>	<u>1968/9</u>
<u>Rutherford Laboratory</u>								
A	Nimrod		11.1	0.2				
A	Heavy Liquid Bubble Chamber		0.4	0.2				
A	Helium Bubble Chamber		0.5	0.2	0.2			
A	Beam Handling Plant - Ph. I		1.0	0.3	0.1			
A	" " " - Ph. II		0.4	0.2	0.2			
A	Parasitic Area Extension		0.2	0.1				
A	Abingdon etc. Houses		0.2	0.1				
B	H.E. Physics Apparatus	1963	0.7	-	0.2	0.2	0.3	
B	Aux. Bldg. for Nimrod Physics	1963	0.1	0.1				
B	Electronic Labs. & Offices	1963	0.2	0.1				
B	2nd Main Experimental Area	1966	0.3			0.1	0.2	
B	Beam Handling Plant - Ph. III	1966	1.0				0.5	0.5
B	Physics & Office Block	1966	0.2				0.1	0.1
C	Nimrod Improvement	1965	-			0.2	0.2	0.2
C	Accelerator Development	1966	6.0				0.1	0.5
C	Large Electrostatic Generator*	1964	3.0	0.1	1.0	1.5	0.4	
C	Future Major Accelerator*	1966	21.0					0.3
C	Research Reactor	(?)	3.0					0.1
				1.6	1.7	2.0	1.8	1.7
<u>Electron Laboratory</u>								
A	NINA (4 GeV E.S.)		3.9	1.6	0.9	0.5		
B	External Electron Beam Plant	1965	0.3			0.1	0.2	
B	Hostel	1964	0.1	0.1				
B	NINA Development	1967	1.0					0.1
C	Storage Rings	1968	3.0					0.1
				1.7	0.9	0.6	0.2	0.2
<u>Atlas Computer Laboratory</u>								
A	Atlas Computer		3.3	1.0	0.5	0.2		
B	Visual Display Output	1964	0.1	0.1				
C	Computer Extension	1965	5.0					2.2
				1.1	0.5	0.2	-	2.2

*Site unknown

Key: A Firm commitment
 B Committed in principle
 C Not committed