Bulletin nº 118 November-December 1959

International Scientific Radio Union

U. R. S. I.

CONTENTS

WISHES

At the beginning of this year we want to present our readers our best wishes for 1960.

May 1960 bring to them and to those they love joy and happiness, may this new year be most fruitful for their work and research.

INFORMATIVE PAPER

Historical Account of U.R.S.I.

Due to the importance of the materials included in this Bulletin, the continuation of the Historical account will be published in Bulletin nº 119.

UNITED NATIONS AND SPACE RESEARCH

During the General Assembly of the United Nations held in New York last Summer, a great place was given to the International Scientific Unions and particularly to the collaboration which these Unions could provide to the organization of the Peaceful Uses of Outer Space.

It was thought interesting to keep the members of U.R.S.I. informed of such important event, which lead us to publish large abstracts of a Report drafted by the Secretary General of the United Nations and of a Report of the « ad hoc » Committee on the Peaceful Uses of Outer Space.

Report of the Secretary General

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NOTE BY THE SECRETARY-GENERAL

The *Ad Hoc* Committee on the Peaceful Uses of Outer Space, at its first meeting on 6 May 1959, requested the Secretary-General to prepare a report on the subject matter of paragraph 1 (*a*) of General Assembly resolution 1348 (XIII), namely, « the activities and resources of the United Nations, of its specialized agencies and of other international bodies related to the peaceful uses of outer space ».

In complying with the request of the Committee, the Secretary-General enlisted the aid of experts from the International Council of Scientific Unions and its Committee on Space Research, and from the specialized agencies concerned, as well as other experts in the scientific disciplines bearing on the peaceful uses of outer space. For this assistance, the Secretary-General wishes to make grateful acknowledgement. It should be noted, however, that the final responsibility for the report rests with the Secretariat.

The report is divided into three Chapters, the first of which deals with space research, the second with international scientific co-operation in general and non-governmental international scientific organizations, and the third with the United Nations and the specialized agencies. This reverses the order in which the activities and resources of these bodies are set forth in the General Assembly resolution itself. This rearrangement was considered desirable because it afforded a smooth and intelligible sequence in the presentation of the report, which consequently proceeds from a description of the main body of activities related to the peaceful uses of outer space, namely the activities of the international scientific community, to the more particular and ancillary activities of inter-governmental organizations in this field.

Note. — Annexes are not published in the *Bulletin II* to *V* are questions submitted by the C.C.I.R. to U.R.S.I.

Some explanation is perhaps required of the construction which has been placed in this report on the terms « activities and resources ». « Activities » has been construed to include not only the things actually being done now, but activities begun before the date of the General Assembly resolution and completed since, notably the International Geophysical Year. « Resources » has been taken to cover the methods employed by the organizations involved and their programmes of work for the near future, as in the next year or two. No effort has been made to deal separately with activities and resources, the treatment of which is combined.

CHAPTER ONE

SPACE RESEARCH

1. The exploration of cosmic space began with visual inspection and theoretical reflection in early times. It penetrated deeper into the nature of space by means of the telescope after 1609, the reception of cosmic rays beginning in 1910, and of cosmic radio waves since 1931. In these researches, man was a simple observer. A more active form of experimentation began when it became possible to send man-made radio signals out into space and receive in return the weak reflections of these signals from the ionosphere, from meteors, and later from the Moon and from Venus.

2. A new phase of space research was initiated when, about 1945, it became technically possible to launch rockets to heights higher than the air-sustained flight of aircraft and balloons, and to use them for scientific investigations. These were the first steps towards even bolder experiments such as the launching of earth satellites. Thereafter, the way was open to space probes reaching even further into space by means of cosmic vehicles escaping the gravitational attraction of the earth.

3. The potentialities of these different types of vehicles — sounding rockets, artifical earth satellites, and cosmic vehicles — are as different as their flight schedules. Sounding rockets are the simplest and least costly types of research vehicles, and are already in commercial production. They are eminently suitable

for the testing of scientific instrumentation and telemetering systems. All important aspects of space research, including ultraviolet observations of sun and stars, measurement of ambient air characteristics, detection of cosmic rays, and photographs of cloud cover looking down on the earth, have started with sounding rockets. They will probably continue to be used for these purposes, especially in those fields where essential information can be obtained from one experiment lasting a few minutes.

4. The general trend is, however, to employ satellites in making all experiments which aim at observing the temporal or global variations of these phenomena. Examples of economically or socially useful applications of these investigations are the possible use of satellites for weather prediction and for world-wide telecommunication. In contrast, the use of cosmic vehicles, including moon rockets, may for some time to come have primarily a purely scientific character. It is likely that the experiments with living animals and the attempts to put « man into space » will also follow the same order — from flights resembling those of sounding rockets to flights around the world and far into space.

5. The aims of space research are not limited to the objectives which the scientists can at present foresee as attainable goals for the next years and decades. In a broad sense, they include :

(*a*) Scientific knowledge of the natural laws of the universe.

(*b*) Scientific knowledge of the influence of fields, waves, particles and objects emanating from outer space, upon the conditions of our planet.

(*c*) Utilization of such knowledge and of direct observation from space vehicles for the improvement of our practical understanding of the Earth, its climate and weather, the geography of continents and oceans and the physics of the atmosphere and hydrosphere.

(*d*) Utilization of the above-mentioned knowledge for the benefit of mankind by furthering world-wide mutual undestanding and by practical application in communications, transportation and weather prediction, including forecasting of droughts, floods, and storms.

CHAPTER TWO

INTERNATIONAL SCIENTIFIC ORGANIZATIONS

A. — Scientific co-operation at the non-governmental level.

6. The growth of science, the rapidly increasing number of countries actively participating in scientific research, and the development of entirely new fields of scientific and technical endeavour, have promoted a rapid expansion of international co-operation in science.

7. International scientific unions, which now comprise a very large part of the international research activities in the various fields of pure and applied science, were organized, beginning in 1919, to co-ordinate and develop scientific activities hitherto dispersed. Since then there has been much co-operation by and among the scientific unions. The establishment of the International Council of Scientific Unions (I.C.S.U.) in 1931, has strengthened this process of such great importance for the advancement of science.

8. Existing resources in the field of outer space indicate that scientific investigations presently under way are extensions of various established branches of science and do not constitute a new scientific discipline. In consequence, not only are scientists belonging to different specialties brought together in their studies of outer space, but also various scientific unions, each with different objectives bearing on outer space, are required to co-ordinate their efforts in many basic research projects and in most, if not all, applied research projects.

B. — The international Scientific Unions.

9. Non-governmental international co-operation in science, as promoted by scientists themselves, has in the international Scientific Unions its most representative bodies. International Unions have been organized in the major fields of science since 1919, and are now thirteen in number, namely :

International Astronomical Union (I.A.U.).

International Union of Geodesy and Geophysics (I.U.G.G.).

International Union of Pure and Applied Chemistry (I.U.P.A.C.).

International Scientific Radio Union (U.R.S.I.).
International Union of Pure and Applied Physics (I.U.P.A.P.).
International Union of Biological Sciences (I.U.B.S.).
International Geographical Union (I.G.U.).
International Union of Crystallography (I.U.C.r.).
International Union of Theoretical and Applied Mechanics (I.U.T.A.M.).
International Union of the History of Science (I.U.H.S.).
International Union of Physiological Sciences (I.U.P.S.).
International Mathematical Union (I.M.U.).
International Union of Biochemistry (I.U.B.).

10. The objects of the international Unions are exemplified in the following provision from the Statute of the International Union of Geodesy and Geophysics, which applies *mutatis mutandis* to all the others :

« 1. The objects of the Union are :

(*a*) To promote the study of problems relating to the figure and physics of the earth,

(*b*) to initiate, facilitate and co-ordinate research into, and investigation of those problems of geodesy and geophysics which require international co-operation, and

(*c*) to provide for discussion, comparison and publication. »

The following description presents only the typical features of the structure and work of these Unions.

11. A Union is maintained by the voluntary, part-time work of a small group of active scientists, who in most cases serve only for a limited number of years. The (honorary) secretary conducts the correspondence ; he usually draws on the resources of his own research institution, supplemented by subventions from Union funds to cover expenses for secretarial assistance. It is significant that the Unions can draw directly on the knowledge and enthusiasm of active scientists, that the administration is small and flexible, but that the possibility (and need) for coping with a large, daily flow of correspondence or inquiries is limited.

12. The activities of the Unions are directed towards organizing meetings of various kinds and maintaining limited publication services, often in association with professional publishing firms.

13. The meetings range from small commission meetings where a few designated experts deal with nomenclature, standardization or other problems of co-operation in highly specialized fields, to larger meetings, such as symposia, often of limited attendance, devoted to prepared discussions of a narrowly defined set of problems. General assemblies or congresses take place at intervals of three or four years. Attendance at these may be very large, and all aspects of the whole discipline be discussed in a variety of sessions. Elections of officers and other administrative matters also form part of the assembly activities.

14. Publications range from monthly or quarterly news bulletins, to symposia proceedings often for public sale, to major volumes recording the general assemblies. Some Unions also engage in promoting publication of tables, etc.

15. The Unions maintain contact with the scientists in the various countries through National Committees or equivalent bodies, one for each discipline. Annual national contributions to the unions are paid by the National Committees, and usually come from public funds or equivalent sources. The total sum of national contributions to all thirteen unions is estimated at between $ 150,000 and $ 200,000 per year — the income varies greatly from one Union to another.

C. — The International Council of Scientific Unions (I.C.S.U.).

16. The International Council of Scientific Unions has two chief objects :

(*a*) to co-ordinate and facilitate the activities of the international Scientific Unions in the field of the natural sciences ;

(*b*) to act as a co-ordinating for the national organizations adhering to the Council.

17. Further objects of the Council are :

(*a*) to encourage international scientific activity in subjects which do not fall within the purview of any existing international organization ;

(*b*) to enter, through the national adhering organizations, into relations with the Governments of the countries adhering to

the Council in order to promote scientific investigation in these countries ;

(*c*) to maintain relations with the United Nations and its specialized agencies ;

(*d*) to make such contacts and mutual arrangements as are deemed necessary with other international Councils or Unions, where common interests exist in the field of the natural sciences covered by the Council.

18. In keeping with the purely scientific character of I.C.S.U., the General Assembly formally adopted in October 1958, the following statement :

« 1. To ensure the uniform observance of its basic policy of political non-discrimination, I.C.S.U. affirms the right of the scientists of any country or territory to adhere to or to associate with international scientific activity without regard to race, religion or political philosophy.

» 2. Such adherence or association has no implications with respect to recognition of the government of the country or territory concerned.

» 3. Subject only to payment of subscriptions and submission of required reports, I.C.S.U. is prepared to recognize the academy, research council, national committees, or other *bona fide* scientific group representing scientific activity of any country or territory acting under a government *de facto* or *de jure*, that controls it.

» 4. Meetings or assemblies of I.C.S.U. or of its dependent organisms such as its special committees and its joint commissions should be held in countries which permit participation of the representatives of every national member of I.C.S.U. or of the dependent organisms of I.C.S.U. concerned, and allow free and prompt dissemination of information related to such meetings.

» 5. I.C.S.U. and its dependent organisms will take all necessary steps to effect those principles. »

19. The membership of I.C.S.U. consists of the thirteen Scientific Unions as autonomous bodies, and of the national academies or research councils in forty-five countries — all with seats in the

I.C.S.U. General Assembly. Here it should be noted that the national committees adhering to the individual Unions are usually related to the national academies or research councils in the respective countries, so that a structure similar to the ties between the Unions and I.C.S.U. also exists in many individual countries.

20. The Council aims to be a truly international federation regulating such interests of the thirteen Scientific Unions as are common to all, while fully respecting their autonomy, each within its own domain. The forty-five national members share with the Scientific Unions in guiding the general policy of the Council. They may also have contacts with the Unions through the national committees, the importance of which lies in the fact that they form the link between the main body of scientists in their particular discipline and the I.C.S.U.-Union structure.

21. Like the individual Unions, I.C.S.U. is maintained by the voluntary, part-time work of a small group of active scientists. The officers of the Unions are few in number, recruited from a very small group of people who give their time freely to international co-operation ; their basic function is to keep in organic touch through the national committees with the developing needs of their fellow scientists as a means of keeping the Unions and I.C.S.U. abreast of the most informed scientific opinion.

22. I.C.S.U. has an administrative office in The Hague, with a salaried staff consisting of a full-time administrative secretary, an accountant whose services are also available to the Unions upon request, and three clerical assistants.

23. Financially, I.C.S.U. is maintained by contributions from the national adhering bodies, to an estimated amount of $ 50,000 per year. One of I.C.S.U.'s services is to act as a central representative for the thirteen adhering Unions in their relation to Unesco. Unesco, as part of its scientific activities, grants an annual block convention of about $ 200,000 to the thirteen Scientific Unions, and this sum is allocated to the individual unions through I.C.S.U., thus ensuring that the block grant from Unesco is always used in the most efficient manner for the scientific community as a whole.

24. The business of the Council is carried on by the General Assembly, the Bureau and the Executive Body. The General

Assembly, to which the other two organs are responsible, meets at intervals of three years. It consists of the representatives of the Unions and the national academies or equivalent organizations. The Bureau, which is elected by the General Assembly, is responsible for the conduct of the current affairs of the Council.

25. The Executive Board consists of the members of the Bureau and of representatives of the Scientific Unions and directs the affairs of the Council between meetings of the General Assembly. Among other powers the Executive Board may set up special committees to facilitate the planning and co-ordination of scientific research on an international basis, such as necessitates the co-operation of several countries and of several Scientific Unions. Each special committee functions under a constitution approved by the Executive Board as appropriate for its specific task. It is worth noting that a special committee may not act as arbiter between its adherents : « Any bilateral or multilateral negotiations must take place directly between the adhering bodies. »

26. In practice, I.C.S.U. has proved to be flexible and has responded quickly to the changing needs of scientific international co-operation. A reasonable balance has been assured between the power of the national academies on the one hand, and the international scientific unions on the other. Inside each Union, commissions have been established, split, combined, discontinued or reorganized, with a division of tasks fitted to newly gained insights.

27. There are always a certain number of tasks which lie on the borderline between two or more Unions. I.C.S.U. takes special care to fill needs for co-operation or joint activities involving the disciplines of several Unions or many national academies. Typical examples are the International Geophysical Year, Antarctic Research, and Space Research. I.C.S.U. copes with these tasks as they arise in international scientific life by the formation of special committees, such as the Special Committee for the International Geophysical Year (C.S.A.G.I.), which was formed in 1953 and will continue to the end of June 1959, the Special Committee on Oceanographic Research (S.C.O.R.), first established in 1957, and the Special Committee on Antarctic Research (S.C.A.R.), 1958.

D. — The International Geophysical Year (I.G.Y.).

An example of international co-operation in science.

28. The I.G.Y., a non-governmental enterprise consisting of a series of geophysical and solar observations, carried out from 1 July 1957 to 31 December 1958, was an outstanding example of effective international co-operation in science. It brought together prominent scientists from sixty-six nations to contribute to a world-wide research programme in the following disciplines : aurora and air-glow, cosmic rays, geomagnetism, glaciology, gravity, ionospheric physics, longitudes and latitudes, meteorology, nuclear radiation, oceanography, rockets and satellites, seismology, solar activity, world days and communications.

29. The I.G.Y. was successful in making remarkable advances into new fields of knowledge with a short-term flexible machinery. Although its objective appealed to many governments from which it gained financial and logistic support, the I.G.Y. operation was smooth and devoid of political or national animosities. This stimulated scientific performance, helped to catalyze extensive research that would not otherwise have been done, and made possible the pooling and sharing of the data acquired from observations. These data are available for study by scientists of every country, whether or not their country took part in the I.G.Y.

I.G.Y. organization.

30. This world-wide scientific endeavour was made possible by action of I.C.S.U. In 1952, the Council responded favourably to proposals for an International Geophysical Year in which observations would be extended so as to cover the whole world, with special attention to certain regions. To this end, it decided to appoint a special committee, later named « *Comité Spécial pour l'Année Géophysique Internationale* » (C.S.A.G.I.), to act on behalf of I.C.S.U. in the preparation and organization of a comprehensive world plan for co-operative geophysical research. The countries adhering to I.C.S.U. were invited to form national committees to organize their participation in the I.G.Y., as the research was to be conducted through national scientific machinery. The over-all planning, on the other hand, was to be international. C.S.A.G.I. central machinery was financed to the end of 1958

as follows : I.C.S.U., $ 40,000 ; Unesco, $ 85,000 ; national contributions, $ 166,000.

I.G.Y. programme.

31. In the planning, emphasis was placed on measurements and observations requiring simultaneous study all over the world ; on measurements requiring a more continuous watch than is usually possible ; and on measurements designed to reveal long-range trends.

32. At a C.S.A.G.I. conference in Rome, in 1954, a resolution was passed urging that as many nations as possible consider the development of satellites carrying scientific instruments, which would be placed in orbits around the earth during the I.G.Y. The resolution stated :

« In view of the great importance of observations during extended periods of time of extra-terrestrial radiations and geophysical phenomena in the upper atmosphere, and in view of the advanced state of present rocket techniques, C.S.A.G.I. recommends that thought be given to the launching of small satellite vehicles, to their scientific instrumentation, and to the new problems associated with satellite experiments, such as power supply, telemetering, and orientation of the vehicle. »

33. Within a year, both the United States and the U. S. S. R. indicated their intention to launch satellites. Successively, attention was devoted by C.S.A.G.I. to the several phases of the earth satellite tracking programmes. Special emphasis was placed on the need for wide international co-operation in tracking satellites to develop their full scientific potential. Many nations indicated a willingness to set up satellite observation stations.

34. C.S.A.G.I. also held a number of special meetings devoted to the co-ordination of work in specific regions and particular scientific disciplines. At these meetings, attention was given to the preparation of technical manuals for each discipline describing the scientific work to be done and the instrumentation to be used. The manuals also set up minimum standards of performance and standardized scientific procedures so that data gained from the experiments would be internationally meaningful.

35. As a result of the C.S.A.G.I. conferences and other special meetings, the programme was given precision and enlarged. Weather observations formed the largest single section of the programme and W.M.O. took a leading part in guiding and stimulating meteorological activities through its representatives on the central I.G.Y. organization. Cosmic physics, which is an area including connected observations of the sun, the earth's magnetism, aurora, ionosphere and cosmic rays, formed another large section. « Rockets and satellites » was, however, a part of the programme that required greatest financial outlays and for this reason had to rely largely on financial and logistic support from governments.

36. Another problem confronting the I.G.Y. was the collection and distribution of data. This problem had two aspects requiring different solutions. The first one was the problem of very rapid communication of a simple message. It was foreseen that this would be needed in the event of important solar flare. Hence, a regular observing system on solar activity combined with a World Warning Agency, A.G.I.W.A.R.N., was set up in Fort-Belvoir, Virginia, U. S. A., to fulfil this task. This agency could call « alerts » or « special world intervals » of intensified observations whenever a solar flare was seen to erupt ; it issued messages at 16.00 Universal Time, daily. These short messages were distributed (*a*) by telegram to ten regional and associate regional warning centres, (*b*) via the W.M.O. network, (*c*) via some standard-frequency broadcasting stations. In less than eight hours the message reached all destinations throughout the world, and many of them were received during the first two or three hours. Concurrent with these unpredictable occasions was a system of « world days » and « world meteorological intervals », periods of specially intensive observations scheduled and communicated well in advance. The A.G.I.W.A.R.N. thus fell under the I.G.Y. World Days Programme.

World Data Centres.

37. C.S.A.G.I. also gave attention to the problem of handling an expected vast quantity of raw data from observations. It stressed that each participating committee was under obligation to supply, at its own cost, and in accordance with a manner and

a time schedule to be established by C.S.A.G.I., all of its I.G.Y. data. Those data would thus be universally available for post-I.G.Y. research and form a common fund of knowledge open to all.

38. Some of the data, it was felt, would undoubtedly be published by individual national institutions on their own initiative, but a vast amount of data would not be generally available unless they were assembled in special centres. These centres would be repositories of material contributed by the various I.G.Y. participating committees, where it would be stored, catalogued and made available to research workers everywhere. Ultimately, three World Data Centres (W.D.C.s) were established, one in the United States, one in the U. S. S. R., and the third one divided by disciplines among several nations in Western Europe, in the Pacific, and W.M.O. Each centre was to have a complete set of all I.G.Y. data, received either directly or by interchange between the centres. Detailed rules were laid down to regulate the flow of data, their collection and safe-keeping, the preparation of catalogues of data, access to available material, and publications.

39. Each of the three World Data Centres is divided into fourteen subsections, devoted to the individual branches of the I.G.Y. researches.

40. For World Data Centre A (U. S. A.) these subsections are located in universities and research laboratories over the whole country from Alaska to Texas. They are directed by an office in the National Academy of Sciences, Washington, D. C. which also presents their common views in matters of policy and in dealing with other W.D.C.s.

41. Similarly, subsections in World Data Centre B (U. S. S. R.) are located at two addresses in Moscov and are officially represented by Akademia Nauk S.S.R., in Moscow.

42. The World Data Centre C, which is composed of many research institutions in Western Europe and in the Pacific, has no common administrative representation.

43. The subsections within the same discipline in each of the three Data Centres A, B, C are in regular contact with each other, without referring to their administrative headquarters. It is felt that these international ties inside each discipline are a valuable

and permanent element in the World Data structure, and may be useful far beyond the period when the central I.G.Y. administration will have disappeared.

44. Scientists from any country are free to visit the individual subsections of the World Data Centres, to study the material there and work together with the active scientists who are found in the same building as the data.

45. It should be emphasized that the World Data Centres are non-governmental institutions. This applies both to the administrative headquarters in the World Data Centres A and B, and even more obviously to the individual subsections, where the real scientific material is stored.

Exchange of information on rockets and satellites.

46. The rules established on exchange of information on rockets and satellites were as follows : After each rocket launching, and within four weeks, « if possible », the responsible committee was to complete and forward a flight information summary form to each W.D.C. and to the other committees sponsoring a programme in rockets during the I.G.Y. The summary would describe the location of the launching, the objective and performance.

47. In regard to satellites, the rules called for flash announcements through radio, telegraph and press of each successful launching, as soon as possible after a launching, but in no case more than twenty-four hours later. Among the launching data required there was the time and co-ordinates of the point at which orbital velocity was first established, and the weight of all separate objects placed in orbit. Furthermore, preliminary reports of satellite experiments were to be published by the launching authority in scientific publications of general availability « several weeks » after the launching. These reports would contain brief descriptions of the scientific observations carried out, the instruments used and other information of scientific interest.

48. Full scientific reports of rocket experiments and investigations with and aboard a satellite would similarly be published by the launching authority in literature of general availability within twelve months after the end of each experiment or investigation.

Publications.

49. In addition to the collection of raw data in the W.D.C.'s, processed I.G.Y. data is being centrally published in the *Annals of the International Geophysical Year.*

50. Volumes III to VI consist of Instruction Manuals for various parts of the I.G.Y. programme (Rockets and Satellites. Vol. VI). The other volumes (I, II, VII to X) give the history and planning of the I.G.Y., the programmes of the participating committees, lists of I.G.Y. stations, and the report of the last I.G.Y. conference (Moscow, July-August 1958) at which the continuation of the I.G.Y. operations beyond 31 December 1958 was considered. Additional volumes will give summaries of the results and their analysis, interpretation and discussion, catalogues of the material available in the W.D.C.s and bibliographies.

I.G.Y. achievements and continuation of its activities.

51. The I.G.Y., being non-governmental in organization, could have recourse only to voluntary procedures. For example, it had no power or means to regulate or control the outer space activities of the participating national committees. Nevertheless, its services were invaluable and great success was achieved in obtaining scientific information of much value on a voluntary basis. In this connexion, it should be noted that there was a wide-spread desire to continue the organized scientific research initiated by I.G.Y.; it was felt, particularly, that its experience in the planning and co-ordination of space research should not be lost.

52. The responsibility for some of the disciplines of the I.G.Y. was taken over, on 1 January 1959, by several special committees previously established by I.C.S.U. to continue the task of international and inter-union co-operation in those disciplines after the I.G.Y. Among them are the Special Committee on Oceanographic Research (S.C.O.R.) and the Special Committee on Antarctic Research (S.C.A.R.).

53. Many of the I.G.Y. activities that were not brought under new committees of I.C.S.U. are nevertheless continued on an equal or slightly reduced basis during 1959. The International

Geophysical Co-operation 1959 (I.G.C.) has invited and received adherence of almost as large a number of countries as the I.G.Y. had. The W.M.O. has strongly urged the continuation of the national I.G.Y. programmes in meteorology.

54. Much thought was given to the continuation of peaceful activities in outer space, and the General Assembly of I.C.S.U. decided before the end of the I.G.Y. to set up a Committee of Space Research (C.O.S.P.A.R.) for an initial period of one year ending 31 December 1959.

E. — The Committee on Space Research (C.O.S.P.A.R.).

55. The Committee was thus established, on a provisional basis, by resolution of the eighth General Assembly of I.C.S.U. (Washington, D. C., 2-6 October 1958) to provide a means of carrying forward international co-operation in space science beyond the end of the I.G.Y. The resolution stated that the primary purpose of C.O.S.P.A.R. was « to provide the world scientific community with the means whereby it may exploit the possibilities of satellites and space probes of all kinds for scientific purposes, and exchange the resulting data on a co-operative basis ».

56. C.O.S.P.A.R. is concerned with scientific research in the broadest sense. This is made clear by the provisional charter according to which the Committee shall promote fundamental research on space, on an international scale, but shall not normally concern itself with such technological problems as propulsion, construction of rockets, guidance and control. This objective shall be achieved through the maximum development of space research programmes by the international community of scientists working through I.C.S.U. and its adhering national academies and international scientific unions. C.O.S.P.A.R. shall report to I.C.S.U. those measures needed in the future to achieve the participation in international programmes of space research of all countries of the world with those which are already actively engaged in research programmes within the domain of C.O.S.P.A.R.

57. The Committee's composition has been provisionally established to consist of (1) :

(1) This composition is under revision.

(*a*) the representatives of national scientific institutions of the seven countries launching satellites or having a major programme in rocket research (1) ;

(*b*) the representatives of the national scientific institutions of three of the countries involved in tracking or other forms of space research on an agreed system of rotation ;

(*c*) the representatives of nine international scientific unions,

58. When C.O.S.P.A.R. first met in London in November 1958, all countries that had taken part in the « Rocket and Satellites » discipline of the I.G.Y., namely, Australia, Canada, France, Japan, the U. S. S. R., the United Kingdom and the United States, were represented. They were all admitted under group (*a*). India. Peru and the Union of South Africa were invited as the first rotating members under group (*b*). Of these, only the Union of South Africa accepted the invitation and was represented at the second C.O.S.P.A.R. meeting at The Hague in March 1959.

59. Nine international scientific unions presently have membership in C.O.S.P.A.R., namely :

The International Astronomical Union (I.A.U.).

The International Union of Geodesy and Geophysics (I.U.G.G.).

The International Union of Pure and Applied Chemistry (I.U.P.A.C.).

The International Scientific Radio Union (U.R.S.I.).

The International Union of Pure and Applied Physics (I.U.P.A.P.).

The International Union of Biological Sciences (I.U.B.S.).

The International Union of Theoretical and Applied Mechanics (I.U.T.A.M.).

The International Union of Physiological Sciences (I.U.P.S.).

The International Union of Biochemistry (I.U.B.).

60. The International Union of Mathematics (I.U.M.) has sent observers to the meetings of C.O.S.P.A.R.

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(1) These seven institutions (Australia, Canada, France, Japan, U.S.S.R., United Kingdom and the United States) contributed or were to contribute the $ 55,000 making up C.O.S.P.A.R.'s budget.

61. At its first plenary meeting in November 1958, C.O.S.P.A.R. established its governing bodies, among them a small Secretariat and the Executive Committee which is to perform *inter alia* the task, set forth in the charter, of maintaining liaison with the United Nations, in order to assure that maximum advantage is accorded to space science research through international regulation. C.O.S.P.A.R. also resolved to establish three continuing working groups : (1) Tracking and Transmission of Scientific Information ; (2) Scientific Experiment (including biological experiments) ; (3) Data and Publications.

62. The task of the Working Group on Tracking and Transmission of Scientific Information is to : (*a*) delineate problems that may exist in this area ; (*b*) propose and facilitate specific working arrangements for and among operating networks ; (*c*) study the compatibility of frequencies, equipment and problems of radio interference.

63. The task of the Working Group on Scientific Experiments is to : (*a*) evaluate scientific experiments submitted by countries which do not have facilities for launching space vehicles in order to determine the scientific desirability and feasibility of incorporating them in some form of space vehicle ; (*b*) draw attention to fields of research not receiving sufficient emphasis, which might profitably be investigated through use of space vehicles ; (*c*) arrange for co-ordinated activities by participating countries.

64. The Working Group of Data and Publications is to study the need for various forms of data exchange and for the publication of results, continuing in this connexion the use of existing World Data Centres and arranging for the continued operation of any recommended means for such publication and exchange.

65. In addition, an *ad hoc* Committee on Contamination by Atomic Explosions has been established to consider whether nuclear testing may cause pollution of the upper atmosphere.

66. Other *ad hoc* committees have been used in connexion with matters related to non-biological experiments, experiments with biological implications, radio and optical tracking and telemetering, and data and publications.

68. The Committee further recommended that C.O.S.P.A.R. (*a*) should inform all participating committees engaged in rocket programmes about the purposes of a proposed series of Rocket Weeks, requesting suggestions and proposals for scheduling such co-operative groups of firing including specific suggestions for a first such Rocket Week to be held in November 1959 ; (*b*) should inform the same participating committees of the United States offer to undertake the launching into space of suitable and worthy experiments proposed by scientists of other countries.

69. The *ad hoc* Committee on Data and Publications has also made recommendations on the following matters : (*a*) rockets (flight information) ; (*b*) satellites (orbital, pre-launching and prompt launching information ; predicted orbits and precise orbits) ; (*c*) space probes or cosmic rockets (methods for prompt communication of information for tracking purposes) ; (*d*) scientific information (observational results, problems of radio interference and ionospheric modulation, reservation of frequencies).

70. The Finance Committee, on its part, has recommended htat the existing I.G.Y. World Data Centres for rockets and satellites be continued to service the archive, bibliographic, and distributive needs of space science, as well as making available modest facilities for visiting scientists. It would not be practicable, the Committee suggested, to store duplication of all raw data in the W.D.C.s, but this should be done for reduced and analysed data.

71. At C.O.S.P.A.R.'s second plenary meeting, in March 1959, delegates from Australia, Canada, France, Japan, Union of South Africa, U. S. S. R., United Kingdom and United States reported on the programmes being carried out by their respective national scientific institutions.

72. The Soviet delegate, illustrating the status of space research in the Soviet Union, divided the primary scientific tasks of space research into three categories : (*a*) study of the phenomena occurring on the earth and in the upper atmosphere and the influence of cosmic rays ; (*b*) the properties of cosmic space as a medium in which man has to work and to travel ; (*c*) the study of the phenomena on the planets and the stars which are impossible to observe from the earth's surface as the result of interference by the earth's atmosphere. The research in the upper parts of the atmosphere

and in outer space was being continued by the Soviet Union. The rocket would be used as a routine means of studying the upper atmosphere ; their number and the number of launching places would be increased. Satellite research would be continued, including experiments of biological and astro-physical nature.

73. At the same meeting, the delegate from the United States stated that, although the scientific planning was still in its preliminary stages, it was hoped that in each of the next two years between 75 and 100 sounding rockets might be launched in the United States and approximately one or two satellites or space probes every two months. In the rocket sounding programme, emphasis would be placed on experiments relating to atmospheric structure ; electric and magnetic fields ; astronomy ; energetic particles in the ionosphere. The satellite programme would emphasize atmospheres ; ionospheres ; astronomy ; energetic particles ; electrical and magnetic fields and gravitation. Space probes would investigate energetic particles, fields and ionospheres. In each case, the objectives were set out in detail and the planned programme was outlined separately for the long-range and for the immediate future.

F. — Other international organizations.

(These organizations are : the Council for International Organizations of Medical Sciences (C.I.O.M.S.), the Union of International Engineering Organizations (U.A.T.I.), and the International Astronautical Federation (I.A.F.)).

G. — Methods of co-operation in science.

78. Scientific manpower is still the most important resource in any project of modern science. The value of this resource lies not only in the specialized knowledge possessed by certain groups or individuals. It lies just as much in the ability to understand each other's minds, to find solutions to new problems, to recognize where such problems may have analogies with problems first encountered in a quite different field, to utilize the results of disappointing experiments for the planning of improved ones, and many further qualities which belong to the best tradition of the scientific community throughout the world.

79. Scientific manpower is limited in quantity and quality. Hence, it should be used without too much waste and without too much duplication. A review of the methods used to achieve the efficient use of scientific manpower should not only mention the various forms of exchange of information from scientist to scientist and the various forms of joint scientific activities. It should review the methods for disseminating the results of research to a much wider audience than the specialists themselves.

80. Co-operation by the exchange of information between scientists may use several well-known channels such as publications in scientific journals, monographs, bibliographies, scientific meetings, consultation, exchange of persons, etc. A number of arrangements have been found, however, to meet the practical problems set by the more complex projects. Major research projects, such as the mapping of the sky in a photographic « carte du ciel », or again the multi-faceted research undertaken during the I.G.Y., can only be carried out effectively if the representatives of national scientific organizations establish a joint international programme of action. The first step is, of course, joint planning. The I.G.Y., the largest joint scientific enterprise in recorded history, was in principle based on such form of planning. The scientific committees, made up by representatives of the International Scientific Unions, established what experiments it would be desirable to carry out and set certain scientific priorities ; the national committees would help with suggestions and then commit the institutions in their country to executing an agreed part of the programme. The result was a common programme with an agreed division of tasks.

81. The voluminous data collected from major research projects, furthermore, can best be analysed by teams of scientists from different countries working in groups, although there are not yet many good examples of joint analysis. Data collecting at world centres may develop this technique. The tradition in astronomy and allied sciences has been to publish all individually observed data, not only the average values or the general conclusions. This made it possible for other scientists, perhaps many years later, to employ the available data fully in subsequent investigations. With moderate financial support, this tradition can be maintained

as long as the results of a year's work covers, for instance, a few hundred printed pages. However, a modern electronic data processing machine may print a hundred pages in less than an hour ; these may form a very tiny fraction of the data telemetered down from an artificial earth satellite. Clearly, the distribution of such data in regular journals or books would impose an impossible economic burden. The problem of handling such vast amounts of data occurs in many fields of modern science and technology.

82. When this problem was considered in the early stages of the I.G.Y., it was already clear that « raw » data would be too voluminous and too difficult to interpret to be regularly exchanged. However, the general idea of the I.G.Y. organization was to have the original data in a useful form available in the three World Data Centres. Hence, the C.S.A.G.I. guide to World Data Centres stated that «... the observational scientific data concerned,... will be sent to the W.D.C.s. Data sent to W.D.C.s should be reduced and corrected as may be necessary to put them in the form of physically significant parameters useful for scientific analysis or interpretation. » The experience proved that even sending these « semi-digested » data was an enormous task.

83. A C.O.S.P.A.R. working group discussing the same problem in the light of further experience, in March 1959, reached the following conclusions on the exchange of observational data outside the spheres of direct application :

« *Other Observations* : Since satellites and space probes will become veritable factories of data, it is essential that careful planning be given to the various means of processing, distributing and publishing the data, which may be subdivided as follows :

» « *Raw* » *Data* (*original*) on tapes or registrations will assume a formidable volume. It is recommended that these original data be stored for at least 10 years.

» *Reduced calibrated data* when possible should be made available to the World Data Centres (W.D.C.).

» *Analysed Data* should be included in the body or appendix of a published research paper, or if this is not practicable, should be sent to all W.D.C.s in tabulation form.

» Reference to availability of all forms of these data should be included in the published research paper. »

84. In addition to joint planning, joint analysis, data collecting and data processing centres, mention should be made of the utilization of instrumental facilities by foreign scientists and of international research institutes.

85. In applied research it has been repeatedly demonstrated that the use of the scientific equipment of one country by scientists from other countries has been beneficial. Thus, the use of astronomical observatories or nuclear accelerators by foreign observers has resulted in the advancement of science through the exchange of ideas in the use of the equipment. It has proved equally valuable for scientists interested in outer space research to serve at the launching site of other countries. This, of course, is particularly important for the training of scientists in the complex techniques entailed in launchings in outer space vehicles of experiments developed in their own country as part of national research programmes.

86. Furthermore, the establishment of international institutions for research in outer space comparable to the nuclear research institute of C.E.R.N. in Geneva and the Dubna Institute is of great importance in furthering the objectives in space research. Such institutes in addition to serving as training centres of scientists in the techniques of applied research also help in reaching a better understanding regarding the administrative and financial problems that are entailed in major projects for outer space research, and facilitate the necessary division of labour, the elimination of duplication and, in general, more effective planning.

87. The benefits of space research for all peoples of the world are not only to be expected from direct application of satellites or space vehicles for practical purposes. They are also present in improved knowledge, which itself enlightens mankind and in unexpected ways may contribute toward the improvement of man's conditions of living.

88. An important function of international co-operation in space science is, therefore, the dissemination of its results to many

people in many countries. Some of the methods that may be used for this purpose are :

(i) publication in the daily press and in popular magazines ;

(ii) lectures to the public by radio or television braodcasts ;

(iii) production of scientific films ;

(iv) publication of popular books or journals devoted to space science ;

(v) travelling to outer space exhibits ;

(vi) formation of amateur clubs ;

(vii) amateur congresses.

89. The borderline between popular diffusion and scientific dissemination of knowledge is not always sharp. The experience with space science is too short to judge but the experience in astronomy certainly is that many amateurs have become eminent professional scientists. Hence a certain amount of activity may be directed to the dual purpose of spreading knowledge and recruiting new scientists. Some methods used for this dual purpose are :

(i) teaching programmes in universities and institutes of technology ;

(ii) international training courses in leading scientific centres ;

(iii) monographs on practical and theoretical problems of cosmic space research ;

(iv) journals at an intermediate scientific level ;

(v) participation of amateurs in scientific programmes.

90. The method of amateur participation proved very useful in the tracking of satellites during the I.G.Y. Both the network of observers in the U. S. S. R. and adjoining countries and the « Moonwatch » network with its central office in the United States consisted partly of amateur observers. Although the methods used can be improved by more professional devices, the amateur results have been of material scientific value. At the same time, their participation has helped to spread a proper understanding of space science in wide circles.

91. The relation between nations bears some resemblance to that between individual men. A scientific co-operative programme between two nations may in many respects be one-sided because one country has the greater resources or experience or both. Nevertheless, it may alos serve the purpose of creating better understanding and training new specialists in the country which is less experienced in this field.

CHAPTER THREE

INTERGOVERNMENTAL ORGANIZATIONS

(For this chapter, refer to II of the First Part of the Report of the ad hoc Committee, p. 36).

Report of the « ad hoc « Committee on the Peaceful Uses of Outer Space

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NOTE BY RAPPORTEUR

1. By resolution 1348 (XIII), of 13 December 1958, the General Assembly established an *Ad Hoc* Committee on the Peaceful Uses of Outer Space consisting of the representatives of Argentina, Australia, Belgium, Brazil, Canada, Czechoslovakia, France, India, Iran, Italy, Japan, Mexico, Poland, Sweden, the Union of Soviet Socialist Republics, the United Arab Republic, the United Kingdom of Great Britain and Northern Ireland and the United States of America.

2. The work of the *Ad Hoc* Committee was conducted at United Nations Headquarters in New York. It began on 6 May and concluded on 25 June 1959.

3. The representatives of the following States took part in the work : Argentina, Australia, Belgium, Brazil, Canada, France, Iran, Italy, Japan, Mexico, Sweden, the United Kingdom of Great Britain and Northern Ireland and the United States of America.

4. The Committee elected the following officers :

Chairman : Dr. Koto MATSUDAIRA (Japan).

Vice-Chairman : Dr. Mario AMADEO (Argentina).

Rapporteur : Mr. Joseph NISOT (Belgium).

5. The Committee established two committees of the whole, one technical under the chairmanship of Dr. D. C. Rose (Canada), and the other legal under the chairmanship of Prof. Antonio Ambrosini (Italy). The technical Committee prepared the report on paragraph 1 (*b*) and the Legal Committee the report on paragraph 1 (*d*). At the request of the *Ad Hoc* Committee, the Secretary-General presented a report covering paragraph 1 (*a*) of the General Assembly resolution which constituted the basis for the Committee's report on that paragraph.

6. The *Ad Hoc* Committee and its committees of the whole have held twenty-five meetings. They were given valuable assistance by the United Nations Secretariat, especially by Dr. Sanford Schwarz, Secretary of the *Ad Hoc* Committee and of the Technical Committee, Mr. Oscar Schachter, Secretary of the Legal Committee, and Mr. Geoffrey S. Murray, the representative of the Secretary-General.

7. By the terms of resolution 1348 (XIII), the *Ad Hoc* Committee was required to report to the General Assembly on the four following matters described in paragraph 1 of the resolution :

« (*a*) The activities and resources of the United Nations, of its specialized agencies and of other international bodies relating to the peaceful uses of outer space ;

(*b*) The area of international co-operation and programmes in the peaceful uses of outer space which could appropriately be undertaken under United Nations auspices to the benefit of States irrespective of the state of their economic or scientific development, taking into account the following proposals, *inter alia* :

(i) Continuation on a permanent basis of the outer space research now being carried on within the framework of the International Geophysical Year ;

(ii) Organization of the mutual exchange and dissemination of information on outer space research ;

(iii) Co-ordination of national research programmes for the study of outer space, and the rendering of all possible assistance and help towards their realization ;

(*c*) The future organizational arrangements to facilitate international co-operation in this field within the framework of the United Nations ;

(*d*) The nature of legal problems which may arise in the carrying out of programmes to explore outer space. »

8. Each of these four matters is the subject of a separate part of the present report, which the *Ad Hoc* Committee adopted unanimously on 25 June 1959 :

Part I : paragraph 1 (*a*),
Part II : paragraph 1 (*b*),
Part III : paragraph 1 (*d*),
Part IV : paragraph 1 (*c*).

PART I

PARAGRAPH 1 (a) OF GENERAL ASSEMBLY RESOLUTION 1348 (XIII))

1. The *Ad Hoc* Committee on the Peaceful Uses of Outer Space, at its first meeting on 6 May 1959, requested the Secretary-General to prepare a report on the subject matter of paragraph 1 (*a*) of General Assembly resolution 1348 (XIII), namely, « The activities and resources of the United Nations, of its specialized agencies and of other international bodies relating to the peaceful uses of outer space ». On 16 June, the Secretary-General submitted a comprehensive and valuable report (A/AC. 98/4) to the Committee on these matters, which stands as a part of the documentary records of the Committee.

2. The present part I is based on the Secretary-General's report. The Committee has sought to summarize the pertinent data in such a way as to facilitate future United Nations discussions relating to the peaceful uses of outer space.

I. — International Scientific Organizations

A. — The international scientific unions.

3. The principal non-governmental international bodies which are interested and active in space research are the international scientific unions in the several major fields of science which benefit by experiments utilizing sounding rockets, satellites, and space probes. These are :

International Astronomical Union (I.A.U.).

International Union of Geodesy and Geophysics (I.U.G.G.).

International Union of Pure and Applied Chemistry (I.U.P.A.C.).

International Scientific Radio Union (U.R.S.I.).

International Union of Pure and Applied Physics (I.U.P.A.P.).

International Union of Biological Sciences (I.U.B.S.).

International Union of Theoretical and Applied Mechanics (I.U.T.A.M.).

International Union of Physiological Sciences (I.U.P.S.).

International Union of Biochemistry (I.U.B.).

4. The International Union of Mathematics (I.U.M.) has also expressed some interest. The interests of the remaining three international scientific unions, i.e. International Geographical Union (I.G.U.), International Union of Crystallography (I.U.C.r) and International Union of the History of Science (I.U.H.S.) lie outside the space field.

B. — The International Council of Scientific Unions.

(See Report of the Secretary General, p. 11).

C. — The International Geophysical Year.

13. The activities of I.C.S.U. in space research began as a part of the programme of the Special Committee for the International Geophysical Year (C.S.A.G.I.).

14. At a C.S.A.G.I. conference in Rome, in 1954, a resolution was passed urging that as many nations as possible consider the development of satellites carrying scientific instruments, which would be placed in orbits around the earth during the International Geophysical Year. The resolution stated :

« In view of the great importance of observations during extended periods of time of extra-terrestrial radiations and geophysical phenomena in the upper atmosphere, and in view of the advanced state of present rocket techniques, C.S.A.G.I. recommends that thought be given to the launching of small satellite vehicles, to their scientific instrumentation, and to the new problems associated with satellite experiments, such as power supply, telemetering, and orientation of the vehicle. »

15. Within a year, both the United States and the U. S. S. R. indicated their intention to launch satellites. Successively, attention was devoted by C.S.A.G.I. to the several phases of the earth satellite-tracking programmes. Special emphasis was placed on the need for wide international co-operation in tracking satellites to develop their full scientific potential. Many nations indicated a willingness to set up satellite observation stations.

16. Being non-governmental in organization, and with limited financial resources, C.S.A.G.I. achieved great success through the voluntary co-operation of the participating national committees. Particularly in the rocket and satellite programmes, the financial and logistic support of the programme by the several national governments was essential.

17. With the termination of the International Geophysical Year, there was a wide-spread desire to continue international co-operation in the planning and co-ordination of space research as well as other activities of the year. This led to a programme of International Geophysical Co-operation 1959 (I.G.C.) and to the formation of several special committees, including a Committee on Space Research (C.O.S.P.A.R.).

D. — The Committee on Space Research.

(See Report of the Secretary General, p. 21).

E. — Other international organizations.

II. — Inter-Governmental Organizations

A. — United Nations.

35. As with other problems in international political co-operation and international economic and social collaboration among its

Members, the ground on which the activities and resources of the United Nations in this field rest is the provision in Article 1, paragraph 4 of the Charter that the United Nations shall be a centre for harmonizing the actions of its Members in attaining their common ends, and the pledge given by Members in Article 56 « to take joint and separate action in co-operation with the Organization for the achievement » of solutions of international economic, social, health, cultural and educational problems. The General Assembly, the Economic and Social Council, and their subsidiary organs, as central organs for harmonizing the actions of Members, have developed international co-operative activities in fields affected with a scientific interest.

36. The Secretary-General has similarly used his functions to promote co-operation among Governments. In this he has sometimes acted on his own initiative and sometimes in response to requests from the General Assembly, asking him to make studies, to take procedural steps or, in some cases, to make proposals.

37. There are other areas of United Nations activity to which developments in the peaceful uses of outer space are relevant. These lie in the domain of promotion of the economic, social and cultural development of States and in the progressive development of international law. The Economic and Social Council is concerned with major inventions or technological improvements which affect existing patterns of economic and social activity. The progress anticipated in the near future in outer space in the fields of meteorology, climatology, telecommunications, transport, and possibly biology, is important from the standpoint of long-range economic policies.

38. One of the more important functions of the Organization is to assist in co-ordinating the activities of the specialized agencies. In this capacity, through the Economic and Social Council, it follows the work of the specialized agencies and assists in inter-agency co-ordination, at the Secretariat level, through the Administrative Committee on Co-ordination and its Preparatory Committee.

39. Of relevance also is the function of the General Assembly under Article 13 of the Charter to initiate studies and make recom-

mendations for the purpose of encouraging the progressive development of international law and its codification.

B. — United Nations Educational, Scientific and Cultural Organization.

40. In accordance with its constitutional responsibilities, Unesco has, since its inception, undertaken as one of its major tasks to promote scientific co-operation between its Member States. In doing so, Unesco has worked in the closest collaboration with the United Nations, the specialized agencies and the International Atomic Energy Agency (I.A.E.A.). To this end the General Conference, at each of its sessions, has included in the regular programmes of the Organization a resolution relating to the promotion of scientific research through international co-operation. The relevant resolution in the programme for1959-1960, adopted by the General Conference at its tenth session (November-December 1958), reads as follows :

« 10 C/Resolution 2.41 : The Director-General is authorized, in co-operation with the United Nations, the specialized agencies, and other appropriate international organizations and national and regional research bodies, on the advice of advisory committees when appropriate, to study scientific problems, the solution of which may help to improve the living conditions of mankind, to stimulate research on these problems and to promote when appropriate the adoption of international or regional measures for the development of such research, particularly in the following fields :

(*a*) General problems of scientific research ;

(*b*) Humid tropical zone ;

(*c*) Marine sciences ;

(*d*) Cell biology ;

(*e*) Basic research in nuclear physics ;

(*f*) New sources of energy ;

(*g*) Numerical processing of information and electronic computation ;

(*h*) Interdisciplinary brain research ; and

(*i*) *Exploration of extra-terrestrial space* ; and

to participate in the activities of member States, at their request, in scientific research in the fields of humid tropics research, marine sciences, basic research in nuclear physics, and the numerical processing of information and electronic computation. »

41. In the past, Unesco has carried out a programme of this type either by drawing up practical proposals to be implemented by groups of member States, or by assuming direct responsibility for international scientific research projects.

42. In fulfilling its scientific functions, Unesco resorts to a number of methods :

(*a*) Co-operation with international non-governmental scientific organizations. Unesco has created, or sponsored the creation of, international non-governmental organizations, such as the Union of International Engineering Organizations and the Council of International Medical Organizations. Special mention should be made of the collaboration between Unesco and I.C.S.U. An agreement between the two organizations, signed in 1951, provides that they will assist one another with a view to facilitating the execution of their joint programme in the field of international scientific co-operation, and that they shall consult each other on all questions falling within their common sphere of interest. Unesco has undertaken to grant I.C.S.U. an annual subvention designed to facilitate the co-ordination of the activities of the Council's member organizations and to provide funds for such scientific projects included in the programme of I.C.S.U. as are of international interest and in line with Unesco's aims. I.C.S.U. has undertaken to give specialized advice to Unesco, at the latter's request, on the planning of its programme in the field of international scientific co-operation, and to advise Unesco on its working relationship with the non-governmental organizations within its field. It has further undertaken to give particular attention to, and to develop to the utmost, those of its programme activities which come within the framework of Unesco's basic programme.

(*b*) Organization of international scientific conferences on important new subjects which are not yet being dealt with by international governmental or non-governmental organizations and of symposia on specific subjects related to the implementation of Unesco's programme.

(*c*) Programme of co-ordinated research, surveys, training, etc., carried out with the help of special advisory committees composed of leading scientists and representatives of international scientific unions.

43. Mention should also be made of the Provisional International Computation Centre (P.I.C.C.) established by a bilateral agreement concluded in September 1957 between Unesco and the Italian Institute of Higher Mathematics (*Istituto Nazionale di Alta Matematica*), pending the establishment of an International Computation Centre on a permanent basis. The provisional Centre has been created for a period of two years but will automatically cease to exist when the inter-governmental Convention establishing an International Computation Centre comes into force.

44. The Provisional Centre commenced its activities in January 1958, in Rome. The main functions of the Centre are : (*a*) to ensure mutual assistance and international collaboration between existing bodies dealing with computation and information processing, in particular as regards scientific and technological studies ; (*b*) to promote the exchange of information both on scientific matters and on the facilities existing in various countries ; (*c*) to assist, on request, the countries which do not possess their own computation equipment, and this assistance may consist either in undertaking certain computation tasks with the help of existing services or in giving advice for the creation of national centres ; (*d*) to help international organizations which require its assistance ; (*e*) to promote the training of specialized staff ; (*f*) to act as a link between the users and the designers of computation equipment.

C. — World Meteorological Organization.

45. The objectives of the World Meteorological Union (W.M.O.), as stated in the World Meteorological Convention of 1947, are :

(*a*) To facilitate world-wide co-operation in the establishment of networks of stations for the making of meteorological observations or other geophysical observations related to meteorology and to promote the establishment and maintenance of meteorological centres charged with the provision of meteorological services ;

(*b*) To promote the establishment and maintenance of systems for the rapid exchange of weather information ;

(*c*) To promote standardization of meteorological observations and to ensure the uniform publication of observations and statistics ;

(*d*) To further the application of meteorology to aviation, shipping, agriculture, and other human activities ;

(*e*) To encourage research and training in meteorology and to assist in co-ordinating the international aspects of such research and training.

46. The Organization acts as a clearing-house for the exchange of information among its members, and for the promotion of agreements among its members regarding both the routine and exceptional transmission of meteorological data. It is not, however, an operational organization. It operates neither weather stations nor communication facilities. Its recommendations and agreements are carried out only through the co-operation of the meteorological services of the member countries.

47. Since earth satellites represent a new observational tool of great potential value to meteorology, early in 1958 W.M.O. began to consider its role in connexion with international co-operation and programmes in the peaceful uses of outer space.

48. The subject was placed on the agenda of the tenth session of the Executive Committee of W.M.O. (29 April, 17 May 1958). The Committee decided (resolution 14 (E.C.-X.)) that W.M.O. should accept responsibility for meteorological questions related to artificial satellites in so far as they call for action or study by a specialized agency of the United Nations. The Committee further requested the President of its technical Commission for Aerology (C.A.E.) to nominate a rapporteur to study the meteorological aspects of artificial satellites and to report to the eleventh session of the Executive Committee on any possible activities which might legitimately be undertaken by W.M.O. in this field.

49. The report prepared by Dr. H. Wexler, was submitted in April 1959 to the Third Congress of W.M.O. which laid down the following policy : the organization would encourage the development and use of artificial satellites as a means of providing

valuable meteorological data, and collaborate as required with the United Nations, other specialized agencies and scientific organizations, in particular C.O.S.P.A.R., in artificial satellite programmes of interest to meteorologists or on which the advice of meteorologists would be useful.

50. The eleventh session of the Executive Committee, which took place immediately after the Third Congress, took note of the latter's policy and directives.

D. — International Telecommunication Union.

56. The International Telecommunication Union (I.T.U.) is the body responsible for the international co-ordination and rational use of all forms of telecommunications by landline, submarine cable or radio means. It is advised by two technical committees, the International Telegraph and Telephone Consultative Committee (C.C.I.T.) and the International Radio Consultative Committee (C.C.I.R.), which deal with line and radio problems respectively. In the field of radio communication, I.T.U. drafts regulations which among other things define the conditions, procedure and standards for all applications of radio to the communication of intelligence in any form, including telegraphy, telephone, picture transmission, broadcasting television, radar, navigational aids, and scientific uses such as radio astronomy.

International control of radio transmission : the technical problem.

57. Radio communication involves the radiation of electromagnetic waves, one of the important characteristics of which is their frequencies. Different bands of frequencies are allotted for different services within a spectrum which has rapidly become overcrowded as the applications of radio have increased, and this is in spite of the fact that for the present and in the foreseeable future the radio spectrum covers the range of 10 kilocycles per second to 3 million megacycles per second. It is thus necessary for all users to conform to very strict rules regarding the area within the band which they may use for their transmissions. Radio transmissions, and the codes and procedure used in connexion therewith, are subject to the control of national administrations, who, as members or associate members of I.T.U., are allotted

precise radio frequencies and may operate transmissions only within their allotment. Consequently, the basic function of I.T.U. is to establish international regulations and codes of operation, and to act as the world agent for the equitable and effective distribution of radio frequencies to all users. These regulations and frequency allocations are subject to adjustments from time to time as may be required, owing to changing conditions or as a result of the improvement of radio techniques. Among the problems facing engineers are the vagaries in the propagation of radio waves around the earth, interference due to atmospheric disturbances, and variations in the troposphere (lower atmosphere) and ionosphere (upper atmosphere) through which the waves travel. The ionosphere, in particular, is subject to disturbance due to solar activity, with the consequent dislocation of terrestrial radio transmissions. It is obvious, therefore, that any launching of rockets or earth satellites which carry radio transmitters must be of concern to all persons connected with telecommunications, since these transmitters are potential sources of further interference with other terrestrial users of the radio spectrum. Over the past year many statements have been made, and there is considerable documentation about the pollution of the radio spectrum and the consequent difficulties for world communications.

58. As an indication of the future dangers that could be expected for the telecommunication services, it is easily possible for a satellite equipped with an effective radio transmitter to be supplied with batteries charged by solar radiation to continue in orbit for many decades. This could seriously interfere with communications that operate on the same frequency or adjacent frequencies to the satellite's transmission during its travel around the earth every hundred-odd minutes. But it is well to remember that it is explicity in the I.T.U. regulations that no such avoidable interference may be caused.

59. According to the 1947 Convention drawn up at Atlantic City, I.T.U. (*a*) acts as the general agent for the allocation of radio frequencies; (*b*) promotes the development of technical facilities by establishing standards and operating rules in order to improve telecommunication services; and (*c*) harmonizes the activities

of nations for the attainment of these ends. To implement this work, the Convention set up an eleven-member International Frequency Registration Board (I.F.R.B.), whose duties are to record the frequencies allocated by members to users in accordance with the provisions in the Radio Regulations and to furnish advice regarding the maximum practicable number of radio channels in those portions of the spectrum where harmful interference may occur. To assist it in this aspect of its work, I.T.U. has also the advice of C.C.I.R. This is a scientific body which meets every three years to consider various technical radio questions and to make recommendations for action either by its national members or by I.T.U. Further, C.C.I.R. has adopted the practice, in recent years, of calling upon U.R.S.I. for its advice. This is a strictly non-political body which fosters international research in scientific radio, and brings a detached scientific approach to any radio problem including those that might in application have a political colouration. It is possible, or even likely, that C.O.S.P.A.R., if it continues in being, could similarly act in an advisory capacity in collaboration with U.R.S.I.

60. At the recent Los Angeles meeting of C.C I R , a recommendation concerning the allocation of frequencies to transmitters on space vehicles was made ; this will be presented during the Administrative Radio Conference of I T.U., which will open on 17 August at Geneva. In its working paper presented to the *Ad Hoc* Committee, I.T.U. indicates that the Conference agenda will also carry the item « Communications with outer space ». Whether this will necessitate the amendment of the 1947 Convention remains to be seen. There appears to be no doubt, however, that efforts will be made for the reallocation of the radio spectrum to provide special bands for communications with and between locations in space.

The International Radio Consultative Committee and its recommendations.

61. As already mentioned, the Committee meets in Plenary Assembly at intervals of about three years to consider questions that had been referred to one or more of fourteen study groups dealing with specific subjects. Recommendations adopted at its plenary meetings are submitted to I.T.U. as a basis for action.

Some technical and frequency problems are, however settled by direct agreement at C.C.I.R. level. The very nature of radio communication makes mutual international agreement on frequency allocation essential. The Committee makes a study of the propagation of radio waves and reception characteristics in different parts of the world to enable it to recommend to I.T.U. the best frequencies for the various services, from the point of view of reliability and freedom from interference. Atmospheric disturbances have been analysed and an atlas of thunderstorm activity prepared to facilitate the planning of world-wide radio communication systems.

62. In recent years frequencies had been assigned to radio astronomers, and their need for the exclusive use of certain bands in the radio spectrum has had to be recognized. The Committee has recommended that I.T.U. should afford complete protection to the frequencies used in radio astronomy : (*a*) molecular or atomic nuclear frequencies, particularly in the hydrogen line of the spectrum ; (*b*) bands allocated for standard frequency and time-signal transmissions ; and (*c*) seven other frequency bands that needed to be kept clear of man-made interference. The case of radio astronomy has thus established a precedent for the allocation and protection of frequency bands for a specific scientific purpose.

63. In the case of space research, C.O.S.P.A.R. has already recommended that special frequencies should be assigned, and C.C.I.R., at its Plenary Assembly held at Los Angeles in April 1949, considered the technical aspects of the matter. In a detailed technical report on « Factors Affecting the Selection of Frequencies for Telecommunication with and between Space Vehicles » (document 662), the relevant requirements are considered. In some cases, it is desired to use radio waves which will be deviated in the transmission through the ionosphere and troposphere, so that the characteristics of these regions can be studied by tracking signals received from satellites in known positions. In some other cases, it is desired to use frequencies for which the atmosphere is quite transparent, so that the waves pursue a straight line trajectory between the space vehicle and the receiver. In a third case, frequencies are required for intercommunication between the space vehicle and the receiver. Finally, frequencies are required

for intercommunication between space vehicles under conditions that the corresponding waves may not be receivable at the earth's surface and so cause no interference with world communications using the same frequencies.

64. These brief comments serve to illustrate the fact that the allocation of frequencies for use in communications with and between space vehicles is a matter that requires some considerable study of the technical problems involved.

65. The Los Angeles Plenary Assembly of C.C.I.R. made recommendations and adopted resolutions on « Selection of Frequencies used in Telecommunication with and between Artificial Eearth Satellites and other Space Vehicles » (document 531), « Influence of the Troposphere on Frequencies used for Telecommunication with and between Space Vehicles » (document 530), and « Effects of the Ionosphere on Radio Waves for Telecommunication with and between Space Vehicles beyond the Lower Atmosphere » (document 538).

66. In addition to making these recommendations and resolutions, C.C.I.R. set up a new Study Group « to study the technical questions regarding systems of telecommunications with and between locations in space ». While the work of the study group will produce more specific recommendations as to what frequencies are appropriate for space communications, it seems likely that the progress of space science will necessitate I.T.U. having to take early action in allotting frequencies for use in space vehicles, even if these are only available on a temporary basis.

E. — International Civil Aviation Organization.

67. The objects of the International Civil Aviation Organization (I.C.A.O.) are to develop the principles and techniques of international air navigation and to foster the planning and development of international air transport so as to ensure the safe and orderly growth of international civil aviation throughout the world.

68. While I.C.A.O. has not so far carried out any specific activity directly related to the peaceful uses of outer space, a number of problems of outer space fall within the field of interest of the Organization.

F. — International Atomic Energy Agency.

73. No work is contemplated by the International Atomic Energy Agency (I.A.E.A.) in the field of outer space in the immediate future. However, I.A.E.A. has an interest in the nuclear technology of outer space and might advise on its health and safety aspects.

G. — World Health Organization.

74. The World Health Organization (W.H.O.) is not now doing any work specific to outer space nor does it contemplate doing so in the immediate future. The Organization can, however, be most useful to any outer space programme in stimulating research, publishing medical findings and holding symposia and seminars pertinent to medical or health problems associated with space exploration and travel.

H. — Inter-Governmental Maritime Consultative Organization.

75. The Inter-Governmental Maritime Consultative Organization (I.M.C.O.) has at present no programmes in the field of outer space. However, in view of its over-all responsibilities for international shipping matters, particularly the problems of safety at sea, navigation and improved communications, it can be expected to become associated with outer space developments affecting these responsibilities.

PART II

(PARAGRAPH 1 (b) OF GENERAL ASSEMBLY RESOLUTION 1348 (XIII))

I. — Introduction

A. — Mandate of the Committee.

1. The task of the *Ad Hoc* Committee on the Peaceful Uses of Outer Space under paragraph 1 (*b*) of General Assembly resolution 1348 (XIII) is to report on :

« The area of international co-operation and programmes in the peaceful uses of outer space which could appropriately be under-

taken under United Nations auspices to the benefit of States irrespective of the state of their economic or scientific development, taking into account the following proposals, *inter alia* :

« (i) Continuation on a permanent basis of the outer space research now being carried on within the framework of the International Geophysical Year ;

» (ii) Organization of the mutual exchange and dissemination of information on outer space research ;

» (iii) Co-ordination of national research programmes for the study of outer space, and the rendering of all possible assistance and help towards their realization. »

2. In preparing this report, the Committee has reviewed the present position and trends in peaceful space activities from a scientific and technical point of view. Drawing on the experience of its members in international scientific co-ordination, it has then analysed the present methods and organs for co-operation in the use of outer space and considered areas of present and future need for co-operation.

3. The Committee completed its task by specifying areas in which co-operation might appropriately be undertaken under the auspices of the United Nations.

B. — Brief history.

4. Man's interest in space is age-old. Until the last decade, however, his inquiries into the properties and objects of outer space have been confined to observations and measurements made from the surface of the earth or near that level. Mountain-top observatories, aircraft and balloons served in the past to sharpen the scientist's measurements, but it remained for the high altitude rocket to open the domains of outer space to direct observation without the obscuring and distorting effect of the earth's atmosphere.

5. Rocket exploration of the upper atmosphere began in 1945. Since then both the development of rocket vehicles and of the techniques for making measurements by rocket-borne instruments have advanced rapidly. The year 1957 saw the advent of man-made satellites circulating around the earth in the adjoining space.

and in 1959 vehicles were launched which passed out of the area predominately controlled by the earth's gravitation to become new planets circulating around the sun. It is now possible to explore the earth's atmosphere with many kinds of instruments to all heights, to place instrumented satellites above the atmosphere, and to probe the depths of space between the planets with automatically operating scientific equipment. Numerous facilities with varying capacities for the launching of scientific research rockets exist around the world, and many countries are expanding their activities in rocket research.

6. Looking into the future, and bearing in mind the rapid development during the past decade, it seems possible now to make reasonably realistic forecasts about expected developments valid for the next two to four years. Admittedly, present views into the future must be subject to continuous review and extension as new lines of thought are developed on the basis of technological achievements.

C. — Problems that face us.

7. In space activities, scientific and technological, there has been a great surge forward which opens new perspectives for human progress. Even more than in astronomy, they inherently ignore national boundaries. Space activities must to a large extent be an effort of Planet Earth as a whole. Along with the opportunities in prospect for all peoples in the space age, there are problems which face us in arranging for these advances in science and technology on a global scale.

8. Means must be found to utilize scientific and technical talent wherever it may exist, either in connexion with space experiments and undertakings themselves or in the invaluable supporting research and activities which must go along with them. Means must be found for co-ordination and facilitation of the activities of the scientific community. A wide-spread problem is the encouragement and support of space activities nationally commensurate with the obvious international and popular interest. For some aspects the question of international financial support becomes important and would be on an unusually high scale compared with most previous international undertakings in science and technology.

9. Coming sooner than many realize are problems connected with effectively taking advantage of the practical applications of space science, some of which, like weather, are already over the horizon while others will surely rise in the near future.

10. The Committee recognizes that the great forward surge of space activities may also tend to widen the gap between the technologically advanced nations actively launching vehicles into space and other nations watching and wishing to take part in space activities, but feeling unable to do so. The problem is to make available and to exploit the possibilities that exist for participation by nations at all levels of development, from supporting research or operation of tracking stations to launching small vehicles or joining with others in more advanced undertakings. A related problem lies in arranging the sharing of basic scientific information and topical data so that wide-spread participation is possible.

11. The Committee feels strongly that the conduct of space activities must be effectively open and orderly. It is therefore important to find means for having peaceful space activities clearly announced right from the earliest stages and to make such activities known both to scientific specialists and to the world at large in an efficient manner. A determined attack on these problems is urgent, because the development of space activities is advancing at a staggering rate.

12. Finally, there is the over-all question of whether man's advancement in outer space will redound to his benefit. Here man's intent is of overriding importance, a point which was recognized during discussions at the last session of the General Assembly, when the resolution which established the Committee was adopted. The Committee has borne in mind throughout the fact that other organs within the United Nations have been given the important tasks of lessening international friction, encouraging mutual trust and confidence and facilitating progress on disarmament.

D. — References to conclusions.

13. The following sections of this report contain numerous specific conclusions. The Committee considered the desirability of restating these conclusions explicitly in a final section, but found

that to do so would require considerable repetition of the text. The following section index calls attention to these conclusions :

II. — Space Activities

14. Attention is also drawn to the general conclusions given at the end of the report.

15. At the outset it is desirable to emphasize that scientific work in outer space embraces many disciplines involving both pure research and applied research.

In the area of pure science, the primary objective is the advancement of knowledge of the environment in which the earth moves, and later the extension of this knowledge to other parts of the solar system, and even further afield. In the applied and more technological area there are two phases :

(*a*) The development of space vehicles of a great variety of sizes and uses ;

(*b*) The use of these vehicles to advance applied science in such fields as meteorology and communication.

16. The development of vehicles which make possible the scientific study of outer space has, to a large extent, been the outcome of military objectives and therefore problems of national security have prohibited the free exchange of information. Nevertheless, the technology of these vehicles has developed along parallel lines in several countries and it may be stated that the problems are now more those of engineering then of science. In view of this, the Technical Committee has not considered it necessary to deliberate on the vehicles used for the exploration of outer space, but has started with the premise that these are available even though the larger vehicles are at present only available to countries whose industrial, technological and, especially, financial resources make them possible.

17. Although great resources are required to construct a space vehicle of extreme range, this does not in any way mean that scientific activities in space are limited only to large countries. Knowledge of the physical state of the upper atmosphere (the exact limits of which cannot be defined) at levels inaccessible to aircraft and balloons is far from satisfactory. Between the range attainable by aircraft and balloons and the lowest practicable satellite level, comparatively inexpensive rockets can be used for the conduct of scientific experiments and many countries should be able to participate in the experiments. The feasibility of such experiments has been well demonstrated by the excellent work carried out by Australian, Canadian, French, Japanese, Soviet, United Kingdom and United States scientists who have made valuable contributions quite apart from the more spectacular results of satellites and space probes.

A. — Scientific investigations.

18. The kinds of measurements made in space science programmes are mostly similar to, or developments of, those made from balloons or sounding rockets in the past several years. In this era of advancing space technology, more complex measurements in the lower atmosphere can be made. The regions accessible to measurement are now being extended to the earth's outer atmo-

sphere, into interplanetary space, to the moon and planets and the sun. The simple experiments of today will soon develop into work with complex satellite or space observatories. Some of the aims of space investigations are to increase our knowledge by direct or improved observation of the following :

(*a*) The atmospheres of the earth, sun and planets, as well as possible vestiges of an atmosphere on the moon, including the electrically conducting regions or ionospheres in these atmospheres ;

(*b*) Electric, magnetic, and gravitational forces throughout space in the solar system, whose strength and properties have hitherto only been inferred by very indirect reasoning ;

(*c*) Diluted gas and scattered dust particles in space between the planets and within comets ;

(*d*) Electrified particles, in some cases emanating from the sun, and always influenced by electric and magnetic forces within the solar system ; such particles include those producing the polar auroras, those stored in the radiation belts in the vicinity of the earth, and the very energetic cosmic rays ;

(*e*) The details of the external form and the internal composition of the earth, planets, and moon ;

(*f*) Conceivable living organisms outside the earth, either on the surfaces of other planets or elsewhere ;

(*g*) Stellar and galactic objects and phenomena.

Special problems such as the verification of certain conclusions from Einstein's general theory of relativity, are also among the objectives of space experiments.

19. These objectives are attainable by series of individual experiments, each with its special instruments, especially designed and tested to withstand the rigours of launching and of the space environment. A whole new technology is involved in the systems for taking the results of the experiments and transmitting them back to earth.

20. The first use of earth satellites and space probes was made under the auspices of the International Geophysical Year (I.G.Y.). The Year enterprise was sponsored by the International Council

of Scientific Unions (I.C.S.U.), a non governmental body, and was carried out through the co-operation of national scientific groups in some sixty-six countries, each of which decided on its scientific programme and arranged for its supports. Many countries had programmes in the I.G.Y. category « Rockets and Satellites ». As a means of continuing this kind of voluntary international co-ordination and co-operation, I.C.S.U. has established the Committee on Space Research (C.O.S.P.A.R.).

21. It is too early in the space age to envisage all, or even the ultimately most important applications of space research ; however, experience from other areas of scientific inquiry started or spurred by some marked scientific or technological advance gives considerable assurance that the findings of space science will have a strong influence on the future of mankind.

B. — Applications furthering human welfare.

22. As a result of these scientific investigations, it can be expected that there will be many developments leading to practical applications which in turn will add materially to the confort and well-being of the world at large. A few of the possible applications of space technology are now coming into focus and are at present in the earliest stages of development. How and when these applications will mature will depend on many factors which cannot now be predicted. Some of the applications which are now foreseen are : the collection of data, particularly for immediate meteorological purposes ; the improvement of long distance radio communication ; a means of improving man's view of the size and shape of the earth and of the distribution of land masses and water ; and an all-weather global navigational system.

23. These and other applications of satellites that develop as a result of advancing technology will not become feasible immediately, but must necessarily depend upon an orderly sequence of technological developments. It must be realized, however, that the time when these applications will become available depends on many other factors over which the scientists can exercice no control.

C. — Improvement of weather forecasting.

D. — Improvement of radio communications.

31. Currently available means of world-wide communications suffer from severe limitations of capacity. For example, the present transatlantic cables are expected to be saturated by 1962. Owing to the anticipated increase in messages during the coming decade, a new cable with several times the capacity of the present ones will be saturated by the time it is available.

32. Apart from enclosed cables, world-wide communications depend on the presence of reflecting regions in the high atmosphere which permit radio waves to be sent from one part of the world to another, despite the obstacle presented by the curvature of the earth. Nature has provided such reflecting regions in the high levels of the atmosphere, from 70 kilometres upwards where free electric charges are created when the sun shines on the air. However, these natural reflecting layers are only useful on certain radio wave-lengths and are ineffective on others. Since they are often disturbed by electromagnetic processes on the sun and by polar auroras, their properties are erratic at certain times and places which can only be anticipated in part.

33. In view of these circumstances, it has become desirable to search for new means of economical world communications ; a promising approach to a truly world-wide system is the use of earth satellites as passive reflectors or active repeaters.

34. In the case of the passive reflector, an antenna using much shorter waves will beam a powerful signal at the satellite which will reflect it in such a manner that it may be received by suitable equipment anywhere within reach, or will reflect the signal in specific directions. Such a satellite might be used simultaneously by many, subject only to allocation of non-interfering frequencies. An operational system might involve some twenty-five satellites together with extensive ground equipement.

35. The technique of using active repeaters in satellites will involve directing a signal to a satellite, which in turn will rebroadcast it to the ground. Rebroadcasting may be accomplished instantaneously or with suitable delay until the satellite has moved into a good position relative to the intended receiver. Three such satellites spaced 120 degrees apart in 35.000 kilometre altitude orbits at the equator might comprise a useful system.

36. Each of the two techniques appears to have advantages and disadvantages. Passive reflector systems involve simple satellites but appear to require relatively large numbers and involve heavy requirements for ground transmitting and receiving equipment. Active repeater systems appear to require fewer satellites and reduced ground equipment; however, they would be susceptible to defective operation, have a limited frequency range, and require a continuing power supply on board.

37. Communications satellites are currently in a very early stage of development. Their technical aspects remain to be explored as does the full extent of their economic and other implications. However, the substantial increase in the amount of information that may be transmitted internationally in a given interval of time may ultimately have a major impact on the relations of countries throughout the world.

38. It should be noted that preliminary experiments conducted at moderate cost with vertically ascending rockets give ample scope for important contributions from scientists in many countries to this technical problem.

E. — Geodetic and mapping satellites.

F. — Navigation satellite.

40. The navigation satellite may provide the basis for an all-weather long-range navigation system for surface vehicles and aircraft. With the use of suitable ranges of frequencies for transmission, it would be possible to establish positions with great precision irrespective of the prevailing weather. At the present time, there is no such world-wide all-weather system of navigation.

G. — Manned space flight and exploration.

III. — Tools for Space Activities

45. The development of vehicles for scientific activities in outer space is the key to executing a successful space programme. Over the centuries, man has accumulated a good deal of knowledge about his planet, the solar system and the universe, but any real penetration of space must still await the development of adequate

vehicles. In terms of the mission to be accomplished by these vehicles, they can be classified as follows : (*a*) sounding rockets ; (*b*) earth satellites ; and (*c*) deep space probes.

A. — Sounding rockets.

46. Rocket exploration of the atmosphere began in 1945. Since then both the development of rocket vehicles and of the techniques for making measurements by rocket-borne instruments has advanced rapidly.

47. The phrase « sounding rockets » designates a rocket research vehicle that is used to sound the upper atmosphere, in much the same sense that the mariner sounds the ocean depths or the meteorologist uses sounding balloons for observations in the lower atmosphere. There exists a wide variety of sounding rockets ; some can reach heights of only tens of kilometres, while others reach to hundreds of even thousands of kilometres. In an effort to distinguish between sounding rockets and the deep space probe to be discussed below, an arbitrary definition is adopted as follows : a sounding rocket is a vehicle launched vertically or nearly vertically that reaches an altitude of no more than one earth's radius, or approximately 6000 kilometres.

48. This definition is somewhat arbitrary, though not completely so. There are advantages to this definition in that vehicles to attain heights greater than about one earth's radius are substantially more expensive than those designed for lesser heights. Thus, one may anticipate the participation of many countries in sounding rocket programmes, whereas participation in the launching of deep space probes will probably be limited for economic reasons. Similarly, a sounding rocket operation can generally be carried out entirely within the domains of a single country.

49. With present technology, the state of the upper atmosphere can be studied by means less expensive than rockets, up to heights of about 30 kilometres. Relatively inexpensive sounding rocket experiments may start from this level and extend upwards. Satellites, as has been noted, cannot cover the intermediate levels between the 30 kilometres mentioned previously and the lowest practical satellite orbits of about 200 kilometres, yet knowledge

of the physical state of the atmosphere at these levels is far from satisfactory.

50. Whereas we have much to learn about the methods and techniques of fully exploiting satellite and space probes, sounding rocket technology is now at the stage of becoming fully developed.

B. — Earth satellites.

51. An earth satellite is simply a man-made moon revolving about the earth. The work of the past year or two has already shown the possibilities of artificial earth satellites as a new technique for exploring the physical characteristics of the earth's atmosphere and the space beyond.

52. When launched in a satisfactory manner as to speed and direction, these satellites travel in elliptical orbits around the earth at heights which may range from a few hundred to many thousands of kilometres. Such a satellite forms a vehicle which may house a number of scientific instruments, and can carry out a number of functions simultaneously.

53. The data associated with the experiments can be obtained from a satellite in three ways : (*a*) by transmission directly to the earth by radio communication ; (*b*) through storage in a suitable recorder which can be interrogated by radio command when the satellite is in a suitable position relative to a receiving station ; or (*c*) eventually, through physical recovery of records from satellites that are returned to the earth.

54. In the case of (*a*) it is necessary to have suitable receiving stations deployed over the earth to collect the information at various points as the satellite travels round its trajectory. In the case of (*b*), although the stored information can be extracted when required, it is still necessary to have a network of tracking stations over the earth, in order to establish the positions of the satellite at the times the various scientific observations were made.

55. The orientation of the orbit of the satellite is predetermined by the launching conditions. When set at an appropriate angle to the meridian, this trajectory may either cover the entire surface of the earth as it rotates as it would in passing over the poles,

or it may be confined to a relatively small zone about the equator. For different investigations, different orbital trajectories may be required and careful planning on an international scale is required to make the best use of this expensive type of technique.

56. Among the space vehicle operational techniques yet to be perfected are those related to the re-entry and recovery of vehicles. At this time, not all the problems associated with this type of operation can be fully evaluated, but because of the nature of the problem, it may be desirable to consider ways and means of minimizing the possibility of accidents.

C. — Space probes.

57. A space probe is defined as an exploratory vehicle, not an earth satellite, that goes into space beyond one earth's radius from the surface of the earth. Such vehicles can be instrumented for numerous important scientific investigations.

58. By launching a payload at a sufficiently great speed, a rocket can be used to project scientific instruments into interplanetary space. If the aim of such a space probe is simply to make measurements deep in space, far from earth without any particular reference to any celestial body such as a moon or planet, then it suffices to project the object at a sufficiently great speed in a general outward direction. On such a mission, control mechanisms can be kept at a minimum. On the other hand if, for example, it is desired to project the object close to the moon or close to Venus, then exacting control and timing requirements must be met.

D. — Network of observing stations.

59. Ground observing stations are essential to the successful conduct of any space activity involving satellites or space probes. The primary functions of such stations are : (*a*) tracking the space vehicle by radio, radar and optical methods, and (*b*) receiving and recording the radio signals transmitted from the vehicle. These signals contain in coded form the observational measurements made in the vehicle : this is called telemetry. Some stations may be used to give instructions by radio to the vehicle. In general, a world-wide network of stations is needed, although in some cases

only a small number may be required. For sounding rocket experiments, for instance, usually only a single station or close-spaced group of stations is needed.

60. Tracking is done by radio techniques for satellites while they transmit. Optical and radar techniques can be employed throughout the life of a satellite. High accuracy of position and time are essential to allow the orbit to be determined well enough to predict future positions for many days in advance. Prompt reporting of tracking observations to computation centres, rapid calculations, and prompt dissemination of prediction information are requirements for an effective tracking network. Customarily, all available observations are used for calculations intended to improve subsequent predictions, while only the most precise tracking observations are used for determination of the definitive orbit needed in interpreting the scientific experiments which may be carried on the satellite.

61. Radio is almost the only way to track space probes. When these are at large distances from the earth, the signals are inevitably very weak and require the use of large radio telescopes such as those used in radio-astronomy for detection. However, few stations are needed in the tracking network for such experiments because at great distances the vehicle is observable from about half of the earth.

62. Telemetering signals are commonly recorded at the same stations which do radio tracking. For space probes this is almost essential because of the extreme sensitivity of receiving equipment needed for both purposes. However, for satellite experiments, telemetry may be recorded easily with radio receivers without the complicated arrangements for measuring the angular position of the radio transmitter. For many experiments, more telemetry stations are needed than tracking stations.

63. The operation of tracking and telemetry equipment in this network of ground stations has been an important way in which many countries have participated in space science beginning with the International Geophysical Year. Some countries have also used tracking-type observations of satellite radio transmissions to make significant findings about the earth's ionosphere. No

single country extends over a sufficient range of latitude and longitude to be able to track earth satellites adequately from its own stations. Earth satellite experiments have been wholly dependent upon international co-operation. This has been accomplished within the I.G.Y.-type framework. Necessary improvements and extensions can be handled within the existing framework.

64. Radio transmissions from satellites and space probes are the only practical way for the scientist to get information on experiments in progress ; they also are the only practical way to track the course of the vehicle, at least until the orbit or trajectory is well determined. Thus the availability of radio frequencies which will not be interfered with by terrestrial radio transmissions is a matter of life and death to the progress of space activities. This is one of the important matters requiring international action in the field of space. The prospective number of satellites and space probes to be launched in the next few years is in the hundreds.

IV. — Supporting Research

65. Many research activities not directly connected with actual flights of sounding rockets, satellites and space probes are essential to the progress of space science and technology. A large portion of scientific research in the field of extra-terrestrial space is done on the ground either at sea level or in high mountains or with the help of balloons up to the altitude of about thirty kilometres. In addition, there are important studies to be done in the laboratory before or after the experiments using space vehicles ; such studies may be theoretical or experimental. Contributions in these areas of research have been made in large number of countries in recent years. In the future, the prospering of space science will continue to depend heavily on work done in countries and by groups of scientists that may not require direct access to space vehicles.

66. Examples of supporting research areas and topics would include the following :

A. — Research which may lead to new or improved equipment to be flown in space vehicles.

This includes :

(*a*) *Instrument components* : power supplies, telemetres, light sources, image intensifiers, photon counters, photomultipliers, micro-electronics ;

(*b*) *Instruments* : magnetometres, spectrometres, pressure gauges, ions probes ;

(*c*) *Materials* : photosensitive, heat resistant ;

(*d*) *Environmental tests* : acceleration effects, radiation effects, vibrational effects ;

(*e*) *Biological* : life support systems, foods, removal of gases and poisons ;

(*f*) *Psychological* : confinement, effects of sensory deprivation.

B. — Research which may lead to more nearly optimum trajectories or knowledge of orbits.

C. — Ground-based physical observation and research.

This includes :

(*a*) *Planetary astronomy* : physical observations of planets and planetary atmospheres by optical and radio techniques ;

(*b*) *Solar activity* : optical flares, radio outbursts, corona, direct and indirect evidence of particle ejections ;

(*c*) *Comets* : photometry and spectroscopy ;

(*d*) *Cosmic rays* : study of primary or secondary cosmic ray particles accessible to ground or mountain-top stations and balloons ;

(*e*) *Meteors* : number, size, orbits by optical and radio techniques ;

(*f*) *Meteorites* : composition, structure ;

(*g*) *Ionospheric studies* : vertical soundings, scattering, whistlers ;

(*h*) *Geomagnetism* : survey of field at surface, variations, disturbances.

D. — Theoretical research and mathematical methods.

This includes :

(*a*) *Magnetohydrodynamics* ;

(*b*) *Cosmology* ;
(*c*) *Astrophysics* ;
(*d*) *Celestial mechanics* ;
(*e*) *Information theory*, including data processing and reduction.

67. Exchange of information is needed in all phases of space research. However, in the areas which are described here, this exchange is particularly valuable because scientific groups in so many countries participate in theoretical, laboratory and ground-based research. Modern techniques could be used to solve documentation and language problems involved in such exchange, which could also be encouraged by symposia, conferences and exchanges of research staff. Mechanisms for some of this exchange of information are being carried over from the period of the International Geophysical Year.

V. — International Co-operation in the Conduct of Space Activities

68. There is a wide area of activities in which international co-operation is desirable, and in some cases required, in order to realize to the fullest the potential benefits of space activities. In some cases, there is simply a requirement for mutual agreements on how to approach specific problems. Once such agreements have been arrived at for the open and orderly conduct of space activities, they can form the basis of an international routine. In other cases, there is need for active co-operation endeavours in which groups of nations assist each other in carrying out various phases of space activities. The following list is illustrative of these kinds of international co-operation :

A. — INTERNATIONAL AGREEMENTS.

Use of radio frequencies.

69. Accomplishment of most uses of space vehicles will depend heavily upon the adequate availability of communications channels. Allocation of frequencies specifically for use by space vehicles and in space activities will be necessary to assure that channels will be available as needed. There already exists in I.T.U. and its advisory bodies the means for handling this problem. The Committee agrees that there is an urgent need for international co-ordination of radio frequencies for use in association with

space vehicles for tracking, telemetry and research purposes. Interference by space vehicles might seriously affect radio services on the earth. Similarly, radio interference from terrestrial sources could cripple the conduct of space programmes. The Committee strongly urges that I.T.U. and the States members of the 1959 Administrative Radio Conference of I.T.U. allocate adequate frequencies for space programmes, with adequate bandwidths for the foreseeable needs of space programmes in the next three years.

70. *Registration of orbital elements.*

Continuing radio transmission.

71. Solar-powered transmitters as well as possible future types of equipment may continue to transmit long after the experimental or other purpose of a satellite has been fulfilled. Such continued transmission can result in interference with transmission from space vehicles still performing a useful purpose. Therefore, it will be necessary to provide for termination of transmission at the end of the satellite's useful life.

Note : The Report deals then with the following items :

Removal of spent satellites,

Re-entry and recovery of space vehicles,

Return of equipment,

Identification of origin,

Contamination.

B. — International co-operation in joint projects.

Simultaneous sounding rocket launchings

77. In the use of sounding rockets to investigate the upper atmosphere and to conduct rocket astronomy experiments, there are several fields of investigation which would be promoted more effectively if simultaneous launchings were made in many countries, as happened during the International Rocket Week in 1958 during the International Geophysical Year, and as is planned for the autumn of 1959 by C.O.S.P.A.R. Organizations such as the International Council of Scientific Unions and the International Astronautical Federation are available to plan the scientific and

technological programmes respectively, but some encouragement by the United Nations may be worth-while.

International use of launching ranges.

78. Thought should be given to means of making available launching ranges for vertical sounding rockets on an international scale for the conduct of experiments for scientific purposes. This has already been done in several cases by mutual agreement between nations or research institutions. This procedure is suitable at the present stage and will continue to be valuable during coming years.

79. In the more distant future, however, these thoughts might be elaborated towards considering the creation of an international rocket range. This step is much more ambitious than earlier arrangements, but its impact on truly international space research would be substantial. Much advice on the selection of programmes for international launching of vertical sounding rockets can be given through the organizations associated with the international scientific unions; possibilities also exist in the United Nations family for the exchange of personnel and for negotiation relating to agreement between Governments on scientific matters. But for instance, through the United Nations, would be a necessary step to take before it would be possible to establish one or more international ranges for sounding rocket research.

Instrumentation of satellites and deep space probes.

80. In some cases it may be desirable to arrange international co-operative projects to provide instruments and scientific payloads in space vehicles. There are several ways in which this may be done.

81. First, one or more scientists from various countries may be invited to become part of the team that is preparing the payload for launching into space. These scientists would work on their part of the instrument equipment in appropriate laboratories in the launching nations, participating as required in all phases of the work. This method seems quite workable and can confidently be expected to be effective.

82. Secondly, a scientist in the launching nation can be designated to prepare an experiment devised by a scientist of another country. He would then work in close co-operation with the originator, and represent him as necessary during all phases of the project. This method, too, is workable and can be effective.

83. Thirdly, one might envisage a scientist in one country preparing an experiment, sending the instrumentation as a box, or a group of boxes, to the launching nation for installation in the payload of the space vehicles. From experience, it can be said that this method will succeed only in exceptional cases, and should not be encouraged during the foreseeable future to the detriment of other approaches.

84. It appears that a strong element in the preparation of such joint instrumentation of space vehicles is the direct negotiation between the responsible scientific administrations. Similar conditions apply to the ground network of observatories at which the measurements must be made by scientists who may be trusted to organize their own co-operation in the most efficient manner.

85. It is worth noting that the international scientific organizations, such as the international scientific unions or Unesco, can contribute substantially to the organization and planning of such forms of co-operation. In this field, however, it may well prove advantageous to have the supporting authority and goodwill of the United Nations, particularly to assist in the resolving of international problems confronting the scientists.

Tracking and telemetering.

86. As discussed in paragraphs 59 to 64, the tracking of a space vehicles and the reception of telemetred signals from it are an essential part of obtaining the scientific or technical data for which the space vehicles is launched. In many cases it will be desirable to have several nations co-operate in the tracking of a space vehicle. Particularly in the case of earth satellites it may be desirable to continue such co-operative tracking for long periods of the satellite's operating life. In the case of space probes, on the other hand, co-operative tracking may well be required only during the first one or two days of the flight, after which only periodic tracking will be required which can probably

be handled by the launching nation with its own facilities and tracking stations.

87. With regard to the telemetering of scientific information from space vehicles, similar remarks apply. It will be usual for the telemetering system to be an integral part of the tracking system. It will frequently be desirable to take continuous records for periods of from hours to days. In such cases, international co-operative reception and recording of the signals will be needed.

Data processing.

88. The processing of tracking and telemetering data to useful form can be a formidable task, particularly in the case of earth satellites from which tremendous amounts of data may be received. It may be desirable to organize an international co-operative programme for such data processing.

Interpretation of data.

89. The theoretical analysis and interpretation of experimental data from space vehicles comprise an area in which international co-operation is highly desirable. The most effective use can be made of experimental results by the participation of scientists throughout the world in interpreting those results and applying them to a further understanding of the universe and to the development of pratical applications.

International exchange of data.

90. Strong international support of existing organizations in the collection, cataloguing and dissemination of data and results obtained from space activities, including supporting is necessary if the world is to benefit fully from and to contribute to the advancement of the space era. Such support includes not only the financial assistance and management provided by the nations operating the already existing world data centres, but also an extension of the number and scope of such centres in view of the bigger role assigned to them by the channeling of data and results from all branches of space research and activities.

91. It appears also that some centralized advice and co-ordination in this area will be required, and this might well be continued within the Unesco-I.C.S.U. framework.

Education.

92. There will be a continuing need to inform not only the scientific and engineering communities, but also Governments and the public about space activities. Unesco has much experience in the preparation and dissemination of texts, manuals, lectures, television programmes, etc., and might be a suitable organization to assume the responsibility for this in the areas of space activities.

Meteorological satellites.

93. It is to be foreseen that a meteorological satellite system of world-wide usefulness will be in operation some years from now. Some international arrangement will be necessary to insure maximum effectiveness of this system in benefiting commerce, industry, agriculture, etc. W.M.O. is an approprate organization to undertake co-ordination, and in fact has already begun to consider this question.

Communications satellites.

94. In the foreseeable future a system of communications satellites may be placed in operation. As in the case of a meteorological system, the communications system will require international co-operation for maximum effectiveness. Problems of frequency allocations, the handling of message traffic, etc., will have to be solved. It would be well for I.T.U. to begin a study of these problems at once.

International launchings.

95. Lauchings of satellites and space probes by an international team would be an extremely complex and organizationally difficult operation, which probably should not be attempted in the immediate future. On the other hand, it may be desirable on occasion for a single nation to undertake to launch a scientific satellite or space probe under the auspices of I.C.S.U. or the United Nations.

In such international project the scientific payload would be instrumented as a co-operative endeavour by some group of nations. In this manner scientists who would not otherwise have the opportunity of performing experiments in space vehicles may be brought more deeply into space research and engineering.

Advice on space activities.

96. Much advice on an international scale on the selection of programmes, on the types of data that should be interchanged and placed in the word data centres, can be given through the organization associated with the international scientific unions. Possibilities also exist in Unesco for the exchange of personnel and for negotiations relating to agreements between Governments on scientific matters.

97. In support of these organizations and activities on the international scene, it would also be desirable to have national committees concerned with space activities in the individual countries; appropriate steps to encourage this should be taken.

VI. — Areas of space activity in which international co-operation should be strengthened

A. — Conduct of space science.

98. Advances in scientific knowledge are usually made by individual specialists or small groups who have reached the frontiers of knowledge in quite a narrow field. By way of example, if one considers such a frontier as the source and nature of the ionization of the upper atmosphere, the number of leading research workers in such a field is by no means too large for the personal exchange of views at meetings or by correspondence. A century ago it would have been only a few individuals who corresponded or met occasionally for a philosophical exchange of ideas or results. As the numbers grew, scientific organizations became desirable and since their aim was advancement of knowledge which knows no national boundaries, scientific organization necessarily was cosmopolitan and soon became international in character. Many such organizations now exist and form the group of international scientific unions represented in I.C.S.U. It must be emphasized

that these unions matured only when the demand for them had grown. Thus, though their organization had been carefully worked out, the need was very apparent before the plan matured.

99. Even with these organizations, actual co-operative projects are often and very effectively carried out between interested and enthusiastic individuals or groups who have studied each other's publications, and, after meeting occasionally to exchange views, have decided to undertake a joint project. Where a national boundary exists between two such groups and an expenditure of money is involved, government approval or support may often be necessary. Such joint scientific activities, however, are by no means bilateral in the sense of excluding others. Their existence and nature is often known to interested colleagues elsewhere and the results are reported at scientific meetings. It may be expected that in the field of space research joint activities of this kind among specialized groups will continue to be an important means of advance. As long as these activities are carried on in an orderly and open manner, they should be fostered and supported since they represent the normal methods of co-operation among colleagues.

100. It is against this background of scientific co-operation that the impact of space science and its possible application must be examined. It is evident that co-operation in space activities will require international organizations of several kinds, but it is necessary to determine these requirements area by area, examining to what extent present organizations are adequate and establishing what need there may be for extensions or additions.

101. The crucial question is thus how international co-operation in the peaceful uses of outer space should be fostered. For example, international co-operation in programmes employing sounding rockets for basic research should probably be carried out by an organization dealing with space research under the aegis of I.C.S.U. or a specific international scientific union, but an active interest on the part of the United Nations would probably be necessary to extend such a programme in due course from the experimental stage into common pratical application. Such interest by the United Nations might be expressed by a recommendation that Member States encourage their national

scientific centres to expand their international relations in the field of space science generally. Another way might be to ask the Secretary-General to keep the development of international co-operation in this specific field under review and report to the next session of the General Assembly on the progress made. Encouragement of this kind might be effected through the establishment of a special United Nations body charged with keeping under review the co-operative arrangements of international scientific organizations, specialized agencies and States, in order to be able to report on the development in breadth and depth of programmes for the exchange of scientists and experts. Alternatively, this body might be advisory to the Secretary-General in this and other matters relating to outer space, leaving to him to report to the General Assembly with recommendations.

102. The General Assembly in paragraph 1 (*b*) of resolution 1348 (XIII), asked for something more than a review of these areas where international co-operation is feasible. It referred expressly to the consideration of programmes of co-operation in the field of outer space under the auspices of the United Nations and did not envisage the limitation of programmes of international co-operation to non-government organizations.

103. While the Committee is of the belief that the world does not yet need an international agency for space, there is an evident need for efforts of co-ordination and encouragement by the United Nations in some areas by way of support for international co-operation in this field.

2. *Promotion of scientific activities in this field.*

104. Where the objective is scientific, whether academic or applied, regulatory provisions requiring agreements among Governments are necessary only peripherally to promote scientific co-operation. Most needs are cared successfully by the international scientific unions.

105. Exploration into the unknown, such as those symbolized by space probes, are well covered by the activities of the international scientific unions and their affiliated bodies. Through

their services, the scientific community exchanges views and ideas, circulates reasonable amounts of information, or establishes co-operation at various levels of formality. The administration of the international scientific unions is largely based on voluntary work by active scientists, supported by a minimum of professional staff. For example, the cost of the entire international administration of the International Geophysical Year for the administrative period 1952-1959 is estimated at less than $ 250,000.

106. The international scientific unions devote themselves to progress and consolidation in the advancing parts of science ; they are less concerned with technical applications of established knowledge, or programmes of broader education and information. Their administrative structure of periodic assemblies and committee meetings, and to a lesser extent of permanent, large agencies, constitutes an inherent limitation on the consideration of problems of a longer range as distinct from day-to-day actions.

107. The expansion of activities into outer space was initiated during the International Geophysical Year and the first steps towards co-operation were part of that programme. It must be realized, however, that activities in outer space now expand at such a rate and into so many fields that the international scientific unions must share the load of international organization in this whole field with a number of other and different international organizations, such as those dealing with engineering and telecommunications.

108. Amongst typical topics falling well within the scope of the international scientific unions can be cited : (*a*) to plan and co-ordinate general programmes for earth satellites and space probes ; (*b*) to stimulate research supporting space science ; and (*c*) to plan and co-ordinate simultaneous launchings of rockets in many parts of the world. The possibility of directing the attention of scientists from many different specialties to common problems in space exploration is a particularly feature of the international scientific unions.

Development of national scientific capabilities in this field.

109. It was mentioned earlier that scientific work in outer space involves no new scientific disciplines in the present epoch.

Space vehicles are vehicles designed purely to carry instruments or living organisms into parts of the earth's environment which could not previously be reached. Previous knowledge of such regions had to be deducted from indirect measurements. The present objective is to use space vehicles to advance knowledge in the fields of physics, geophysics, astronomy, chemistry and biology related to the environment in which the earth moves. A number of applications have been discussed, those nearest achievement being in meteorology and communications. When these have crystallized out of the research stage, a technology will develop and their application spread into common use.

110. In such applications, particularly in meteorology, both sounding rockets and satellites may be used. The development and use of the sounding rocket by several countries, large and small, shows that the use of this vehicles is not limited to countries having the greatest technological facilities. As they are used they will become cheaper and available to even more countries. The need for world-wide coverage of atmospheric studies at altitudes between about 30 kilometres and 200 kilometres will make international co-operation among many countries a necessity as soon as these applications have reached an appropriate phase.

111. There can be no monopoly of the research activities that are part of space science. It is perhaps useful to point out also that no country could possibly have a monopoly on the production of scientists capable of making contributions in the specialized branches of science that are involved. These include atmospheric physics, ionospheric physics, aurora studies, meteor studies, many branches of astrophysics, and the physics, psychology and biology of unusual environments.

112. Earlier sections of this report have emphasized that the majority of the problems involved in these disciplines are still in the research stage; that there is need for work in them all over the world; and that laboratory work and theoretical work done on the ground on a small scale at no great cost can make important contributions which are required in the scientific utilization of satellites and space probes, although it is true that the launching of these is likely to remain for some time to

come a preserve of the countries with the greatest technical facilities.

113. In any scientific endeavour the most effective way to learn is by experience, particularly in co-operation with those active in the field. Some of the countries active in space science offer fellowships and visiting professorships which may be held in government supported laboratories or universities where research in space is undertaken. Since no new basic science is involved, the requirement for any country to start research in space science are to assist its trained scientists in the fields of physics, geophysics, astronomy or biology, in visiting centres of active space research in these fields, and to give them some facilities and time in their home institutions to undertake original work.

114. It is quite possible that the opportunities for visits and exchange of personnel are now adequate. In spreading information about opportunities for participation in space activities to many States not now taking part, and in the provision of material for wide-spread education, Unesco occupies a key position.

115. Discussions indicate that there is need for a greater and more up-to-date exchange of scientific information, preferably through existing channels, which, however, require clearing and broadening. The arrangement of symposia on certain aspects of space science is also an important activity, to which Unesco's attention might be drawn. These are projects best undertaken by organizations of the type of the international scientific unions which co-operate with Unesco. Because the effects of space developments concern all mankind, it is essential that opportunities for co-operation and extensive distribution of information be made available to all countries, irrespective of the state of their scientific and economic development.

116. States with capabilities for launching satellites should be supported in including in them scientific experiments devised by other countries. The international scientific unions could properly play an important role in this kind of co-operation.

117. National contact with non-governmental international scientific organizations is normally made through academies or

research councils recognized as the appropriate bodies to advice their Governments. More efficient contact between scientists in different countries can be furthered through the formation of national committees on space science. Such bodies could build on the experience of I.G.Y. national committees.

B. — Application of the results of space science.

118. As discussed in paragraphs 22 to 40, foreseeable applications in the field of outer space include the following : meteorological satellites, communications satellites, television and broadcasting satellites, geodetic satellites, and navigation satellites.

119. The foregoing activities will need an ever increasing degree of inter-governmental agreement.

120. Such inter-governmental scientific and technical agencies as W.M.O., I.T.U. and its affiliated committees, I.C.A.O. and others, are the important channels for international co-operation in this field. Their attention is partly directed towards maintaining order in the conduct of many kinds of international activities, such as radio communication, the enormous data exchanged between weather services and others ; in part it is also directed towards planning and preparation when new techniques are maturing to the stage where they can be put into practical application. Their experience in these fields should be brought to bear urgently on space activities.

C. — The open and orderly conduct of space activities.

121. From the description and analysis of the various aspects of peaceful uses of outer space, certain common lines emerge, and one can discern the outlines of a pattern, still sketchy and incomplete, but worth elaborating.

122. In all projects there is an emphasis placed on the need for systematic and regular description of progress, exchange of information stage by stage, and adherence to certain agreed rules. It is necessary to improve the means for the distribution and assimilation of knowledge about space activities throughout the world, so that there can be no doubt of the orderly character of such activities, and so that all countries may have the oppor-

tunity to take part in them irrespective of the state of their scientific and economic development.

123. Reviewing the wealth of present projects from this angle, some typical examples can be quoted.

124. *A regular census of satellites* which are circling the earth must be maintained.

125. *International plans for the wide-spread use of sounding rockets* to moderate heights have already been carried out (see paragraph 77). Their scope is widening (see paragraphs 15-17 and 24-30), spreading into further applications and to many countries. Looking into the future, thought might be given to the creation of international launching centres for sounding rockets (see paragraphs 78-79).

126. *Re-entry and recovery of space vehicles* returning to the earth are techniques in the course of perfection and calling for co-operation (see paragraphs 73-75).

127. *Channels of information* must be maintained and broadened to serve scientists already working on problems of outer space (see paragraphs 80-85, 89 and 104-108) to bring in new groups of scientists and students (see paragraphs 92 and 109-117) and to inform the general public reliably and effectively.

128. This set examples, which is not exhaustive, shows that a principle of open and orderly conduct lies at the root of international co-operation directed towards the peaceful use of outer space. Adherence to this principle would further the progress of space science and technology, both in the narrow sense as activities in themselves, and in their relation to human progress. Such experience is not new, but is common to co-operation in any branch of science ; as one example, it guided the success of the recent International Geophysical Year.

129. Another feature is also apparent. Space activities have wide implications, spreading beyond pure science into technical applications, international co-operation, and effects on the world at large. These implications involve many international organizations covering a wide range of interests, such as scientific societies, government organizations, international news services, etc.

130. This wide dispersion calls for a rallying point related to the United Nations, small in size and well informed. There exists

already a variety of organizations to carry heavy loads of work in different areas of space activity, but there is a need for a centre, to which inquiries can be directed at any time, and by which information can be communicated effectively to the appropriate body in much the same way as I.C.S.U. meets a similar need for the existing international scientific unions.

131. Such a small central body, with expert technical knowledge, would have to act in intimate contact with existing technical agencies and international organizations. Starting modestly, its work would be directed to assisting and corelating the many efforts towards open and orderly conduct of space activities. As a corollary, it would naturally serve as a means for current summary of the position in this rapidly expanding field. Thereby it would provide a most useful continuing service for any panel of experts which from time to time might meet for more extensive reviews.

VII. — General Conclusions

132. As the first technical area in which immediate international action is required, the Committee calls attention to the conclusion regarding allocation of radio frequencies for space activities.

133. On the basis of the specific conclusions reached in previous sections of this report and listed in paragraphs 13 and 14, the following general conclusions have emerged :

(1) There is a need for a suitable centre related to the United Nations that can act as a focal point for international co-operation in the peaceful uses of outer space.

(2) Progress, plans and needs in connexion with the peaceful uses of outer space should be reviewed again by the United Nations in about one year.

PART III

(PARAGRAPH 1 (d) OF GENERAL ASSEMBLY RESOLUTION 1348 (XIII))

I. — Introduction

A. — Mandate of the Committee.

1. The task of the *Ad Hoc* Committee on the Peaceful Uses of Outer Space under paragraph 1 (*d*) of General Assembly resolution 1348 (XIII) is to report on :

« The nature of legale problems wich may arise in the carrying out of programmes to explore outer space. »

2. The scope of the mandate thus given the Committee was the subject of discussion. It was recognized that the terms of reference of the Committee referred exclusively to the peaceful uses of outer space. One view expressed was that the task of the Committee related only to the identification and listing of legal problems which might arise in the carrying out of programmes to explore outer space and that the Committee was not called upon to formulate either general or particular solutions of those problems. Another view was that the Committee, in identifying and listing the problems, should give some indication of the significance and implications of each problem and the priority which might be given to its solution. Others stressed the importance of giving attention to certain relevant general principles, such as those contained in the preamble and operative paragraph 1 (*b*) of resolution 1348 (XIII). It was also pointed out that, while paragraph 1 (*d*) of resolution 1348 (XIII) referred only to problems which might arise in the exploration of outer space, it was not always possible in relation to certain activities to differentiate between exploration and exploitation of outer space and that both the exploration and the exploitation of outer space were expressly mentioned in the preamble to the resolution.

3. The Committee recognized that it would be impossible at this stage to identify and define, exhaustively, all the juridical problems which might arise in the exploration of outer space. Recognizing the multiplicity of these juridical problems, the Committee considered that it could most usefully fulfil its mandate from the General Assembly, in view of the complex character of these problems, by : (1) selecting and defining problems that have raisen, or are likely to arise in the near future, in the carrying out of space programmes ; (2) dividing the problems into two groups, those which may be amenable to early treatment and those which do not yet appear to be ripe for solution ; and (2) indicating, without definite recommendation, various means by which answers to such problems might be pursued. The identification of legal problems entails, of necessity, some consideration of possible approaches to their solution, particularly with a view to

presenting the best informed comment that can be made on the matter of priorities.

B. — General observations.

4. The Committee considered the relevance to space activities of the provisions of the United Nations Charter and the Statute of the International Court of Justice, which synthetized the idea of co-operation between men and joint achievement of great projects for the benefit of all mankind ; it observed that as a matter of principle those instruments were not limited in their operation to the confines of the earth. It considered as a worthy standard for international co-operation and programmes in the peaceful uses of outer space which could appropriately be undertaken under United Nations auspices, to the benefit of States irrespective of their economic or scientific development, the principles set forth in the operative paragraph 1 (*b*) and the preamble of resolution 1348 (XIII), in which the General Assembly called attention to Article 2, paragraph 1, of the Charter which states that the Organization is based on the principle of the sovereign equality of all its Members, recognized the common interest of mankind in outer space and the common aim that it should be used for peaceful purpose only, and expressed the desire of promoting energetically the fullest exploration and exploitation of outer space for the benefit of mankind.

5. It was unanimously recognized that the principles and procedures developed in the past to govern the use of such areas as the air space and the sea deserved attentive study for possibly fruitful analogies that might be adaptable to the treatment of legal problems arising out of the exploration and use of outer space . On the other hand, it was acknowledged that outer space activities were distinguished by many specific factual conditions, not all of which were now known, that would render many of its legal problems unique.

6. The Committee agreed that some of the legal problems of outer space activities were more urgent and more nearly ripe for positive international agreement than others. It was felt that the progress of activities in outer space and of advances in science and technology would continually pose new problems relevant

to the international legal order and modify both the character and the relative importance of existing problems. For example, future arrangement among Governments or private groups of scientists for co-operation in space research or dissemination of space data may entail legal problems tanging from administrative or procedural arrangements to regulation or control. The Committee noted the indispensable usefulness of close and continuous co-operation between jurists and scientists to take these and other developments into account.

7. The Committee considered that a comprehensive code was not praticable or desirable at the present stage of knowledge and development. Despite the progress already made, it was emphasized that relatively little is so far known about the actual and prospective uses of outer space in all their possible varieties of technical significance, political context, and economic utility. It was pointed out that the rule of law is neither dependent upon, nor assured by, comprehensive codification and that premature codification might prejudice subsequent efforts to develop the law based on a more complete understanding of the practical problems involved. Although an attempt at comprehensive codification of space law was thought to be premature, the Committee also recognized need both to take timely, constructive action and to make the law of space responsive to the facts of space.

8. For these reasons it was agreed that the rough grouping of legal problems according to the priority hereafter suggested should itself be kept under regular review by whatever means the General Assembly should deem fitting.

II. — Legal Problems Susceptible of Priority Treatment

A. — Question of freedeom of outer space for exploration and use.

9. During the International Geophysical Year 1957-1958 and subsequently, countries throughout the world proceeded on the premise of the permissibility of the launching and flight of the space vehicles which were launched, regardless of what territory they passed « over » during the course of their flight through outer space. The Committee, bearing in mind that its terms of reference

refer exclusively to the peaceful uses of outer space, believes that, with this practice, there may have been initiated the recognition or establishment of a generally accepted rule to the effect that, in principle, outer space is, on conditions of equality, freely available for exploration and use by all in accordance with existing or future international law or agreements.

B. — Liability for injury or damage caused by space vehicles.

C. — Allocation of radio frequencies.

13. It was recognized that there are stringent technical limits on the availability of radio frequencies for communications. The development of space vehicles will pose new and increasing demands on the radio spectrum. It was emphasized that rational allocation of frequencies for communications with and among space vehicles would be imperative. In this way, what might otherwise come to constitute paralysing interference among radio transmissions could be avoided.

14. Attention was drawn to the fact that there is already in existence and operation an international organization suited to the consideration of problems of radio frequency allocation for outer space uses, namely, I.T.U. A technical committee of this organization has already issued a recommendation and a report which bear the following titles : « Selection of Frequencies Used in Telecommunication with and between Artificial Earth Satellites and other Space Vehicles » and «Factors Affecting the Selection of Frequencies for Telecommunication with and between Space Vehicles ». The findings contained in these two documents will be presented to the Administrative Radio Conference of I.T.U. which will open in Geneva on 17 August 1959.

15. Attention should also be given to the desirability of terminating transmissions from space vehicles once these transmissions have outlived their usefulness. Such a measure would help conserve and make optimum use of the frequencies which are assigned for outer space communications. In considering this problem, it would be necessary to balance this factor against the interest in conserving a means for continuous identification of space vehicles.

15. The *Ad Hoc* Committee has felt that its report under paragraph 1 (*c*) should briefly survey the types of long-term organizational arrangement which are possible within the framework of the United Nations, and relate these to the reports made in connexion with paragraphs 1 (*a*), 1 (*b*) and 1 (*d*) of resolution 1348 (XIII). The findings in the reports on the reports on those paragraphs underline the importance already attached by the General Assembly to the common interest of mankind in outer space. While its studies fortify the belief expressed in General Assembly resolution 1348 (XIII), which stressed the need for vigour in the development of programmes of international co-operation in the peaceful uses of outer space, the Committee recognizes that continued study and review of the problem is

necessary. Accordingly, the Committee has limited its conclusions to the steps toward such development to be taken at the present stage without taking a position on the longer-range measures.

16. The Committee believes that it would not be appropriate at the present time to establisch any autonomous inter-governmental organization for international co-operation in the field of outer space. Likewise, the Committee considers that it would not be suitable to ask any existing autonomous inter-governmental organization to undertake over-all responsibility in the outer space field.

17. The sections of this report dealing with legal and scientific aspects of the question of the peaceful uses of outer space suggest certain general functions and tasks that might appropriately be undertaken within the framework of the United Nations at the present time. These include :

(*a*) To provide a focal point for facilitating international co-operation with respect to outer space activities undertaken by Governments, specialized agencies and international scientific organizations ;

(*b*) To study practical and feasible measures for facilitating international co-operation, including those indicated by the *Ad Hoc* Committee in its report under paragraph 1 (*b*) of the resolution ;

(*c*) To consider means, as appropriate, for studying and resolving legal problems which may arise in the carrying out of programmes for the exploration of outer space ;

(*d*) To review, as appropriate, the subject matter entrusted by the General Assembly to the *Ad Hoc* Committee in resolution 1348 (XIII).

18. The Committee believes that, for the most part, the questions involved under (*b*), (*c*) and (*d*) above may be such as to require consideration at the governmental level. The General Assembly, if it agrees with this conclusion, may wish to consider the establishment of an Assembly committee composed of representatives of Member States and having such membership as the Assembly may decide, to perform these functions, to report to the General Assembly and to make recommendations as appropriate.

19. The Committee considers that the functions suggested in paragraph 17 (*a*) above, which primarily is intended to implement the conclusion of the Technical Committee that « there is a need for a suitable centre related to the United Nations that can act as a focal point for international co-operation in the peaceful uses of outer space », are of a different character. These are functions of the type frequently entrusted to an international secretariat. The General Assembly may therefore wish to consider among other possibilities that of requesting the Secretary-General to organize a small expert unit within the Secretariat for this purpose. Because the precise character of such a Secretariat unit can be developed only in the light of experience and after consultation with the various bodies involved, it may be desirable to provide a means whereby the Secretary-General can avail himself of the advice and assistance of those directly concerned in this field.

20. Consideration might therefore be given to provision for a small advisory committee, advisory to the Secretary-General, which could include representatives of the appropriate specialized agencies, scientists designated by international scientific organizations, and representatives of Member States, as necessary.

21. It would be possible for the General Assembly to adopt some or all of the suggestions described in paragraphs 18, 19 and 20, in any combination it deems appropriate.

22. The Committee believes that it would be appropriate for existing specialized agencies to continue to pursue lines of endeavour within their competence in regard to outer space activities. The Committee believes that the General Assembly might ask these agencies to include in their reports to the United Nations information on their activities in connexion with outer space.

XIIIth GENERAL ASSEMBLY

Commission VI

On Radio Waves and Circuits

TO : Official Members of Commission VI.

SUBJECT : Program of Commission VI of the 1960 General Assembly.

Dear Colleagues :

You have received already from Col. Herbays copies of the summary of results of the meeting of the Coordinating Committee held in Brussels on June 28, 29 (ref. letter N° 1882, July 31, from the Secretariat). I am writing now to fix some details of the program for Commission VI.

1° *Procedure.* — In my letter of last May, I proposed that we set up all of our technical discussions in the form of panel discussions. I was fortunate in being able to discuss the proposal directly with Mr. Loeb, vice chairman of Commission VI and with Dr. Stumpers, Prof. Tellegen, and Prof. Sinclair, chairmen of Sub-Commissions VI-1, VI-2, VI-3, respectively, and with several of you. I also submitted my ideas to the Coordinating Committee in the course of our discussions at Brussels. Out of those discussions I have developed the following procedure for the conduct of our sessions.

The topic of each session will be introduced by a set of papers directed toward summarizing the status of the field and the outstanding developments. The papers will be obtained either by a synthesis out of material supplied by the National Committee reports. I believe that in general three such papers will suffice for any given session, but each case will be considered separately. The paper will be followed by a discussion of the subject by a panel made up of members of the delegations of respective National

Committees. The panel members can round out the reviews by presenting material from their countries which was not known to the introductory speakers and, of course, they will be called upon generally to analyze and develop the subject matter of the session. We hope to be able to set up the panels as well as the keynoting papers in advance of the General Assembly and distribute some material to panel members prior to the meeting.

I trust that all of you will support me in my decision not to allow any other papers to be presented. Each National Committee has, of course, the prerogative to include in its report any papers which it feels represents a major contribution of its country to the fields covered by our Commission. Indeed, I strongly encourage that procedure. But let us understand that that imposes no obligation on myself or the Subcommission chairman to have those papers read at the technical sessions, even though the author of a paper may happen to be present.

Discussions from the floor will also be encouraged and we hope that we shall give every delegation the opportunity to present its country's work while maintaining a coherent and purposeful program.

2° *Topics of the Technical Sessions.* — The choice of topics which I made at the Brussels meeting was based on the commitments which we had made at the General Assembly in Boulder, the replies I received to my letter of last May (in which I listed topics and asked for your views regarding them), and on the discussions at Brussels which indicated the impotance of certain joint sessions. A few words of explanation are in order.

The sessions on Surface Waves, Boundary Value Probems, and Coding are in accordance with the resolutions and recommendations made at the 1957 General Assembly. Dr. J. Wait is chairman of an ad hoc committee on surface waves and we are looking forward to a report from his committee together with several other summary papers on the subject. In the Boundary Value session we hope to clarify the status of the work on scattering and diffraction by single bodies so that it will be clear where we should direct our efforts in the future. The scope of the session on Coding has already been defined by Dr. Stumpers in a separate letter.

A joint session with Commission VII has been set up on solid state circuit elements and devices. Commission VI has the responsibility for the organization of the session. The objective will be to examine the conditions under which solid state elements can be characterized as linear active or linear passive elements, consideration of non-linearities and their origin in the physical characteristics of the element, and problems in this area of future interest to the Commission.

The joint session with Commission VII on the microwave properties of ferrites is the responsibility of Commission VII.

A joint session with Commission V was set up on Antennas and Data Processing. This is a subject of increasing importance not only in Radioastronomy but in air traffic control and space communications technology. The general problem can be formulated as that of synthesizing effective patterns of an array of antennas by data processing techniques. Here is truly a situation in which information and communication theory become wedded to antenna theory.

The session on propagation through statistically inhomogeneous media will also bring together our work on electromagnetic theory and communication theory. We shall consider the general formulation of solutions to Maxwell's equations for stastistically inhomogeneous media and the conditions under which the medium, as a communication channel, can be resolved into a coherent channel and « incoherent » channel. The scale of inhomogeneities encountered on the various parts of the atmosphere will be discussed. We shall then discuss the channel capacities of both the coherent and incoherent components.

Dr. Berkner has on several occasions during the past year stressed the increasing importance of space-radio-relay technology and the challenge it presents to U.R.S.I. He looks to Commission VI taking a more important position in the over-all program of U.R.S.I. A plenary session of the Assembly will be devoted to U.R.S.I.'s role in space science and I felt that it is important for Commission VI to discuss its future work in the field following the plenary sessions. The details of the program of the session will be decided upon after the program of the plenary session is established.

You will recall that we have a committee under the chairman-

ship of Mr. Loeb, to consider practical aspects of information and communication theory. At the Brussel's meeting I made no explicit arrangements for a session covering the work of that committee because of uncertainties in its program. Since then I have had an opportunity to discuss the matter directly with Mr. Loeb and he informs me that the results of the committee are directed more toward time varying channels than the original objectives. We agreed to drop the monograph project and I am planning instead to set aside time for a discussion on time varying channels. This may very well be part of the session scheduled as space radio relay or may be an entirely separate session according to the extent to which the work of the committee has developed.

In summary then the topics for which Commission VI has prime responsibility are :

1. Surface waves.
2. Boundary value problems.
3. Coding.
4. Solid state circuit elements.
5. Antennas and data processing.
6. Propagation through statistically inhomogeneous media.
7. Time varying channels.
8. Space-radio-relay.

3.*Information Needed.* — I shall need your assistance to insure that our technical program is of the highest quality and is as representative as possible of all national efforts. Please furnish me with a list of the members of your delegation assigned to Commission VI and indicate for each member the topic for which he can serve as a pannel discussant. If your delegation is still in the formative stage, please exercise your influence to have appointed members who can be most effective in the topic areas which we have chosen for the program.

I shall also appreciate very much suggestions as to members of your delegation whom I should invite to give keynote papers. Alternatively, if there should be outstanding scientists in your country whose work bears directly on the subjects of our program but who will not be members of the delegation, I would

be pleased to invite them to give papers (which may be presented for them by a member of your delegation.)

I trust that I may look forward to an early reply. Thank you very much for your interest and cooperation.

Sincerely yours,

October 27, 1959

Samuel SILVER
Chairman, Commission VI,
U.R.S.I.

NATIONAL COMMITTEES

India

We have the pleasure to announce that the Indian National Committee decided to enter, from 1960, into category 3 instead of category 2.

New Zealand

The New Zealand National Committee has also decided to change its category, from 1959 onwards it has come into category 2 instead of category 1.

* * *

We want to express our warmest thanks to both National Committees.

Switzerland

ANNUAL MEETING

The Swiss National Committee held its annual meeting in Meyrin-Geneva on November 6th, 1959. The technical part of this meeting was devoted to C.E.R.N. (Organization for nuclear research). U.R.S.I. is connected through Unesco to that organization whose activities have many aspects in common with problems relevant to Commissions VI and VII. The following papers were submitted and discussed during the meeting which was attended by many representatives of sciences and technics :

J. R. Mac Cabe : Das C.E.R.N. und seine technischen Dispositionen im allgemeinen.

I. Pizer : Electronics and the 600 MeV synchro-cyclotron.

Ch. Schmelzer : Hochfrequenztechnische und elektronische Probleme beim 25 GeV Protonen Synchroton.

The attendants to this meeting had the opportunity of visiting the big proton sychroton and the synchro-cyclotron.

COMMISSIONS

Commission IV
On Radio Noise of Terrestrial Origin

I.G.Y. DATA

The National Committee of the Science Council of Japan has issued « I.G.Y. Data on Atmospherics, Whistlers and Solar Radio Emissions » (Vol. II, from Jan 1 to June 30, 1958).

INTERNATIONAL ASTRONOMICAL UNION

The Hertzsprung-Russell Diagram

Proceedings of a Symposium held in Moscow, 15-16 August 1958. Edited by Jess L. Greenstein. Reprinted from Annales d'Astrophysique, 1959, Supplément, Fascicule nº 8.

This work countains two parts :

I. The observational data on the Hertzsprung-Russell diagram.

II. Theoretical interpretation of the Hertzsprung-Russel diagram.

U. R. S. I.

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