A NOTE ON
PROBLEMS OF SCIENTIFIC PERSONNEL

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INTRODUCTION

1. The terms of reference of the Scientific Personnel Committee are comprehensive :—

i) to consider the problem of demand and supply of scientific, technical, and engineering manpower, both in its quantitative and qualitative aspects, in relation to national development plans, in its long range perspective;

ii) to consider how best training and educational programmes existing and planned, could be integrated with (i) above;

iii) to consider generally conditions of employment of scientific and technical personnel;

iv) to consider and recommend on the terms and conditions of service of such personnel in Government and their placement in administrative and technical cadres; and

v) to consider and recommend the details of constitution of a Scientific Service under the Government of India.

2. It would be remembered that a similar Committee had been set up in 1947 to review the demand and supply of scientific and technical manpower which led to the initiation of the National Register of Scientific Personnel. In the absence of clear ideas on national planning it was not possible, at that time, to adopt any long-range programme regarding scientific and technical manpower.

3. It is comparatively easy to estimate the supply of scientific manpower. The demand however would depend on the rate of progress of the national economy in future. Extrapolation is possible only if it can be assumed that the future trend would be a continuation of past conditions. This assumption would have implied ten years ago, in the case of India, a stagnant economy or one with a very slow rate of progress; and would not have been valid in a planned economy. In India the aim of national planning must be to achieve a rapid rate of economic development; and the future demand for scientists must be related to the desired rate of progress in future.

4. The Second Five Year Plan gave special emphasis on the production of energy, metals and machinery. The size of Public Sector plan was roughly doubled, from about Rs. 2,200 crores during the First Plan to something like Rs. 4,600 crores in the Second Plan. Owing to the backward conditions of the machine building industry, it became necessary

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to make heavy imports of capital goods; and there was acute shortage of foreign exchange immediately after the initiation of the Second Plan. The total investment contemplated in the Second Plan amounted to only Rs. 6,200 crores inclusive of both the public and private sectors. There was, however, much adverse criticism of the Plan as being 'over-ambitious'; and considerable pressures developed in 1956 and 1957 in favour of a 'small' Third Five Year Plan of perhaps only Rs. 7,000 or 7,500 crores of net investment.

5. This was the position at the time of the fourth meeting of the present Committee in September 1957 when five members agreed to form study groups (in science, engineering, education, medicine, and agriculture). The uncertainty regarding the size of the Third Five Year Plan continued throughout 1958 and even in 1959. It is only recently that opinion within the Congress Party and in Government circles has strengthened in favour of total net investments of about Rs. 10,000 crores (of which about Rs. 6,000 crores together with a non-investment plan outlay of about Rs.1,100 crores would be in the public sector) in the Third Five Year Plan with the possibility of a further stepping up of investments in the Fourth Plan by 50 or 60 per cent.

6. The importance of perspective planning to supply broad estimates of targets of development over 15 or 20 years began to be appreciated with the initiation of the Second Five Year Plan. However, it is only very recently that tangible progress has been made at a technical level. The Perspective Planning Division of the Planning Commission, in collaboration with the Council of Scientific & Industrial Research and the Indian Statistical Institute, has prepared a number of studies on scientific and technical manpower which gave a good deal of information on the supply side. To prepare realistic estimates of personnel requirements it is necessary to know the total amount of investments (for example, whether it would be Rs. 10,000 crores or something else in the Third Plan with a possibility of its rising to, say Rs. 15,000 crores in the Fourth Plan) as well as the broad pattern of investments, that is, the respective shares of basic and light industries, power, transport, agriculture, education, health services etc. This part of the work will necessarily have to be done in step with the preparation of future plans.

7. Action has been already taken on some of the short-term problems of adjustments of pay-scales and allowances within the Council of Scientific & Industrial Research. The Central Pay Commission has also submitted its recommendations; and decisions for the near future would be made in the Central Government on the basis of these recommendations. It is quite proper to adopt short-range solutions to deal with pressing problems.

8. The planning of scientific manpower, is, however, basically a part of long-range planning; and involves deep seated structural problems of the organisation of science as a whole. Also, policy and programmes relating to scientific manpower will have to be made necessarily within the wider frame of decisions regarding economic and social policy and programmes for the future.

9. Some general observations on the place of science in national development would be pertinent. Economic progress consists of a steady increase in the amount of national product. This can be achieved only through the transformation, with the help of engineers and technologists, of raw materials into machinery, power, and other capital and consumer goods. Natural resources vary widely from one country to another, and are sometimes highly specific. It is only through technological research that such resources can be properly and fully exploited. It is, therefore, necessary continually to expand technological and applied research by utilising basic scientific knowledge for the solution

of practical problems. The success of such research can be assessed by the resulting technological improvement in the exploitation of resources to suit local needs and conditions.

10. The advancement of applied and technological research is determined by the available stock of scientific knowledge. The promotion of pure research (in addition to giving satisfaction arising from an increase of scientific knowledge by itself) would continually expand possibilities of applied and technological research, and hence of economic development. Assessment of such fundamental research must, of course, be made on the basis of world standards, and independently of any immediate aims of solving practical problems. It may, however, be noted that scientists of ability engaged in pure research, in any emergency, would be often able to take a wide view and make a fundamental approach to the solution of urgent applied problems. Organisation and promotion of scientific research in its most comprehensive sense is thus an essential requirement for rapid economic development.

11. The United Kingdom (UK) and a little later, the Western European countries and the United States of America (USA), became world powers through industrial developments based on the advancement of science and technology. Much more rapid developments have now occurred in the Union of Socialist Soviet Republics (USSR), also with the help of scientific and technological research. It is being increasingly realised that Soviet economic and industrial progress has been possible only because of a scientific revolution which has taken place in the course of a single generation of about thirty years. The possibility of a rapid transformation of a backward country into a modern industrial economy with the help of science and technology has been demonstrated beyond dispute.

12. In spite of the very high level of scientific and industrial developments in the advanced countries of Europe and America, increasing attention is being given in all these countries to the strengthening and deepening of the teaching of science and scientific research.* A proper appreciation of the need of scientific and technological research for national development is essential in formulating the scientific policy of India.

13. Objective methods for the assessment of scientific work are necessary for the sound organisation of science. This is a difficult task. Proper appraisal and appreciation of scientific work is possible only in a society in which there is an independent frame of scientific values and criticisms. This is the heart of the problem of scientific progress in India.

14. In UK, West Europe, and America, science and technology had developed independently of Government for centuries, and a great tradition of independent scientific criticism had been built up before the two wars. Scientific societies of a general type (like the Royal Society of London) or in particular subject fields (like the Physical or Chemical Society) had grown up over centuries in UK, Europe and America. Most of the funds for scientific research had come for a long time either from private benefactions, university endowments, or private industries.

15. Scientific research under Government auspices started on an appreciable scale in UK only during and after the first world war. Similar developments occurred still later in USA and other countries. It is only after the second world war that large funds are being made available by Government for scientific research. Because of the enduring tradition of scientific values and criticisms which had been built up earlier, the large inflow

* There has been much discussion in this connexion during the last two or three years, for example, in the Rede Lectures delivered by Sir Charles P. Snow at Cambridge in 1959.

of Government funds in recent years has not had, as yet, any serious adverse effect on the progress of science in UK, or in West European countries and America. Also, Government in these countries, are sensitive to the need of preserving a fabric of independent scientific criticism. In all these countries a most important feature is the high degree of decentralisation in the organisation of science and a multiplicity of sources of funds for scientific research.

16. The pattern of development of scientific research in USSR after the revolution has also been highly decentralised and has served as a model to other socialised countries. At the apex is the USSR Academy of Sciences (Akademi Nauk) which has about 120 institutes and field stations with a staff of over 50,000, out of which about 15,000 are professional scientific workers, and 4,000 have the status of professor. The Academy is not under the control of any Ministry but deals directly with Government and in financial matters with the Finance Ministry. There are twenty other academies either of a general type in the different Republics, or of an all-Union character in special subject fields like agriculture, medicine, buildings and architecture etc., which have a research staff of 15,000 professional workers. There are thirty-three universities and eight hundred educational institutions with research facilities in a large variety of subjects. In addition, there are over 1200 research institutions and establishments under the different Ministries and Republic Governments with research units in all important industrial enterprises. The total number of professional scientific workers was 240,000 in 1957 out of which 106,000 were in research institutes, 125,000 in higher educational establishments including universities, and 8,000 in enterprises. It would be seen that USSR has developed a far flung and highly decentralised system for scientific research. It is also worth mentioning that in USSR the accepted policy is to assign only the easier tasks to single teams. The more difficult the problem the greater is the duplication or replication of research groups working on it, the only limit being the involvement of all scientists who have competence to work on the problem.

17. The point to be emphasised is that UK, West European countries and America, on one hand, and USSR and other socialist countries, on the other hand, have in their own way developed a very wide and highly decentralised system of scientific research with multiplicity of sources of funds in the same subject field. This has given strength and flexibility to the structure of research in all the advanced countries and in all countries which are rapidly advancing in the world. Rapid progress in science has been and is being achieved by promoting a critical evaluation and appreciation of scientific work by scientists themselves working in independent institutions.

18. The value of science to society lies in its unorthodoxy and ability to challenge accepted concepts and theories. The scientist must have freedom to do his work in the way he thinks proper, and the right to express his views in scientific matters. It is characteristic of underdeveloped or pre-industrial societies that the system of administration is highly centralised as all authority tends to be derived from the top. Recent experience has shown that even when democratic forms are set up, these often remain somewhat on the surface; and the tendency continues to look to the top for guidance in making decisions; this prevents the growth of the capacity to shoulder responsibility. In this situation there is a tendency to the development of "established" views and of hierarchical levels of authority which inevitably discourage the spirit of independent criticism. Also, if there is only one, or a predominantly single source of research funds in any subject field there would be also an inescapable tendency to conform to established views. Decentralisation is, therefore, essential to preserve the dynamic character of scientific progress. This can be achieved by

guaranteeing the right of migration of scientific workers from one institution to another, the freedom of publication and expression of opinion in scientific matters, and a multiplicity of sources of research funds in the same subject field.

19. A multiplicity of sources of research funds is compatible with, and can be made most fruitful through an overall planning of the allocation of resources to different subject fields and different agencies. If an application for funds or facilities is rejected by one agency, a scientist would still have the opportunity of approaching another agency which, being independent, may take a different view of the matter. The planning and coordination of scientific work and research in any particular subject field, at each level of specialisation, would then become primarily the concern of the scientists themselves. The different agencies sanctioning research funds would have the responsibility of reviewing and assessing the progress achieved in each field from time to time.

20. In India scientific studies and research of the modern type started only very recently in comparison with Europe and America. Pioneering and significant work was done at first by a few individuals usually in some private (non-government) scientific societies such as the Asiatic Society of Bengal and of Bombay, the Indian Association for the Cultivation of Science in Calcutta, the Bombay Natural History Society, and a few other such institutions but their resources were meagre. About fifty years ago specialised scientific societies began to be formed; and quite a large number are now in existence; but excluding Government grants, they have very little income except membership subscriptions. The Indian Science Congress Association was started in 1914, and twenty years later the National Institute of Sciences and other science academies; these also have very little funds excluding Government grants. The Indian Institute of Science, the Bose Institute, the Indian Statistical Institute, the Indian Academy of Sciences, the Tata Institute of Fundamental Research and a few industrial research institutions, such as the Shri Ram Institute in Delhi, the ATIRA at Ahmedabad, etc., have some funds of their own but are being increasingly financed by Government. Also, excluding developmental work, very little research is being done in private industries.

21. The Survey of India, the Geological Survey, the Meteorological Service, the Botanical Survey, the Zoological Survey, the Anthropological Survey, etc., are all Government agencies. The Atomic Energy Commission is a department of the Central Government. The Indian Council of Medical Research, the Indian Council of Agricultural Research, and the Council of Scientific & Industrial Research are in form autonomous but function in practice under a good deal of Government control and under Government audit. The remaining scientific laboratories and institutions mostly belong to the Central Ministries, or in a few cases to State Governments. The Universities have very little funds of their own and depend mostly on Government grants. For historical reasons, rather than by intention, a situation has developed in India in which practically all funds for research flow from Government. Decentralisation of scientific research, therefore, has special significance in India, and has a deep connexion with the terms of reference of the present Committee.

2. Supply and demand

22. The first term of reference relates to the supply and demand of scientists. (As decided by the Committee, the word scientists would be used in a comprehensive sense and would include engineering, technological, medical, and agricultural personnel). It would be convenient to consider requirements under certain broad heads :

(a) operating scientists (such as production and maintenance engineers, general practitioners, scientists engaged in day to day work in agriculture, irrigation and power, meteorology, minerals prospecting etc.);
(b) science teachers (in universities and higher educational institutions, junior technical institutions, secondary schools, etc.);
(c) research scientists (for both developmental and fundamental research in pure and applied subjects);
(d) supporting and auxiliary junior technical staff; and
(e) personnel required for the diffusion of science as a part of general culture.

23. If Rs.10,000 crores is accepted as the dimensional size of net investments with a developmental outlay of Rs.1100 or 1200 crores in the public sector in the Third Five Year Plan (and, possibly, investments of about Rs.15,000 crores in the Fourth Plan), it would be possible to work out broad patterns of industrial and economic development over the next 10 or 15 years. The solution is not unique and there is an element of choice. The permissible limits of variation are, however, not very wide. For example, industrial and agricultural developments are closely interlocked for both technological and economic reasons. Any rapid increase of agricultural production is not possible without industrial development to provide additional supplies of fertilisers, pesticides, irrigation, agricultural machinery and implements, transport etc. Industrial development, on the other hand, would depend on the progress of agriculture to give additional supplies of food and of raw materials to meet the increasing demand. Expansion of employment, increase of income and improvement of the level of living are merely different aspects of industrial and agricultural progress.

24. There is some greater choice in social services. For example, theoretically, it is possible to have a great deal of advance in education without any progress in health services, or vice versa. But this also is only a hypothetical possibility. In practice, human nature would demand some kind of a balanced progress of both education and health. Once certain social aims are accepted (such as a continuing increase of income, getting rid of the fear of unemployment in 10 years, increasing equalisation of opportunities, etc.), and the size and pattern of investments are settled in a broad way, it would be possible to work out, at a technical level, aggregate targets of production and of targets of social services at the end of the Third and Fourth Plan periods.

Operating scientists

25. On the basis of such targets of production and of expansion of social services during the next 10 or 15 years it would be possible to make realistic estimates of the requirements of operating scientists. Such estimates need not be highly refined or extremely precise. There is some margin of transferability from one specialised field to another; and training programmes can be adjusted according to changing needs. Also, it is usually possible to increase the output of operating scientists by 40 or 50 per cent at comparatively short notice. This has been already the experience in India. The admission to degree level courses in engineering and technology have increased from 6600 per year in 1955-56 to 9800 in 1957-58, and are expected to rise to 13,000 in 1960-61.

Science teachers

26. Once the requirements of operating scientists are dimensionally known, it is possible to estimate how many teachers would be required to train the required number

of operating scientists. Also, if the provision for teachers and teaching facilities can be made in a "comfortable" way, then a margin would be left to increase the training capacity at short notice.

27. A very large number of teachers would be, however, required to extend the base of science teaching. Important policy decisions would, therefore, have to be made regarding the coverage and intensity of programmes of science teaching during the next 10 or 15 years. The spread and consolidation of science education is a difficult and complicated task. A superficial knowledge of some scientific facts is not enough. Science is an integral part of the culture of the present day, and enduring foundations can be built only by making the scientific outlook and way of thinking a part of general education. This, however, will take time. Also, with available resources (which are extremely meagre in competent personnel) it is not possible to cover adequately all stages of education in the immediate future.

28. The school stage cannot, however, be neglected. Without a broad base of science education in schools it will never be possible to build a sound superstructure at the top. To have an impact at the school stage, it is necessary to have competent science teachers in very large numbers. To produce such large numbers of science teachers, it would be logical to strengthen science education at higher levels in the first instance. This would, in time, provide an increasing supply of science teachers for schools.

29. What should be the proper phasing of the different levels of science teaching requires careful study. Once policy decisions have been reached, in a general way, regarding the scope and coverage of the teaching of science at different stages (schools, technical institutions, college, university, etc.) over the next 10 or 15 years, it would be possible to formulate the requirements of science teachers by broad subject groups at different levels.

Research scientists : applied research

30. It may be convenient to consider requirements of research scientists under two heads. One is "applied research" in which the main task would be to utilise existing knowledge for the solution of technical and technological problems. This is quite different from what has been called operating work in science and technology but is closely related to it. The number of scientists required for applied research is likely to be broadly proportional to the number of operating scientists. The use of an overall ratio (or specific ratios for particular subject fields) should supply fairly realistic estimates of future requirements.

31. Training in applied research can possibly be best organised through research units attached to technological institutions and big enterprises or groups of small and medium enterprises. It would not be difficult to prepare some rough estimates and programmes at a concrete level, once the pattern of industrial development (in its broad sense) is formulated.

Research scientists : fundamental research

32. The position is entirely different in fundamental research. The number of persons who have competence and aptitude for fundamental research in either pure or applied science is very small in every country. Neither demand nor requirements have any meaning. It is only the supply which matters.

33. The only wise policy is to give necessary facilities for work to as many scientists as are found fit to undertake fundamental research. The number would be very small in the near future. The cost per research worker would not be large in most subjects; and total funds required would be comparatively small and may not be prohibitive in relation to the size of the Third Five Year Plan. The really difficult tasks are to select suitable men, to create a congenial atmosphere for work, and to make a proper appraisal of performance. This question has been considered in somewhat greater detail in another section.

34. Experience of the more advanced countries of the world tend to show that about three or four auxiliary and supporting staff is required, on an average, for each professional scientist. The ratio varies widely in different subject fields. The use of an overall ratio, or of specific ratios in particular subjects, would enable realistic estimates being made of future requirements.

35. It is also necessary to have scientific and technical personnel for the diffusion of science as a part of general culture. Requirements would depend on the total effort at the popularisation of science. This is likely to be small for some time to come; and the required personnel would probably be available as a bye-product of the general expansion of science teaching. Separate estimates for this purpose may not be necessary at present.

Summary

36. To sum up, in the case of operating scientists, science teachers, personnel for applied research, and auxiliary technical staff, the task of estimating the demand would be fairly straightforward and can be taken up as soon as certain broad policy decisions have been reached regarding the size and shape of the Third Plan. This would also necessarily have to be a continuing task. The Committee may indicate what steps should be taken in this connexion. The case of research scientists is discussed later.

3. Educational and training programmes

Training in relation to service and employment

37. The educational and training programme in science must be suited to the needs of the pattern of scientific employment in the country. The educational policy and programme, therefore, in principle, can be formulated in the most effective way only after policy decisions have been made regarding recruitment, appraisal, and promotion of scientists. Some of the general problems may, however, be considered at this stage. Also, much can be learnt from the experience of the more advanced countries. Some information on recruitment, promotion, and structure of scientific employment in UK and Western European countries, USA, and USSR is given in Appendix (1).

Experience of advanced countries

38. In the United Kingdom (and to some extent in West Europe) the basic concept is a "service" which scientists would join at a comparatively young age and which would offer a career for life. There is great security, and "service rights" are carefully safeguarded. Promotion is vertical within the service, usually by seniority, and would be possible only when a vacancy occurs higher up. The greatest emphasis is placed on the initial qualifications, and recruitment is usually through competitive examinations at the time of entering the service. This is facilitated by the structure of education in UK and Europe where a

comparatively small number of persons have university education, and the higher services are recruited from among this small group. There is stringent selection in admissions to universities which helps in maintaining a high standard. This system is well suited to administrative work in which emphasis is usually laid on the conservation of the established order, and in which experience is generally transferable.

39. The Scientific Civil Service as well as the Administrative Civil Service in UK have a class structure which is closely related to the structure of education in the country. Promotion from one class to another is extremely difficult and rare. Owing to pressing requirements of scientific and technical manpower in increasing numbers, significant changes, however, are being made in the British service system to permit greater flexibility in recruitment and promotion of scientists.

40. The American and the Soviet systems are more flexible; and make it possible for young scientists of ability to work their way up from the bottom. In USA the emphasis is on the qualifications required for each particular post; and, although there is something like a service system, each post has to be filled, in principle, by the best available candidates either from within or outside the service. In USSR there is no concept of a service system in science and technology, and each post must be filled, in principle, by the most highly qualified candidate available. In consequence there is no great emphasis on initial qualifications or competitive examinations in these two countries; and there are incentives to acquire additional qualifications to improve one's prospects of securing more attractive posts.

41. In UK and Western Europe (and, to a smaller extent, in USA) opportunities for higher education used to be and still are somewhat associated with the income level of parents. In UK, there is still a good deal of class stratification in education. The tendency in all Western countries has been, however, to broaden opportunities for higher education through the liberal provision of scholarships.

42. In USSR education is free at all levels. Admissions are on the basis of the results of qualifying examinations. Also, the general rule is for students at the university level to receive a stipend which would pay for his expenses during the period of study. Some mistakes, no doubt, would occur in making assessments through examinations and other tests. Some differences in opportunities would also arise indirectly from disparities in income of parents. But by and large the Soviet system is believed to be attracting most of the qualified candidates into the educational system. A great deal of thought is being now given to this matter in the Western countries. It is possible that the American and the other Western countries would tend to adopt more and more the Soviet model by widening educational opportunities.

43. In the Soviet system great importance is attached to technical trainning at all levels. Day and evening courses in a very large number of subjects at different levels are organised not only by educational institutions but by government agencies and industrial enterprises. The social and cultural prestige of an institution, or an office, or an enterprise depends to some extent on the number and variety of training courses offered and on the number of students attending such courses. There are qualifying tests for admissions to such courses. Sometimes a candidate attending and passing an examination at the end of the course receives a special allowance which acts as an incentive. In all cases, the candidate would receive a certificate which would serve either as an obligatory or as an additional qualification for certain posts.

The position in India

44. The "service" system was established in India on the British model for historical reasons, but has continued in more or less the same form after independence. The experience of both USA and USSR and the general trend even in UK, would seem to indicate that the "service" system is too rigid for scientific posts. It is doubtful whether it would be wise to establish in India a "scientific service" on the model of the administrative services; and then modify it as is being done in UK. It may be desirable to develop a more flexible system for scientific personnel suited to the needs of a planned economy. This has been considered in greater detail in another section.

45. It is necessary at this stage to point out some of the educational consequences of the "service system" in India. Before independence the Indian Civil Service and other administrative services with high pay and great social prestige used to offer the most attractive career for youngmen of ability. Entry was almost always on the basis of competitive examinations. This placed a great premium on passing such examinations. This emphasis on examinations inescapably pervaded the whole educational system. The position has remained unchanged, or has perhaps worsened, since independence. Academic success is still interpreted as success in passing examinations.

46. The emphasis on examinations is particularly harmful in science. Examinations at any given moment would be largely an assessment of the amount of knowledge which the candidate has succeeded in acquiring; such success may in some cases even indicate a refusal to get interested in a particular branch of a subject. Also, it is the very nature of science to go beyond the limits of current knowledge. The capacity of help in this process and not merely to acquire knowledge is the true measure of scientific ability. A system of recruitment through competitive examinations is likely to lead to a wrong selection of candidates for a scientific career. In research the only reliable criterion is performance.

Need of a long range programme

47. The system of employment and the system of education and training are closely interlocked. It is difficult to change one without changing the other. In India a strongly or almost exclusively examination-oriented system of education has become established because of the dominance of the service system based on success in competitive examinations. If it is decided to develop a more flexible system of employment in science the educational system would also have to be changed to suit the new needs.

48. It is particularly important to give education and training in science and technology to a very large number of the people of India as quickly as possible. This would be the most effective way of strengthening the forces in favour of social and economic progress. This would call for an effective organisation of science teaching, at all levels, from schools to universities and technological institutions and post-graduate research. Unfortunately, it is not possible to undertake this task on a large scale because of the lack of competent teachers. The only way to turn out teachers in adequate numbers at all levels is to give the highest priority, in the first instance, to the strengthening of science teaching at the university level.

49. It is not possible, however, to build a broad superstructure without a sound and widespread system of science teaching in the schools. The Indian educational system

is weakest at this stage. It would be desirable, therefore, to start experiments in science teaching on proper lines at the school stage. Such experimentation would necessarily have to be on a small scale for lack of teachers of ability. The first task must be, therefore, to offer attractive terms and create a congenial atmosphere for work for science teachers in selected schools. The fullest advantage must be taken of local resources to develop the capacity of the students for observation, measurement, and experimentation. An imaginative approach may eliminate much unnecessary expenditure on appliances and paraphernalia. The Committee may consider making some recommendations in this regard.

Preferential treatment for science

50. Because of the urgent need of rapid advance in science and technology it is desirable to give preferential treatment to science. Special incentives are given to the natural sciences in USSR by awarding scholarships of higher value. Pay and prospects are also higher in natural sciences. The same policy may be adopted in India with great benefit to the country.

51. It is now being increasingly appreciated that the successful implementation of the big developmental plans would depend entirely on the availability of the required number of scientists and technologists at the right time. Greater attention is also being given to expanding the facilities for scientific and technological education. The greatest need at this stage is to ensure that quality is not sacrificed to numbers.

Maintenance of standards of teaching and examinations

52. The maintenance of desired standards in teaching and examinations is a difficult problem during a period of rapid expansion of training programmes. Facilities for higher education had grown more or less gradually in UK and the West European countries; and standards of education and examinations have been maintained in these countries through a generally high level of scientific and cultural traditions. In UK, Europe, and USA, a large number of scientific societies and professional institutes also play an important part in the maintenance of standards. Professional membership of such institutions provide recognised and country-wide standards of qualifications. In USA there is collaboration, for example, between professional institutes of engineering, for the evaluation of courses of instruction showing equivalence between different institutions. The American Medical Association also has some similar functions. These represent (non-government, but) definitely professional grading of higher educational and training courses.

53. In India, owing particularly to the speed of educational expansion, the problem of maintaining standards of teaching and examinations has become quite serious. In engineering and medicine the professional associations are looking after the question of standards to some extent. The scientific societies, however, are not generally active in this field. The whole question calls for urgent consideration.

Admissions on merit

54. The questions of admissions to technical and higher educational institutions is of fundamental importance. In principle, there cannot be any dispute that all admissions should be on merit. Also, no candidate should get any advantage because of a higher income level of his family. The desirable system then must be to admit candidates strictly

on merit; and, secondly, to make education free and give adequate stipends to the admitted candidates to cover their living expenses. This single step would go a long way in the equalisation of opportunities, and would strengthen the social and educational structure of the country. There is a strong case to introduce this system in scientific and technical subjects because of the urgent requirements of trained personnel for national development.

55. Methods of selection of students for admission to universities and higher scientific institutions require careful study. Here the question arises of setting up of standards of examinations on a country-wide basis. The use of objective tests (which may include performance exercises, and written and oral examinations) deserve consideration in this connexion. Such objective tests can be constructed and administered with greater validity and uniformity than the conventional type of examinations. With the help of such tests it should be therefore possible, in principle, to set up objective standards on a country-wide basis.

56. It would be useful if the present Committee can make, for example, a review of possibilities of introducing, in the course of the Third Five Year Plan, a system of admission on merit and provision of stipends to meet educational and living expenses in selected scientific and technical subjects. The questions for decision would be subject fields, level of instruction (post-graduate, degree level, junior techinical, school, etc.), institutions where tenable, number of scholarships, and broad principles of awarding the same. For example, it may be decided that a beginning should be made at the research and university level; and a certain number of scholarships of the value of say, Rs.1000 per year may be offered to all or a selected number of science students of outstanding ability, assessed on the basis of all-India standards, for the whole period of the study at the degree or the post-graduate level. In the same way, it may be possible to offer, say, scholarships of Rs. 500 per year to a limited number of school students of outstanding ability for two or three years for the study of science in selected secondary schools. Action on these lines would be in accordance with a basic policy which is unexceptionable and would also supply valuable experience for wider applications.

Standard text books of science

57. The question of providing standard text books of science for the whole country is important. Such text books are used extensively in USSR, and Soviet experience seems to have been entirely satisfactory. This need not necessarily lead to a stereotyped pattern of teaching. The text books would supply basic material; and every teacher would be free to supplement them by additional readings in any way he likes.

Evening and correspondence courses

58. Expansion of evening courses and double-shift work in laboratories would lead to large economies in laboratory buildings and equipment. The teaching in evening courses can be done either by whole-time teachers, or by teachers of day courses or by persons engaged in research or other work during the day. The experience of the advanced countries has been entirely satisfactory. In India also there are some evening courses. It is necessary to consider possibilities, at a concrete level, of better organisation and expansion of such facilities in India.

59. Organised courses through correspondence would have great advantages in a big country like India. Opportunities for education and training can be made available very widely at a comparatively low cost. It is of interest to note that more than a million persons receive instruction through correspondence courses at the junior technical and higher educational level in USSR. In USA also between one million and a million and a half undertake home study courses through correspondence. In scientific subjects, miniature laboratory sets are used in both USA and USSR. Also, short intensive courses of practical work are arranged in laboratories in educational institutions during vacations or in the evening. Students trained through correspondence courses, on passing prescribed examinations, receive regular degrees and diplomas in USSR. This is comparable to the system of "private students" appearing in university examinations in India. This has obvious advantages and the possibility of strengthening and extending this system deserves serious consideration.

Indian students abroad

60. There is a special problem of Indian students who go abroad for education and research. About five or six thousand Indians are believed to be studying or working in the field of science and technology outside the country. It is a serious loss that some of the most competent men are staying abroad, but they are earning their own living. A very large number of students depend on remittances from India which involve a continuing expenditure of foreign exchange.

61. There are two separate issues. One is the problem of persuading Indian scientists working abroad to come back to India; this has been considered in the next section. The other is sending students abroad for education and training. It must be recognised that there are many subjects in which adequate training facilities are not available in India. It would be necessary to send scientists and technologists abroad to acquire technical knowledge and wider experience. Some broad principles should be followed in this regard. The general rule, for example, may be to send students abroad for training in specified subjects or fields in which they would work on their return to India; this would ensure the proper utilisation of the knowledge and experience acquired abroad. In all cases it should be a condition that the trainees should have received education and training up to the highest level available in India. It would be more profitable, whenever possible, to send persons who have already got a good deal of experience in their own line of research or work within the country as this would enable them to identify what would be most useful in India. Studying for examinations and foreign degrees should be discouraged. A rapid expansion of research and training facilities in India must also, of course, proceed all the time.

62. I have mentioned a number of problems. There are many others. What is now necessary is to select some of the important problems of high priority for detailed and critical examination. As regard standards, for example, enquiries may be made in one or two selected subjects, in the first instance, at one or two selected levels. Some experiments may be started on developing objective tests. Ways and means of improving and maintaining more uniform all-India standards can also be examined at the same time. Or, in a technical subject, an enquiry can be made of the adequacy of available courses of instruction. Or, a beginning can be made in the preparation of standard text books in selected subjects, for example, different branches of mathematics which are of special importance

in the teaching of science. A first task should be the preparation of a programme of technical studies for the improvement of educational and training programmes in science and technology.

4. Terms and conditions of employment of scientists

Social appreciation of science

63. The scientific revolution which has taken place during the last twenty-five or thirty years has given the scientists an indispensable and leading role in the economic and social developments of the future. Terms and conditions of employment, therefore, require to be considered in the new context. The scientist cannot replace political and social leaders or administrators but he must take the initiative in the advancement of knowledge and in the utilisation of this knowledge for the advancement of social and human welfare. It has, therefore, become necessary to attract to science as many men of ability as possible and to give them adequate facilities for their work.

64. The only way to do this is to make the scientist feel that he has the appreciation of society. It is necessary that a scientist should be given as attractive terms as men of comparable ability in administration and other occupations. But this is not enough. He must also have adequate facilities and a congenial atmosphere for work; encouragement for initiative in his professional activities; evaluation of his work by fellow scientists; freedom of expression of scientific views; opportunities of exchange of experience and scientific discussions with colleagues at a national and international level; and also, when of senior status, facilities to offer opportunities and encouragement to junior colleagues and pupils.

The need of a flexible system

65. The first basic question is whether the "service" system which was established in India during the British period, and is continuing in the same form since independence, is really suited to scientists. The service system was originally developed for government administrators. The higher administrative posts are organised forms of all-India services such as the Indian Administrative Service, the Indian Foreign Service, the Indian Police Service, Central Services (Audit and Accounts, Revenue, Posts and Telegraphs) etc., and also different State services, all broadly on the British model. On the scientific side, there are organised services in the Geological Survey, the Meteorological Services, the Defence Science Service, etc.; and also for engineering works. Otherwise, recruitment is to individual scientific posts. The services generally have a structure of the British type with a clear separation of Class I, Class II and Class III officers. Postings and promotions take place within each service. There is no possibility of movement to a post outside a service or from one post to another except through the usual procedure of recruitment.

66. Recruitment is through either the Union or State Public Service Commissions. The age for recruitment for most of the higher services varies between 22 and 25. Usually several candidates are selected every year for each service on the results of competitive examinations. There is a safety in this method of group selection for the services. In spite of appreciable variations in ability, individuals of the required ability are likely to become available from among each batch of entrants, in time, to full senior posts of responsibility. Also, as a good deal of the administrative work is broadly of a similar nature in each service, and there are well established norms and precedents, the general efficiency of the service would be maintained if the quality of the fresh recruits every year can be maintained at an average level.

67. The method of group selection by competitive examinations for a life career does not seem to be at all appropriate for research scientists. Ability to do well in a competitive examination is not a safe criterion of success in research. Each scientist has to make his own contribution. This is true even in team work in science, just as in a football or cricket team. The selection of young scientists for research requires an individual approach. It is desirable to offer facilities in the form of research fellowships to promising young graduates on the basis of their academic and other records. But this is only a first step. The appraisal of the quality of the work done during a probationary period must be done on an individual basis. The pay and prospects and facilities to be offered for further work must also be settled separately for each individual. Only scientists with knowledge and experience of the different subject fields can undertake this responsibility.

68. The inherent tendency in any system of administration must be to preserve the established order and to take action in conformity with past precedents. Promotion on grounds of seniority and conformity to established norms is inescapable and even desirable. Scientists, on the other hand, must be temperamentally unorthodox, and would be necessarily vulnerable because of their tendency to deviate from established norms. Secondly, in administrative (or defence) services there may be need of a structure of successive levels of powers and responsibilities. In the case of scientists, there must be, in principle, complete equality of status in discussions in scientific matters because decisions cannot be made on the basis of authority but must have the sanction of reason. Also, evaluation by scientists themselves would be the only suitable method for the selection and promotion of scientific workers.

69. The American and Soviet systems of scientific employment are more flexible, offer greater equality of opportunities and are more suited to the needs of scientists than the service system. The trend in many countries would seem to be towards the more flexible system in USA and USSR.

A universal system for India

70. For the most fruitful utilisation of scientific talent in India it would seem desirable to build up a universal system which would cover, in time, all scientific personnel in the Central Government, the State Governments, and non-government (but public) institutions like universities and scientific institutes. Selection, appraisal of performance and promotion would have to be by competent scientists. There should have to be parity with persons of comparable ability in the administrative services in respect of salary, leave, retirement rights, medical care, housing and other benefits. The pay structure and prospects should be uniform for the whole country with however special allowances, when necessary, to compensate for regional differences in the cost of living. There should be guaranteed rights of freedom of expression of scientific views and of freedom of movement from one post to another, with transferability of leave, retirement rights and other benefits so that the requirements of particular posts can be satisfied by the most suitable candidates available. Also, there should be no discrimination on grounds of political views.

A phased programme

71. It may, however, be argued that even if this be the ideal, it is not possible immediately to have one single, comprehensive scheme for the whole of India. It would be proper then to have a phased programme and to adopt short-term measures which would facilitate the transition to the desired system. It would be useful to consider to what

extent unified schemes can be developed, step by step, for the Central Government, quasi-Government agencies, State Governments, local authorities and non-Government (but public) agencies like universities and scientific institutions. A start may be made with the Council of Scientific & Industrial Research (CSIR) and the Ministries and agencies in the Central Government.

72. It may be desirable, for example, to create for scientific workers a number of grades or categories, perhaps four or five in number, each with a short time scale, and provide for promotion from one grade to another on merit as assessed by panels or commissions of scientists. Also, it would be desirable to permit entry from outside the system in each grade.

Pay and prospects

73. A fundamental issue of special significance in an underdeveloped country like India with a highly developed system of administrative services is the question of parity of the terms and conditions of service for scientists and administrators. Remuneration and prospects in the administrative services are much higher and are generally considered much more attractive than those in scientific services or posts. Pay and prospects of scientists and teachers in universities and non-government agencies are, again, even lower than those enjoyed by scientists working in Government agencies. Disparities of pay and prospects between scientific workers in non-Government agencies and officials in the administrative services are thus extremely high. For persons of comparable qualifications, the pay of officers in the higher services may be three or four times higher than that received by scientific workers in universities and non-government institutions. These disparities must be reduced or eliminated.

74. Some information on scales of pay in the advanced countries is given in Appendix (2). It would be seen from this Appendix that in the Western countries scientists and administrators have basically similar pay. In USSR and socialist countries scientists get much higher pay than administrators.

75. Another important question is whether the terms and conditions of service should be the same or similar for (a) operating scientists, (b) science teachers, and (c) research scientists. In principle, there is a good case in favour of uniformity of terms and conditions. This would promote free mobility from one group to another, depending on individual aptitudes and abilities, and thus ensure most effective utilisation of available resources. Special incentives and promotions should be provided for persons of outstanding ability on the basis of their performance in each sector (operating, teaching, and research). Research would attract a large number of persons of outstanding ability. In practice, a larger proportion of research scientists are likely to be found deserving of special rewards and promotions. This should be, of course, encouraged; and generous provision should be made for rewards for success in research. This would not be discriminating as the rewards would be awarded not on the basis of the occupation but on individual merit.

Leave, retirement rights, and other benefits

76. Besides pay-scales, there are benefits and amenities such as leave, provident fund, retirement rights, medical care, housing etc. Making these benefits uniform would be equitable and would facilitate mobility. Each scientist would then have his own leave

and retirement rights and also be entitled to other amenities on the same standards. On transfer from one post or agency to another the scientists would carry his leave and retirement rights and other benefits with him which would be a simple and automatic procedure.

77. If complete uniformity cannot be achieved immediately it should still be possible to arrange transfer of benefits from one agency to another. A scientist having earned leave or provident fund or retirement benefits etc., on transfer from one agency, would carry his credit which would be accepted by the agency he joins. This could be easily arranged by introducing a system of clearance of credit and debit between different agencies, possibly through a central clearing house as in the case of banks. Individual investment of provident fund contributions in the form of life insurance would automatically facilitate the transfer of such benefits. The existing differences would have to be, however, accepted in the case of current benefits like housing and medical care until a more universal system is established.

78. The age of retirement is usually 60 or 65 in all the advanced countries Research scientists in West European countries, after retirement from their official posts, may continue their scientific work as long as they are active. In some countries, they continue to draw the same or almost the same salary. In USSR they get the old age pension at 60 but also get their salary as long as they are fit to continue their work. In India it seems desirable to introduce a similar system, at least, in the case of research scientists. The appointment of National Professors and the scheme for retired scientists have been first steps. Such facilities require to be provided on a wider scale and at more than one level.

Trade unions of scientific workers

79. In all the advanced countries there are well organised trade unions; or there are excellent channels of communication between Government and legislators on one hand, and scientists on the other, through Congressional and Parliamentary Committees as in USA and UK. This is a sign of maturity of the fabric of science. Some information on trade unions of scientific workers in the advanced countries is given in Appendix (3).

80. In India the position in this respect is weak. The Indian Medical Association is well organised but it is probably much less influential than its counterparts BMA and AMA in UK and USA respectively. Some of the professional engineering societies are occasionally taking up questions of economic interests to their members but have very little activities of a trade union type. As regards scientific workers, the Association of Scientific Workers of India was established in 1947 but its membership is small and it has at present little influence on government policy.

81. The special situation in India requires to be taken into consideration in the present connexion. Opportunities for employment in scientific posts are comparatively small and research posts are very rare in the private sector. Teaching posts are poorly paid. Government is by far the largest employer of scientific workers. Since independence most of the research posts have been created in Government or quasi-Government agencies like the ICMR, ICAR, CSIR, AEC etc. In this way a kind of monopolistic situation has arisen which makes it absolutely necessary for Government to devise ways and means to offer opportunities for expression of opinion about service conditions or specific or general grievances.

82. Taking a long view, it would seem desirable to promote the growth of a trade union movement among scientific workers on the British and European model. In India it may be desirable to make a double approach, somewhat on the Scandinavian model, by strengthening the Association of Scientific Workers on one hand, and by persuading the scientific and professional societies to take interest in social and economic concerns of their members. The promotion of educational, training and cultural facilities, on the Soviet model, would also be useful.

83. It would seem desirable for Government to take a view regarding the Association of Scientific Workers of India (ASWI) and give it official recognition. Early action should also be taken to set up machinery for joint discussions between what are usually known as the "staff side" (representing the employees) and the "official side", on the lines of the Whitley Councils. On the financial side, it would be advisable for Government, in the initial stage, to sanction adequate funds (which would not be large) to enable the ASWI to maintain a small but efficient secretariat, a really useful journal, and organise a few meetings and conferences at different places.

Scientists working in the private sector

84. The existence of a large private sector competing in some ways with an enlarging public sector in an underdeveloped country like India gives rise to some special problems. It is known that private industry sometimes offers very high pay to individual scientists and technologists. The average salary of scientists in private industries is lower scientists and technologists. The average salary of scientists in private industries is lower than that in Government agencies. The real competition between the private and the public sectors occurs only at the very top in regard to individuals of outstanding ability. Men of ability are very few in number in an underdeveloped country. The loss of such men, even if few in number, can be a serious handicap to the public sector. Also, it is not always a question of pay. Scientists of ability are sensitive regarding their status in relation to other Government officers. They require a congenial atmosphere for their work. The real remedy would be to improve conditions of work in the public sector so that it would be possible to attract and retain scientists and technologists of ability.

Scientists working abroad

85. A considerable number of competent Indian scientists are working abroad. Some of them may prefer to stay abroad for personsl reasons. But many are eager to come back to India. Some came back, but have again gone away because they could not adjust themselves to Indian conditions. In many cases there is something lacking on their part. But this is not the whole truth. There is something also lacking in conditions of work in India which young scientists who have never been abroad also find discouraging. This is a deep-seated malady which requires careful diagnosis and courageous remedial measures.

Lack of the spirit of criticism

86. Expenditure on scientific research has increased in India, perhaps by ten times since independence. A large number of laboratories and institutes have been established; and the number of scientific workers has increased very considerably. And yet the output of research of high quality does not seem to have been commensurate with the physical volume of expansion of facilities. There are complaints of lack of enthusiasm and frustration among young workers. It is generally agreed that, before independence, resources

were meagre and the number of workers was also much smaller but there was great enthusiasm for research; the quality of work was also reasonably high.

87. Professor J. B. S. Haldane has pointed out that Indian scientists are too polite to criticise one another's work; he thinks that is the great weakness of Indian science. Science thrives on criticism. And, conversely, in the absence of criticism, progress of science must be retarded. Although a large number of distinguished scientists from all over the world visit India every year, they stay for a short time; and, having come as guests, are probably too polite to give expression to their views bluntly. It is possible that Indian scientific opinion has become somewhat isolated; and the spirit of criticism has not been cultivated in a sufficient measure. It is necessary to examine the reasons for this failure.

"Officialisation" of Science

88. I venture to suggest that the basic factor has been progressive "officialisation" of science since independence. The high pay and great prestige and power of the administrative services dominate the thinking of both administrators and scientists. The ambition of a young man is to become a high official. Also, success or failure is decided by a single event, namely, the results of a competitive examination with which an element of luck is always associated.

89. A linear order of ranking and of levels of authority is indispensable in administration. The opinion or decision of a superior officer must prevail. This is in complete contrast to decision making in science in which the ideal must be complete equality of status of all scientific workers, as all decisions must be based on reason and not on authority.

90. Before independence, total resources were very small but an appreciable part of the funds for scientific work came from private and non Government sources. Since independence a great deal more money is available for science but it is coming in an increasing measure from Government sources. Officials are thus having an increasing influence on the sanctioning of funds for scientific work. It is inevitable that, in the present set up of Indian administration, official "control" should also increase. This is not the fault of individual officials. The present system is a legacy of the British period when the prevailing idea was that Government must function as trustees of the whole country. In the British period, grants for science were, however, few in number; and usually once the grant was sanctioned, there was no further question of control. Due to the great increase of the volume of work in connexion with scientific activities since independence, decisions in scientific matters tend to be made, in effect, at lower levels although, in form, the sanction is given higher up. The desire for control and interference in details, usually in the form of seeking information or clarification, has been continually increasing.

91. It is worth noting in this connexion that the present practice of giving sanctions at a high level of authority is leading to a continual dilution of real responsibility. It is not possible for any authority at a high level (whether an individual officer, or a Minister, or a Committee or a Governing Body) to examine each case on its merits; the inevitable tendency must be to accept most of the recommendations which come up from lower levels. The practice of securing formal sanctions at a high level leads to the possibility of recommendations at lower levels being influenced by personal considerations because, once the high level sanction is given, recommendations originating at lower levels cannot be questioned. Unfortunately, this has given rise to a widespread feeling among scientists that "cultivating the officials" is likely to be of advantage. Gradually confidence is shaken

that decisions in scientific affairs rest on reason, and the belief becomes more and more general that such decisions can be and are being influenced by personal considerations.

92. It should be again stressed that it is the system which requires to be changed. Placing scientists in administrative posts is no solution. It may lead to some short term advantages in expediting the flow of funds or some good decisions. It would, however, retard progress in the long run, because scientists also are human beings and would yield and conform to the prevailing practices. The existing administrative pattern, with its vertical ranking of levels of authority and little delegation of powers, is tending to become dominant even in scientific laboratories, universities and research institutions. Scientists are burdened with administrative responsibilities and have to deal with an increasing flow of recommendations for sanction from lower levels. Administrative rank rather than scientific activity becomes more and more important. It is widely believed that many young workers of ability are feeling frustrated by the discouraging influence of their official superiors who hold their position because of their administrative seniority rather than scientific competence. In this situation there is widespread belief in the advantages of "cultivating" the superior officers, and also that those proficient in this art are likely to get promotions and secure special facilities. This leads to the growth of cliques and power groups at different levels. A large number, usually the majority of the scientific workers, develop a feeling of cynicism and of indifference to work. Another group reacts in an opposite way and becomes troublesome. It is only a very few rare individuals of great strength of character who can pursue their scientific work with devotion and undivided attention.

93. There is also a tendency on the part of the government agencies to extend their directing and controlling functions. This is inevitably leading to a loss of sense of responsibility on the part of scientists, which, in its turn, is leading to government agencies taking over still more and more functions which should have been left to the scientists themselves. I may give some recent cases from the National Institute of Sciences of India as illustrations. There is a system of applications for funds from scientific societies being submitted to Government through the National Institute. In recent years it was found that favourable recommendations of the NISI were not accepted in some cases while in other cases applications not recommended by the NISI were successful in securing grants from Government. The result was that the NISI felt it had no real responsibility and, therefore, started forwarding practically every application like a post office. There is nothing improper in Government making independent decisions. A satisfactory procedure would be to place a part of the available funds in the hands of the NISI and make it responsible for the distribution. Government can also directly sanction grants out of the balance to be reserved for this purpose.

94. An instance of the increasing desire for secretariat control may also be mentioned. Government had sanctioned some time ago a grant to the NISI for the construction of buildings. After very careful consideration, the NISI approved the plan of the buildings, submitted a copy to Government, and entered into a contract with a firm of engineers for construction. At this stage, one room originally reserved for guests was changed into a reading room. After construction work had made considerable progress, payment of the Government grant was held up pending explanation why an additional reading room was being provided. The matter was quickly settled on reference to higher authority, but it is significant that a request for explanation did come and also that this had to be settled by an appeal to a higher authority. The practice of personal approach to different levels

of authority or power is tending to become general both inside and outside Government. There is widespread belief among young scientists that a personal approach to senior scientists is essential to get elected as a fellow of the NISI.

95. The real task is to promote the growth of a sense of integrity and responsibility among the scientists. Taking over more and more control by Government agencies would not be a solution. It is necessary to eliminate from scientific affairs the form and spirit of the present administrative system with its successive levels of authority. The only way to do this is to hand over specified responsibilities to scientists and hold them accountable for the discharge of such responsibilities. The scientists must be given the initiative in scientific affairs. The concept of supervision, control, and sanction by administrative agencies must be replaced by the concept of holding the scientists accountable for their own decisions and performances. An experimental approach is essential. Assessment would have to be made, not on conditions precedent, but on achievements realised in practice.

96. This is the basic remedy. Once this principle is accepted, grants would be given to scientific laboratories, institutions and societies for specified purposes but otherwise unconditionally so as to fix the entire responsibility directly on the organisations themselves. Each laboratory or institution or society would be judged, not on the routine fulfilment of conditions attached to a grant, but on the successful achievement (or otherwise) of the objects for which the grant was sanctioned. This would immediately throw the entire responsibility on the scientific institutions to make the best use of the available resources. To attract and hold scientific workers of ability would immediately become important factor for success in scientific work. Nothing short of this will be of any real avail.

Private donations for science

97. There is one way of giving the initiative to scientific institutions to raise donations from private sources which is worth mentioning at this stage. In USA and UK there are provisions for exemption of income-tax for donations to recognised scientific and educational institutions. In India such exemption is granted to the extent of only five per cent of the income. There is a strong case in favour of increasing the exemption limit or not having any limit at all. In India great social virtue has been always attached to donations for public benefit. Exemption from income-tax, if given in a large way, is likely to stimulate substantial benefactions for scientific research, health, education, and social services. Abuse can be prevented by allowing such exemption only in the case of scheduled institutions (such as universities, national laboratories, recognised scientific and educational institutions, public hospitals etc.). Also, a limit can be placed on the earmarking of donations for specified institutions preferably in the form of a slab system. This would make a part of the donations available for distribution to other institutions to promote a balanced development.

98. This approach may be used as an indirect way of getting round tax evasion which is believed to be widespread in India. The income from donations would be to some extent counterparts of taxes. In case the donations exceed the amount of tax exemptions, there would be a net increase of available resources for constructive purposes. The greatest beneficial effect would be in strengthening the initiative of the institutions themselves to raise such donations, and in giving them the freedom to decide the best way of utilising the donations in consultation with the donors.

A pool of research scientists

99. To restore initiative to the scientists themselves and make them accountable for their endeavours and achievements is the only way out of the present difficulties. Because of its strategic importance it would be desirable to make a beginning with the organisation of research. The quality of fundamental research must be assessed on world standards, and of applied research on its value in solving practical problems. Research institutions would be then eager to attract scientific workers of ability, give them a congenial atmosphere of work, and promote them on merit. Attention would be focused on the identification of scientific talent and its most effective utilisation.

100. Research is still a comparatively small sector in India. The total number of scientists engaged in research was about 2,500 in 1955, according to the National Register; and the total number at present may be about 3,000. The expenditure on research (excluding the Atomic Energy Commission and developmental research) is also comparatively small. To initiate some action in this sector would not be very expensive.

101. Consideration may be given, for example, to the creation of a pool of research scientists covering both Government and non-Government agencies (universities, scientific institutes etc.) during the period of the Third Five Year Plan. All scientists engaged in research need not be absorbed in the pool. Admissions should be restricted to persons of proved ability.

102. It is essential that the scheme should be started on an adequate scale. Progress is sometimes impossible without a concentrated attack. In India, although the steel industry was established in 1908, production did not rise above one million tons for nearly half a century. At the end of the Second Five Year Plan or within a year or two, the production would increase to nearly 6 million tons per year; and it is only in this way that the industrial transformation would start. In the same way, an effective transformation of scientific research in India may become possible only through a rapid expansion within a very short time to create a new atmosphere. This would call for adequate funds. But the amount involved would be comparatively small and should not be considered excessive in the context of a Government outlay of perhaps Rs.7,000 crores during the period of the Third Five Year Plan.

103. It should be possible to make experiments on terms and conditions of service in connexion with this pool of research scientists. For example, this pool may be arranged into a number of grades; and selection and promotion to each grade may be done by panels or committees or commissions of scientists on the basis of an objective evaluation of the work done. Experiments can also be made in giving different rates of increment (regular, above average, or exceptional as in Netherlands) on the quality of research. The members of the pool may be guaranteed complete freedom of movement from one post to another *within the same grade;* and allowed to carry their leave, retirement rights and other benefits with them. They may be permitted or encouraged to undertake part-time teaching or consultation work. The right of publication and freedom of expression of views in scientific matters may be guaranteed subject only to the requirement of keeping secret data which may have to be treated in this way; in practice this restriction should come into operation only on very rare occasions.

Grants to institutions and societies

104. It may be desirable to adopt a new approach to sanctioning grants to scientific institutions and societies on an experimental basis. The objects of the grant would be

clearly specified, otherwise no conditions would be attached so that the institutions concerned have complete freedom in making the best use of the funds at their own discretion. Government must, however, assume the responsibility of assessing the success or otherwise of the realised achievements.

Task forces for scientific research

105. In spite of the high degree of decentralisation of scientific research in USSR, it is interesting to note that some of the leading Soviet scientists are showing great sensitivity to regidities which may be developing in some of their institutes and agencies. Academician Kapitza has recently advocated the organisation of research, *not* in permanent institutes or agencies, but through *ad hoc* temporary "task-forces" of scientists which would be formed to solve assigned problems and would be given necessary facilities for their work. These task-forces would remain in existence only for the period required to complete their assigned task, but would never form a permanent organisation and would be dissolved as soon as they have fulfilled their task either by solving the problem or by reaching the conclusion that further work on the same lines would not be worth while. When any task-force is dissolved, the scientists would be free to join other task-forces. Kapitza thinks that the only way to prevent the loss of dynamism in research is to have a system of perpetual task-forces for temporary periods. There would be adequate provision of buildings and scientific equipment which, however, would not belong to any permanent institute or agency and would be placed at the disposal of different task-forces according to needs. It may be desirable to set up one or two such task-forces in India, on an experimental basis, for the study of assigned problems especially in relation to planning, and thus explore possibilities of this form of research for national development.

Conclusion

106. Some of the issues raised in this note cannot be decided by scientists themselves. They may, however, perform a valuable task by making a scientific analysis of the problems and by recommending to Government suitable lines of action. What can be achieved in the near future would depend on how much importance is attached to the advancement of science by persons who make decisions. Progress would also depend on whether the principle of decentralisation is accepted and also to what extent it can be realised in practice. The task is not to try to "control" scientific work through Government machinery which must fail, but to promote seriousness of purpose among scientists so that they can shoulder greater responsibilities. It is only in this way that science can progress in India.

107. It is the long-term problems on which the views of a committee of the present type are likely to be of value. The reorganisation of science and technology to serve the needs of national development is likely to call for structural and institutional changes which can be brought about only through a fuller appreciations of the basic issues by both scientists and administrators. This is not primarily a matter of quick implementation of a number of administrative decisions. It would be necessary, no doubt, to make policy decisions of a far-reaching character. But this would have to be preceded by an educative process of serious thinking on basic problems.

APPENDIX (1): RECRUITMENT, PROMOTION, AND STRUCTURE OF EMPLOYMENT OF SCIENTIFIC WORKERS IN UK, USA AND USSR

Great Britain

1. The general outlook or philosophy underlying the structure of scientific employment is characteristically different in UK and the Western European countries, USA, and USSR. In UK (and also in many Western European countries) the basic concept is of a "service" or a "cadre" consisting of a group of individuals who have entered the service for life careers. The "service" system offers great security of tenure and prospects of promotion usually on the basis of seniority. Time scales of pay are also characteristic features of the service system in UK and in most of the Western European countries. Every service officer has certain rights regarding his pay, and other benefits and higher posts. Promotions are normally from within each service and, at higher levels, depend on vacancies. Transfers from one service to another are rare, and very few resign or are discharged from the service.

2. The "service" concept logically leads to recruitment at comparatively young ages through a Civil Service Commission. In UK, in principle, this Commission is completely centralised. The Civil Service Commission also acts as a referee in various questions relating to the services. Posts are publicly advertised and candidates either sit for special examinations or are selected usually after interviews by selection boards or committees.

3. In UK there have been some significant developments in the case of scientific posts. The need of making special arrangements for scientific posts began to be appreciated during the war; and a new organisation, the Scientific Civil Service, was established in 1945 which led to an improvement of the status and prospects of scientists working in Government agencies. A scientific committee was set up with the responsibility of making a continuing review of the efficiency of the Scientific Civil Service. (This service consists only of scientists and engineers engaged in research, development and design activities. Operating scientists including engineers engaged in production, maintenance etc., structural and other work serve in other branches of the civil service). There is a scientist member of the Civil Service Commission who has special responsibility for scientific appointments; and a scientific section of the commission works exclusively on recruitment to such posts.

4. The scientific officer class is recruited mainly from first and second class honours graduates from the universities; the experimental officer class mostly from junior technical institutions with about 20 or 25 per cent of graduates from the universities. The scientific assistant class correspond to laboratory mechanics and technicians in the universities and are recruited from among persons with high school education who have had some training in scientific or technical work. Candidates for permanent appointment are selected on the basis of academic records and experience and usually after a personal interview by a selection board with scientists as members.

5. The scientific officer class has six grades; and promotion in the three upper grades depends not only on the ability of the individual but also on the existence of specific vacancies. Promotion usually implies larger supervisory duties. Some special provisions have been made for merit promotion in the British Civil Service; and additional posts can

be created in the higher grades to provide from the promotion of individual research scientists of outstanding ability without necessarily expecting them to carry additional administrative responsibilities. Merit promotions are made on the recommendation of an inter-departmental scientific panel which works through sub-committees of which all the members are scientists of established reputation.

6. The stratification into three classes is quite rigid and reflects the social structure and stratification of the educational system. Promotion from one class to another is extremely rare. The maximum age of entry is 31 years for the grade of senior scientific officer (with certain exemptions for officers from Defence Service). In UK, in addition to the Scientific Civil Service, there are also some Defence Science Services.

7. In UK salary scales for top Government posts in science are, however, still lower compared to top posts in the administrative class. There is a good deal of feeling within the Scientific Civil Service against the lower status of scientists compared to the administrative class in the Civil Service. In UK the Atomic Energy Authority, however, has a large scientific organisation which has been separated from the Civil Service in order to secure greater flexibility and greater opportunities for promotion for outstanding scientists. There is also provision for offering higher pay in special cases.

8. The most significant change in the British system has been the recognition of the principle that the accomplishments of scientists can be properly evaluated only by their peers. Panels of scientists are therefore used for recruitment and also for normal and special promotion.

9. In the British Scientific Civil Service opportunities are being provided for advanced training at Government expense at universities and non-government laboratories by the award of fellowships; and there is a system of sabbatical leave on full pay. Attendance at professional meetings is encouraged. There is occasional inter-change of scientists with other parts of the British Commonwealth.

10. In UK the universities and non-Government agencies have separate structures of recruitments, promotion, pay and prospect etc. The system is broadly similar in the different universities; and there is some movement of scientists from one university to another. Leave and retirement benefits are usually transferable without difficulty (and medical care is practically free as in USSR). Scientists working in government agencies or in industrial concerns get somewhat higher pay. Scientific traditions, however, are very strong in the British universities; and many scientists of ability prefer to work in the universities because of the academic freedom and other social and cultural amenities.

11. In the Western European countries the normal system is that of career services to which recruitments are made at a comparatively young age. The class structure is absent or is much less rigid compared to UK. Recruitment is more decentralised and in some countries there are arrangements for contract posts. The status of scientists is generally high and the social prestige of university professors (who are usually members of the Civil Service) is in most Western European countries as high as members of the higher Civil Service. In Switzerland the pay and status of scientists in universities and higher educational institutions is higher than the pay and status of administrative officers of comparable ability and qualifications serving under Government.

USA

12. In USA the system is entirely different and there is nothing which is really comparable to the service system in UK and other Western European countries. In USA

the emphasis is on the "post", and in principle it is possible to select for any post the best available candidate from within or outside Government agencies. In UK if any post falls vacant in a Government agency, normally it must be filled by promotion from within the service itself. In the Western European countries also the position is broadly the same but there is greater freedom of movement because the service system is more universal and covers the universities and scientific institutions.

13. In UK recruitment to Government service is completely centralised. In USA, although there is a Federal Civil Service Commission, recruitment is decentralised to a very large extent. In UK the appointment authority is in fact the Civil Service Commission but in USA the authority for making appointments is vested in the department or agency concerned and not in the Federal Civil Service Commission. In USA the Civil Service Commission prepares standard job classifications and lays down the required qualifications for appointment to particular posts and prescribes rules and procedures for selection. The actual recruitment is delegated to selection boards of a department or an agency or to a board representing a number of such departments in the same fields of activities. In USA the selection boards for scientists consist entirely of scientific members; and the evaluation of candidate's qualifications for appointment or promotion is made by scientists.

14. In USA, Government employees can apply for any post in any Government agency on his own initiative. In UK and Europe the movement of Government employees is kept strictly under official control; and individual employees cannot take the initiative in looking for more attractive posts. Because of the greater initiative in seeking other posts in USA, there is much greater mobility compared to UK and Europe not only between different Government agencies but also between Government agencies and non-Government educational and scientific institutions as well as private enterprises.

15. Because of the service concept, promotion in UK and Western European countries is normally possible only when there is a specific vacancy in a higher grade. In UK some flexibility has been introduced through the provision for special merit promotions, but these are very few in number, only about 10 or 12 per year on an average. In USA promotion depends on an individual being selected for a higher post. There is great emphasis on evaluation of posts with a system of classification and specification of requirements. In the American system which is oriented to the concept of the "post," the ability or achievement of any individual scientist is not relevant except when he is seeking a new post. That is, there is no explicit concept of normal promotion. However, in USA there is an increasing tendency to create additional posts in order to attract or retain scientists of ability. In fact one very important feature in USA is the financial provision for a larger number of posts than are filled at any given time. Government agencies are continually on the look out for man of ability and usually have sanctioned but unfilled vacancies at their disposal to enable the appointments being made very quickly. The American system is highly decentralised and promotes greater mobility depending on individual aptitudes and also on mutual adjustments between the superior and subordinate workers. For persons of comparable ability, promotions are normally much more rapid in USA compared to UK and Western European countries.

16. In USA the universities and non-Government scientific institutions have their own individual systems for recruitment and promotion of scientists. There are also wide variations in scales of pay and prospects from one institution to another. However, in the larger universities and institutions the tendency is towards a great deal of uniformity

in the pay structure. Retirement benefits are generally similar and transferable ; and a person serving in a Government agency can take out his benefits when he accepts a post outside Government and also, if after an interval, he comes back to a Government agency he can usually bring back his benefits and deposit the same with Government. Leave rules are also basically similar.

17. There is practically no class stratification of the British type in USA, and there are good opportunities for scientists to work their way up from the bottom. Compared to UK and Western European countries there is far greater horizontal and vertical mobility.

18. In USA pay scales in Government agencies and in educational and scientific institutions used to be appreciably lower compared to private industries. This has received a great deal of attention in recent years and already there is a good deal of improvement in pay scales in the universities and scientific institutions. Pay scales in Government agencies have also been increased.

19. In America there are also indirect methods of offering high pay for Government work. Large contract projects are given by government to universities and private scientific organisations which enable very high pay being given to scientists of outstanding ability. I have heard that a big research institution (The Rand Corporation) is in legal form a non-Government non-profit incorporated agency which, however, in actual fact is practically an organisation of the Defence Services. This enables the Rand Corporation to offer terms and conditions to scientists without any of the Civil Service restrictions.

USSR

20. USSR has developed again, still another system which resembles the American system, but is even more flexible. There is no concept of a scientific service in either the British or Indian sense. There is a great deal of emphasis on classification and specification of posts somewhat resembling the practice in USA. But the real emphasis in the Soviet system is on the functional qualifications of individual scientists.

21. The structure of scientific posts is broadly as follows :—(1) Technicians (which correspond broadly to the scientific assistants in the British Civil Service); (2) Junior Scientific Worker ; (3) Senior Scientific Worker, (4) Professors and Directors, and (5) about 500 members of the USSR Academy of Sciences and 1200 members of 200 other Academies of Republics, or of all-union academies in special fields (medicine, agriculture, buildings and construction, etc.).

22. There is no concept of any service system on time-scales. There is more or less a fixed pay (with a very small band to provide some flexibility) in each category. The pay is basically uniform for each category of posts (with slightly higher pay by 10 or 15 per cent in some institutions of national importance). Also a personal allowance of the order of 10 per cent or 15 per cent of the pay can be given in special cases. There are certain personal allowances for additional qualifications, for example, for passing prescribed examinations in foreign languages or acquiring special qualifications in particular subjects.

23. Qualifications and eligibility for each category are carefully prescribed. Candidates who have completed their training in junior technical schools are eligible for appointments as technicians in category (1). Graduates from universities and higher educational institutions are eligible for appointment as junior scientific workers in category (2). Persons with the degree of "Kandidat" (the junior doctorate) are eligible for

appointment as senior scientific officers; and persons with senior doctorate degree for appointment as professors. (Exceptions can be made on the basis of actual accomplishments and record of work but are subject to confirmation by a higher authority).

24. The system of recruitment is completely decentralised and the authority for making appointments vests in each agency or institution. There is, however, a well organised system and procedure for this purpose. Each scientific institute and institution has a scientific committee which is appointed by a higher authority and which consists of the Director and some members of the staff with some outsiders. In the case of the research institutes of the USSR Academy of Sciences (to be referred to as Akad. Nauk) the scientific committees are appointed by the presidium (governing body) of the academy. Posts are normally advertised. There are prescribed qualifications for each post with possibility of giving preference to candidates with recognised additional qualifications. Applications are scrutinised by a small committee on which there is a representative of the USSR Trade Union of Scientific and Educational Workers. The task of this scrutiny committee is to examine the qualifications of each candidate and check whether these satisfy the prescribed requirements. This committee simply prepares a report on the eligibility of the candidates without giving any opinion on their merit. This scrutiny prevents any candidate without prescribed qualifications being considered for the post. The applications then go to the Director and the scientific committee.

25. The Director can appoint technicians with the concurrence of the scientific committee. For any appointment in any higher category the selection is made by the scientific committee on the recommendations of selection boards. Evaluation of the candidates including personal interviews is entirely by scientists and the concurrence of the Director is necessary. The scientific committee has the powers of selecting an eligible candidate for any post in the category of junior scientific workers ; but appointments which are proposed to be made on grounds of exceptional individual merit require confirmation by a higher authority. Promotion to a post in the category of senior scientific worker is subject to scrutiny and examination by a higher appointments committee, nominated by the presidium of the academy. Such examination, I understand, is real, and cases occur in which the recommendation of the scientific committee is not accepted. Appointments to posts of directors and professors are made by the presidium on the recommendation of scientific committees or selection boards. It is also worth mentioning that no candidate can be appointed to a post, even by the presidium of the academy, except on the recommendation of the scientific committee concerned.

26. The system is basically similar in universities and Government agencies. The initiative comes from the agency concerned but there are higher committees to examine recommendations for promotion to a higher category. In the universities, for example, the appointment of a professor is subject to approval by a special committee of the Ministry of Education. There are similar committees consisting of scientists in other ministries with similar functions.

27. The Soviet educational system is closely related to the methods of recruitment and promotion of scientific and technical man-power. There is a comprehensive system of education covering the whole country which is free up to the highest level. The 10-year school education up to the normal age of 16 plus is free, compulsory and universal. (A radical change has been, however, recently announced and would be soon introduced by which all school students would start earning their living two years before completing the

school course and would finish the last two years of the present school programme by taking evening courses extending over 3 years). After the 10-year school education, admission to all educational institutions (both junior technical and university level) is strictly through entrance examinations. The subjects differ for different types of institutions (university, engineering, or medical, agricultural etc.) but for the same type of institution the syllabus and standards of examination are more or less the same for the whole country. A candidate passing the entrance examination for universities becomes eligible, in principle, for admission to any university in USSR. The most important feature is the high degree of uniformity of standards.

28. As a general rule, stipends are given to practically all students who are admitted to technical and higher educational institution which are sufficient to meet their living expenses during the whole period of study. This has ensured the maximum flow of students of ability into science and technology.

29. In addition to day courses, there is a highly organised system of education through evening and correspondence courses. Evening courses are given not only in educational institutions but also in industrial enterprises. Big enterprises individually, or groups of small and medium enterprises in a locality would give training in evening courses not only in general education but also at different levels, in subjects related to their respective type of production. In 1954, during a visit to Erevan (in Armenia, which used to be a very backward are before the Russian revolution) we saw a big enterprise with about 3,000 workers engaged in the production of heavy electrical goods. We found that four types of evening courses were being given in this enterprises. There was a 3 year upper school course for workers who had completed only 7 years of school work but did not have the opportunity of receiving the full 10-year education. There was a junior technical school which admitted workers who had completed 7 years of school education. There were also higher (or university level) courses leading to the degree of electrical engineering with specialisation in heavy electricals. Finally, post-graduate courses had also been started a year ago which would enable workers who had completed the higher (university-level) degree course to study for the "Kandidat" (or junior doctorate) degree and later for the senior doctorate degree. Most of the teaching is done by the engineering and scientific staff of the enterprise itself; a number of teachers also come from the local university and higher technical institutions. Teachers participating in the evening courses received additional remuneration which (depending on the amount of work) can go up to 50 per cent of the pay for the regular day time occupation. The enterprise had a good research section and possessed a great deal of scientific equipment which was used for purposes of training in the evening. We learnt that a programme for expansion had been sanctioned which would double the capacity of this factory, and saw that some construction work had already started. It was the responsibility of the enterprise to recruit the additional technical staff; and the manager of the factory told us that they expected to do this mostly by giving training in their own evening courses. This made the training completely suited to the task.

30. The normal period of study in an evening course is usually one year longer compared to the corresponding day course leading to the same degree or diploma. In addition to courses leading to regular degrees or diplomas a very large number of special courses are provided. These are usually qualifying tests or examinations for admission to their courses. Usually there is also an examination at the end of the course which is not necessarily a written one, but may be a practical exercise or an oral examination. Passing

these examinations is considered as obligatory or additional qualifications for appointments to particular types of posts. This acts as a great incentive for undertaking such courses.

31. Every Soviet employee has an absolute right to resignation (except in a limited number of cases where a trainee has accepted an incentive scholarship for training in a specialised field on condition that he would serve for a limited number of years in assigned posts). This right of resignation together with complete decentralisation of recruitment enables young scientists to find opportunities of work to suit their own aptitudes. For changes within the same strata, he would not get any higher pay (or only to a very small extent in the case of a small number of designated institutions of national importance).

32. An important feature of the Soviet system is that the responsibility is thrown on the Directors and the supervisory staff to attract and retain promising candidates, *not* by offering higher pay, but by providing better facilities and a congenial atmosphere for work. (During my visit to Moscow two months ago I asked a distinguished Academician, who is setting up a new Institute of which he would be the Director, how he would select the professional staff. He answered: "Well, it is mostly with the help of a smiling face and sweet words to point out to the candidates how he would feel happy with us, how he would get a little more space for work or some special equipment. We cannot offer higher pay except in the case of a promotion from one category to another. This is, however, a more difficult procedure and usually appointments are made within the same category.")

Comparison between the different systems

33. The American and the Soviet systems are a good deal similar. The American system is naturally restricted to posts in the Federal Government while the Soviet system is universal and covers all posts in the country. In the Soviet system there is much greater emphasis on scientific and technical training and on the acquisition by each candidate of general and academic and specialised training qualifications. There is a high degree of decentralisation of recruitment in both USA and USSR. In USSR it is not possible to offer higher pay for posts of the same category which leads to a great deal of emphasis on creating a congenial atmosphere for work for the scientists.

34. There is, however, one important difference between the American and the Soviet system. In USA posts have to be created in terms of duties and responsibilities without any reference to the qualifications of individual candidates. In USSR there is much greater emphasis on individual qualifications and ability; and normally additional posts would be created to promote suitable candidates. For example, when a scientist working in any institute under the Akad. Nauk receives the Kandidat's degree or the Doctor's degree, a new post in the category of senior scientific worker or in the category of professor would almost automatically be created to give him promotion. This acts as a great incentive for a continuing improvement of individual qualifications. In USA also, in actual fact, government agencies usually have unfilled vacancies in reserve so that appointments can be made very quickly as soon as suitable candidates become available.

35. In contrast the service system in UK or in the Western European countries is far more rigid. In UK (but not generally in the Western European countries) the scientific service is still in a somewhat lower position than the administrative class. The service system also has a sharply defined class structure in UK (but this is not so in Western European countries).

36. For historical reasons the service system with a very rigid class structure was established in India on the British model and has continued (and has become possibly even more rigid) after independence. The basic issue in India is whether it would be wise to continue indefinitely the present system on the British model or whether, at least in the case of scientists, attempts should be made to evolve a more flexible system on the lines of USA and USSR.

APPENDIX (2): PAY SCALES FOR SCIENTIST IN ADVANCED COUNTRIES

United Kingdom

1. In the British Civil Service the standard pay scales (before taxation) are in pound sterling[1] per year : (1) Scientific Officer (£ 506 to £ 1055), (2) Senior Scientific Officer (£ 1135 to £ 1345), (3) Principal Scientific Officer (£ 1375 to £ 1950), (4) Senior Principal Scientific Officer (£ 2000 to £ 2300), (5) Deputy Chief Scientific Officer (£ 2400 to £ 2700), and (6) Chief Scientific Officer (£ 3000 to £ 3250). It is interesting to note that a "broad band" has also been recently established from £ 3500 to £ 6000 for scientists of exceptional ability who may be given any suitable pay within the band. This entirely new and unorthodox provision had to be introduced in order to attract and hold outstanding men.

2. There have been also considerable improvements in pay scales in educational institutions in UK. In grammer school the pay range until recently was from £425 to £900 per year for an assistant teacher, £1250 to £1525 for a deputy headmaster, and upto £2200 for a headmaster. Very recently further improvements have been made. A teacher with an honours degree may now go up to £1700 in London and a little less elsewhere. If he is a scientist he is likely to reach this stage in late thirties ; most science graduates would reach £1400 to £1500 per year, and the least successful will earn £1200 by the age of forty. The maximum for headmasters in bigger schools has been increased to £3000.[2]

3. In British universities the standard pay scales are £550 to £650 for an Assistant Lecturer, who is, in fact, on probation and would go elsewhere unless he is promoted to the post of a Lecturer on £650 to £1350. A Senior Lecturer or Reader would get from £1400 to £1850 and a Professor from £1900 to £2850. In UK the pay in educational institutions (both schools and universities) is somewhat lower than that in the regular civil service posts but the difference is not very great (except for the "broad band" of £3500 to £6000 mentioned above).

4. In UK it is also possible for a scientist in universities and higher educational institutions to undertake outside work on a part-time basis either through his own institution or on his own for which he may receive additional remuneration upto a certain proportion of his regular pay.

Western European Countries

5. In Western European countries pay scales are usually the same for men of comparable ability working in Government agencies and in universities, educational and

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[1] One pound is equal to Rs. 13.33.

[2] *The New Scientist*, 18 June 1959. It is also noted that a newly graduated chemist would get more in a school upto the age of 25 but after that age he would get more in industry. In late thirties an industrial chemist could expect o earn on an average £ 1750, and about £ 2200 in his fifties.

scientific institutions. It is usual to have a number of overlapping grades with short time scales. Among scientific workers the dispersion or the ratio of the maximum to the minimum pay is usually quite small. In UK and practically all Western European countries there are dearness allowances and also some compensatory allowances in places with a high cost of living. Also, scientists can accept part-time consulation or teaching work for which he can receive suitable remuneration.

6. In France in universities and scientific institutes and laboratories, a Laboratory Assistant would get a monthly salary of about 60,000 francs (one rupee = 100 francs), a Junior Scientific Worker from 75,000 to 95,000 (in 15 years), a Senior Scientific Worker from 90,000 to 110,000 (in 10 years), a Reader from 100,000 to 125,000 ; and a Professor would start at 120,000 and go up to 150,000 or in exceptional cases to 200,000 per month. The top civil service pay would be 250,000. Engineers in France would get from 65,000 to 115,000 francs per month.

7. In Germany there is a large number of overlapping grades A(1) to A(6) with time-scales in each grade and higher posts on fixed pay in grades B(1) to B(11). A scientist or engineer would normally start at A(13) with a scale of from 735 to 1155 (German) Deutsch Marks per month. (One DM = Rs. 1.14). Promotion to the next grade A(14) with a pay scale from 807 to 1335 DM per month would be normal, but after this only a selected few would reach higher grades A(15) and A(16) rising to 1490 and 1735 DM. The director of a large research establishment may be promoted to B(3) with a monthly salary of 1925 DM. There are family and other allowances and pensions which may be as high as 75 per cent of the pay, and a widow may receive pension up to 60 per cent of the husband's pay.

8. In Switzerland there are 25 grades, each with a short time-scale. The lowest grade (25th) has a pay scale from about 6000 to 7,100 Swiss francs per year. (One Swiss franc = Rs. 1.11 approximately). Engineers would start at the 8th grade (11000 to 15500) and after a few years reach the 5th grade (13100 to 17700) and may stop there for the rest of his career. The top (1st) grade in civil service has a scale from about 21,000 to 25,700 Swiss francs per year. Professors in universities would often get higher pay, up to about 30000 Sf. The range is small, and the ratio of maximum to minimum for scientific workers would be less than 3.

9. In Sweden also there are 30 grades ranging from the bottom (1st grade) with a monthly salary of about 700 Swedish Kroner to the top (30th grade) with 3000 Skr. per month (One Skr = Rs. 0.90). A graduate would start in grade 13 on 1257 Skr., and persons with a higher degree in grade 15 on 1400 Skr. and may normally go up to grade 27 or 28 on 2500 or 2600 Skr. per month. In universities and higher educational institutions a junior part-time teacher may start on 1000 Skr. per month, and fully qualified research workers on about 2000 Skr. Professors get from 3200 to 3500 Skr. which may be compared with the pay of Cabinet Ministers of about 4500 Skr. per month, which is the highest pay in Government.

10. In Norway, in educational and scientific institutions a Scientific Assistant has a salary of about 16,800 Norwegian Kroner per year, Research Fellow 17600, Lecturer 24900, Associate Professor 26100, and Professor 33000 Nor Kr. per year (One Nor. Kr. = Rs. 0.67).

11. In Denmark engineers start at about 13,400 Danish Kroner per year (inclusive of cost of living bonus) and rise in 15 years to about 27000 Dkr. per year (One Danish Kr. =Rs. 0.71). The ratio of maximum to minimum pay for qualified professional personnel in the Scandinavian countries is about 2 or 3.

12. In Netherlands there are short time-scales in different grades. An Assistant Engineer has a scale of about 6000 to 7100 Dutch Guilders[1] per year (in 3 years), Engineer 7100 to 9900 (8 years), 1st Class Engineer 9500 to 11400 (5 years), Chief Engineer 11000 to 13200 (6 years) and 1st Class Chief Engineer 12000 to 14100 (6 years). Head Engineers may go up to 18400 Dutch Guilders. The ratio of maximum to minimum pay is again about 2. Salaries for research scientists have three rates of promotion for "average," "above average," and "outstanding" persons; these rates and promotions are reviewed every year.

United States of America

13. In USA there are great variations in pay scales in different universities and institutions. In the bigger institutions, the pay scales are broadly similar for men of comparable ability in Government agencies. In universities and scientific institutions the teaching staff can undertake part-time consultation work in industry or Government. In fact, in M.I.T. and similar institutions such part-time work is encouraged as a mark of competence. Men of comparable ability would get higher pay in private industry. However, many scientists prefer to work in universities and educational and scientific institutions because of greater academic freedom. In USA it is usual for scientists working in universities and educational institutions to accept additional paid work during vacations.

14. Because of wide variations it is somewhat difficult to quote figures for USA. The scale in Government increases from $ 2400 to about $ 12000 or $ 14,000 per year. (But sometimes very high pay is offered to scientists in an indirect way through "contract projects" for Government work). In the larger universities and higher technical institutions the pay would increase from perhaps $ 4,000 or $ 5,000 for junior instructors to $ 10,000 or $ 12,000 (and $ 15,000 in exceptional cases) for full professors. There are also earnings for part-time consultation work or for lectures given (usually in other institutions) during vacations. In industry, men of comparable ability may get from 25 per cent to 50 per cent more but conditions of service are sometimes considered less congenial. There are also outstanding prizes (beyond the reach of scientists in government or educational institutions) but greater risks in industry. There has been a great deal of complaint that industry has been taking a large number of men from the universities and higher educational institutions; and it has been also stated that about ten per cent of science posts have remained permanently vacant at university level in recent years. Serious attention is being given to this problem at the national level; and pay scales in universities are being steadily increased.

Union of Soviet Socialist Republics

15. Scientists have the highest pay scales and other incentives in USSR. This policy was initiated long ago with the object of attracting persons of ability to a scientific career. It is now agreed that this policy has achieved its purpose in the spectacular development of science and technology in USSR in recent years. During the last two or three years there has been, however, a general reduction in salaries at higher levels, as an egalitarian measure, but even now scientists receive the highest salaries.

16. There are no time-scales and all appointments are for five years, subject to review at the end of each five year period. For persons working in the same post for five years there may be a slight increase in pay, of the order of 10 per cent, and another similar increase after 10 years of service but such increase is not given in every case. There may also be special allowances on the basis of additional qualifications (for example, for having

[1] One Dutch Guilder = Rs. 1.24.

passed an examination in a foreign language or having attended a post-graduate course in medicine). On the research side, the institutes are now placed in two categories, namely, (a) "leading" institutions and (b) ordinary institutions. The Trade Union authorities have an effective hand in this classification. Pay scales in "leading" institutions would be from 10 per cent to 15 per cent higher. Pay scales in natural sciences are also generally somewhat higher.

17. Most of the institutes in the USSR Academy of Sciences (which will be briefly referred to as Akad. Nauk) belong to the "leading" class. Typical pay scales in natural sciences in Akad. Nauk are given below. The Laboratory Assistant in the lowest category of scientific worker would start at about 900 roubles* per month if with training from junior technical schools, and at about 1000 roubles (which in special cases may go up to 1200 roubles) if with a university level degree. The next higher category is the Junior Scientific Worker (for which the minimum qualification is the university level degree), who would get about 1200 roubles (fixed pay) which would be increased to 1800 or 2000 roubles if he gets the "Kandidats" (junior doctorate) degree. The next category is the Senior Scientific Worker (for which the minimum qualification is now a Kandidats' degree) who would get from 2500 to 3000 roubles, which would be increased to 4000 roubles, when he gets a senior doctorate degree, which is also the pay of a Professor. Thus a Senior Research Worker with a doctor's degree and a Professor have practically the same status. An Associate Professor would get about 3500 roubles and would be normally a Senior Research Worker of experience with a Kandidats' degree. The head of a "chair" (which would imply some supervisory responsibilities, such as the guidance of some research workers) would get about 5000 roubles. A Director of a laboratory or institute may get 5000 or 6000 roubles per month, depending on the importance of the institute. The ratio of maximum to minimum salary is thus about 6.

18. In Akad. Nauk, a "Corresponding" (or associate) member gets 3000 roubles as life pension; there are about 320 such members. An Academician, or full member, would get a life pension of 5000 roubles (and a surviving widow would get a life pension of 2500 roubles), a country house and a car. As he would be almost certainly a professor or a director, his income would be at least 10,000 or 11,000 roubles per month. There are about 170 Academicians or full members of Akad. Nauk. Members of the presidium (governing body) of Akad. Nauk get about 13,000, Vice Presidents 15,000 and the President 19,000 roubles per month which is the highest salary received in USSR (and is higher than the salary of the Prime Minister and the President of USSR).

19. Pay scales in other All-Union Academies (for Medicine, Agriculture etc.), the Academies of Sciences of the different Republics, and in the universities and higher educational institutions are similar but somewhat lower than the pay scales in Akad. Nauk. It may be noted that pay scales for research scientists and teachers in university level institutions compare very favourably with pay scales in Government service. For example, in the Foreign Service, junior officers get 1200 roubles (about the same as Junior Scientific Workers), Officers of the standing of Vice-Consuls and Second Secretaries about 1800, Consul-Generals and First Secretaries, 2,000 to 2,200, Counsellors 2,200 to 2,500 and Ambassadors 2,500 to 3,000 per month as basic pay when working in USSR, that is, exclusive of special allowances when serving abroad.

20. Pay scales are lower in industry, but the staff may earn substantial bonuses on the fulfilment or over-fulfilment of the plan. The general view is that on the whole there

*One US dollar is 4 roubles at official rate and 10 roubles at the tourist rate; and one rouble is about Rs.1,19 at official and Rs. 0.48 at tourist rates.

is a good balance between industry, education, and research depending on individual aptitudes; and there is no appreciable drain from any particular sector.

21. There is wide-spread practice of scientific workers in research institutes giving lectures in the universities and educational institutions for which they get additional pay which may be of the order of 500 or 1000 or 2000 roubles per month depending on the number of lectures. (A. N. Nesmeyanov, the President of Akad. Nauk, gives regularly two or three lectures in undergraduate classes in the Moscow University. Other Academicians also participate in university teaching. This, of course, is a cultural gesture). It is also usual for the teaching staff of universities and educational institutions to participate in the evening courses or to do some work in research institutes for which they would get additional allowances. Scientists in all institutions are encouraged to do part-time consultation work in industry; and scientists in industry participate in evening courses or sometimes in research work in institutes or universities for which they receive additional allowances. In fact additional part-time work is a strong feature of the Soviet system; the additional earnings may amount to half the salary of the regular full-time post. Many scientific workers have a good income from books and articles, as in USSR all scientific articles are paid for. It may also be noted that in USSR income-tax is very low and for top salaries would be of the order of about 12 or 13 per cent.

22. There is a system of awards of medals and money prize for distinguished work in science and technology, the highest award being the Lenin Prize of 50,000 roubles. There is still a great shortage of housing in USSR and residential accommodation is very strictly rationed on the basis of the size of the family. Scientist with a Kandidats' or Doctor's degree are entitled by law to have an additional room (in principle, for use as his study); this privilege is highly prized.

23. Great encouragement is given to attend special training courses for which there are prescribed requirements which may include passing a qualifying examination. Fellowships (which would not be less than the regular pay) are awarded for full-time study, also grants for books and equipment, travel expenses, and additional paid holiday of one month after completing the courses. Incentives are offered for part-time training in the way of supplementary paid holiday or special leave to prepare for examinations.

24. The pattern is broadly similar in all socialist countries. Scientists receive very high pay; professors are practically at the same level as the top administrators in government; and academicians enjoy still higher pay and have a higher status.

APPENDIX (3): TRADE UNIONS OF SCIENTISTS

1. In UK and Western European countries there are well established channels of communication between scientific workers and Government and the legislators for the representation of the personal, social and economic needs of scientists and for collective negotiations.

2. In UK there is a highly developed staff association, the Institution of Professional Civil Servants, with over 500,000 members from all scientific and technical grades in public services. This Institution functions as a trade union and represents the "staff side" in the National Whitley Council Organisation in negotiations with the "official side" in staff matters. It is generally agreed that the Institution is working quite effectively. There is also a Civil Service Arbitration Tribunal which consists of a Chairman and one person from the "official side" and one person from the "staff side" to consider cases which could not be otherwise resolved.

3. The British Medical Association is a powerful professional organisation which functions in some ways as a trade union and represents the whole profession in negotiations with Government. In UK, there are also large trade unions of engineering and technical workers and an Association of Scientific Workers which look after the wider interests of scientific and engineering workers of the country in both Government and non-Government employment.

4. In UK the Parliamentary Scientific Committee is a voluntary organisation with members elected from among Members of Parliament on one side and scientist members elected by a large number of professional organisations and societies on the other side. This Committee is quite active and maintains effective contact between the legislators and scientists.

5. In Germany there is a German Federation of Civil Servants (Deutscher Beamtnbunden) with a membership of over 400,000 and also a much bigger General Federation of Trade Unions (Deutscher Gewerkschaftsbund) with about 600,0000 members. These two trade unions represent the staff side and are able to exercise a good deal of influence on Government policy.

6. In France employee participation in joint consultations with Government is provided by legislation. There are Technical Committees in each department consisting of an equal number of members appointed by Government and staff representatives appointed by trade unions of employees. There is also a Higher Council of the Public Service with a Chairman and 12 members each nominated by Government and by employee unions. In addition there are Administrative Committees for each occupational group consisting of four members, of which two are appointed by the ministry and two by the employees.

7. In Sweden there is a Central Organisation of Academies (Sveriges Akademikers Central Organisation), representing all university graduates and also non-degree holding professional employees, which includes thirty-one member organisations representing 45,000 members. The SACO looks after the economic and social interests, tries to improve the training and career prospects of its members, and represents its affiliated associations or helps such associations in negotiations with Government.

8. In both Norway and Denmark there is federated association of unions of graduates and government scientists which function as counterparts of SACO in Sweden. In both countries there are also Engineering Societies which, in addition to their professional activities, represent the economic interests of these members.

9. In USA there are, as yet, no trade unions of scientists of the European type. The American Medical Association functions in the same way as the BMA in UK and probably exercises an even greater influence. The professional engineering institutions to some extent look after social and economic interests of their members.

10. In USA there are, however, good contacts with legislators. Several important committees of Congress are concerned with science and technology and have a highly developed system of studies and investigations by their own staff which are sometimes published in the form of reports. A good deal of discussion on science and technology also takes place at the time of budget hearings before various Appropriation Committees. In addition, the scientific societies and various committees of scientists look after scientific interests in a general way.

11. In UK and Western European countries there are thus well organised trade unions of scientific workers which function broadly in the same way as trade unions of

industrial workers. In addition, the professional societies and institutions of science and engineering take up from time to time questions of social and economic interests of their members. In USA, although there are no trade unions of scientific workers, there are good contacts between scientists and legislators.

12. In USSR there is a federation of trade unions of all workers in scientific and educational institutions with over four million members in about 115,000 local committees or associations in individual institutions. In addition to negotiations regarding terms and conditions of service, the Soviet trade unions play an active role in promoting education and training and cultural amenities for its members.

13. It is worth noting that in USSR until two or three years ago there used to be separate trade unions for the scientific workers of professional standing and for other workers in scientific and educational institutions. Although these have been now amalgamated in a big federation, usually there are separate functional committees to look after the interest of the professional scientists and of other workers. This is necessary as the terms and conditions of service are in many respects dissimilar for the two groups.

14. Other socialist countries have Associations of Scientific Workers with membership broadly from among the professional workers. These function generally on the Soviet model and have large educational and cultural activities. In Yugoslavia the trade union of scientific workers is broadly of the Soviet pattern with some minor variations. In addition, there are workers' councils in all enterprises which participate in management decisions.

15. There is a World Federation of Scientific Workers to which the Associations of Scientific Workers of a large number of countries are affiliated. The Association of Scientific Workers of India is also affiliated to this World Federation.

SCIENTIFIC PERSONNEL COMMITTEE

POINTS FOR RECOMMENDATIONS

[Paragraphs 1—42 of the draft recommendations (circulated by Professor P. C. Mahalanobis, the Chairman of the Committee) were considered at a meeting of the Scientific Personnel Committee held in New Delhi on 24 March 1960, and are given below in a revised form. Paragraphs 43–60 of the draft recommendations have not yet been considered by the Committee].

I. SUPPLY AND DEMAND OF SCIENTIFIC AND TECHNICAL PERSONNEL

1. The demand for technicians and operating scientific workers* would have to be estimated on the basis of the physical targets of production and objectives of social services desired to be attained in the successive five year plans, keeping in view a perspective of 15 or 20 years of development.

2. The demand for science teachers at all levels and for scientists for developmental research is likely to be roughly proportional to, (and can be estimated on the basis of requirements of technicians and operating scientific workers.

3. The number of persons competent to work on basic research is small in every country. It is the supply only which matters. The aim must be to identify and attract all such persons to take up research as a career and to give them necessary facilities for their work.

II. EDUCATION AND TRAINING OF SCIENTIFIC AND TECHNICAL PERSONNEL

4. It is necessary to make the teaching of science universal in the sense that every pupil at the high school stage would have some education in science. As this cannot be achieved immediately, it is necessary to work out a phased programme to achieve this objective in 10 or 15 years.

5. Standard lists of scientific equipment (at different levels) should be prepared for the guidance of educational authorities; and arrangements should be made for the manufacture and supply of such equipment at low costs to educational institutions in which science teaching would be introduced.

6. Adequate assistance should be given for the provision of workshops in science laboratories.

7. It is necessary to make special provisions to encourage education in science. One immediate step should be to give a more important place to science by allocating a

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* For convenience of reference and for purposes of presenting quantitative estimates the following functional classification is proposed: (*a*) technicians and auxiliary technical personnel; and (*b*) scientific workers (including engineers and medical personnel) with education broadly of university level and engaged in activities of a professional type.

Secondly, professional work is classified into three broad types: (i) operating work, (ii) teaching work, (iii) research work (sub-divided into two groups, developmental research and basic research). The same individual may be sometimes doing work of more than one type.

larger number of marks to science subjects in all competitive examinations to government service. Once the principle is accepted, the details should be worked out and continually reviewed with the help of committees of scientists.

8. To overcome the shortage of science teachers it would be desirable to offer special allowances for teachers of science at all levels.

9. An essential step in the equalisation of opportunities would be to remove the existing disabilities of students coming from poor families in securing facilities for education. A beginning can be made by providing special scholarships of sufficient value to meet both living and educational expenses in the case of students to be admitted strictly on merit for the study of science and technology in selected educational institutions. The scheme can be gradually widened as increasing resources become available.

10. It would be desirable to develop all-India standards of selection on merit for such special scholarships ; and to explore the possibilities of using objective and standardised tests (in combination with written examinations) for this purpose.

11. It would be desirable to provide funds for giving loans to meritorious students to enable them to study science and technology on the condition that these loans would be repaid after they start earning their livelihood.

12. It is necessary to make adequate provision for a continuing review of standards of teaching and examinations in science and technology at all levels. This can be best achieved through the active cooperation, at appropriate levels, of government agencies in education and science on one hand and non-governmental agencies like universities, scientific institutions, and scientific and professional societies on the other hand.

13. Appropriate action should be taken for the preparation and publication of standard text-books, adapted as necessary to suit Indian conditions, for use in educational and training programmes at different levels.

14. Existing buildings and available scientific equipment should be utilised to the fullest extent by organising evening courses on a large scale ; and evening students should be made eligible to sit for all examinations open to day students.

15. It would be desirable to develop at a national level a programme of correspondence course which would make educational facilities available to large numbers, especially in the rural areas, at a low cost.

16. In the case of science subjects such correspondence courses should be supplemented by intensive courses of practical training in selected institutions ; and all students successfully completing appropriate correspondence courses should be eligible to sit for examinations open to day and evening students.

17. Arrangements should be made for every big enterprise and groups of medium or small enterprises to provide technical education and training facilities in their respective special fields. Candidates successfully completing such training should be eligible to sit for examinations (or for recognition of qualification) open to day and evening students.

18. It is desirable to encourage teachers in universities and higher educational institutions to participate in part-time teaching in the evening courses in the enterprises; and scientists and technologists working in enterprises to participate in the teaching and research programme in the universities and higher educational institutions.

19. Scientists in research institutions should be encouraged to participate in part-time teaching work in universities and higher educational institutions and also teachers in universities and higher educational institutions to take up part-time research work in scientific institutes.

20. To prevent waste of resources in both personnel and foreign exchange through a large number of students going out of India for training (many of whom continue to live abroad) it is necessary to adopt clear guiding principles. As a general rule, students should be sent abroad for specialised training only in such subjects in which such training is considered necessary for national development. Trainees should be selected from among those who have already received education and training at the highest level available within the country, and preferably have also acquired some experience in their respective fields of study and would be engaged in the same field of work on their return to India.

21. In giving permission to students to go abroad for training preference should be given to science and technology.

III. General terms and conditions of employment

22. The aim should be to build up a comprehensive system of service for scientific and technical personnel which would ultimately cover scientific posts in the Central and State Governments, and non-Governmental agencies like universities and scientific institutions and societies. This is not immediately possible. Action may, however, be started in selected sectors (for example, in research) in the Council of Scientific & Industrial Research, government agencies, universities, and non-governmental research institutions. The interim measures should be such as would facilitate the transition to the more comprehensive system.

23. A service system with entry at a comparatively early age, usually on the basis of competitive examinations, and with promotions on the occurrence of vacancies, is not suitable for scientific workers especially at the professional level. It would be desirable to adopt the concept of a "pool" of scientific workers, classified into a number of grades in which the emphasis would be on filling each post by the most qualified person available, and on the recognition of special qualifications of individual scientists especially of those engaged in advanced studies and research.

24. It would be desirable to adopt a standard structure for scientific workers in the form of perhaps six grades such as :—

(1) Technicians
(2) Scientific assistants
(3) Junior scientific workers
(4) Senior scientific workers
(5) Principal scientific workers
(6) Chief scientific workers

25. There should be short time-scales in each grade.

26. The logical course would be to have uniform scales of pay all over the country irrespective of the employing agency (Central, State or non-governmental), and to give supplementary allowances to compensate for higher cost of living in particular places.

27. Selection of candidates for each grade should be on the basis of assessment of performance by committees of specialists in particular subject fields from different agencies, universities, and non-governmental institutions.

28. Where selection has to be made by the Union Public Service Commission, a separate wing for the recruitment of scientific workers should be set up in the UPSC (on the British model) in the immediate future. As a first step it would be desirable to set up a uniform and standard system of reporting on the performance of scientific work.

29. Promotion should not be made to depend upon assuming additional or supervisory or administrative duties but should be on the basis of the quality of the work done.

30. There should be provision for accelerated increment in the time-scale and also a grade promotion for outstanding performance irrespective of vacancies. This is particularly important in research in which the emphasis must be on the individual performance of each scientist.

31. Proper appraisal of scientific work is of crucial importance and would call for the gradual building of standards of scientific criticism and evaluation throughout the country. This can be promoted not so much by particular schemes or administrative decisions, but by encouraging the growth of independent centres of scientific work, especially in non-governmental institutions like universities and scientific institutions.

32. Standard and uniform schemes should be established for leave, provident fund and pension, medical care, housing and other benefits so that each scientific worker can carry his benefits with him, on transfer from one agency to another.

33. Individual investments in life insurance would facilitate such transfers.

34. Even before standard schemes can be prepared, it should be possible to work out marginal adjustments to enable the transfer of leave, provident fund, and other benefits through some kind of central clearance by agreement between different employing agencies.

35. All scientific workers should be assured freedom of movement from one agency to another in posts in the same short grade.

36. All scientific workers should be given the right of publication of papers and of expression of opinion in scientific journals with clearance from appropriate authorities or together with the observations of the clearing authorities concerned.

37. Restrictions on the publication of information and data should be reduced to a minimum and should be systematically reviewed by appropriate mixed committees of specialists from different government agencies, universities and non-governmental institutions.

38. Independent committees of specialists from different agencies, universities and non-governmental institutions should be set up for a continuing review and evaluation of scientific work in different fields. This is particularly important in research.

39. Special incentives and rewards should be offered on the basis of such evaluation of scientific work.

40. A cause of frustration among some of the younger scientists of ability is ascribed to the discouraging influence, in some cases, of persons in immediate control or direction of their work. Effective steps have to be devised to remedy this.

41. Part-time participation in research and consultation work should be encouraged and payment should be made for such additional work.

42. As Government has already become the largest employer of scientific workers, it is desirable that they support suitable association or associations of scientific workers which would (*a*) exchange ideas on scientific work, (*b*) discuss terms and conditions on which scientific work can best thrive, and (*c*) have consultations with Government for any remedial measures that may be necessary.

[*The following points have not yet been considered by the Scientific Personnel Committee but are being circulated for general Information.*]

IV. Administrative and technical cadres in Government agencies

43. The Committee is of unanimous opinion that pay and prospects, retirement and other benefits of scientific workers should be made as attractive as those of the administrative services in Government.

44. Scientific workers possessing administrative ability should be given opportunities to hold high administrative posts. This is particularly important in the enterprises in the public sector where scientific and technical knowledge is likely to be of special value.

45. There should be also provision for transfer from the administrative services of individuals, seriously interested in scientific work, to scientific posts permanently or for specified periods.

V. A Central Pool of research scientists

46. As it would take time to develop a comprehensive system for the employment of scientific personnel on a country-wide basis, it would be desirable to organise a Central Pool of Research Scientists on the lines recommended in Section III. The pool may be classified in 5 or 6 grades with short time-scales, and complete freedom of movement may be guaranteed from one post or agency to another within the same grade. Standard schemes may be established for leave, provident fund or pension, medical care, housing and other benefits; and these may be made transferable from one post or one agency to another. Freedom of publications and expression of opinion in scientific matters should be also guaranteed and restrictions, if any, should be clearly stated and reviewed periodically by committees of specialists from different agencies and institutions.

47. Committees of specialists from different agencies should be set up in different subject fields for the evaluation of the research work done by scientific workers who may have established a claim for such consideration. The prospective candidates should be admitted to an appropriate grade in the pool on the basis of such evaluation.

48. A beginning may be made in the Council of Scientific and Industrial Research and the scheme should be widened to include other Government or non-Governmental agencies by bi-lateral agreement.

49. It is not necessary to absorb all scientific workers into the pool but a careful selection may be made of those who have proved their competence to undertake basic research. Candidates from outside the CSIR may also be admitted if they are prepared to join the pool (unless they are holding posts in agencies which have already agreed to cooperate with the CSIR in this matter, in which case they may continue to hold the posts in the cooperating agencies concerned).

50. Candidates admitted to the pool would be given the pay of the appropriate grade in the pool (which should normally imply some increase in the emoluments of those already in service).

51. Candidates admitted to the pool may be encouraged to participate in part-time teaching or consultation activities and should receive some additional remuneration for such additional work. They may also be given suitable remuneration for approved papers and publications.

52. Experiments may also be made in setting up one or two task forces of carefully selected scientific workers to solve specified problems and provide them with necessary facilities for this purpose.

VI. Diversification of sources of research funds

53. It would be desirable to diversify the sources of funds for research in the same subject field. If an application for funds is rejected by one agency there would still be a possibility of an independent view being taken by some other agency. In basic research there is no harm in more than one person or team working on the same problem. On the contrary, there are great advantages in this plan as such duplicated or replicated attacks may lead to a speedier solution of the problem or to different methods of solving the same problem.

54. Such diversification of sources of research funds can be secured by placing specified resources for particular subject fields at the disposal of different distributing agencies.

55. It would be convenient to set up a coordinating organisation for this purpose which may consist of representatives of the distributing agencies and individual scientists of independent standing.

56. There would be great advantages in distributing the research funds not only through governmental and quasi-governmental agencies (like the ICMR, ICAR, CSIR, AEC, UGC or the Ministries) but also through general or specialist scientific societies and professional institutions.

57. Increasing emphasis should be given to the promotion of basic research in universities and non-governmental institutions.

58. Research funds should be placed at the disposal of the distributing or operating agencies without any administrative or procedural restrictions (except, of course, of utilisation for the assigned purpose and maintenance of proper accounts of expenditure incurred) so that the scientists would be made wholly responsible for the proper use of the funds.

59. There should be at the same time a continuing review and evaluation of the results achieved to assess how successfully the funds were being utilised for the promotion of research. This would be an effective way of promoting the spirit of criticism and the growth of a sense of responsibility among scientists.

60. One way of securing diversification of funds for scientific work would be to give exemptions from income-tax in a large way for donations to scheduled scientific and educational institutions (or hospitals and agencies for social services). This would give an incentive to the scientists to secure donations for their work from private benefactors and utilise the same for suitable purposes in consultation with the donors. Concentration of donations to particular institutions can be prevented by making it obligatory to place a suitable part of the donation (possibly in the form of slabs) at the disposal of a central coordinating agency for distribution for the purposes specified by the donor but among institutions to be selected by the central agency.