Science and public expenditure, 1989 : a report to the Secretary of State for Education and Science / from the Advisory Board for the Research Councils.

Science and Public Expenditure 1989

a report to the Secretary of State for Education and Science

from the Advisory Board for the Research Councils

XRA

Advisory Board for the Research Councils
Elizabeth House York Road London SE1 7PH

Direct line 01-934 9849
GTN Number 2914 9849
Fax 01-934 9389

1297 ADV

Chairman
Sir David Phillips FRS

Secretary
P J Thorpe

The Rt Hon Kenneth Baker MP
Secretary of State for Education and Science
Elizabeth House
York Road
LONDON
SE1 7PH

12 May 1989

Dear Secretary of State,

PUBLIC EXPENDITURE SURVEY 1989: THE SCIENCE BUDGET

I am pleased to submit the enclosed advice from the Board for this year's Public Expenditure Survey.

We present this against the background of the substantial increases in the Science Budget which you announced last autumn. Our primary aim is to sustain the new research initiatives, the protection of curiosity-motivated research and the start on essential reshaping of the science base which those increases have made possible. Much good work will be undone if present expenditure plans - which imply a real reduction in the Science Budget of more than 3% - are retained.

Beyond that, the Board is very conscious of the nation's need to build on the excellent foundations laid by last year's settlement. As the Government has recognised, Britain's future economic and social well-being depends in no small part on the strength of our basic and strategic science. But there are increasingly serious worries about the supply of the scientific manpower which the country needs and persisting deficiencies in equipment provision. These must be tackled before they blight the progress which should otherwise be achieved.

Our advice also highlights a number of scientific opportunities now evident - particularly concerning environmental research - for which additional resources are needed if we are to capitalise on the internationally recognised quality of UK research and play our proper part in advancing scientific knowledge in these areas of increasing worldwide concern.

The Board and I will be pleased to discuss with you any points arising from this advice. We trust that, as on previous occasions, you will agree to its publication.

Yours sincerely,

David Phillips

DAVID PHILLIPS

1989 PUBLIC EXPENDITURE SURVEY
ADVICE OF THE ADVISORY BOARD FOR THE RESEARCH COUNCILS

INTRODUCTION

1. This submission presents the Board's annual advice to the Secretary of State for Education and Science on the implications of the Government's expenditure plans for the Science Budget. It includes an assessment of the health of the science base and our judgement of the resources necessary to maintain and improve the coherence and efficiency of the system and the quality and utility of its output.

2. In our corresponding submission last year we advised that the Government should provide increases in the Science Budget planning figures of £97 million in 1989-90, £131 million in 1990-91 and £151 million in 1991-92, for the strategic reshaping of the science base and to grasp new scientific opportunities offering great potential benefits to the nation.

3. The Secretary of State responded in November by announcing that the Science Budget for 1989-90 would be £825 million, with planning figures of £838m and £856m for the following two years. This represented an increase of about £100 million a year on the Government's previous expenditure plans and implied spending in 1989-90 which would be 11% higher in real terms than in 1988-89. The Secretary of State also made a special allocation of £14 million in 1988-89 for urgently needed equipment for basic science. The Secretary of State specified the amounts within these new totals which were to be earmarked for national scientific commitments - the British Antarctic Survey, British Geological Survey, CERN and AIDS research - and invited the Board's advice on the detailed allocation of the remainder (some £70 million a year).

4. The Board was greatly encouraged by this substantial increase in the Science Budget and particularly welcomed the Government's recognition of the importance of basic and strategic science for national economic and social well-being. The settlement enabled funds to be provided for a selection of new research initiatives; for some protection to be given to curiosity-motivated research; for progress to be made in achieving closer integration of Research Council establishments with the university system; and for the strategic reshaping

of the science base to be carried forward through the restructuring of Research Council institutes and the establishment of Interdisciplinary Research Centres.

5. The Board said that it regarded the settlement as a solid foundation for further advance, but it identified a number of areas requiring detailed examination and additional support before that foundation could be built upon with reasonable surety of securing successful progress. Chief among these were the critically important issues of scientific manpower (including postgraduate training) and research equipment: these are central themes in our Advice this year.

6. The Board agreed last autumn that it would be timely to review the progress of the IRC initiative during 1989. Information about this review - which focusses on processes for selecting and establishing IRCs, their management, and arrangements for the assessment of their effectiveness - is given in paragraph 40 below.

7. Despite the substantial uplift announced last autumn, the Board noted that the Science Budget planning figures for 1990-91 and 1991-92 implied a reduction in real terms over the two years of about 3% (taking account of the Government's inflation forecasts). This would mean a significant diminution in the volume of research supported by the Councils. We therefore welcomed the Secretary of State's assurance that these figures would be reviewed in the 1989 PES. This Advice is the Board's input to that review. We believe that it makes a compelling case for the additional resources necessary to sustain the momentum of UK science into the 1990s.

THE HEALTH OF THE SCIENCE BASE

8. In its annual expenditure advice to the Secretary of State and in its 1987 strategy document*, the Board has repeatedly stressed the importance of basic and strategic science for industry, the economy and social welfare, both as a source of knowledge and ideas and as a provider of very highly qualified manpower. It has argued that the science base in higher education and the Research Councils must be maintained and enhanced in strength and quality - through greater concentration of research activities and more selective allocation of resources, the

---

* A Strategy for the Science Base, May 1987

sustenance of basic research, greater responsiveness both to scientific opportunities and to national needs, and (where this gives good value for money) increased international collaboration. It has encouraged closer collaboration between the science base and users of research, and has stressed the need for improved efficiency and effectiveness in the management of resources for research and postgraduate training. The following paragraphs comment on how effectively these objectives are being met.

9. Selectivity and concentration of research funding have helped the UK to maintain its competitive edge in many fields of science. The UK's record of scientific achievement remains outstanding and the continuing emphasis within the Research Councils on improving effectiveness, efficiency and value for money will help preserve it. But this is unlikely to be sufficient: high quality output depends on the size of the input as well as on the efficiency and effectiveness with which resources are deployed.

10. As we noted in our advice last year, analysis of the Science Literature Indicators Data-base has revealed worrying signs that the UK's share of world scientific output is declining relative to that of other countries - notably the USA, Japan, France and West Germany. Moreover, the preliminary results of a recent cross-national comparative study of expenditure on academic and academically related research, commissioned by the Board, suggest that the UK is spending between £150m and £200m per year less on such research than its main European competitors, even after allowing for the increases which the Government announced last autumn, whether such expenditure is measured on a per capita basis or as a proportion of GDP. The study concludes that in materials science, chemistry, physics and the medical and biological sciences, Britain is lagging well behind public funding of research in France and West Germany. These are strategically important areas, both for scientific progress and technological development, where heavy investment in state-of-the-art equipment and in excellent training of first-rate research manpower are required both to advance research at the frontiers of knowledge and to underpin industrial progress. Increased investment in science is essential to provide both the equipment and personnel the UK needs to meet the challenges of the 1990s.

11. Many of the major challenges facing science and technology are international or global in scale; the best means for meeting some of them will be through effective international co-operation. We return to this theme in making

our case for funds for new scientific opportunities. In the context of the health of the UK science base, however, we wish to register our concern that British science is insufficiently resourced to grasp the opportunities for increased co-operation in research and for much greater exchanges of manpower and expertise which will flow from the completion of the single European market in 1992. We have invited the Research Councils to assess the detailed implications of "1992" for their operations and to develop proposals for concerted action. We expect to be in a position to offer further advice on this later this year.

12. As part of its Forward Look exercise this year, the Board has had detailed discussions about each Research Council's Corporate Plan; and we will be considering this summer how the process of corporate planning by the Research Councils can be clarified and improved. The Board has also received some of the material produced by Councils as a result of the work which the Department is coordinating in the development of output and performance indicators relevant to the Government's policy objectives for science. The different structures, styles and traditions of the Councils make a completely uniform approach to corporate planning, objective-setting and performance measurement difficult and in some respects inappropriate. But good progress is being made towards achieving greater consistency; and there is evidence from all Councils of substantial progress in achieving greater effectiveness, efficiency and value for money in pursuit of the objectives of science policy. Some of this evidence is detailed below.

13. Concentration Concentration on the research side is shown by the fact that ten institutions receive between 40% and 60% of the total research grant funds disbursed by each Council. Most Councils have shifted the balance of their support increasingly towards larger project grants and to programme grants (which are typically of longer duration and facilitate more flexible and efficient use of manpower and equipment). Between 1987 and 1988 the overall average size of research grants awarded by the Councils increased from £38k to £50k. Similarly, on the postgraduate training side, between 40% and 60% of research studentships awarded by each Council are concentrated in ten institutions. SERC, which supports more than three-quarters of the postgraduate students funded by the Research Councils, concentrates 50% of its awards in 14 institutions and 75% in 29 institutions.

14. Reorganisation and Restructuring All Councils have undergone significant reorganisation and restructuring in recent years, with the objective of better

management yielding greater value for money. AFRC completed its organisational restructuring into 8 Institutes last year and has begun the process of rationalising its facilities to no more than one or two sites per Institute: it plans to complete this process within the next 5-7 years rather than the 10 years originally planned. ESRC completed the reorganisation of its internal structure last year and is now on target to bring its administrative costs below 8% of its budget before the move to Polaris House. NERC has privatised a number of its functions in the past year. It will make substantial savings in costs and improvements in efficiency during the coming year by: relocating the BGS Geochemistry Unit from London to Keyworth; moving its laboratory at Bangor onto the University College of North Wales campus; merging two of its stations in Dorset and selling one of the sites; and starting planning for the move of the IOS Deacon Laboratory and the Research Vessel Services to Southampton. MRC has set up a new Strategy Committee to oversee the assessment of priorities and reallocation of resources; its Development and Integration of Behaviour Unit, Epidemiological Studies in Psychiatry Unit and Social Psychiatry Unit are due to close this year and a further nine of its units are scheduled for review during 1989-90. SERC has introduced a new senior management structure with clearer operational and policy responsibilities and has finalised arrangements for the move of the Royal Greenwich Observatory to Cambridge to create a world-class centre for UK optical astronomy. The relocation of the AFRC and ESRC headquarters to Swindon has created the opportunity for increased joint working and efficiency savings for four of the five Councils when they are co-located on the Polaris House site after 1990.

15. Collaboration with industry and other users Between 1985 and 1988 the Research Councils have increased collaborative funding from industry and other sources (excluding commissioned income from Government Departments) from some £36 million to about £60 million. AFRC has substantially exceeded its own targets by increasing its funding from commercial and other sources from £5 million in 1983-84 to £15 million in 1988-89. The MRC Collaborative Centre now has 12 projects fully funded by industry, with a value of £1.5 million a year, and is on course to be fully self-financing at an annual budget of £2.5 million by 1991. The SERC is involved in LINK schemes which it is envisaged will attract £66m from industrial collaborators over the next five years.

16. Contract Research Manpower Those Councils which employ a large proportion of scientific staff in their own institutes and units have increased the

number and proportion with period, rather than permanent, appointments. 12% of staff employed by AFRC and NERC and 15% of those employed by MRC are now on fixed-term contracts. This is partly a reflection of the success of the Councils in attracting commercial and other contracts and is an important means of training the senior research manpower needed by industry as well as the science base. It also gives the Councils more flexibility in responding to changing research needs, which is essential in institutes that depend heavily on commissioned work.

17. Postgraduate Research Studentships All Research Councils have given high priority to improving PhD submission rates and three of them (ESRC, NERC and SERC) have used sanctions against institutions and departments whose submission rates are low. The targets accepted by all Councils are for 70% of research students supported by them to submit their theses within four years of the start of their awards and 85% within 5 years. At present, four of the Councils have 4-year rates of more than 60% and 5-year rates of more than 70%. The exception is ESRC, which began from a much lower base but has raised its 4-year rates from 22% to 47% in the past four years, by the vigorous application of sanctions and other measures to improve the quality and effectiveness of research training.

18. Output All the available evidence suggests that the productivity of scientists funded by the Research Councils remains high. Numerous examples could be given of individual pieces of research which have contributed to the UK's industrial competitiveness, to advances in health and welfare, and to the improvement of the environment. All Councils are making efforts to improve their data-bases on research output and its impact, and studies commissioned by the Board are contributing to improved methods of analysis. However, this is not a straightforward matter: the output of research is not susceptible to precise quantification and some quantitative indicators say nothing about the quality or usefulness of research output. The following examples can do no more than give a flavour - from currently available data - of the Councils' outputs and achievements:

- AFRC: Some 9,600 papers by AFRC institute scientists have been produced in the past 3 years and the number of published papers per institute scientist increased from 1.9 in 1985-86 to 2.5 in 1987-88. Income from royalties on inventions by AFRC scientists has more than trebled in the past three years. The value which industry

attaches to AFRC research is shown by the increase in its funding from commercial and other sources (paragraph 15 above).

- ESRC: Output of books produced by researchers at four of ESRC's leading centres more than doubled, from 8 in 1985-86 to 17 in 1987-88, and the number of published articles by staff at these centres increased from 120 to 164 over the same period.

- MRC: More than 10,000 papers by MRC staff have been published in refereed journals in the past 4 years. 102 patents were filed on inventions in MRC Units (excluding research funded in HEIs) between 1985 and 1988. Royalty income from inventions by staff in MRC Units increased from £96k in 1982-83 to £550k in 1987-88, excluding proceeds from the sale of cloned material.

- NERC: The contribution of NERC to public understanding of science is shown by the fact that staff of NERC laboratories and units produced more than 4000 "widely available publications" between 1985 and 1987, apart from many more publications in specialist scientific journals.

- SERC: Inventions resulting from SERC-funded programmes brought a net return, through royalty payments, of more than £3.7m in 1987 and £3.8m in 1988. Each year SERC contributes to the provision of very highly qualified manpower for industry and the science base: through the training of 7300 research students and 2300 advanced course students, and through research grant support for 200 Research Fellows, 5800 Research Assistants and 1400 other staff.

IMPLICATIONS OF PRESENT EXPENDITURE PLANS

19. We noted in our Allocations Advice, submitted in December, that the planning figures announced for 1990-91 and 1991-92 implied a 3% reduction in the Science Budget in real terms over the two years, after allowing for inflation at the level forecast by Government for the economy generally (the GDP deflator at market prices). Since that Advice was prepared, the Government's inflation forecasts have been revised upwards. The increase in the Science Budget in real terms between 1988-89 and 1989-90 is now estimated to be just over 9%, rather

than the 11% originally assumed. On the latest forecasts for the GDP deflator, the present planning figures for the Science Budget imply a real terms reduction below the 1989-90 level equivalent to about £20m in 1990-91 and £30m in each of the two subsequent years. But these estimates do not take account of the likely higher rate of increase in the costs of scientific research.

20. The outcome of pay negotiations for university academic staff is uncertain at the time of writing but it seems likely that the eventual settlement will be at least 1.5% higher than the Government's present forecast of general inflation in 1989-90. The Research Councils play no part in these negotiations, but the consequence for them of such an increase would be an extra £4.5 million on their costs. Increases for technical and (for MRC) clinical grades are also likely to exceed the Government's inflation forecasts. Other significant elements in science costs which are rising rapidly include:

- costs of contracts for equipment maintenance, which have risen by more than 10% during the past year and, because they are usually based on a percentage of equipment costs, increase more rapidly as equipment becomes more sophisticated and expensive;

- costs of computer software, which have risen by up to 11% in the past year;

- costs of chemicals, glassware and plastic-ware, which have increased by between 8% and 10%;

- computer-aided design, for which SERC's costs have risen by 17%.

After taking account of the Councils' efforts to achieve efficiency savings, we estimate that science costs will increase overall by around 1% a year more than the Government's forecasts of inflation in the economy generally (the GDP market prices deflator). The impact on individual Councils will vary depending on their particular circumstances and mix of expenditures; the following paragraphs illustrate the consequences for their programmes.

21. AFRC Failure to maintain the value of AFRC's Science Budget funding in line with actual inflation seems likely to result in the loss of more than £4 million in real terms between 1989-90 and 1992-93 - over and above reductions in MAFF

commissioned research of about £4 million in 1990-91 and a further £4 million in 1991-92. Examples of the science that it may no longer be possible to support include research on reproductive and lactational physiology, cellulose digestion, exotic and endemic virology, hormonal studies on plant physiology and morphogenesis, soil properties, nitrogen fixation, and aspects of food science including cell wall biopolymers and novel analytical techniques.

22. ESRC spends about 50% of its budget on salaries and related costs for university research workers. Its budget will decline in real terms by at least £2.4m between 1989-90 and 1992-93 on the basis of present planning figures. This will result in reduced funding for the ESRC's research grants scheme, which is already under severe strain with only 25% of applications currently being funded. New programmes of research into Transport, Pollution, the Single European Market and Eastern Europe may have to be cut or postponed and the funding of some other major activities, such as ESRC's contribution to the joint SERC/ESRC Committee's work on the management of technological change, may have to be reduced.

23. MRC's programmes are likely to be seriously affected by pay increases. As well as the general impact of the university pay settlement already mentioned, the Council's staff and the clinicians it supports through grants to universities have received pay awards - tied to Government-approved increases in NHS salaries - which have been 1-2% higher than for other groups in recent years. Additionally, the MRC estimates that its non-pay costs have normally risen by at least 1% more than the Government's GDP deflator. After making every possible allowance for redeployment and efficiency savings, the Council estimates that it will require an additional £3 million in 1990-91 rising to £15 million in 1992-93 to maintain the volume of science it supports. Among the programmes immediately at risk are studies of immunosuppression, research on normal and abnormal visual pathways, cognitive development in normal and handicapped children, genetics of inherited disease, immunochemistry, and clinical pharmacology and associated studies of disease. The expanded programme of clinical training awards and the new scheme of collaborative studentships would be threatened. Plans to increase expenditure on health services research, to mount major clinical trials in breast cancer screening and whooping cough vaccine, and for studies of the causes of and remedies for excess winter deaths in the elderly, would be held back; and some might have to be abandoned.

24. NERC expenditure will increase by £27m in 1989-90 but this is mainly accounted for by capital expenditure for the British Antarctic Survey and equipment provision for other major programmes. Support for institutes, directed university support and responsive-mode university support will increase by £2.6m in 1989-90 but then fall by the same amount in the subsequent three years. Commissioned research income may fall by as much as £4m in real terms by 1992-93. The combined effects are likely to be: severe cuts in the work of institutes in the marine, terrestrial and freshwater sciences - in which many areas of work have already been terminated or seriously reduced over the last year, with the loss of 160 staff; no provision for major capital projects other than those already approved; and a steady decline in university support.

25. SERC estimates that to maintain its programme at the level established for 1989-90 will require additions to its present planning allocations of about £11m in 1990-91, £29m in 1991-92 and £43m in 1992-93. Increases in pay and equipment costs above the Government's inflation estimates will be offset to some extent by smaller increases in the cost of international subscriptions. The main consequences of failure to maintain the volume of Science Budget expenditure at the 1989-90 level are likely to be cuts in research grants through the responsive mode; continued serious under-funding of important initiatives, including molecular recognition, non-linear optics and computation science; and the postponement of new priority work in materials and biotechnology. Expenditure on astronomy and planetary science, whose share of SERC's domestic expenditure has fallen from 16% to 12% in the past 4 years, would have to be cut still further, necessitating a smaller role for the UK in the European Space Agency and the closure of at least one major telescope. There would be further cuts in manpower and equipment for nuclear physics research.

26. The Royal Society anticipates that failure to compensate adequately for expected cost increases, of which pay increases would form a very significant part, would mean non-replacement of at least 4% of its University Research Fellowships by 1990 and a further 4% by 1992; cuts in research support both for University Research Fellows and for other holders of research appointments; reduced support for international exchanges and travel grants; and cuts in the real value of the new Small Grants Scheme. These cuts would follow a period, between 1983 and 1988, when 16 URF posts and 11 more senior Research Fellowships were not replaced when they fell vacant.

NEW SCIENTIFIC OPPORTUNITIES

27. Every major advance in science opens up new fields of study and new problems demanding research. As the applications of science have proliferated, so has recognition of its importance for industrial competitiveness, the quality of the environment and the health and well-being of the population. Scientific advances - and hence new scientific opportunities - have tended to grow more vigorously in interdisciplinary fields, or in areas of science such as molecular biology, where a very wide range of possibilities for further developments in knowledge or practical application have resulted from every new breakthrough.

28. The boundary between basic and strategic research has become increasingly blurred, and the time required to exploit fundamental discoveries has shortened. As a result industrial firms have become more willing to help support basic and strategic research, as the evidence on industrial collaboration (paragraph 15 above) helps to demonstrate. There is much scope for extending these collaborative activities both in research - through mechanisms such as LINK and the Teaching Company Scheme - and in postgraduate training - through SERC's Integrated Graduate Development Scheme (IGDS), for example. All Councils are making strenuous efforts to increase the level and proportion of their funding from commercial and industrial sources and to encourage private sources to match their investment in areas with strategic potential. But industrial funding cannot by itself fill the gap in scientific investment between the UK and its competitors. The Governments of all major industrialised nations have come to accept that public investment in basic and strategic science is indispensable, both for technological competitiveness and for the advances in fundamental understanding which can, often quite rapidly, provide solutions to environmental, medical, economic or social problems. The study referred to in paragraph 10 found that West Germany, France, the Netherlands and the USA all spent appreciably more per head of population than the UK on academic and academically related research between 1980 and 1987, and that the gap between the UK and the lowest placed of these countries (France) had widened significantly since 1980.

29. Competition helps stimulate scientific advance. At the same time, the need and the scope for scientific co-operation across national boundaries is increasingly recognised. Understanding of climatic changes and the search for solutions to global environmental problems, for example, will only come through such international collaboration. In these and other fields, the costs of science are

such that international collaborative funding is the only practicable way forward, quite apart from the desirability of sharing knowledge and expertise in fields of common interest and concern.

30. There will be some areas in which the UK is not well placed or cannot afford either to compete or to collaborate with other countries. The Board continues to recognise that selectivity and concentration are vital. Earmarked funding for directed programmes and centres must be targeted towards the highest priority areas, but not at the expense of an adequate level of support for curiosity-motivated research from which new ideas and breakthroughs may come.

31. Research Councils have a clear responsibility to fund the highest priority work from their existing resources, redeploying funds from existing activities to meet new and more important demands. As we have indicated in the previous section, Research Councils have introduced increasingly rigorous processes for reviewing priorities; but new resources are still required if the UK is to continue to play an adequate role in the international scientific community, maintaining a leading position in selected fields, developing understanding of advances elsewhere, and being able to exploit some of the most exciting new opportunities now emerging.

32. We have concluded from our detailed scrutiny of Councils' current activities and future plans that increased provision is justified, not only to maintain the volume of research at its 1989-90 level but also to increase activity in selected high priority fields. The opportunities which would be foregone if present planning figures were not increased in line with expected increases in costs are outlined above (paragraphs 21-26). The following paragraphs describe in more detail the main elements for which we regard additional funding, over and above maintenance of the 1989-90 level in real terms, to be necessary.

Environmental and Climatic Research

33. The increase in public awareness and concern about environmental issues during the past year has derived largely from new scientific discoveries, most notably about man-induced climatic change. However, predictions about climatic changes, especially at regional and local level, and their potential environmental and socio-economic consequences remain uncertain, largely because of major gaps in our knowledge about fundamental processes and mechanisms. NERC and SERC

together with the Meteorological Office, already support research into some of the most pressing aspects of climate change. AFRC and ESRC also have significant interests. The UK is involved in a number of important international research programmes in this field; but our assessment is that, without additional resources, UK scientists will be unable to play a full role in these. They will be unable to contribute fully to the range of satellite missions planned for the 1990s: funding for the proposed, and scientifically desirable, ERS-2 has yet to be found; and the UK contribution to instruments for the NASA and ESA Polar Platforms is still to be fully secured. British scientists will therefore not be well placed to exploit the possibilities for fundamental understanding of physical and chemical processes and interactions which may be derived from data collected by these new satellite-based instruments. Nor will the UK be able to participate to the extent previously planned - and justified by our scientific expertise - in the major World Ocean Circulation Experiment (WOCE), which will permit improved prediction of variability in the ocean and hence of the climate system generally, and will also enhance understanding of the role of the oceans as a sink for atmospheric CO_2. £11 million in 1990-91 and £13 million in each of the two subsequent years will be required, over and above the funds already planned by NERC and SERC.

34. In our Advice last year we commended the case made by NERC for a major conversion and upgrading of the research vessel RRS Discovery. This is essential if NERC's fleet is to be capable of meeting scientific requirements in the 1990s. The ship, built in 1962, requires major refurbishment to remain seaworthy; but it will be much more cost-effective to rebuild and re-equip it to modern scientific standards than to spend almost twice as much on a new ship. About 60% of a refitted RRS Discovery's sea-time until the late 1990s would be devoted to the WOCE programme (to which the USA, France, West Germany, Japan and Canada will also be contributing seven ships, five of them new or substantially refurbished). Apart from WOCE, the needs of the marine scientific community - especially in marine geophysics and biology - require another research vessel in addition to RRS Challenger, RRS Charles Darwin and the new ship to be launched in 1990, RS James Clark Ross. Of these, only the specification of the latter is suitable for WOCE and similar deep-sea research; but the James Clark Ross is specifically earmarked for work in the Antarctic. The cost of the refurbishment of RRS Discovery will be £6m in each of 1990-91 and 1991-92.

35. Other environmental research priorities which cannot be accommodated within planned expenditure levels include NERC's proposals for development of

work on river ecosystems, and for a programme of basic research in environmental microbiology. Allied to the latter are AFRC's plans for a new research programme on biological response to environmental change; but we believe the two could be more closely coordinated. Indeed we intend to offer further advice on the general issue of coordination in these related fields following our consideration of the Morris Committee's report on the disposition of responsibilities for the biological sciences. For the present, our judgement is that additional funds of about £4m in 1990-91 and £6m in each of the subsequent years are required to carry these programmes forward.

Biological Science Opportunities

36. AFRC's ability to sustain the volume of its directed research programmes and to grasp important new opportunities in biological sciences will be severely constrained by the exigencies of restructuring and adaptation to cuts in both commissioned and Science Budget income (see paragraph 21). There are two important priority areas, both with potential applications for human and animal health, in which AFRC is well-placed to make scientific progress, but cannot do so without additional funds. Stem cell biology has reached a point where scientific advances may soon lead to improvements in gene regulation, repair, transfer and expression in both animals and plants; while AFRC's work on Slow Viruses (in co-operation with MRC) is not only a field of great significance for animal and human health but also an exciting area of science for which extra funds will enable the UK to maintain its world lead. The funds required for these two programmes are £2m in 1990-91, £4m in 1991-92 and £6m in 1992-93.

Curiosity-Driven Research

37. Our advice in previous years has stressed the importance of sustaining an adequate level of support for curiosity-driven research through the responsive research grant schemes of the Research Councils and the new small grants scheme of the Royal Society. This was given priority in the allocation of the Science Budget for 1989-90 and it will be possible as a result to effect some improvement in the proportion of alpha-rated grant applications which can be funded. The most recent figures available show that 878 alpha-graded applications valued at £64 million (29% of all such applications by number and 38% by value) could not be funded in 1987-88. These proportions should be reduced this year as a result of the enhanced funding; but further increases of £6 million for 1990-91, rising to

£13 million in 1992-93 are required to ensure that the proportion of alpha-rated projects which can be supported is restored to the levels of the early 1980s.

38. Statistics showing the number, value and proportion of "unfunded alphas" give a broad indication of the amount of excellent science which is lost as a result of under-funding of Councils' research grant schemes. But they do not reveal the extent to which younger researchers or first-time applicants, as distinct from well-established scientists already holding several grants, are affected. We also need to know more about the impact on particular subjects and disciplines. The Board intends to review the data available on these matters, with the Research Councils, in order to be able to offer more detailed advice on the implications of funding trends in future years.

Interdisciplinary Research

39. Many of the most important scientific advances have been and will continue to be made in interdisciplinary fields, but building effective programmes of interdisciplinary research takes time and new mechanisms and institutional arrangements are sometimes required to bring it about. The Board has advocated Interdisciplinary Research Centres (IRCs) as one such mechanism. But neither the Board nor the Councils have regarded IRCs as the only means of building large-scale programmes of interdisciplinary research, achieving co-operation between higher education institutions or encouraging collaboration between Research Councils. Some of the proposals initially put forward as leading contenders for IRC funding - AFRC's proposals for plant molecular biology and MRC's for therapeutic immunology, for example - were considered more appropriate for a coordinated but dispersed programme than for concentration in a single centre, once detailed proposals from institutions had been fully assessed.

40. Having recommended the establishment of and funding for seventeen Interdisciplinary Research Centres (IRCs), the Board agreed with the Secretary of State that it would be desirable to take stock before proceeding further with this new mode of research funding. We have therefore established a group under the Chairmanship of Mr John Flemming, Executive Director of the Bank of England and a member of the Board, to review the progress of the IRC initiative with particular reference to: the process of initiating and selecting proposals for new IRCs; appropriate management structures; links between IRCs and higher education institutions, Research Council institutes and industry; and Councils' arrangements

for on-going support, monitoring and evaluation. It is too early to make an objective assessment of the output and performance of the IRCs, but the Board anticipates that the review group will bring forward some evidence regarding the output to date of the first tranche of IRCs and their success in bringing together the best scientists from the UK and overseas to work at the frontiers of knowledge in interdisciplinary fields. We will also expect the group to give guidance on the relative merits of alternative approaches to building and sustaining interdisciplinary research, including the different models for IRCs being developed by Councils.

41. However, notwithstanding the Flemming Review, and pending its outcome, the process of developing and promoting interdisciplinary research should continue. We have identified a number of research fields in which we consider interdisciplinary collaboration on a larger scale to be timely and important, while reserving our position as to whether such research should be organised through the IRC mode or by other means. These areas include: neurodegenerative diseases; clinical molecular genetics; molecular and cellular studies of simple nervous systems; clusters and nucleation phenomena; economic performance and the labour market; the brain and behaviour; safety critical and high integrity systems; biomedical materials; biochemical engineering; and advanced electronic materials. The additional cost of IRCs or large-scale interdisciplinary programmes in six of these areas would be around £7m in 1990-91, £16m in 1991-92 and £13m in 1992-93.

MANPOWER

42. We promised detailed advice this year about how the problems of meeting pressing needs for very highly qualified manpower, both within the science base and the wider economy, might best be tackled. This is a subject about which data and understanding are far from perfect. Except in the most broad-brush terms, there are no reliable projections of demand for postgraduate places; of the output of qualified postgraduates; of the needs for postgraduate scientists in the science base and in industry; or of changes in supply and demand between fields of study. Additionally, the Government's new "top-up loans" regime for undergraduate finance may lead to major changes in demand for postgraduate places and in the pattern of postgraduate support - for example, if more people decide to opt for part-time instead of full-time postgraduate study. We will wish to give further advice on these matters next year when the results of investigations set in train by the Research Councils and the Board will be known.

43. Nevertheless, despite these many uncertainties, several important facts are clear. An adequate supply of talented and very highly qualified manpower is essential for the health of science and technology and hence for the nation. But too few children are opting for scientific subjects at school, applications for science and engineering places at universities are falling and the pool of excellent science graduates willing and able to go on to postgraduate work is declining. The career opportunities and high rewards now open to the most talented graduates in non-scientific occupations contrast strongly with the relatively limited opportunities and poor rewards open to scientists and engineers. Graduates are now in a sellers' market. Unless action is taken very soon there will be a critical shortage of suitably qualified and trained researchers in the 1990s. We therefore agree with the conclusion of the recent House of Lords Select Committee Report that "all the United Kingdom's plans for civil research and development are at risk from one factor, manpower shortages".

44. Extra provision through the Science Budget can be only one element in an overall strategy to address this critical problem, but it is a vitally important element. We wish to draw the Secretary of State's attention to five aspects for which extra provision is necessary - maintenance of postgraduate studentship numbers, with increases in shortage areas; improvement in the level of postgraduate maintenance awards; experimentation with new and more flexible forms of postgraduate support; measures to provide career opportunities at postdoctoral level; and schemes to encourage collaboration and interchange with the international scientific community.

45. The Research Councils at present support about 60% of the full-time home PhD students in the fields for which they are responsible. Support for advanced course (Masters) students varies greatly between Councils and is highly selective; overall, no more than 25% of full-time home students on such courses receive Research Council support. But the provision of an adequate number of studentships - limited to the most talented and highly motivated applicants, held in institutions and departments offering the best possible environments for research and training, and directed to meeting needs for scientific manpower - is essential if manpower needs for the science base, and hence for the wider economy, are to be met. Some of the Councils have identified potential shortages which must be filled by increasing studentship numbers. AFRC needs to sustain the important - and, in the Board's view, overdue - expansion of its studentship scheme, which will

start in 1989-90. ESRC - and other influential commentators - see a need for more studentships in cognitive science, information technology, geographical information systems and health economics. MRC wishes to expand studentship numbers across the board, building up critical masses in excellent departments and larger MRC establishments, and is also introducing a new scheme of collaborative research training with industry. NERC is concerned to meet shortages of trained manpower especially in the physical science disciplines which contribute to the terrestrial and freshwater sciences and in areas of the earth sciences where industrial demand is greatest. SERC has always given very high priority to postgraduate training, and plans to keep postgraduate studentship numbers broadly constant, whilst keeping the pattern of support between subjects under review.

46. But the best candidates will not be attracted to apply for studentships if the level of maintenance awards is insufficient to give them a reasonable standard of living without having to undertake substantial amounts of teaching and other paid work, to the detriment of their time for study and training. We strongly support the case made by the Research Councils for a general increase in the level of maintenance awards for postgraduate students, in order to maintain the flow of graduates into research and advanced study. There is no logical case for linking the value of postgraduate awards to the levels of undergraduate grants. Postgraduates have heavier needs than undergraduates for books and materials, wordprocessing and computing facilities; thesis preparation and binding costs are high; they often have family responsibilities; and they do not - or should not - have opportunities for enhancing their income by taking paid work during their much shorter vacations. The disincentive of low maintenance awards must be removed.

47. We do not - except in the small and highly specific field of AIDS research where MRC has already taken action - think there is a case at present for offering higher awards to students in some disciplines than in others. We recommend that additional provision should be made to enable all the Research Councils to increase postgraduate maintenance awards by an average of £600 per student, for both research and advanced course students, above the DES recommended levels for 1989-90. This would restore the real value of awards to their 1978-79 levels. The additional funds required for this will be £4 million in 1990-91 and £8.5 million in each of the two subsequent years.

48. Maintaining full-time studentship numbers and offering more generous maintenance allowances will, however, not be enough. We have encouraged the Research Councils to undertake a fundamental review of the balance of support between PhD and Masters' studentships and to explore possibilities for experimenting with new modes of support. We would favour more Masters' courses to facilitate "conversion" to areas of greatest need; and we are encouraging Councils to give careful consideration to the case for providing selective support to part-time students. We commend SERC's Integrated Graduate Development Scheme (IGDS), jointly funded with the DTI and the Training Agency and designed to meet industrial needs for very high qualified manpower; but this will require additional funds if it is to expand from the present 12 programmes to the 24 needed by 1993. We are also following with interest two schemes being planned by MRC to evaluate US-style postgraduate training methods - 4-year awards in cell biology combining MSc/PhD training with further research experience within an IRC, and support for the three year PhD element of a five year MB/PhD "sandwich" being developed at Cambridge University.

49. Greater concentration of research support and better management of manpower and resources at institutional and departmental level are essential if the right conditions are to be created for research training and, for a more select few, academic career development. AFRC and NERC have given increasing attention to the training and retraining of their own manpower, partly to assist redeployment as a consequence of restructuring, and have managed to reduce the scale of redundancies and retain experienced staff by these means. One of the advantages of co-location of Councils' headquarters in Swindon will be closer co-operation between Councils over recruitment and training.

50. We continue to believe that the Royal Society's University Research Fellowships (URF) Scheme is an important way of renewing the cadre of research talent at postdoctoral level and retaining many of our best young scientists in the system until more academic appointments become available in the 1990s. The Society's aims are to build up a stock of 200 URF appointments by 1992 and to maintain the value of the Fellowships in real terms: we support these aims most strongly. Small funding additions are also required for an expansion of AFRC international research groups and fellowships, NERC fellowships, MRC support for posts at senior lecturer level in clinical schools, and Fellowship of Engineering sponsorship of chairs and research fellowships in engineering and design.

51. The Royal Society and Fellowship of Engineering also support a variety of schemes, funded from private as well as public sources, for overseas exchanges and visits; these need to be enhanced. The Royal Society has responded positively to opportunities for increased collaboration with Soviet scientists, not least in environmental research, but modest additional funding is needed to build on these valuable links. Such contacts can provide the seedcorn from which large and important programmes of international collaborative research can grow.

52. The additional funds required for this total package of manpower-related items - to which we attach very high priority - is £10 million in 1990-91, rising to £17 million in 1991-92 and £21 million in 1992-93.

SELECTIVE RE-EQUIPMENT

53. The special allocations for equipment of £14 million in 1988-89 and a further £12.3 million in 1989-90 have enabled some of the most urgent needs for selective re-equipment, both in universities and in Research Councils' own establishments, to be met. Although we were aware of widespread concern, we were hampered in our Advice last year by lack of evidence about the extent and nature of equipment needs, the estimated cost of alleviating present deficiencies and the kind of strategy which would be needed to ensure that these do not recur. A substantial body of evidence has now been assembled through a survey commissioned by the Board of academic research equipment in UK universities and a sample of polytechnics.

54. The survey - the report of which the Board will be publishing shortly - covered current items of equipment with a replacement cost of between £10k and £1m and departments' views on their need for equipment to support present and prospective research activities. There was a very high response rate (95%) and details were given about approximately 14,000 items of equipment. It was found that 14% of equipment was "state-of-the-art", 33% very good, 39% adequate, and 14% no longer adequate. Most of the latter was due to obsolescence: 37% of the national equipment stock is now 10 years old; 11% is over 20 years old. The costs of the additional equipment needed to support current research was estimated at £259m, with further items needed for new research being valued at £200m. Set against the available data from surveys elsewhere, these results suggest that the UK is not as well provided for as some other advanced countries, with worrying

implications for our international competitiveness in research and scientific training.

55. A distinction must be drawn between the continuing need to replace or update basic equipment which is an essential part of the well-found laboratory, and the need for large but selective injections of funds to make good the deficiencies which have been allowed to accumulate over the years. Our judgement is that there is a need for substantial investment in equipment over the next few years but that this must be phased, so that a rolling programme of carefully planned replacement may become established. Some separate provision also needs to be made for major items of state-of-the-art equipment, which should be funded on a particularly selective basis with arrangements to stimulate sharing by departments and institutions and with strategies for training in its use. Separate consideration must also be given to the requirements of Research Councils' institutes, units and other establishments and the extent to which they are - or should be - more closely integrated with the requirements of the universities.

56. It is, of course, not the responsibility of the Research Councils to meet equipment needs right across the science base. It is for the UFC to satisfy itself that the essential infrastructure exists, with the Councils providing selective and targeted support to enhance equipment provision for particular programmes or projects, centres or establishments, and managing major facilities for use by large numbers of scientists from many institutions. The survey found that 46% of equipment in universities had been funded by the UGC, 34% by Research Councils (primarily SERC) and the remainder from other sources. On this basis, it seems reasonable to suggest that provision should be made to enable the Research Councils to undertake a programme of selective re-equipment covering about one-third of the £260m shortfall in provision for current research, and to allow them to sustain a more adequate programme of regular updating and replacement thereafter. This would be achieved by: increasing the equipment component in research grant funding, selectively according to evidence of need; providing facilities accessible for use by communities of scientists, to be based in Councils' own establishments, in IRCs or in other centres of excellence; and making special provision for equipment (after a careful review) in the context of major new programmes of directed research, with arrangements for sharing in order to ensure optimal use. We recommend additional funding of £20 million per year from the Science Budget to meet these needs. More details of the justification for this

major increase in equipment spending, and of a complementary UFC initiative, will be submitted separately in conjunction with the UFC.

57. Over and above that, we recommend provision of an additional £7-8m a year for selective re-equipment in Research Council institutes, units and other establishments, including further upgrading of the joint Research Councils' CRAY supercomputer. Among the most pressing needs are:

AFRC: advanced analytical equipment, including mass spectrometer and NMR equipment: a gene sequencer and synthesizer for use in molecular biology and biochemistry; and expenditure to bring other equipment - ultra-centrifuges, cell-sorters and electron microscopes, for example - up to present day standards.

MRC: flow cytometers; cell sorters and analysers; x-ray crystallography; upgraded electron microscopes, and protein sequencers.

SERC: items relating to the Synchrotron Radiation Source, including high performance detectors for biological and surface science, equipment for a new materials science laboratory and high performance instruments for second Wiggler stations; completion of detectors for ISIS instruments; geophysics database workstations; upgrading of the laser loan pool; and a supercosmos measuring machine to replace outdated equipment.

RESEARCH COUNCIL RESTRUCTURING

58. Modernisation, rationalisation and, in some cases, relocation of Councils' in-house operations are essential if they are to be able to adapt to changing scientific priorities. Cuts in the funding of near-market research by Government Departments, especially MAFF, have made the need for such restructuring more pressing. At the same time, Councils have recognised the importance of bringing the research and training activities of their institutes and units into a closer relationship with those of higher education institutions. The scale of restructuring required is considerable and the amount of investment needed in the early stages is large, but this will be more than repaid in due course by the sale of assets and by cost savings through improved efficiency and effectiveness.

59. AFRC has 8 institutes but 24 main sites and its policy has been to reduce each institute to no more than one or two sites over the next 10 years, as opportunities present themselves. The need to reorganise its activities to cater for cuts in MAFF commissions and to prepare for the national and international scientific challenges of the 1990s now means that physical restructuring should be completed within the next 5-7 years. Priority has been given as a result of last year's Science Budget settlement to consolidating the Institute of Animal Health at Compton and transferring the Institute of Food Research Reading Laboratory to the University of Reading campus. Restructuring of the Institute of Animal Physiology and Genetics Research in Edinburgh and of the Institute of Plant Science Research has been possible without the aid of additional Science Budget funding. The Institute of Engineering Research is already on a single site and the Institute of Arable Crops Research on two main sites. But restructuring of the remainder of the Council's institutes is urgent, largely because most of the near-market MAFF research which will be lost is concentrated in them. AFRC has recently set up a Development Committee to advise it on the rationalisation programme and to ensure that receipts from the disposal of surplus assets are maximised and obtained as quickly as possible. The speed with which the cost of restructuring can be recouped will, however, be constrained by the need to avoid disrupting scientific programmes. We consider that £8m in 1990-91 is the maximum that is necessary to achieve AFRC's objectives for the restructuring of three institutes - the Institute of Food Research, Institute of Horticultural Research and Institute for Grassland and Animal Production - and our best estimates of the probable net costs in the two subsequent years are £8m in 1991-92 and £4m in 1992-93. Much of this should be recouped by major assets sales in 1994-96. The Board intends to review these estimates later this year, taking account of the Development Committee's work.

60. As we made clear in our advice last year, the Board strongly supports the MRC's Clinical Research Initiative. There is a great need for stronger and better managed programmes of clinical research, more effective integration of basic research work, and improved links with postgraduate training and postdoctoral career developments. The MRC is currently engaged on a thorough appraisal of options with a view to ensuring that the necessary improvement in provision for clinical research of the highest quality can be secured in the most cost-effective way. On the hypothesis that these studies produce a preferred option with costs broadly in line with previous forecasts, and allowing for a 20% contribution from private funds, we tentatively estimate that additional provision of £8m in 1990-92 and £10m in each of the following years will be needed to carry this important

initiative forward. These amounts are, however, gross of any savings which may accrue to the NHS through release of existing buildings. We hope to be in a position to offer firmer estimates and more detailed advice on these proposals in late summer.

61. The bringing together of the headquarters of four of the Research Councils on the Polaris House site will be achieved by 1991. The Councils have given close attention both to obtaining maximum value for money in the development of the site and also to introducing the joint working arrangements and efficiency savings which will be possible as a result. AFRC and ESRC, at present in temporary premises in Swindon, cannot meet the building costs in full from the allocations we had previously recommended for this purpose, even making allowance for savings in rent and salary costs; additional funding of £2m in 1990-91 is needed.

EARMARKED PROGRAMMES

62. The Board is aware that on two programmes - where Government decisions about funding take into account broader considerations than those of purely scientific priorities - NERC is in direct contact with Departments. We understand that discussions about the British Antarctic Survey have identified the need for additional resources: to cover the contracted cost of the RS James Clark Ross and its equipment; to meet new waste disposal requirements at existing bases; and to make a start on the satisfactory decommissioning of the 26 abandoned BAS bases. Discussions on the needs of the British Geological Survey are, we understand, less advanced: extra funding has provisionally been identified as necessary for the National Geosciences Information Service, to replace the present inadequate buildings of NGIS (Scotland), and to facilitate completion of the on-shore survey of the UK land-mass and a start on strategic hydrogeological surveys of major UK aquifers. Present estimates of the sums needed for both BAS and BGS are given in Annex A.

FLEXIBILITY MARGIN

63. Our assessment of the additional funds needed by the Research Councils and other funded bodies is based on their present planning allocations for the next three years. In total we estimate that additions of £110m in 1990-91, £164m in 1991-92 and £188m in 1992-93 will be necessary to avoid the loss of high quality science, to meet new scientific opportunities, to ensure an adequate provision of

manpower and equipment for the science base, and to make much-needed progress with restructuring of Councils' institutes.

64. As in previous years, the Board has retained a strategic reserve to provide for the highest priority new developments, to meet contingencies and, if appropriate, to make some changes in the balance of funding between Councils. This Flexibility Margin amounts to £15.7m for 1990-91, £33.6m for 1991-92 and £52.7m for 1992-93. Our proposals for extra funding are thus reduced, accordingly, to recommendations for net additions of:

1990-91	£94m
1991-92	£131m
1992-93	£135m.

A more detailed summary is given in Annex A - where, for the purposes for this submission, the Flexibility Margin monies have been netted off the various items pro-rata.

65. The Board will consider the allocation of the Flexibility Margin for 1990-93 at its July meeting, taking account of the latest information on needs and priorities.

FUTURE DEVELOPMENTS

66. We have made reference above to the report of the Morris Committee on Research Councils' responsibilities in the biological sciences, the Flemming Review of the IRC initiative, the further consideration to be given to the timing of and financial returns from AFRC's restructuring programme, and further detailed discussion of MRC's proposals for its clinical research initiative. We will advise further on these matters later in the year.

CONCLUSIONS

67. The substantial increase in the Science Budget in 1989-90 has helped to restore confidence within the scientific community and has enabled some important new initiatives to be started. But much of this momentum will be lost unless the value of the Science Budget is preserved in real terms. The reduction implicit in the present planning figures for 1990-93 means that not only will some of the

initiatives started in 1989 have to be reduced in scale and scope, but that Research Councils' plans for increasing support for higher education institutions - through more responsive research grants and training awards - will be severely curtailed, and the much needed reshaping of the science base will be delayed.

68. The past year has witnessed a burgeoning of new scientific opportunities, many as a consequence of increased awareness of environmental problems at both national and global level. The Board has no doubt that increased research resources will need to be made available if the UK is to play its proper part in understanding and tackling these problems. We are also now able to provide considered advice, as previously promised, about the additional resources necessary for the trained manpower and good quality equipment which are essential for the health of the science base. Much has been done to refocus scientific activity, to build closer links with industry and other users of research, and to improve the management of research to give greater efficiency, effectiveness and value for money. But without a major new programme of investment in the training and development of manpower and the replacement and updating of scientific equipment, the UK will be poorly placed to compete with other European countries whose investment in science is increasing at a much faster rate, and to play a full and effective role in international scientific effort.

69. Overall, the additional resources which we recommend for the Science Budget are equivalent in total to: the balance of the additions which we recommended in 1988; the sums needed to meet the higher forecasts of inflation for which we must now plan; and a small supplement for new scientific opportunities, particularly in the field of global environmental research.

THE SCIENCE BUDGET

The Government's Present Expenditure Plans

	1989-90	1990-91	1991-92	1992-93
Cash (£ million)	824	836	854	876
1989-90 prices (£ million)*	824	804	798	798
% change from 1989-90		-2.4	-3.2	-3.2

(* Government forecast of GDP deflator)

Increased Funding Recommended by the ABRC+

£ million

	1990-91	1991-92	1992-93
Avoiding loss of high quality science	17	37	53
New scientific opportunities			
- environmental	18	20	14
- interdisciplinary	6	13	9
- other	7	11	14
Manpower training and support	8	14	15
Selective re-equipment	23	22	20
Restructuring of Councils' Institutes	15	14	10
TOTAL	94	131	135

(+ items reduced pro-rata to allow for use of Flexibility Margin)

Additional Funding under consideration by Government

£ million

	1990-91	1991-92	1992-93
BAS	8	3	-
BGS	6	9	7

ABRC: TERMS OF REFERENCE AND MEMBERSHIP

THE ADVISORY BOARD FOR THE RESEARCH COUNCILS was established by the Secretary of State for Education and Science in 1972 with the following terms of reference:-

a. To advise the Secretary of State on his responsibilities for civil science with particular reference to the Research Council system, its articulation with the universities and departments, the support of postgraduate students and the proper balance between international and national scientific activity;

b. To advise the Secretary of State on the allocation of the Science Budget amongst the Research Councils and other bodies, taking into account funds paid to them by customer departments and the purposes to which such funds are devoted;

c. To promote close liaison between Councils and the users of their research.

MEMBERSHIP

Professor Sir David Phillips, KBE, FRS (Chairman)	-	Professor of Molecular Biophysics, University of Oxford.
Professor E Ash, CBE, FRS, FEng	-	Rector, Imperial College, University of London.
Professor R L Bell, CB	-	Director-General of ADAS, Ministry of Agriculture Fisheries and Food.
Professor Margaret Boden, FBA	-	Professor of Philosophy and Psychology, University of Sussex.
Dr R F Coleman	-	Chief Engineer and Scientist, Department of Trade and Industry.
Sir Roger Elliott, FRS	-	Secretary to the Delegates and Chief Executive, Oxford University Press.
Mr J Fairclough, FEng	-	Chief Scientific Adviser, Cabinet Office.
Dr D J Fisk	-	Chief Scientist, Department of the Environment.
Mr J S Flemming	-	Executive Director, Bank of England.

Professor J L Knill	-	Chairman, Natural Environment Research Council.
Professor June Lloyd, FRCP	-	Professor, Institute of Child Health, University of London.
Professor E W J Mitchell, CBE, FRS	-	Chairman, Science and Engineering Research Council.
Mr J R S Morris, CBE, FEng (Deputy Chairman)	-	Chairman, Brown and Root (UK) Ltd.
Professor H Newby	-	Chairman, Economic and Social Research Council.
Professor Sir Richard Norman, FRS	-	Scientific Adviser, Department of Energy.
Professor E R Oxburgh, FRS	-	Chief Scientific Adviser, Ministry of Defence.
Professor F W O'Grady, CBE	-	Chief Scientist, Department of Health.
Sir Charles Reece	-	formerly Research and Technology Director, ICI.
Dr D A Rees, FRS	-	Secretary, Medical Research Council.
Dr N J Shackleton, FRS	-	Director of Quaternary Research, University of Cambridge.
Sir David Smith, FRS	-	Principal and Vice-Chancellor, University of Edinburgh.
Professor W D P Stewart, DSc, FRSE, FRS	-	Secretary, Agricultural and Food Research Council.
Sir Peter Swinnerton-Dyer, KBE, FRS	-	Chief Executive, Universities Funding Council.
Sir Francis Tombs, FEng	-	Chairman, Rolls-Royce Ltd; Chairman, ACOST.
Mr J M M Vereker	-	DES Assessor.
Mr D A Wilkinson	-	DES Assessor.

SECRETARY

Mr P J Thorpe

ELIZABETH HOUSE
YORK ROAD
LONDON SE1 7PH
01-934 9000

Sir David Phillips KBE FRS
Advisory Board for the Research Councils
Elizabeth House
York Road
London
SE1 7PH

21 JUL 1989

Thank you for your letter of 12 May submitting the Board's Advice in respect of the 1989 Public Expenditure Survey.

I am most grateful to you and to the Board for the work which you have done. The Advice continues to provide an important contribution to thinking and discussion in Government on scientific priorities and the size of the Science Budget.

I am arranging for the Advice to be published on Thursday 27 July.