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COMMITTEE ON THE PEACEFUL USES OF
OUTER SPACE

REPORT OF THE SCIENTIFIC AND TECHNICAL SUB-COMMITTEE ON THE
WORK OF ITS SIXTEENTH SESSION

INTRODUCTION

1. The Scientific and Technical Sub-Committee of the Committee on the Peaceful Uses of Outer Space held its sixteenth session at United Nations Headquarters from 5 to 22 February 1979 under the chairmanship of Professor J. H. Carver (Australia).
2. Representatives of the following Member States attended the session: Argentina, Australia, Austria, Belgium, Benin, Brazil, Bulgaria, Canada, Chad, Chile, Colombia, Czechoslovakia, Ecuador, Egypt, France, German Democratic Republic, Germany, Federal Republic of, Hungary, India, Indonesia, Iraq, Italy, Japan, Kenya, Mexico, Mongolia, Netherlands, Niger, Nigeria, Pakistan, Philippines, Poland, Romania, Sierra Leone, Sweden, Turkey, Union of Soviet Socialist Republics, United Kingdom of Great Britain and Northern Ireland, United Republic of Cameroon, United States of America, Venezuela and Yugoslavia.
3. Representatives of the United Nations Environment Programme (UNEP), the United Nations Centre for Natural Resources, Energy and Transport (CNRET), the Office of the United Nations Disaster Relief Co-ordinator (UNDRO), the United Nations Development Programme (UNDP), the Food and Agriculture Organization of the United Nations (FAO), the International Telecommunication Union (ITU), the World Meteorological Organization (WMO), the International Atomic Energy Agency (IAEA), the European Space Agency (ESA), the Committee on Space Research (COSPAR) of the International Council of Scientific Unions (ICSU) and the International Astronautical Federation (IAF) also attended the session.
4. A list of representatives of Member States and specialized agencies attending the session is contained in document A/AC.105/C.1/INF.8.

Agenda

5. At the opening meeting of the session, the Sub-Committee adopted the following agenda:

1. Adoption of the agenda
2. Statement by the Chairman
3. General exchange of views
4. Questions relating to remote sensing of the earth by satellites
5. Consideration of the United Nations programme on space applications and co-ordination of outer space activities within the United Nations system
6. Question of convening a United Nations conference on outer space
7. Questions relating to space transportation systems
8. Questions relating to the use of nuclear power sources in outer space
9. Examination of the physical nature and technical attributes of the geostationary orbit
10. Other matters
 - (a) Review of the future role and work of the Scientific and Technical Sub-Committee
 - (b) Other reports
11. Report to the Committee on the Peaceful Uses of Outer Space

Meetings and documentation

6. The Sub-Committee held 16 meetings, which were covered by summary records (A/AC.105/C.1/SR.207-222).
7. The Sub-Committee had before it the following documents:
 - (1) Physical nature and technical attributes of the geostationary orbit: updated report (A/AC.105/203/Add.1-2, A/AC.105/203/Corr.1 and Add.1/Corr.1);
 - (2) Characteristics and capabilities of sensors for earth resources surveys: study prepared by the Committee on Space Research (COSPAR) of the International Council of Scientific Unions (ICSU), addendum (A/AC.105/204/Add.1 and Corr.1);
 - (3) Highlights in space technology 1977: progress report submitted by the International Astronautical Federation (IAF), addendum (A/AC.105/207/Add.1);
 - (4) Review of national and co-operative international space activities for the calendar year 1977 (A/AC.105/212/Add.5);
 - (5) Third United Nations/FAO training course on the applications of small-scale remote sensing techniques to tropical forestry in co-operation with the Government of Italy (Rome, Italy - 15 May-2 June 1978) (A/AC.105/222);

- (6) Co-ordination of outer space activities within the United Nations system: programme of work for 1979 and 1980 and future years (A/AC.105/223);
- (7) Comments of members of the Committee on the Peaceful Uses of Outer Space on the proposed United Nations panel of experts on remote sensing (A/AC.105/224 and Add.1-2);
- (8) WMO Tropical Cyclone Project: report by the World Meteorological Organization (A/AC.105/225);
- (9) Progress of space research 1977-1978: report submitted by the Committee on Space Research (COSPAR) of the International Council of Scientific Unions (ICSU) (A/AC.105/226);
- (10) United Nations regional training seminar on remote sensing applications co-sponsored by the United Nations Environment Programme (UNEP) and Sweden (Nairobi, Kenya - 4-16 September 1978) (A/AC.105/227);
- (11) United Nations regional seminar on the use of satellite technology for disaster applications (Sao José dos Campos, Brazil - 2-13 October 1978) (A/AC.105/228);
- (12) Regional training seminar on the interpretation, analysis and use of meteorological satellite data (Tokyo, Japan - 23 October-2 November 1978) (A/AC.105/229);
- (13) United Nations/FAO training seminar on remote sensing applications for agricultural resources (Dehra Dun, Ahmedabad and Hyderabad, India - 6-25 November 1978) (A/AC.105/230);
- (14) Views of Member States on the United Nations conference on the exploration and peaceful uses of outer space (A/AC.105/231 and Add.1-3);
- (15) Report of the Secretary-General on international centres for remote sensing (A/AC.105/232 and Add.1-2);
- (16) Report of the United Nations Expert on Space Applications to the Scientific and Technical Sub-Committee (A/AC.105/233 and Corr.1);
- (17) Fifth annual report by the International Telecommunications Satellite Organization (INTELSAT) (A/AC.105/234);
- (18) Records of the International Conference of States on the Distribution of Programme-carrying Signals Transmitted by Satellites held in Brussels, 6-21 May 1974 (A/AC.105/235);
- (19) Note verbale dated 19 December 1978 from Canada addressed to the Secretary-General on Cosmos-954 (A/AC.105/236);

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- (20) Review of national and co-operative international space activities for the calendar year 1978 (A/AC.105/237 and Add.1);
- (21) Consideration and review of the United Nations Programme on Space Applications - Financial implications of the United Nations Programme on Space Applications for 1980 proposed by the United Nations Expert in his report (A/AC.105/L.105);
- (22) Provisional agenda, with annotations, for the sixteenth session (A/AC.105/C.1/L.105 and Corr.1-2);
- (23) Questions relating to the use of nuclear power sources in outer space: report presented by Canada (A/AC.105/C.1/L.106);
- (24) United Nations conference on outer space matters; India: working paper (A/AC.105/C.1/L.107);
- (25) Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space; Australia, Austria: working paper (A/AC.105/C.1/L.108);
- (26) Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space; Austria and India: working paper (A/AC.105/C.1/L.110);
- (27) Report of the Working Group on the Use of Nuclear Power Sources in Outer Space (A/AC.105/C.1/L.111);
- (28) Questions relating to the use of nuclear power sources in outer space; India: working paper (A/AC.105/C.1/WG.V/L.1);
- (29) Draft report of the Working Group on the Use of Nuclear Power Sources in Outer Space (A/AC.105/C.1/WG.V/L.3 and Add.1-2);
- (30) Use of nuclear power sources in outer space; United Kingdom: working paper (A/AC.105/C.1/WG.V/L.4).

8. At the opening meeting, the Chairman made a statement outlining the work of the Sub-Committee at its current session. At the same meeting, a statement was also made by the Chief of the Outer Space Affairs Division introducing the documents before it and the Expert on Space Applications outlined activities carried out and future activities under the Space Applications Programme. The Sub-Committee held a general exchange of views, the summary records of which are contained in documents A/AC.105/C.1/SR.208, 210, 212 and 214.

9. In accordance with a recommendation made at its previous session (A/AC.105/216, para. 149) and revised and endorsed by the Committee on the Peaceful Uses of Outer Space and the General Assembly, the Sub-Committee, at its sixteenth session, gave priority to the consideration of agenda items 4, 5, 6 and 7.

10. At its 207th meeting, the Sub-Committee decided to establish a Working Group on the Use of Nuclear Power Sources in Outer Space. At its 210th meeting, the Sub-Committee elected Prof. J. H. Carver (Australia) chairman of the Working Group.

11. Also at its 207th meeting, the Sub-Committee decided to establish a Working Group to assist the Sub-Committee in carrying out its task as the Advisory Committee to the Preparatory Committee on the United Nations Conference on the Exploration and Peaceful Uses of Outer Space. At its 210th meeting, the Sub-Committee elected Prof. Yash Pal (India) chairman of the Working Group.

12. At its 211th meeting, the Sub-Committee set up an informal drafting group dealing with remote sensing under the chairmanship of Dr. Murray Strome of Canada.

13. After considering the various items before it, the Sub-Committee at its 222nd meeting, on 22 February 1979, adopted its report to the Committee on the Peaceful Uses of Outer Space containing its views and recommendations set out in the paragraphs below.

I. QUESTIONS RELATING TO REMOTE SENSING OF THE EARTH BY SATELLITES

14. In accordance with the recommendations of the Committee on the Peaceful Uses of Outer Space, as endorsed by the General Assembly at its thirty-third session in paragraph 6 of resolution 33/16, the Sub-Committee considered the questions relating to remote sensing of the earth by satellites (item 4) as one of the priority items of this session.

15. At its fifteenth session, the Sub-Committee recommended that the Secretary-General undertake a study in the area of remote sensing with a view to assisting the Sub-Committee in its work relating to remote sensing. This recommendation was subsequently endorsed by the Committee on the Peaceful Uses of Outer Space. The Sub-Committee expressed its appreciation to the Secretary-General for the submission of this comprehensive study, which it found to be useful in its deliberations on questions relating to remote sensing from satellites, and which are referred to in detail in paragraphs 2 and 3 of annex I.

16. At the current session, the Sub-Committee continued to consider the current pre-operational/experimental phase of remote sensing, as well as possible future operational satellite remote sensing systems.

17. In the course of the session, a film presentation was made by the Union of Soviet Socialist Republics on its remote sensing experiment involving the MKF-6 multispectral camera jointly developed by the USSR and the German Democratic Republic.

18. At its 211th meeting, the Sub-Committee agreed to set up an informal drafting

group, under the chairmanship of Dr. M. Strome (Canada), to prepare the draft of the section of the Sub-Committee's report dealing with remote sensing.

19. The discussions in the Sub-Committee are reflected in annex I.

20. In accordance with the recommendation of the Committee made at its twenty-first session, as approved by the General Assembly in resolution 33/16, the Sub-Committee continued to stress the importance of co-ordination of its work relating to remote sensing of the earth by satellites with the work of the Legal Sub-Committee in that field. To that end, the Sub-Committee drew the attention of the Legal Sub-Committee to the views expressed in this connexion by the Scientific and Technical Sub-Committee in annex I.

II. CONSIDERATION AND REVIEW OF THE UNITED NATIONS PROGRAMME
ON SPACE APPLICATIONS AND CO-ORDINATION OF OUTER SPACE
ACTIVITIES WITHIN THE UNITED NATIONS SYSTEM

A. Report of the Expert on Space Applications to the Scientific and Technical
Sub-Committee

21. The Sub-Committee, noting that the United Nations programme on space applications for 1978 (A/AC.105/233 and Corr.1) had proceeded satisfactorily, commended the work of the Expert who had carried out his work programme as endorsed by the Sub-Committee at its last session.

(1) Panels/seminars/training workshops

22. The Sub-Committee expressed its appreciation to the Government of the Philippines for having hosted and the Environment Research Institute of Michigan (ERIM), United States, for organizing, in co-operation with the United Nations, an international seminar on the benefits of remote sensing for national development, held in Manila from 17 to 19 April 1978. The objective of the seminar was to provide knowledge and understanding of the techniques, methodology and benefits as well as a survey of current results in the use of modern remote sensing technology for resources survey for the benefit of developing countries.

23. The Sub-Committee expressed its appreciation to the Government of Italy and FAO for conducting the third international training course on the applications of remote sensing to tropical forestry from 15 May to 2 June 1978 at FAO headquarters in Rome (A/AC.105/222). The main subject areas of application covered were small-scale techniques including sampling techniques, use of side-looking airborne radar (SLAR), high and low flight aerial photography in earth resources surveys and LANDSAT satellite imagery in high tropical forest inventory and classification.

24. The Sub-Committee expressed its appreciation to the Government of Sweden for supporting and the Government of Kenya for hosting a United Nations training seminar on remote sensing applications co-sponsored by UNEP, and held in Nairobi from 4 to 16 September 1978 for the benefit of the Economic Commission for Africa (ECA) region countries (A/AC.105/227). The programme included lectures, practical exercises and field exposures in the use of aerial and satellite imagery for crop statistics and agricultural census, forestry and water resources.

25. The Sub-Committee expressed its appreciation to the Government of Brazil for having hosted a United Nations regional seminar on the use of satellite technology for disaster applications, co-sponsored by UNDR0 and the United Nations Educational, Scientific and Cultural Organization (UNESCO), from 2 to 11 October 1978 at Sao José dos Campos (A/AC.105/228). The main objective of the seminar was to familiarize the participants from developing countries in the region of the Economic Commission for Latin America (ECLA) with the current means and future potential benefits of satellite technology for disaster applications.

26. The Sub-Committee expressed its appreciation to the Government of India for hosting and organizing the United Nations/FAO training seminar on remote sensing applications for agricultural resources from 6 to 24 November 1978 for countries in the Economic and Social Commission for Asia and the Pacific (ESCAP) and the Economic Commission for Western Asia (ECWA) regions (A/AC.105/230). The main objective of the seminar was to impart education and practical training for participants from developing countries in the use of remote sensing techniques and methodology in agricultural resources survey and monitoring.

27. The Sub-Committee expressed its appreciation to the Government of Japan for hosting a United Nations/WMO training seminar on the uses of meteorological satellites, held in Tokyo from 23 October to 2 November 1978 for the benefit of countries in the ESCAP and Far East regions (A/AC.105/229). The main objective of the seminar was to provide training to participants from developing countries on the latest methods and techniques of interpretation, analysis and use of data received from meteorological satellites and its application to tropical cyclone areas.

28. The Sub-Committee also expressed its appreciation to Member States that had contributed to the successful results of the United Nations-sponsored panels/seminars/workshops by providing their experts to be speakers at those meetings, to the specialized agencies, particularly FAO, UNESCO, WMO as well as UNDRO and UNEP, for the assistance they had provided in co-sponsoring or participating in these seminars and other assistance and contributions extended.

29. The Sub-Committee also noted the report of the Expert regarding the status of the Space Applications Programme in 1979.

30. The Sub-Committee in this connexion noted with approval the following programmes: (a) a fourth international training course on remote sensing applications in the area of fisheries organized in co-operation with FAO and the Government of Italy to be held at FAO headquarters in Rome from 14 May to 1 June 1979 on an interregional basis; (b) a joint United Nations/FAO regional seminar on remote sensing applications in agriculture for the benefit of developing countries in the ECA region to be held in Ibadan, Nigeria, from 13 to 31 August 1979; the Sub-Committee expressed its appreciation to the Government of Nigeria for agreeing to host the seminar; (c) a United Nations training seminar on remote sensing of earth resources for the benefit of countries in the ECWA region to be held in Damascus, Syria, from 1 to 13 December 1979, to examine the need for environmental observation of existing techniques and data handling requirements, with emphasis on existing sensor techniques; the Sub-Committee noted that this programme was a follow-up of the recommendations made by the United Nations consultant (Dr. F. Shahrokhi) who visited some developing countries in the Middle East area during 1977, and expressed its appreciation to the Government of Syria for having agreed to host the seminar; (d) an international training course on the applications of remote sensing with emphasis on non-renewable resources for the benefit of ECLA region countries to be held in Argentina from 6 to 23 November 1979 at the National Space Research Commission (CNIE); the Sub-Committee expressed its appreciation to the Government of Argentina for agreeing to host this training course.

31. The Sub-Committee noted with approval that the United Nations was co-sponsoring the Vikram Sarabhai Symposium on Space and Development and a symposium on the contribution of space research to water resources studies being organized by COSPAR in Bangalore during May 1979.

(2) Fellowships

32. The Sub-Committee expressed its appreciation to the Governments of Belgium, India and Italy for having offered fellowships in 1978 and expressed the hope that those fellowships would be continued in 1979.

33. It stressed the need for providing for more opportunities with financial support to enable developing countries to gain advanced knowledge on space applications.

(3) United Nations programme on space applications for 1980 and review of future programmes

34. In regard to the proposed space applications programme for 1980, the Sub-Committee approved the programme as proposed by the Expert in his report (A/AC.105/233), with the financial implications as set out in A/AC.105/L.105.

35. The Committee noted that there was wide support for the view that the United Nations programme on space applications should be expanded both in scope and content, if it was to better respond to the needs of and be of more value to the developing countries. The view was also expressed that this may be done with the support of UNDP within its system of country programming.

36. The Sub-Committee expressed its appreciation for the continuation of training courses on remote sensing applications to be held at FAO headquarters with the co-operation of the Government of Italy.

37. The Sub-Committee noted that an international seminar on benefits of remote sensing for national development would be organized in co-operation with ERIM in conjunction with the sixteenth international symposium on remote sensing of the environment in San José, Costa Rica, during April 1980.

38. The Sub-Committee noted that it was proposed to hold a training workshop on remote sensing applications for agricultural and natural resources in Japan for the benefit of Member States in the ESCAP region, possibly with the co-operation of IAF and the Government of Japan.

39. The Sub-Committee also noted that a training course on remote sensing applications for earth resources survey and land use planning would be held in Athens, Greece, for the benefit of developing countries in the ECWA and the ECA regions. The Sub-Committee expressed its appreciation to the Government of Greece for having agreed to host the seminar.

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40. The Sub-Committee further noted that a training seminar on remote sensing for vegetation monitoring of agricultural rangeland with emphasis on semi-arid zones for the benefit of developing countries in the ECA region would be held in the French language at Ouagadougou, Upper Volta, in co-operation with the Regional Training Centre in Ouagadougou.

41. The Sub-Committee noted the offer made by the USSR to organize a seminar on remote sensing applications in the fields of geology and hydrology in 1980 and agreed that the Expert on Space Applications could explore possibilities of including this in his programme of activities in 1980.

42. Some delegations expressed the hope that it would prove possible for more detailed information to be communicated at the appropriate time to interested Member States on the preparation and organization of seminars, including programmes for training, the specialists required and arrangements for participation in these seminars.

B. Interagency co-ordination of outer space activities

43. The Sub-Committee noted the information provided by the Chief of the Outer Space Affairs Division on the progress achieved in furthering consultation and co-ordination of outer space activities among organizations within the United Nations system. In this connexion it expressed its appreciation for the report submitted by the Secretary-General (A/AC.105/223) which reflects recent and future activities of the organizations concerned.

44. At the same time, the Sub-Committee noted that, as a result of recent restructuring of the machinery of the Administrative Committee on Co-ordination (ACC), various subsidiary bodies working in the substantive areas, including the ACC Sub-Committee on Outer Space Activities, have been discontinued.

45. In this connexion, the Sub-Committee recalled that the present degree of co-ordination of outer space activities within the United Nations system had been possible largely due to measures adopted in response to the concern expressed by the Sub-Committee since 1974. In its report in 1975 (A/AC.105/150, para. 51) the Sub-Committee had commented favourably on the need for ensuring effective interagency co-ordination and was of the opinion that such co-ordination could be effected either through setting up a new machinery or within the then existing arrangements. In 1976 (A/AC.105/170, paras. 112 and 113), the Sub-Committee noted the efforts made in this direction by ACC and in particular the decision taken by ACC to establish a Sub-Committee on Outer Space Activities and welcomed that arrangement. In 1977 and 1978, the Sub-Committee noted with appreciation (A/AC.105/195, para. 122 and A/AC.105/216, para. 121) the report submitted by the Secretary-General outlining the activities of the various organizations within the United Nations system and noted that the report had usefully served as a basis for discussion in the Sub-Committee on the question of the extent to which the co-ordination of activities within the United Nations system in the area of peaceful uses of outer space had been effected.

46. The effectiveness of consultation machinery utilized thus far was again reflected in the last report of the Secretary-General referred to in paragraph 43 above.
47. The Sub-Committee shared the view that, on the basis of experience gained so far, there continued to be a need for regular annual meetings among the organizations concerned, in particular for the preparation of the integrated report by the Secretary-General, for preparing studies by the Secretariat requiring interagency consultations and for co-ordination of activities of the two international centres for remote sensing. Such regular annual meetings of representatives of the specialized agencies would become even more important in view of the input and assistance required of specialized agencies in the preparatory work for the second United Nations Conference on the Exploration and Peaceful Uses of Outer Space.
48. The Sub-Committee therefore stressed the necessity to assure continuous and effective consultations and co-ordination in the field of outer space activities among organizations within the United Nations system.

III. SECOND UNITED NATIONS CONFERENCE ON THE EXPLORATION
AND PEACEFUL USES OF OUTER SPACE

49. At its thirty-third session, the General Assembly, endorsing the recommendations of the Committee on the Peaceful Uses of Outer Space to hold a second United Nations Conference on the Exploration and Peaceful Uses of Outer Space, designated the Committee as the Preparatory Committee for the Conference and the Scientific and Technical Sub-Committee as the Advisory Committee to the Preparatory Committee.

50. Acting accordingly, the Sub-Committee, at its current session, considered various questions relating to the preparation of the Conference. To facilitate its task, the Sub-Committee, at its 207th meeting, agreed to set up a Working Group, under the chairmanship of Prof. Yash Pal (India).

51. The Working Group had before it a working paper prepared by India (A/AC.105/C.1/L.107), a working paper by Australia and Austria (A/AC.105/C.1/L.108) and a working paper by Austria and India (A/AC.105/C.1/L.110) as well as informal background papers prepared by Pakistan and by the Secretariat.

52. The Working Group held three meetings and decided to set up an informal drafting group under the chairmanship of Mr. Carlos Moreira Garcia (Brazil) which met from 14 to 16 February 1979.

53. In reviewing the various requirements for the preparation of the Conference, the Sub-Committee noted that arrangements for the preparation of the Conference as outlined in paragraph 75 of the Committee's report (A/33/20) had been endorsed by the General Assembly at its thirty-third session in resolution 33/16 (para. 10) of 10 November 1978. It further noted that Member States had been invited to submit their comments on the arrangements relating to the Conference and to make them available at its present session. Replies from nine Governments have been received to date (Brazil, Egypt, France, Greece, Japan, Netherlands, Thailand, United Kingdom of Great Britain and Northern Ireland and United States of America) and have been reproduced in document A/AC.105/231 and Add.1-3.

54. The Sub-Committee noted that the United Nations Conference on Science and Technology for Development (UNCSTD) would be held in Vienna from 20 to 31 August 1979. As the outcome of this Conference will be of relevance for the preparation and work of the Conference on the Exploration and Peaceful Uses of Outer Space, it was recommended that the results of UNCSTD be taken into account in the preparation for the Conference on the Exploration and Peaceful Uses of Outer Space.

55. The Sub-Committee considered the work of the Working Group, and the views and conclusions of the Sub-Committee in regard to the preparation of the Conference are set out below.

I. Title

The Conference should be entitled "United Nations Conference on the Exploration and Peaceful Uses of Outer Space".

II. Agenda

(1) The Conference agenda should be broad enough to meet the objectives recommended by the Scientific and Technical Sub-Committee at its last session (A/AC.105/216, paras. 98-110) and endorsed by the Committee at its twenty-first session (A/33/20, para. 75);

(2) Under these broad guidelines, the agenda should include the following items:

(A) State of space science and technology

- (i) Review and projection of the current and future state of science and technology for space research and applications;
- (ii) Evaluation of the major developments in space science, technology and applications and assessment of the usefulness of these developments so far.

(B) Applications of space science and technology

- (i) Evaluation of the current and potential applications of space technology, taking into account present and foreseeable programmes, national and international, in areas of space research;
- (ii) Examination of the possibilities and mechanisms for enabling all States to benefit from space technology, bearing in mind their various levels of development, varying capacities to absorb new technologies and particular needs and priorities;
- (iii) Examination of the choices for utilizing space technology available to countries at various stages of technological growth and of the difficulties they face in this regard;
- (iv) Examination of the existing infrastructure and scientific and technological development in various countries, especially the developing countries, and of appropriate measures to augment their capabilities to develop space technology and facilitate access to such technology and to participate and co-operate in space activities so as to derive maximum benefit from space technology and its applications;
- (v) Examination of developments and system configurations appropriate to the use of space technology for education;
- (vi) Discussion of compatibility and complementarity between various satellite systems, including those used for remote sensing, meteorology, communications and navigation;

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- (vii) Consideration of the implications of projected developments in the areas of space technology such as earth orbiting solar power stations, space manufacturing, space transportation and manned space stations; consideration of the implications of the use of the geostationary orbit, the need and possibilities for optimizing that use, as well as of the measures to be taken to that end;
 - (viii) Discussion of the nature of, and ways of protecting, the near-earth environment including the upper atmosphere and magnetosphere.
- (C) International co-operation and the role of the United Nations
- (i) Consideration of reports on the nature and extent of the bilateral and multilateral co-operation in outer space activities;
 - (ii) Consideration of reports on the activities of the United Nations and other international organizations dealing with the exploration and peaceful uses of outer space;
 - (iii) Evaluation of the role of the United Nations, its specialized agencies, other international organizations and programmes of bilateral and multilateral co-operation in order to ensure broad international co-operation on an equal basis;
 - (iv) Evaluation of the role of the United Nations in the realization of benefits of space technology for all countries and examination of the need and possibilities for enhancing this role.

(3) Review of programmes, presentation of national/international programmes, results of scientific experiments, etc. should not consume too much time. In order to achieve the objectives of the Conference it is important that emphasis be placed on agenda items which relate to basic concerns of most of the Member States.

III. Preparation and organization of the Conference

A. Preparation

It is proposed that:

- (i) The provisional agenda, as approved by the Preparatory Committee in 1979 and endorsed by the General Assembly at its thirty-fourth session, be circulated by the Secretary-General of the United Nations to all Member States in January 1980 together with an invitation to submit national papers to be received by the Secretary-General of the Conference by spring 1981.* The national papers should contain abstracts which will be translated by the Secretariat in the working languages of the Conference and together with the national papers circulated to Member States;

* These dates are only applicable on the assumption that the Conference will be held in the second half of 1982.

- (ii) The Secretary-General of the United Nations be requested to assist in the organization of regional and topical interregional seminars on selected scientific and other substantive aspects, with a view to fostering the widest participation of Member States in the preparation of the Conference. In organizing these seminars the facilities of the United Nations Space Applications Programme should be taken into account;
- (iii) The Preparatory Committee, during its meetings in summer 1981,* consider the papers received and draw up an outline for the draft final report of the Conference (as envisaged in para. 112 of document A/AC.105/216);
- (iv) At the same session, the Preparatory Committee also consider recommendations on all aspects of the organization of the Conference, including its Bureau, to be approved by the General Assembly at its thirty-sixth session;
- (v) The Secretary-General of the Conference prepare a first draft of the final report based on the outline referred to above for submission to the Scientific and Technical Sub-Committee;
- (vi) The Scientific and Technical Sub-Committee, at its meetings in early 1982,* consider this first draft and give its advice thereon to the Secretary-General of the Conference;
- (vii) The Secretary-General, taking into account the recommendations of the Scientific and Technical Sub-Committee, prepare a second draft for consideration by the Preparatory Committee at its last session before the Conference;
- (viii) The draft final report of the Conference, as considered and revised by the Preparatory Committee, be circulated to Member States at least 90 days before the opening of the Conference;
- (ix) The Member States, if they deem it necessary, may also submit national papers to the Conference;
- (x) The Committee on the Peaceful Uses of Outer Space, when meeting as the preparatory body for the Conference, may invite representatives of interested Member States and of the competent organs of the United Nations, its specialized agencies and recognized governmental and non-governmental international organizations to participate in its sessions; and may receive representations and papers directly related to the agenda of the Conference from scientific organizations and individual scientists.

* These dates are only applicable on the assumption that the Conference will be held in the second half of 1982.

B. Organization

(1) Secretariat of the Conference

It is proposed that:

- (i) The Secretary-General of the United Nations appoint a Secretary-General and three Deputy Secretaries-General of the Conference at least 18 months prior to the date scheduled for the last session of its Preparatory Committee; the Secretary-General of the Conference and his deputies should assume office on a full-time basis as soon as possible after their appointments and in any event not less than nine months prior to this last session of the Preparatory Committee;
- (ii) The Outer Space Affairs Division provide the Executive Secretary and the secretariat of the Conference, on the assumption that the secretariat, in accordance with the relevant regulations of the United Nations, would be empowered to hire additional temporary staff as required;
- (iii) The Secretary-General of the Conference be empowered to co-opt consultants from both developed and developing Member States on a secondment basis and, if necessary, engage the services of consultants with particular reference to the preparation of studies and reports on topics selected by the preparatory body for the Conference, papers commissioned by the regional and interregional seminars and national reports on items included in the agenda of the Conference.

While the Sub-Committee had made several recommendations concerning the preparation for and organization of the Conference which are set out above, it believed that further decisions would have to be made by the Preparatory Committee before any recommendations could be made to the General Assembly on setting a ceiling for the cost of the Conference, taking into account a statement of financial implications to be prepared by the Secretariat.

The Sub-Committee reached agreement on the recommendations set forth in section 1 above. Due to time constraints, however, the Member States were able only to express their views concerning the following four aspects of Conference organization.

(2) Bureau of the Conference

The Scientific and Technical Sub-Committee, in its role as the Advisory Committee to the Preparatory Committee of the Conference, considered various options as to the composition of the Bureau for the Conference itself, but was unable to formulate any definite recommendations on this subject at this preliminary stage of its work. It was generally agreed that a President would be required as well as a varying number of Vice-Presidents, depending on the function

which the latter Conference officers would be expected to fulfil. One choice, in accordance with the practice of the General Assembly, would be to elect a number of Vice-Presidents, broadly representative of all regional groups in the United Nations, whose main function would be to stand in for the President in his duty of presiding over plenary sessions. A second choice would be to elect three Vice-Presidents, selected on the basis of their personal capacities, to chair the detailed Conference deliberations on the three broad groupings of agenda items. A third option - essentially combining features from the two previous alternatives - would be to elect a relatively large number of Vice-Presidents, essentially to act as substitutes for the President in plenary sessions and three Committee Chairmen to preside over the Committee deliberations on the three groupings of agenda items. If the Committee approach were adopted, other Conference officers - such as Committee Vice-Chairmen, Committee Rapporteurs and a Rapporteur-General for the Conference as a whole - might also be required.

(3) Form of the Conference

While no agreed consensus was reached as to the form of the Conference, various alternatives were suggested. One view advanced was that the main proceedings of the Conference should be held in plenary session, supplemented as necessary by informal panel discussions and working groups. Another view was that the Conference would commence with some plenary meetings, subsequently break up into three committees (corresponding with the agenda divisions) on the understanding that no more than two committees would meet simultaneously and then conclude with further plenary meetings. Under both of these scenarios, it was envisaged that the formal part of the Conference proceedings might be supplemented by special evening lectures and/or technical expositions.

The view was also expressed that the sessions of the Conference should be organized according to the topics of the agenda by subject area, i.e. remote sensing, communications, etc. Another view was expressed that the organization of the Conference should be left to the Conference itself. A further view was expressed that while the discussion under agenda items under II (A) could be organized subject-wise, the agenda items under II (B) and (C) would have to be discussed in a more integrated manner. Further details on this need to be worked out.

IV. Date

Pursuant to resolution 33/16 adopted at the thirty-third session of the General Assembly, the Scientific and Technical Sub-Committee considered various possible dates for the second Outer Space Conference between the beginning of 1981 and the end of 1983. It was agreed that the exact dates for the Conference would depend partly on the duration of the Conference, i.e. whether it would last two or three weeks, and the timing of other international conferences related either in terms of their subject-matter or their participants to this Outer Space Conference. One specific date suggested was August 1982; a second suggestion was that it be held in the second half of 1982. The Sub-Committee eventually agreed that a final recommendation as to the dates for the Conference should be left to participants in the 1979 session of the Outer Space Committee, acting in its capacity as the Preparatory Committee for the Conference.

The Sub-Committee requested the Secretariat to prepare a list of United Nations conferences to be held in 1982 for submission to the Preparatory Committee at its next session.

V. Venue

The Sub-Committee noted with appreciation the offer made by the Government of the USSR to host the second Outer Space Conference in Moscow in August 1982, and an offer from the Government of India to host the Conference. It was agreed that, similar to the issue of the timing of the Conference, the question of venue required further consideration and consultations with other Member States of the United Nations not members of the Outer Space Committee and should be held over for final recommendation by the Committee on the Peaceful Uses of Outer Space in its capacity as the Preparatory Committee for the Conference.

IV. QUESTIONS RELATING TO SPACE TRANSPORTATION SYSTEMS

56. In accordance with General Assembly resolution 33/16, the Sub-Committee considered the item relating to space transportation systems as one of the priority items at this session.
57. The Scientific and Technical Sub-Committee heard a presentation by the USSR delegation describing the creation and development in the Soviet Union of a space transportation system based on the use of manned ("Soyuz") and automatic ("Progress") modules and intended to prolong the duration of the effective functioning of long-lived orbital scientific space stations.
58. In the course of the meetings of the Sub-Committee, a presentation using slides and film was made by the United States on its Space Shuttle Programme. In making the presentation for the United States, Dr. M. S. Malkin discussed the parameters of the space transportation system. He stated that the Shuttle Orbiter would move to the Kennedy Space Center on 10 March and that the space shuttle would fly on 9 November 1979 if technical difficulties did not intervene. The operational date of February 1981 gave some flexibility in this regard. The European contribution to the space transportation system, the Spacelab, and the Canadian contribution, the remote manipulator system, were also discussed. He indicated the variety of upper stages available to various users. The pricing policies were reviewed. Flights were available at fixed prices and on a shared basis. Through the beginning of 1983, 41 payloads were booked, with many of them already paying progress payments. Small self-contained payloads were available and 274 had already signed up.
59. A similar presentation was made by ESA on its Ariane programme. The Ariane programme is aimed at achieving in late 1980 an economically competitive European capability of placing satellites in orbit, particularly geostationary satellites of the order of 900 kg. It was planned that four launches for a year would take place from the French Space Centre at Kourou in 1980. The control of this joint European programme was entrusted to ESA while its management of the development was entrusted to the Centre national d'études spatiales (CNES).
60. The Sub-Committee noted the progress being made in the various programmes relating to the space transportation systems and decided to continue consideration of this item at its next session.
61. To facilitate its task, the Sub-Committee requested the Secretariat to prepare, for consideration at its next session, a study on the progress being made in the space transportation systems and their scientific, technical, economic and social implications. To that end, the Sub-Committee recommended that the views of Member States and relevant international organizations should also be sought on this question.

V. USE OF NUCLEAR POWER SOURCES IN OUTER SPACE

62. The Sub-Committee noted that in paragraph 8 of resolution 33/16 of 10 November 1978, the General Assembly had approved the decision of the Committee on the Peaceful Uses of Outer Space to request it to include in its agenda consideration of technical aspects and safety measures relating to the use of nuclear power sources in outer space, for which purpose it was recommended that the Sub-Committee should, unless it decided otherwise, create a working group of experts which would be open to all its members and would meet during its session, in accordance with paragraph 76 of the report of the Committee on the Peaceful Uses of Outer Space.

63. In accordance with the above recommendation, the Sub-Committee established a Working Group on the Use of Nuclear Power Sources under the chairmanship of Professor J. H. Carver (Australia). The Working Group met from 12 to 16 February and adopted a report (A/AC.105/C.1/L.111) on 16 February.

64. Having considered the report of the Working Group, the Sub-Committee decided at its 220th meeting to adopt that report, as contained in annex II.

VI. EXAMINATION OF THE PHYSICAL NATURE AND TECHNICAL ATTRIBUTES OF THE GEOSTATIONARY ORBIT

65. In accordance with General Assembly resolution 33/16, the Sub-Committee dealt with the examination of the physical nature and technical attributes of the geostationary orbit and decided that further consideration should be given to this item at its next session. In this connexion, the Sub-Committee noted the useful study (A/AC.105/203, Corr.1, Add.1, Add.1/Corr.1 and Add.2) prepared by the Secretariat in response to a request by the Committee on the Peaceful Uses of Outer Space. The study shows, among other things, that actual positions of geostationary satellites correspond to the positions assigned in the documents drawn up by the International Frequency Registration Board of ITU. It also deals with static electrical charges of geostationary satellites which result from the combined effect of the ionized atmosphere and solar radiation. The study further explains two concepts which might be of importance in increasing the total capacity of the geostationary orbit and adjacent regions of outer space: antenna farms and generalized geosynchronous orbits. Another section of the study contains a discussion of the stability of circular orbits situated beyond the geostationary orbit which might be used as disposal orbits for inactive satellites. Addendum 2 of the study contains excerpts from reports by the International Radio Consultative Committee (CCIR) of ITU, which have been prepared as technical bases for the World Administrative Radio Conference to be held in 1979.

66. The Sub-Committee recommended that the study on the physical nature and technical attributes of the geostationary orbit should be further brought up to date when necessary; that an informative paper on the dynamics of the population of satellites should be prepared; and that a study should be undertaken on the most efficient and economical means of using the geostationary orbit with a view to assessing its wider use, particularly by developing countries. In order to

facilitate the task of the Secretariat in the preparation of the latter study, the Sub-Committee recommended that the views of Member States be sought on this question.

VII. OTHER MATTERS

(a) Reports

67. The Sub-Committee expressed its appreciation to Member States that had submitted reports on their national and co-operative international space activities for the year 1978, as contained in document A/AC.105/237, and called upon Member States to continue to submit such reports, and in good time, for consideration by the Sub-Committee.
68. The Sub-Committee noted with interest the fifth annual report by the International Telecommunications Satellite Organization (INTELSAT) covering the period from 1 April 1977 to 31 March 1978 (A/AC.105/234).
69. The Sub-Committee noted with appreciation the participation in its session by representatives of United Nations bodies, the specialized agencies and international organizations, and found the reports they had submitted helpful in enabling the Sub-Committee to fulfil its role as a "focal point" for international co-operation, especially with respect to the practical application of space science and technology in developing countries. The Sub-Committee further expressed its appreciation to the specialized agencies for their continued co-operation with the Sub-Committee and, in particular, for their participation in the United Nations programme on space applications and in interagency co-operation and consultation in works relating to outer space in general, as noted in section II of this report.
70. The Sub-Committee noted with appreciation the participation of COSPAR and IAF in its work and, in particular, noted that in accordance with the request made by it, both organizations had continued to provide valuable reports to the Sub-Committee on an annual basis on scientific and technical development in the exploration and practical uses of outer space. In this connexion, it expressed its appreciation to COSPAR for the additional report submitted by it in document A/AC.105/204/Add.1 and Corr.1 and for the report contained in document A/AC.105/226, as well as to IAF for the additional report submitted by it in document A/AC.105/207/Add.1. The Sub-Committee also expressed its appreciation to these two organizations for the informative statements made by their representatives in presenting those documents to the Sub-Committee.
71. The Sub-Committee noted with appreciation that in response to General Assembly resolution 32/192, WMO had submitted a report on its Tropical Cyclone Project (A/AC.105/225) and expressed the hope that WMO would continue to keep it informed of the achievements and outlook on the future conduct of the programme.
72. The Sub-Committee also expressed its appreciation to ITU for making available material on the physical nature and technical attributes of the

geostationary orbit by way of extracts from the report of the Joint Meeting of the CCIR Study Groups Special Preparatory Meeting for the World Administrative Radio Conference 1979, contained in the annex to document A/AC.105/203/Add.2, as well as the provisional version of its eighteenth report to the Committee on the Peaceful Uses of Outer Space.

73. The Sub-Committee further expressed its appreciation to ESA for its participation in the United Nations Space Applications Programme and for making available the report prepared by a group of experts from its Remote Sensing Working Group.

74. The Sub-Committee expressed its appreciation to the International Conference of States on the Distribution of Programme-carrying Signals Transmitted by Satellites for providing the records of the Conference published by UNESCO and the World Intellectual Property Organization (WIPO) (brought to the attention of members by document A/AC.105/235).

(b) International sounding rocket facilities

75. The Sub-Committee noted with satisfaction that work continued to be carried out at the Thumba Equatorial Rocket Launching Station of the Vikram Sarabhai Space Centre in India and the CELPA Mar del Plata Rocket Launching Station in Argentina relative to the use of sounding rocket facilities for international co-operation and training in the peaceful scientific exploration of outer space. The Sub-Committee therefore recommended that the United Nations continue to grant sponsorship to these ranges.

(c) Review of future role and work of the Sub-Committee

76. In reviewing its future role and work, the Sub-Committee agreed that, while there was a wide range of subjects to be examined, it would not be possible to consider all of them at the same time and that, in order to examine those subjects thoroughly and meaningfully, the Sub-Committee would have to be selective in drawing up its agenda.

77. In this connexion, the Sub-Committee agreed that in addition to the priority items it already had on its agenda, it should examine the co-ordinating role of the United Nations in the use of space science and technology especially for the benefit of the developing countries and recommended that the matter should be listed as a separate item in the agenda of the next session of the Sub-Committee. Accordingly, the Sub-Committee recommended that the Secretariat should prepare for its consideration a comprehensive study examining current and potential benefits of space science and technology to Member States, particularly the developing countries, stressing their applications in such fields as remote sensing, communications, meteorology, navigation and other potential applications, as well as emphasizing the benefits that may be derived by co-ordinating the activities of the United Nations system in the various areas of space applications.

78. Having considered the various suggestions made at its current session, the Sub-Committee recommended that the agenda of its seventeenth session include the following priority items:

- (a) Consideration of the United Nations Programme on Space Applications and the co-ordination of space activities within the United Nations system;
- (b) Questions relating to remote sensing of the earth by satellites;
- (c) Use of nuclear power sources in outer space;
- (d) Co-ordinating role of the United Nations in the use of space science and technology, particularly in the developing countries.

With regard to the item on remote sensing, the Sub-Committee recommended that its future examination of questions relating to remote sensing also include the specific areas of applications of remote sensing technology so as to enable it to further assess the needs of Member States, particularly the developing countries, in the various areas of current and future applications.

79. The Sub-Committee also recommended that the agenda of its seventeenth session should include the following items:

- (a) Questions relating to space transportation systems;
- (b) Examination of the physical nature and technical attributes of the geostationary orbit.

80. In regard to its dates for the seventeenth session, the Sub-Committee noted that the Committee on the Peaceful Uses of Outer Space had planned it from 4 to 15 February 1980.

81. In this connexion, the Sub-Committee noted that the Working Group on the use of Nuclear Power Sources in Outer Space had recommended in paragraph 41 of its report that, at the seventeenth session of the Scientific and Technical Sub-Committee, arrangements be made for the working group of experts to meet for one week during the Sub-Committee's session to continue its consideration of questions related to the use of nuclear power sources in outer space.

82. The view was also expressed that in the light of the tasks assigned to the Working Group, the possibility of holding a 2 1/2 to 3 week session of the Sub-Committee in 1980 should not be excluded at this stage.

Annex I

VIEWS AND CONCLUSIONS ON QUESTIONS RELATING TO REMOTE SENSING
OF THE EARTH BY SATELLITES

A. Classification of primary data

1. At its twenty-first session, the Committee on the Peaceful Uses of Outer Space, taking note of the inconclusive discussion that took place at the last session of the Sub-Committee concerning the proposal to classify remote sensing data into three categories - global, regional and local - based on spatial resolution, had agreed with the view of the Sub-Committee that it was necessary to continue scientific research, to provide a technical definition of spatial resolution and to determine what aspects of data, such as resolution, spectral characteristics, polarization, etc., might correspond to particular applications. The Committee had also noted that the Sub-Committee, at its fifteenth session, was not in a position to agree upon specific recommendations concerning the need for classification of data nor the manner in which such a classification might be made. The Committee had, therefore, endorsed the recommendation of the Sub-Committee that the Secretariat should continue the study on the matter, as suggested in paragraph 30 of the report of the fifteenth session of the Sub-Committee (A/AC.105/216).

2. The Sub-Committee noted the report submitted by the Secretariat, entitled "Characteristics and capabilities of sensors for earth resources surveys" (A/AC.105/204/Add.1 and Corr.1) and drew the attention of Member States to that report. The Sub-Committee expressed its appreciation to COSPAR for the assistance it had given in the preparation of the report, which contains very useful scientific information.

3. In summary the report states:

"For the purposes of this study it is assumed that the targets of interest correspond to 2 bar targets of contrast ratio 2:1. For such targets, the analysis which follows predicts that the equivalent photographic resolution of the LANDSAT MSS scanner is equal to the product of its instantaneous field of view and a factor 2 to 2.5. It should be understood that in practice, the value of this factor may differ from the above, as it depends on the real contrast ratio and geometrical arrangement of the objects in the scene and the general brightness of the scene as compared with the full scale sensitivity of the scanner.

"In examining available studies which dealt with the usefulness of present sensor systems and the advantages to be gained in using systems with improved capabilities, the panel came to the conclusion that higher spatial resolution, greater spectral resolution, improved signal-to-noise ratio, and better radiometric resolution will make an instrument more useful for gathering remote sensing information for use in virtually all applications.

However, it is very difficult to quantify these improvements. It appears extremely difficult to accurately separate the expected improvements due to changes in each of the parameters. Moreover, it is not possible to define rigid boundaries of the type of application which will result from arbitrary limits on the various sensor parameters. Rather, there seems to be a gradual improvement in each application as each of the sensor parameters is gradually improved."

4. Various aspects of the matter were further discussed at the current session of the Sub-Committee, in the course of which many delegations expressed their views.
5. Some delegations expressed the view that trade-offs among spatial, spectral and radiometric resolutions can be made in the design of optical remote sensing instruments.
6. Some delegations reaffirmed the view that there was no simple or practical scientific basis for classifying remote sensing data into global, regional and local data. Other delegations expressed the view that classification of remote sensing data would be essential for purposes of data dissemination and that spatial resolution should be the key parameter for such classification.
7. The view was expressed that the studies on the definition of spatial resolution might be extended to include radar sensors and radar images. In the case of remotely-sensed data provided by synthetic aperture radar systems, the ground spatial resolution and the radiometric resolution were related in the sense that (within certain limits) some trade-off could be made between these two parameters during the processing of the data.
8. The Sub-Committee also noted that the delegation of the United Kingdom was prepared to submit to the Secretariat a paper on spatial resolution with emphasis on radar sensors. The Sub-Committee expressed the hope that the paper could be submitted for consideration at its seventeenth session.
9. The view was also expressed that, with regard to resolution, it is obvious that there are many definitions, and that the relations between these, modulation transfer function (MTF) and instantaneous field of view (IFOV) are very complex. A new concept, called effective resolution element (ERE), is being developed, which might prove to be a useful spatial figure of merit for all imaging remote sensing sensors, including synthetic aperture radar.
10. The Sub-Committee also noted the request and subsequently recommended that the Secretariat should arrange to provide a report on the concept of ERE before its seventeenth session in 1980.
11. The view was expressed that there is a need for further definitions of terms in the field of remote sensing and in particular to define such widely used terms as "coarse", "medium", "fine", etc. spatial resolution of imaging systems for remote sensing. The Sub-Committee recommended that the Secretariat should solicit

views of members of the Committee and such international organizations as WMO, COSPAR, IAF, the International Society for Photogrammetry and the Remote Sensing Society.

B. Dissemination of primary data

12. Some delegations expressed the view that remote sensing data should be freely disseminated. In this connexion, it is the view of those delegations that if dissemination of data is to be restricted in any way, only States operating satellite systems will have complete access to data. This, in fact, places the nations who cannot afford or do not wish to develop their own systems at a distinct disadvantage vis-à-vis the sensing States.

13. The view was expressed that the dissemination of data obtained by remote sensing must be subject to prior consent and should be made available freely to the sensed State as an expression of respect for its sovereignty and not be distributed to third parties without its consent.

14. Other delegations expressed the view that some classification of data should be established. Based upon such a classification, there should be an agreement on a limit beyond which the dissemination of data should have the prior consent of the sensed States. In this connexion, some delegations were of the view that a sensing State possessing primary data about a sensed State finer than a certain spatial resolution should not disseminate such data to a third State without the permission of the sensed State. Some delegations suggested that the appropriate limit be a photographic resolution of 50 metres, since it was their view that dissemination of data with finer resolution might affect the economic and/or defence interests of sensed States.

15. The Sub-Committee reiterated the view which it had expressed at its fourteenth session (A/AC.105/195, para. 41) that there was no scientific or technical basis for a sensed State not having timely and non-discriminatory access to data of its territory.

C. The co-ordinating role of the United Nations

16. The Committee on the Peaceful Uses of Outer Space and its Scientific and Technical Sub-Committee as well as its Legal Sub-Committee have, for a number of years, considered the extent to which the United Nations can play a co-ordinating role in future operational remote sensing systems, fostering further international co-operation in the field of remote sensing.

17. Some delegates expressed the view that the co-ordinating role of the United Nations on remote sensing was paramount, and at the very least in the best interest of the developing countries. It was their view that the United Nations was the appropriate forum for undertaking such an activity. Consequently, it was their view that the co-ordination being undertaken outside the United Nations at

this time and in future should not preclude the future co-ordinating roles of the United Nations in remote sensing.

18. In the last few years, the Committee has devoted particular attention to the discussion of the possibility of co-ordination by the United Nations through a remote sensing panel of experts. In this connexion, at its fifteenth session, the Scientific and Technical Sub-Committee considered the Secretariat's report entitled "Feasibility study on the possible co-ordinating function for the United Nations in future operational activities in remote sensing satellites" (A/AC.105/154/Add.2). This report, the result of more than three years of deliberations on the issue, outlines the possible composition, functions and terms of reference (A/AC.105/216, paras. 64-66) of the proposed United Nations panel of experts on remote sensing.

19. During the discussions that followed at that session, the Sub-Committee concluded that the Secretariat, taking into consideration the views of Member States, should present a single approach in the report to be presented to the sixteenth session of the Sub-Committee (A/AC.105/216, para. 67).

20. The Sub-Committee noted the observation made by the Secretariat in reporting the view of Member States that, because of the divergent views presented by Member States (A/AC.105/224 and Add.1-2), the Secretariat was not in a position to present the single approach report requested by the Sub-Committee.

21. Some delegations were of the view that a panel of experts should be established and that it would perform a great service to the cause of remote sensing globally. The views of these delegations on the functions, composition and terms of reference of this panel were along the lines of the report of the fifteenth session of the Sub-Committee (A/AC.105/216, paras. 64-66).

22. Some delegations expressed the view that the following terms of reference might be considered, should such a panel be established:

(a) To study and report on existing and proposed formats of data and index systems;

(b) To study and report on procedures for exchange of data and information among Member States;

(c) To study and report on procedures for dissemination of data to users;

(d) To study and report on procedures for information retrieval;

(e) To examine and report on the characteristics of future systems, based upon experience to date;

(f) To study and report upon other related matters.

23. The view was expressed that the proposed panel should be limited in mandate and structure, should not formulate any rules for standardization, and should serve only as a documentation centre for facilitating the exchange of views.
24. The view was expressed that the proposed panel of experts could not be established before the international community agreed on the legal principles that would apply to the operational activities of remote sensing of the earth from satellites.
25. The view was also expressed that the activities envisaged for the proposed panel to date could be better undertaken through direct co-operation between States that were contemplating the establishment of remote sensing systems in the future; such activities are currently being effectively conducted on a bilateral basis.
26. Having further discussed the matter at this session, the Sub-Committee concluded that it was not in a position to recommend the establishment of the proposed panel at this time. Consequently, the Sub-Committee urged those nations or agencies operating or planning ground or space segments of satellite remote sensing systems to continue and expand the co-operation and co-ordination of their activities. Member States were urged to inform the Secretariat of any changes in their views on the question of the panel so that those views could be brought to the attention of the Sub-Committee at future sessions. To that end, the Sub-Committee recommended that the Secretariat request Member States to include their views reflecting such change, if any, in the annual reports on their national and co-operative international space activities. The view was expressed that the lack of agreement of the Sub-Committee on the formation of a panel might lead to the actual co-ordination of future operational systems taking place outside the United Nations framework.

D. International co-operation

27. The Sub-Committee was of the opinion that remote sensing from outer space should be carried out with the greatest possible international co-operation and participation. In this context, the need to provide assistance to developing countries was recognized. The United Nations, through its Space Applications Programme and the remote sensing centres of FAO and CNRET and other interested agencies, could play an important role in providing such assistance.
28. The Sub-Committee recognized the necessity of regional co-operation and the creation of indigenous capacity to give especially the developing countries a capability to analyse and use remote sensing data themselves.
29. The Sub-Committee also noted that the principal focus of its activity over the past few years had been the transfer of remote sensing technology to the developing countries. The Sub-Committee might now begin to focus its attention on developing a comprehensive catalogue of the applications of remote sensing, with particular emphasis upon those in the developing countries. Such a catalogue could include a description of the problem (such as locust control, flood mapping, or perhaps

various forest management problems), the remote sensing techniques applied to its solution, the degree of success or failure of such attempts, the degree to which the technique has been operationally adopted, and the tangible and intangible benefits derived from adopting these new techniques. The catalogue should be continually brought up to date as new applications are developed. Particular emphasis should be placed upon the new applications developed for and by the developing nations, so that these may be used by all interested nations. To that end, the Secretariat was requested to inform the Sub-Committee at its seventeenth session on the scope and format of the catalogue and on the extent to which Member States and interested international organizations could contribute to its compilation.

30. The Sub-Committee also agreed to the suggestion made regarding preparation by the Secretariat of a catalogue listing specific remote sensing applications that have been put to use by developing countries, including names and addresses of organizations within those countries, and that this information should be furnished by the Expert on Space Applications as a supplement to his report to the next session of the Sub-Committee.

31. The Sub-Committee noted the reports by ITU on its work (seventeenth and eighteenth reports by ITU on telecommunication and the peaceful uses of outer space (A/AC.105/199 and A/AC.105/213) in the regulation of the radiocommunication part of remote sensing systems. The allocation of frequency bands and the relevant procedures were contained in the Radio Regulations attached to the International Telecommunication Convention. The World Administrative Radio Conference, 1979, would review these provisions as necessary.

32. The ITU International Consultative Committees (CCIR and CCITT) were preparing studies and making recommendations concerning telecommunication systems; in the case of remote sensing this includes CCIR studies concerning the radio system (propagation, antenna, orbits, frequency sharing, modulation, etc.). ITU was also considering other parameters, such as the format or recording characteristics for their influence on the performance of the telecommunication system, in particular in case of data transmission on the general telecommunication network.

33. The Sub-Committee also noted the reference made by the ITU observer to the ITU International Radio Consultative Committee (CCIR) Study Group 2 (Space Research and Radioastronomy) recommendations and reports adopted by the last CCIR Plenary Assembly (Kyoto, 1978) concerning the radiocommunication aspects of earth exploration satellites, including active and passive microwave sensors. These documents contained the presently available information on needs and characteristics of remote sensing programmes related to radio frequency use studies under way in ITU.

34. The Sub-Committee recalled that the General Assembly, in order to strengthen further the programme aimed at assisting the introduction of satellite remote-sensing data into projects in the developing countries, had endorsed the recommendations of the Committee on the Peaceful Uses of Outer Space for the

strengthening of the FAO remote sensing centre in Rome in the area of renewable resources and of the centre in CNRET in the area of non-agricultural resources.

35. In this connexion, the Secretary-General, in a note verbale dated 3 November 1978, requested Member States to provide the Secretariat with their views on possible assistance for the strengthening of those two international centres for remote sensing at FAO and CNRET. The views received to date by the Secretariat are contained in document A/AC.105/232 and Add.1 and 2 which have been presented to Member States at this session.

36. The Sub-Committee noted with satisfaction that FAO was continuing to increase its provision of on-the-job training at its centre in Rome; that the third United Nations training course on remote sensing applications, in co-operation with FAO and the Government of Italy and with assistance from several other countries, had been held at the FAO centre in Rome; that a fourth United Nations course would be held in Rome in 1979 and a fifth in 1980 on remote sensing applications to fisheries and water resources respectively; that a FAO/WMO/ESA course on remote sensing applications in agro-meteorology had been held; and that FAO was pursuing its grass-roots approach in providing advice, country-based training, technical assistance to Member States and advice to United Nations bodies. The Sub-Committee noted with satisfaction the important contribution being made by the Government of Italy and the increasing assistance being provided to FAO by other countries, and recommended that FAO give priority to strengthening its centre in Rome, utilizing existing resources, and that it make a progress report at the next session of the Sub-Committee.

37. The Sub-Committee noted that CNRET is developing capabilities in the area of on-the-job training and a variety of assistance on remote sensing applications in non-agricultural resources management. In this connexion, CNRET has acquired catalogues and maps to locate satellites coverage on a world-wide basis. The data collected in this manner would be integrated into field projects. Equipment for further interpretation of satellite data has been purchased for use in the United Nations technical assistance programme. The Sub-Committee recommended that the Department of Technical Co-operation for Development give priority to strengthening its remote sensing centre in CNRET, utilizing existing resources, and that it make a progress report at the next session of the Sub-Committee.

38. The Sub-Committee noted that as part of its global environmental monitoring system (GEMS) the United Nations Environment Programme (UNEP) was co-operating with both FAO and UNESCO on a number of natural resource projects using LANDSAT imagery. Soil degradation and tropical forest assessments had been carried out in various parts of Africa and the Middle East. Similar studies were contemplated for South-East Asia and Latin America. Projects on desertification and range land monitoring were also at various stages of planning and development.

39. The Sub-Committee noted the information provided by WMO that satellites were indispensable for the success of the World Weather Watch, the Global Atmospheric Research Programme (especially its First Global Experiment), the Tropical Cyclone Project, the Integrated Global Ocean Stations System, the operational hydrology

and water resource development programme, agro-meteorological programmes, research and other WMO programmes.

40. Based upon international co-operation as a traditional feature of meteorology, the performance of the satellite subsystem of the Global Observing System (GOS) of WWV is at present actively supported by the European Meteorological Satellite Programme (METEOSAT), the Meteorological Satellite Programme of Japan, the Meteorological Satellite Programme of the USSR and the Environmental Satellite Programme of the United States.

41. More than 220 APT stations are now operated by national meteorological services and plans exist for establishing additional stations. A large number of members also have WEFAX receiving stations. In addition to stations capable of receiving analogue signals from satellites, a number of stations capable of receiving digital signals both from geostationary and polar-orbiting satellites are in operation.

42. Since 1973, WMO has set up and is presently increasing its information service on the technical and operational aspects of the use of satellite data. This activity includes: keeping under constant review the planning efforts and implementation of space and ground segments of the satellite subsystem of GOS; monitoring the operation of the satellite subsystem of GOS and evaluation of the reports and summaries on this subject; and providing direct assistance to members in the implementation of ground segments and its operation through the provision of expert services and Secretariat staff.

43. In an effort to contribute effectively to the implementation of various WMO programmes and to meet promptly the needs of Member States, WMO has organized a number of seminars, symposia and workshops on remote sensing of the earth's surface, including the world's oceans, interpretation and use of satellite images from polar orbiting and geostationary satellites and is also co-sponsoring similar activities organized by other international organizations and institutions (e.g. United Nations, FAO and ESA).

E. Education, training and technical assistance

44. With respect to education and training, the Sub-Committee noted the importance of providing adequate training facilities, including on-site training in all aspects of remote sensing, particularly to the developing countries to enable them to derive the maximum benefit from this new technology.

45. The Sub-Committee noted with appreciation that several Member States, specialized agencies and international organizations were co-operating with the United Nations in conducting several education and training programmes relating to remote sensing activities. It particularly noted the contribution of Member States in the implementation of the United Nations Space Applications Programme related to remote sensing and especially those highlighted in the report (A/AC.105/233) of the United Nations Expert on Space Applications.

46. The Sub-Committee took note of the activities of the Remote Sensing Centre in Cairo, one of the five institutions recommended by ECA as regional training and user assistance centres serving Africa. The Centre started its activities in 1971 as a co-operative venture between the Egyptian Academy of Science Research and Technology, the United States National Science Foundation and Oklahoma State University. The Cairo Remote Sensing Centre has conducted several major research and field projects with direct applications to large national resource survey programmes and other engineering development projects in Egypt, the Sudan and other Middle Eastern countries. The Centre is capable of providing training in English and French in remote sensing applications. At the Conference of Arab Ministries responsible for Application of Science to Development held in Rabat in 1976, it was recommended that it should serve as a regional centre for all the Arab States.

47. The Sub-Committee took note with satisfaction of the diversity of the activities conducted by the Cairo Remote Sensing Centre and recommended that this Centre as well as the four African international remote sensing centres receive from the United Nations the technical assistance and co-operation which could be made available for such a purpose.

48. The Sub-Committee noted that the International Institute for Aerial Survey and Earth Sciences (ITC) in Enschede (Netherlands), which was founded at the initiative of the United Nations, had been in operation since 1951. Its mandate includes investigation, training and consultancy in aerial survey and remote sensing applications. Addressing itself exclusively to the needs of participants from developing countries, the Institute has provided training for more than 5,000 students. Recent activities of the Institute include the organization of four seminars on the potential of remote sensing surveying techniques on decision-making and planning for development in, respectively, the Netherlands, Colombia, Malaysia and Kenya.

49. The Sub-Committee noted with appreciation the offer made by Argentina to make its Celpa centre in Mar del Plata available as a regional centre for research and training in remote sensing.

F. Existing and planned space and ground segment

(i) Pre-operational space segment

50. The Sub-Committee noted that after almost six years of successful operation, LANDSAT-1, NASA's first earth resources monitoring satellite, was turned off on 23 March 1978. On 5 March, a more advanced LANDSAT-3 was launched. LANDSAT-3 contains a two-camera panchromatic return-beam vidicon system, which has now transmitted 12,000 scenes with an IFOV of about 40 metres. A still more advanced earth resources monitoring satellite, LANDSAT-D, will be launched in 1981 or 1982. LANDSAT-D will incorporate a scanner with an IFOV of about 30 metres and seven channels in the visible and extending into the IR portions of the spectrum.

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51. A major LANDSAT experiment completed in 1978 demonstrated that LANDSAT data, supplemented by surface observations and information from environmental satellites, permits useful forecasts of wheat production on a global basis, as was reported to the Sub-Committee by the United States.

52. The Sub-Committee also noted that the United States launched four major environmental satellites during the year 1978. These were:

(a) Applications Explorer Mission (AEM), or Heat Capacity Mapping Mission (HCCM), a satellite designed to measure day and night temperature differences on the earth's surface (25 April);

(b) SEASAT, designed to study the earth's oceans. SEASAT returned data for 106 days before a massive short circuit ended data transmission. SEASAT sent back valuable data on ocean surface winds, currents, wave heights and ocean topography (24 June);

(c) TIROS-N, a third generation weather satellite, which was turned over to the National Oceanographic and Atmospheric Administration as an operational satellite on 30 November; and

(d) NIMBUS-G, the first pollution monitoring satellite. New instruments on this spacecraft were designed to detect earth and solar radiation parameters, total ozone amounts, sea ice concentration, sea surface temperatures, wind speed, atmospheric water vapour, rain rates and stratospheric temperature profiles.

53. The Sub-Committee also noted that work on various applications of aerospace technology for remote sensing of the earth is under way in the USSR. Multispectral images of coarse (IFOV about 1,000 m), medium (IFOV about 100 m) and fine (photographic 20 m) resolution are collected on a continuous basis from both operational METEOR satellites and automatic photographic satellites and manned spacecraft. Two state centres created in the USSR to explore earth/natural resources have distributed during 1978 hundreds of thousands of space images among more than 400 national organizations for practical applications. Most of the branches of the USSR national economy passed from experimental research/methodological use of space data to their practical production use. The information provided by the USSR is supplied to a number of socialist and developing countries on the basis of bilateral agreements.

54. The Sub-Committee noted the decision of France to develop an experimental earth observation satellite called SPOT (satellite probatoire d'observation de la Terre). The satellite would be launched by the Ariane launcher currently under development by the Centre national d'études spatiales (CNES) in the framework of ESA from the French Space Centre in Guyana. This satellite would have a multimission platform capable of carrying several payloads. The first mission scheduled for 1983 or 1984 would carry two identical imaging instruments in the visible and the infra-red which would provide high resolution multispectral images. The IFOV corresponding to the picture elements (pixels) of these multispectral images would be about 20 metres.

55. The Sub-Committee also noted that Sweden had signed an agreement with France covering co-operation on the development of the SPOT remote sensing satellite.
56. The Sub-Committee noted that, based upon its SURSAT experience, which is an outgrowth of activities involving the testing of the applicability of all weather sensors for monitoring and managing vast Canadian coastal and ocean resources, Canada would proceed towards exploring the possibility of developing a cost-effective, operational remote sensing system. The plan is to develop a satellite system whose prime sensor is a synthetic aperture radar, but which would also have imaging capability in the visible and infra-red regions. The Sub-Committee also noted that Canada would be exploring partnerships or other means of co-operation with interested States.
57. The Sub-Committee noted that Japan would start work on developing a satellite named Marine Observation Satellite-I (MOS-I) in 1979 with the aim of launching it about 1984. This MOS-I will be Japan's first earth observation satellite whose purpose is to survey sea phenomena and to seek the establishment of technology which is common in the earth observation satellite series.
58. The Sub-Committee noted that an experimental earth observation satellite called SEO (Satellite for Earth Observation) being built by India is expected to be launched by mid-1979. SEO would carry two television cameras with observation in two bands (0.54-0.66 and 0.75-0.85 micrometre) using 1 km resolution and two microwave radiometers (19.350 GHz, 125 km Swath and 22.235 GHz, 200 km Swath). The satellite, its sensors and ground segment, including data processing and handling systems, were being designed and built in India.
59. The Sub-Committee further noted that India had begun work on the design and planning of a pre-operational remote sensing satellite IRS (Indian remote sensing satellite) to be launched in the 1983/84 time-frame. It was expected that IRS would work in several spectral bands, with a ground resolution of 100 metres or better.
60. The Sub-Committee noted that ESA had developed a geostationary meteorological satellite (METEOSAT) whose area of coverage extended over Europe, Africa and the Middle East. Part of the data from this satellite was being used in the execution of the major WMO operational and research programmes, namely meteorology, agro-meteorology, hydrology and environment, etc. ESA had organized working demonstrations of this satellite in Greece, Kenya, Egypt, Tunisia, Morocco, the Upper Volta, the Ivory Coast and Ghana. Similar demonstrations were scheduled for Nigeria and Syria in 1979.
61. ESA had initiated studies on a future European space segment for remote sensing in which emphasis would be given to microwave payloads for specific European land and ocean sensing applications. In this connexion, it was anticipated that two satellites in this series would be launched in the 1985/86 period. It was intended in these studies to take account of the needs of the developing countries. At the same time, ESA would endeavour to ensure that any European system would produce data compatible with those produced by other

established remote sensing programmes and would itself be complementary to those programmes, thus avoiding wasteful duplication.

62. The Sub-Committee also noted that ESA had developed the metric camera for the SPACELAB maiden voyage which would be flown on the space shuttle in 1981. Over 100 proposals were received by ESA from Asia, Africa, Latin America and Europe for experiments that would be conducted from the SPACELAB using the metric camera.

(ii) Operational space segment

63. The Sub-Committee reaffirmed its view that current feasibility studies and deliberations in the United Nations about organizational or other aspects of an operational system should be seen as an important part of the build-up of information gained from the present pre-operational/experimental phase and were necessary for possible plans concerning the future operational phase. One of the main purposes of the present phase could be seen as paving the way through the accumulation of experience at all levels for defining the parameters of a possible operational phase.

64. The Sub-Committee reaffirmed its view that progress to date suggested that satellite remote sensing systems would one day, like weather and communication systems, become operational. As that occurred, the use of satellite data could be expected to become an integral part of national economies and their planning activities. International co-operation was necessary as that was the only cost-effective approach for acquiring the benefits of satellite remote sensing for the majority of countries, keeping in mind the special needs of the developing countries.

65. The Sub-Committee noted that it was already evident that several operational systems with quite different operational roles and different, but, hopefully, compatible characteristics might be implemented by various nations or agencies. It expressed the view that there would be an important role for the United Nations to play in encouraging the greatest practicable degree of compatibility of the technical features of such systems as well as complementarity in terms of capabilities and roles.

(iii) Ground segment

66. The Sub-Committee noted with satisfaction that because of the widely reported benefits resulting from the use of LANDSAT data, a number of receiving stations had already been set up in Brazil, Canada, Italy, Sweden and Japan and were now operating their own LANDSAT receiving, processing and data dissemination facilities. It further noted that other receiving stations were either completed or under construction in Australia, Iran, India and Argentina, while still others were being planned in Chile, Indonesia, Pakistan, Romania and the Upper Volta. The Sub-Committee recognized the importance of these receiving stations, with the help of which a fairly wide coverage of most of North and South America, most of Europe and large parts of Africa and Asia could be assured. The Sub-Committee, while expressing once again the hope that countries and other regions would consider

co-operating with other States operating remote sensing systems, called upon all countries setting up such stations to discuss the matter with neighbouring States, with a view to examining the feasibility of setting up such stations on the basis of regional collaboration.

67. The Sub-Committee also noted that NASA and ESA had signed three memoranda of understanding in Paris on 7 October 1978. These memoranda concerned the acquisition of LANDSAT data by European ground stations, together with the pre-processing and distribution of the data and several ESA-co-ordinated investigations involving data received in Europe from the NASA NIMBUS-7 and SEASAT satellites.

68. NASA and Canada's Department of Energy, Mines and Resources (EMR) signed an agreement on 19 September to carry out a scientific programme using SEASAT data received directly by Canada. In October, however, SEASAT ceased to function due to an electrical problem.

69. The Sub-Committee noted that, for purposes of acquisition of data, no ground-receiving stations were required to obtain all primary data from the United States experimental LANDSAT satellites and that those data could be acquired by anyone requesting them from the receiving country or organization.

70. The Sub-Committee also noted that, for purposes of acquisition of data, no ground-receiving stations were required to obtain primary data from the Soviet photographic space platforms as these data were collected on film returned to earth and then disseminated in a centralized manner to any State on a bilateral basis (in case of imagery with a spatial photographic resolution finer than 50 m, permission of the sensed State must be obtained for the dissemination of such data to any third party).

71. The Sub-Committee noted that in May 1978 the Convention on the Transfer and Use of Data of the Remote Sensing of the Earth from Outer Space was concluded by a group of socialist countries and opened to all States. A copy of the text of this convention was circulated in document A/33/162. The Sub-Committee welcomed this initiative as an indication of further efforts to strengthen international co-operation in the area of peaceful exploration and use of space technology for the benefit of all countries.

72. The Sub-Committee noted that India was preparing for an operational phase in the area of satellite meteorology. A ground segment would be set up by the Indian Meteorological Department. Meanwhile, a station for NOAA/TIROS data reception is operational and is being used for the study of cyclone dynamics in the Bay of Bengal and the Arabian Sea. An active participation in the Monex experiment is planned this year for which, among other things, three rocket launching sites are operational, Omega upsondes have been developed and aircraft with thermal infra-red and microwave sensors would be deployed.

73. The Sub-Committee noted that within the framework of a joint venture of the Netherlands Agency for Aerospace Programmes (NIVR) and ESA, the National Aerospace Laboratory (NLR) and the Netherlands Aerospace Industry completed a study on a conceptual design for a low-cost ground station for reception and pre-processing of remote sensing satellite data.

Annex II

REPORT OF THE WORKING GROUP ON THE USE OF NUCLEAR
POWER SOURCES IN OUTER SPACE

1. The Working Group on the Use of Nuclear Power Sources in Outer Space, established by the Scientific and Technical Sub-Committee in accordance with General Assembly resolution 33/16 of 10 November 1978 (para. 8) to consider the technical aspects and safety measures relating to the use of nuclear power sources in outer space, held a series of meetings at United Nations Headquarters between 12 and 16 February 1979.
2. Prof. J. H. Carver (Australia) was elected its Chairman.
3. In addition to closed informal meetings, the Working Group held four formal meetings. It was attended by representatives to the sixteenth session of the Scientific and Technical Sub-Committee (see list of participants contained in document A/AC.105/C.1/INF.8). A list of experts who attended the Working Group is annexed.
4. The Working Group had before it the following documents: Uses of radio-active (nuclear) materials by the United States of America for space power generation (A/AC.105/L.102); Questions relating to the use of nuclear power sources in outer space - a report containing views of Member States (A/AC.105/220 and Add.1); Questions relating to the use of nuclear power sources in outer space - report presented by Canada (A/AC.105/C.1/L.106); Questions relating to the use of nuclear power sources in outer space - working paper presented by India (A/AC.105/C.1/WG.V/L.1); Use of nuclear power sources in outer space: predicting satellite re-entry, working paper presented by the United Kingdom (A/AC.105/C.1/WG.V/L.4). The Working Group also had before it a number of informal papers. During the course of the meetings of the Working Group, two presentations on the use of nuclear power sources in outer space were made by the USSR and the United States.
5. Following a general discussion and a review of the papers before it, the Working Group adopted the following report at the conclusion of its meetings on 16 February.
6. The Working Group noted that various types of power sources exist for use on spacecraft such as solar cells, fuel cells and chemical batteries, as well as nuclear systems. Selection of a suitable power source is a complex technical issue and in practice most space missions have used conventional power sources. The particular advantages on the use of nuclear power sources (NPS) are their long life, compactness and ability to operate independently of solar radiation.
7. For certain important space missions NPS have been the preferred technical choice. Provided the additional risks associated with NPS are maintained at an acceptably low level, the Working Group considered that the basis of the decision to use NPS should be technical.

8. Two types of NPS have been launched into outer space - radio-isotopic generators and nuclear reactors:

(a) Radio-isotopic generators consist of radionuclide fuels surrounded by energy conversion systems. The radio-isotope decays spontaneously, emitting ionizing radiation which is absorbed as heat and can be converted into other forms of energy.

(b) Nuclear reactors derive their thermal energy from the controlled fission of uranium 235. The reactor consists of an enriched uranium core with a reflector, producing heat for possible conversion to other forms of energy.

Both systems require that appropriate design and operational measures be taken, in order to protect the population and the environment for both normal and accidental conditions.

9. At present, the safety of radio-isotope sources is based on the use of containment which can survive the return to earth without release of radio-active materials and may be recovered intact.

10. For uranium 235 fueled space reactor systems, safety can be assured by delaying the re-entry until radio-active materials have decayed to a safe level.

11. The Working Group noted that the technical aspects of the safe use of NPS in outer space include safety, search and recovery, and notification.

12. The Working Group noted that there were several technical areas relating to safety of both types of NPS including (i) design, (ii) normal operation and (iii) abnormal conditions.

13. The Working Group agreed that appropriate measures for radiation protection during all phases of an orbital mission of a spacecraft with NPS - launch, parking orbit, operational orbit, or re-entry - should be derived principally from the existing, and internationally accepted, basic standards recommended by the International Commission on Radiological Protection (ICRP), in particular ICRP document No. 26.

14. It was noted that the safety of radio-isotope systems was being assured by designing them to contain the radio-isotope for all normal and abnormal conditions. The design should ensure minimal leakage of the radio-active contents and must at least meet the limits recommended by ICRP in all circumstances including launch accidents, re-entry into the atmosphere, impact and prolonged water immersion.

15. The Working Group agreed that the safety of reactor systems did not present any difficulty when they were started and operated in orbits sufficiently high to give time for radio-active materials to decay to a safe level in space after the end of the mission. In this way the dose equivalents at the time of re-entry could be guaranteed in all circumstances to be within the limits recommended by ICRP for non-accident conditions. If reactors are intended for use in low orbits where the

radio-active materials do not have sufficient time to decay to an acceptable level, safety depends on the start of the operation in orbit and the success of boosting NPS to a higher orbit after operation is completed. In the event of an unsuccessful boost into higher orbit the system must in all circumstances be capable of dispersing the radio-active material so that when the material reaches the earth the radiological hazard conforms to the recommendations of ICRP.

16. The Working Group noted that the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space and the Convention of International Liability for Damage caused by Space Objects are of direct relevance to search and recovery questions relating to nuclear power sources. It noted in particular that under the first agreement a launching State is obliged, at the request of a State affected, to eliminate possible damage or harm that might result from the return of a space object or its component parts which is of hazardous or deleterious nature, and that, under the second agreement, a launching State is obliged to examine the possibility of rendering appropriate and rapid assistance to a State suffering damage caused by a space object which presents a large-scale danger to human life or seriously interferes with the living conditions of the population or the functioning of vital centres, when that State so requests.

17. The present standards and practices do not provide any specific guidelines for the provision of information concerning power sources being used on board spacecraft, except as provided for in General Assembly resolution A/33/16, which requests launching States to inform States concerned in the event that a space object with NPS on board is malfunctioning with a risk of re-entry of radio-active materials to the earth.

18. The Working Group considered that States should be informed of a possible re-entry or malfunctioning of a spacecraft carrying an NPS so that those concerned might take necessary precautionary measures. The earliest possible notification of such an occurrence is deemed essential. Even prior notice of a few hours before possible re-entry can be of assistance to authorities planning emergency measures. Accurate prediction of time and place of impact for an uncontrolled spacecraft is recognized to be difficult. However, the Working Group felt that every effort should be made to determine, on a priority basis, the technical feasibility of early notification to States which might be affected by the re-entry of the spacecraft and of early notification to the Secretary-General of the United Nations.

19. The Working Group took note of the information and views brought before it by some delegations suggesting that notification could be greatly facilitated if the accuracy of orbital predictions could be improved.

20. In this connexion, it was stated that the accurate prediction of satellite lifetimes some months or years prior to their decay remains one of the most difficult and intractable problems of orbital mechanics, due to the dependency of such lifetimes on a variety of factors. For most of those satellites which do not perform any manoeuvres in the last phases of their lives, decay dates can be predicted with an error of about 10 per cent of their remaining lifetime. Thus, a prediction of 10 days before decay would be likely to be in error by one day, and a

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prediction of 10 hours before decay might be in error by about one hour - during which time a satellite travels more than half-way around the world. Therefore, although a track over the earth on the final orbit can be specified about a day in advance, the predicted re-entry point along this track may still be in error by thousands of kilometres.

21. In some cases, even the above-mentioned accuracy cannot be reached and the prediction is further degraded.

22. In order to understand the complexity of the problem, it must be realized that the remaining lifetime of a satellite is critically dependent on the density of the upper atmosphere, which can vary irregularly and unexpectedly by up to 50 per cent. Also, a satellite in its last few orbital revolutions suffers stronger aerodynamic forces than at any previous time during its life, and this may change its mode of rotation, thereby greatly altering its drag, and hence modifying the re-entry point.

23. The gravitational attraction at the position of the satellite must be computed precisely, taking into account the complicated shape of the earth. The perturbations of this force by the attractions of the sun and moon depend themselves on the evolution of the orbit, and the future values of the local time and latitude at perigee, which are needed for an accurate prediction, vary in accordance with most of the factors mentioned above.

24. Further difficulties may arise if current orbital elements are not available or if the available elements are not sufficiently accurate.

25. The Working Group felt that the above sources of inaccuracy could be improved only by further research and study and by extensive and co-operative use of tracking stations and communications lines.

26. The Working Group noted that it was within the sovereign rights of the State(s) affected to decide as to whether it will carry out search and recovery operations utilizing its own resources and/or request the assistance of other States, including the launching State. The Working Group expressed the hope that, in the event that a State affected requests such assistance from other States, such States will respond promptly to provide the necessary assistance.

27. In the event that some information is available on the area of impact of an NPS, it may be prudent to mount a search operation to assess the potential hazard to the population and the environment and, if warranted, a recovery operation. However, the Working Group noted that the area of impact may not be known due to very limited prediction accuracies and tracking facilities.

28. Assessment, planning and possible execution of a search and recovery operation will be greatly assisted by information on the nature of the NPS. This information might include: the type of the device, the expected behaviour of the device during re-entry and the quantity and form of the radio-active materials.

29. The Working Group noted that such a search and recovery operation might involve communications, transportation, engineering equipment, supplies and services, and radiation safety expertise. These requirements will vary depending upon the location, size and accessibility of affected areas and on whether or not an airborne search would be required.

30. In this connexion, it was also noted that the International Atomic Energy Agency (IAEA) Emergency Assistance Plan encourages Member States to develop plans for all nuclear-related accidents and, where appropriate, enter into bilateral and multilateral agreements with other States to provide technical services which they might need beyond their own resources. IAEA itself has an action programme by which it could, upon request, arrange to provide technical assistance to any Member State, following an accident involving radio-active material. The effectiveness of this and other such programmes for the use of NPS in outer space might usefully be further studied.

31. The Working Group recommended that assistance in training be provided through appropriate international channels to personnel of States requesting training on hazard evaluation following re-entry of an NPS and on performing pertinent search and recovery and emergency planning operations.

32. Some delegations expressed the view that notification prior to launch of an NPS would greatly facilitate proper handling of any radio-active materials recovered from a malfunction occurring during the ascent phases of placing a spacecraft into orbit. It should be noted that only if prior information is provided that maximum tracking assistance can be made available to refine impact predictions.

33. Some delegations expressed the view that in light of the risks posed by uncontrolled re-entry or other accidents, NPS should be considered very carefully and used only when alternative power sources do not meet the mission's goals.

34. The view was expressed that NPS should only be launched into operational orbits which are high enough, as to allow the radio-active material to decay to a safe level prior to re-entry of the space vehicle and to rely on the other safety measures only to cover launch accidents and failures to achieve the operational orbits.

35. Some delegations expressed the view that the safety of nuclear power systems launched for operations in low earth orbits requires more detailed information and evaluation to assure compliance with the safety guidelines established in paragraphs 13, 14 and 15.

36. Some delegations expressed the view that a proper evaluation of the risks presented by NPS in space depends on establishing the number of NPS launched, the quantities of radio-active materials these involve and the probability of each entering the terrestrial environment at times corresponding to re-entry under normal and accident conditions.

37. Some delegations expressed the view that the launching of an NPS should be preceded by a systematic safety assessment.

38. The view was also expressed that the dispersion principle of a nuclear reactor in case of re-entry, referred to in paragraph 15 needs further assessment.

Conclusions and recommendations

39. The Working Group concluded that NPS can be used safely in outer space provided the safety considerations in paragraphs 13, 14 and 15 are met in full. The decision to use NPS in outer space should be based on technical considerations providing safety requirements can be met while satisfying mission requirements.

40. The Working Group agreed that in order to assist its future work, further studies should be made on the following subject areas:

(1) Elaboration of an inventory of the safety problems involved in the use of NPS in outer space.

(2) Implementation of ICRP recommendations for populations and the environment in the context of space vehicles utilizing NPS.

(3) Evaluation of existing methods in understanding orbital mechanics to determine if improvements may be made in predicting re-entry phenomena.

(4) Definition of technical considerations with regard to a format for notification.

41. The Working Group recommended that, at the seventeenth session of the Scientific and Technical Sub-Committee, arrangements be made for the Working Group of Experts to meet for one week during the Sub-Committee's session to continue its consideration of questions related to the use of NPS in outer space. In this regard, interested members are encouraged to include appropriate experts in their delegations.

42. The Working Group requested that interested members and international agencies contribute, by September 1979 at the latest, studies on technical aspects and safety measures of NPS in outer space, including those which have been identified by the Working Group in paragraph 40 above as requiring further examination.

43. The Working Group further requested that the Secretariat collate and summarize those studies already submitted and new studies to be submitted in response to paragraph 42 above, and circulate this material to members of the Working Group in advance of its next session.

44. The Working Group recommended that, to facilitate its task at its next meeting, informal consultations of interested members of the Working Group could be held not later than December 1979, to assist with the collating and summarizing of the studies submitted.

Appendix

UNITED NATIONS WORKING GROUP ON THE USE OF NUCLEAR
POWER SOURCES IN OUTER SPACE

LIST OF EXPERTS

Chairman: Prof. John H. Carver (Australia)

ARGENTINA

Vicecomodoro Dr. Edgardo Salvatelli, Comisión Nacional de Investigaciones
Espaciales, Buenos Aires

AUSTRALIA

Mr. D. G. Keeley, Department of Science and Environment, Canberra

AUSTRIA

Dr. Erwin Mondré, Austrian Solar and Space Agency

BELGIUM

M. Louis Groven, conseiller scientifique à l'Ambassade de Belgique à Washington

BULGARIA

Prof. Dr. Kiril Serafimov, Corresponding Member of the Bulgarian Academy of Sciences

CANADA

Mr. P. F. Walker, Director, Science, Environment and Transportation Policy Division,
Department of External Affairs, Ottawa

Miss A. Pollack, Space Policy Officer, Science, Environment and Transportation
Policy Division, Department of External Affairs, Ottawa

Dr. R. Eaton, Atomic Energy Control Board, Ottawa

Dr. R. Mamen, Communications Research Centre, Department of Communications, Ottawa

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CZECHOSLOVAKIA

Mr. Václav Bumba, Director of the Institute of Astronomy of the Czechoslovak Academy of Sciences and Scientific Secretary of the Czechoslovak Intercosmos Commission

Mr. Stefan Kalina, Attaché, Permanent Mission

EGYPT

Mr. Hussein Mesharrafa, Counsellor, Permanent Mission

FRANCE

M. Michel Levy, Comité interministériel pour la sécurité nucléaire

GERMAN DEMOCRATIC REPUBLIC

Dr. Robert Knuth, Scientific Adviser, Academy of Sciences

GERMANY, FEDERAL REPUBLIC OF

Prof. Dietrich Rex, Technische Universität Braunschweig, Department for Space Engineering

INDIA

Prof. Yash Pal, Director, Space Applications Centre, Indian Space Research Organization, Ahmedabad, India

Mr. Mohinder Kumar Gupta, Scientific Officer, Reactor Control Division, Bhabha Atomic Research Centre, Trombay, Bombay, India

ITALY

Dr. Fernando Lay, First Secretary, Permanent Mission

Dr. Sergio Sabbadini, National Committee for Nuclear Energy (CNEN) - Rome

Dr. Cesare Albanesi, National Center for Research (CNR) - Rome

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JAPAN

Mr. Akio Horiuchi, Head, Space Activities Planning Division, Research Co-ordination Bureau, Science and Technology Agency

KENYA

Dr. John P. Thiongo, Assistant Chief Engineer, Nairobi

MEXICO

Dr. Julián Sánchez Gutiérrez, Instituto Nacional de Energía Nuclear

NETHERLANDS

Mr. N. de Boer, Netherlands Institute for Aerospace Programmes (NIVR)

Mr. J. J. G. M. van Boeckel, Adviser for Space Matters of the Directorate-General for Science Policy, Ministry for Education and Science

SWEDEN

Mr. Sune Danielsson, First Secretary, Ministry for Foreign Affairs

Mr. Kay Edvarson, Head of Division, National Swedish Institute of Radiation Protection

UNION OF SOVIET SOCIALIST REPUBLICS

Dr. V. I. Serbin, State Council for Peaceful Uses of Atomic Energy of the USSR

Dr. A. I. Beliakov, Academy of Sciences of the USSR

Dr. M. I. Gneushev, Ministry of Health of the USSR

Mr. B. G. Maiorski, Ministry of Foreign Affairs of the USSR

Mr. I. F. Vanin, Ministry of Foreign Affairs of the USSR

UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND

Dr. Brian Wade, Atomic Energy Authority

Mr. M. H. McTaggart, Ministry of Defence

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UNITED STATES OF AMERICA

Mr. Leonard Jaffee, Special Assistant to the Chief Engineer, National Aeronautics and Space Administration

Mr. Thaddeus J. Dobry, Jr., Chief, Safety and Isotope Fuels Section, Department of Energy

Mr. Thomas B. Kerr, Manager, Nuclear Safety, National Aeronautics and Space Administration

YUGOSLAVIA

Prof. Dr. Ilija Stojanovic, Faculty of Electrical Engineering, Belgrade University

Secretariat of the Working Group

Mr. N. Jasentuliyana, Secretary

Mr. D. Felske, Assistant Secretary
