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International Scientific Radio Union

U. R. S. I.

INFORMATION BULLETIN

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CONTENTS

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IXth GENERAL ASSEMBLY

Resolutions and Recommendations of the Commissions

COMMISSION I. — METHODS OF MEASUREMENTS AND STANDARDIZATION

1. — All National Committees should examine the reception in their own territories of the present standard frequency transmissions, from the standpoint of the use of these transmissions for frequency standardising purposes, and with the object of proposing a time-sharing of programmes in the future.

The possibilities of sharing programmes on a zone reception basis, and taking account of ionospheric propagation conditions, have been examined in a preliminary manner and are considered to present great practical difficulties.

2. — It is recommended that the national laboratories of the countries which have developed precise methods of measuring power at frequencies between 30 and 300.000 Mc/s, should :

(*a*) arrange for the exchange of the measuring apparatus with laboratories of other countries, with a view to effecting a comparison of the standards of measurement.

(*b*) inform Mr. C. W. OATLEY, as representative of U.R.S.I., of the arrangements made and results obtained.

It is further recommended that the results of any such intercomparisons be reported in the *Bulletin of U.R.S.I.* as soon as they are available.

The following countries have agreed to participate in this work : U.S.A., Great Britain, France, Norway, Sweden, Italy, Netherlands and Switzerland.

COMMISSION II
ON TROPOSPHERIC PROPAGATION

1. — In the light of the communications relating to the scattering of radio waves by fluctuations in the refractive index of the atmosphere, made to Commission II during the present General Assembly, it is formally recommended by Commission II that the study of this subjects should be fostered by U.R.S.I. especially in the following directions :

(*a*) The extent of the dependence of the scattered field on latitude, climate, and terrain to be further studied by means of observations in different countries.

(*b*) The statistical characteristics of fluctuations in atmospheric refractive index to be explored, making use of recent developments in micrometeorological measuring technique.

(*c*) Quantitative knowledge of the means of relating the findings under (*b*) to pratical radio results to be extended, especially in the direction of providing satisfactory approximations for the case of metre-wavelengths.

2. — That present knowledge of the relationship between atmospherics turbulence and the scattering of electromagnetic waves be communicated to the International Union of Geodesy and Geophysics, the International Astronomical Union, and the Mixed Commission on Radio-Meteorology ; and that the opportunity for further study of turbulence in the troposphere, and possibly in the lower stratosphere, by radio means be pointed out.

3. — In view of the importance of conditions in the lower atmosphere to the propagation of the shorter radio waves, it is recommended that U.R.S.I. take steps to ensure that national meteorological authorities are aware of the need of radio scientists for aerological observations ; and that aerological observations should be organised so as to provide as much information as possible for application in the radio field.

4. — The Commission wishes to draw the attention of the Joint Commission on Radio-Meteorology to the need to ensure that in

planning the meteorological measurements for the International Polar Year 1957-1958, attention is given to the need of radio-meteorology.

COMMISSION III
IONOSPHERE AND WAVE PROPAGATION

(1). The U.R.S.I., strongly supports the Mixed Commission on the Ionosphere in its plans for organizing an international network of radio observing stations during the solar eclipse of February 25 th., 1952. Furthermore it is agreed that the responsability for the over-all planning of observations of eclipse phenomena in the ionosphere shall be assigned to the Sub-Commission appointed by the Mixed Commission at the meeting in Brussels in September 1950.

The Sub-Commission concerned consists of :

Dr. L. V. Berkner (*Chairman*),
Father P. Lejay,
Dr. D. F. Martyn,
Prof. D. H. Menzel.

(2). That ionospheric forecasting organisations be invited to compare the method of dividing the world into F2 layer zones according to magnetic latitude (as determined by magnetic dip *in situ*) with the present method fo division according to geomagnetic latitude (as determined by the first degree harmonic of the earth's geomagnetic field).

In addition the following 16 Resolutions formulated by the Mixed Commission on the Ionosphere were endorsed by the General Assembly.

(3) *Laboratory researches relating to the formation of ionospheric layers.* — It is resolved that encouragement and support be given to physics laboratories to initiate and extend experimental researches on ultra-violet absorption, atomic collision processes (including recombination), discharges in electro-negative gases and the motion of charges in plasmas in magnetic fields.

(4) *Scaling of ionospheric records, and accuracy in measurements.* — In view of the great geophysical significance of ionospheric data, all ionospheric observatories are urged to aim at the highest accuracy and maintenance of consistency, in both experimental work and the scaling of records. Many important facts have already emerged from the material supplied by present ionospheric observations and it is clear that even further results would follow from enhanced accuracy. It is also recommended that routine measurements should be supplemented by especially accurate observations made less frequently but at regular intervals.

(5) *Publication of data.* — That, in the investigation of phenomena of the ionosphere and their relation to other terrestrial and extra-terrestrial phenomena, there is need for readily accessible data in published form of hourly measurements of ionospheric characteristics from all stations. Therefore this Commission urges that all stations consider this need and take steps to publish such hourly measurements not yet published which exist in their records. If difficulty is experienced in publishing all parameters then preference should be given to the quantities now scaled in C.R.P.L. reports.

(6) *Winds in the ionosphere.* — The Commission is of the opinion that further experimental knowledge of winds at ionospheric levels is vitally essential to the proper understanding of ionospheric phenomena. Such experimental studies should be supplemented by theoretical investigations of the phenomena attending the motion of electrically conducting fluids in non-uniform magnetic fields.

(7) *Rocket research.* — The Commission stresses the great importance of upper atmospheric research by means of rockets at many places over the earth. Since such information is obtained *in situ* it is supplementary to that obtained by other methods used at present.

(8) *Siting of new stations.* — In siting new ionospheric stations preference should be given to perfecting chains of stations on lines of longitude at which stations already exist e. g. at the approximate longitudes 75° W, 0° and 120° E. In view of the fact that the F2 layer is simultaneously affected by both solar and geo-

magnetic influences, the Commission recommends that a detailed study should be made of ionospheric and magnetic characteristics at sites on the geographical and magnetic (zero dip) equators. This should be done preferably in the South American and African continents where very few ionospheric stations exist at present.

(9) *Sporadic E ionisation.* — That in sporadic E ionisation measurements, attention should be paid to the variation of reflection and scattering characteristics of this ionisation with frequency.

(10) *Solar work.* — Increasing evidence of a direct relationship between solar activity and numerous radio phenomena emphasises the need for new and more general indices of solar activity. The Commission suggests that such indices as coronal emission, Hα emissions, flare activity, prominence activity, etc. would probably be of great practical value. To obtain the necessary continuity and completeness of solar records, world wide cooperation is necessary and a few additional high altitude stations are desirable, for example, in longitudes of Australia, India and Egypt. Some special studies can be made at high latitudes, where, during part of the summer, unusually extensive « runs » can be made during the long day. The Commission wishes to point out that no serious duplication of effort would be involved in the expansion of the solar observing programme. It is further suggested that methods for more rapid dissemination of solar data especially useful to radio experimenters be developed as far as possible. In addition, close collaboration and contact between workers in the radio and solar fields should benefit both parties.

(11) *Solar work in relation to 1952 eclipse.* — In connection with the total solar eclipse of 1952, maps and other special studies designed to exhibit the location of active solar areas on the disk and in the corona are a necessity. Such data should generally be made available for all eclipses, total, annular or partial.

The Commission recommends the I.A.U., that resolutions (10) and (11) above be referred to the cognisant solar commissions for consideration and implementation.

(12) *Organising observations for 1952 eclipse.* — That the Sub-Commission on the total eclipse of February 25th. 1952 (see

1, above) be appointed to encourage the organising of the maximum nomber of observing stations for ionospheric, radio astronomy and related astronomical observations and to recommend the optimum network for adequate coverage of individual areas.

(13) *Third International Polar Year.* — That, for the reasons attached (1), the 3rd. International Polar Year be nominated for 1957-58, and that, in view of the length of time necessary for adequate organisation of the complex physical equipment now potentially available, an International Polar Commission be appointed in 1951 to supervise planning.

This resolution is transmitted by the Mixed Commission on the Ionosphere for the approval of the Unions affected and sponsoring this Commission and for action by the I.C.S.U.

(14) *Median and Mean Values.* — In view of the widespread statistical analyses of geophysical data now being made, the Commission recommends stations to publish both median and mean values.

(15) *Nomenclature.* — The Commission gives provisional support to the suggestions on « Upper Atmospheric Nomenclature » in the memorandum prepared by Professor S. CHAPMAN and refers the document for general consideration of I.G.G.U.

(16) *Auroral observations.* — Such information of importance to the interpretation of ionospheric phenomena would follow from a proper understanding of auroral spectra. Since information concerning the wavelengths of the lines in the auroral spectrum is sufficient to enable identification to be made with some certainty, the Commission considers that whilst still more precise wavelength measurements are required, more attention should now be paid to the measurements of relative and absolute intensities of selected auroral lines of major significance.

(17) *Radio sounding of aurorae and auroral noise.* — The Commission records its support for experimental work on direct quan-

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(1) The reasons will be given in a special memorandum prepared by members of the Commission.

titative measurements of the ionisation density in aurorae by radio sounding methods and for observation on radio noise from aurorae.

(18) *Proposal for « International » or « World Days »*. — With increasing activity in many fields of upper atmospheric research, complete coordination of effort becomes more and more difficult. Certain phases of the studies are on a routine continuous basis ; others represent special studies designed to cover a limited period of time. (Rocket observations are, perhaps the most significant studies of the latter group).

In order to obtain as high a time concentration as possible of upper atmospheric data, it is recommended that a set of special days be designated as « world » or « international days ».

These should consist of approximately two days per month, one near full and the other near new moon. In addition, certain extra world days may be designated to coincide with such natural predictable phenomena as solar eclipses or meteor showers. If some experiment of a routine character is envisaged relating to conditions in the upper atmosphere or associated phenomena, it is recommended that the experiment be performed in a world day if there is no specific reason for choosing another day. When only selected data are to be published, or when detailed analyses are made only for selected days, the «world days» may provide a useful basis for such selection. This programme will lead automatically to the collection of concentrated atmospheric data at special times and will effect coordination with a minimum of trouble to the experimenters. Associated studies may include such fields as auroral measurements, solar activity, solar noise, special ionospheric studies, night-sky observations, upper air meteorology, cosmic ray experiments, magnetic measurements, ozone measurements, super-refraction of sound waves, rocket firings, plane or balloon flights, etc.

Only a few of the above fields are represented by a single Commission. This resolution should be referred to U.G.G.I., U.R.S.I., I.A.U., I.U.P.A.P., and other Unions interested for general consideration and ratification. It is further suggested that formal implementation and detailed drafting of the plan be referred to U.G.G.I.

COMMISSION IV
ON TERRESTRIAL ATMOSPHERICS

1. That the following remarks be communicated to C.C.I.R. in reply to their letter U.R.S.I./17 of September 4th. 1950 [1].

Notes.

The recommendation regarding C.C.I.R. Question N° 9 [2] has been considered by U.R.S.I. and the following comments are submitted for the consideration of C.C.I.R.

a) It is suggested that a more appropriate wording of the opening paragraph of Annex III is a follows

« that results of subjectives methods of noise measurements for a particular type of service may readily be interpreted for that service, but are difficult to translate for use with other types of service ».

b) In the absence of knowledge of the required parameters for the specification of noise, the evaluation of subjective effects from the results of objective measurements cannot at present be made.

Annex III would appear to suggest that such a transformation may generally be achieved.

c) A completely objective method of specifying a noise field applicable to all types of service would involve a large number of parameters ; some of these might be applicable to a number of types of service, but others would vary greatly in importance according to the type of service under consideration. For example, many parameters measured by existing methods have some application to an amplitude-modulated service but little relevance to frequency or pulse types of modulation.

d) Existing knowledge is not sufficient to permit specification of the parameters which are important for each type of service, and it is by no means certain that subjective effects may be adequately defined by a small number of parameters, suitable for practical application.

e) Considerable further research is required before it will be possible to define the relevant parameters and to specify the characteristics of equipment suitable for measuring these parameters.

f) The attention of the National Committees, of U.R.S.I. has been drawn to the requirements outlined in C.C.I.R. letter U.R.S.I./17 and to the need for further research on the topics discussed therein.

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[1] See p. 29.

[2] See U.R.S.I. Inf. Bul., **59**, 27.

2. — That National Committees encourage research designed to determine the parameters of noise necessary for specifying the degree of interference to various types of radio service.

Note : It appears to be desirable to make direct comparisons between subjective measurements of interference and objective measurements of selected parameters which appear to be relevant to the particular type of service.

A theoretical approach to the problem based on the known forms of noise and on the characteristics of common types of receiving equipment might also be profitable.

3. — That systematic measurements be carried out on the wave form of terrestrial noise and the corresponding response of selective circuits to provide exact quantitative information for the construction of terrestrial noise meters.

4. — That the international programme of simultaneous recording of atmospheric wave forms arranged at the VIIIth. General Assembly of U.R.S.I. (Stockholm) be continued and developed (1).

5. — That the detailed programme of recording atmospherics, the method employed and mode of exchange of data be arranged directly by the collaborators.

6. — That members wishing to participate in the programme of simultaneous wave form recording should contact one of the two rapporteurs of Commission IV.

7. — That bearing in mind the need of an accurate system for the synchronisation of records made at different distant stations on individual atmospherics, steps be taken to investigate the possibility of utilising existing services or creating some special system of international synchronisation of records.

8. — That the phenomenon known as « whistlers » be observed or recorded at as many stations as possible, at all latitudes, especially with relation to magnetic and ionospheric disturbances, and that the results of the observations be reported as soon as possible.

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(1) U.R.S.I. Vol. VII, p. 78.

COMMISSION V
ON EXTRA-TERRESTRIAL RADIO NOISE

1. — Refering to U.S.A. National Committee proposal nº 7 : Resolved that « Commission V » be renamed « Commission on Radio Astronomy », and extend its scope to include subjects such as meteors and the moon, when observed by radio techniques.

2. — Refering to U.S.A. National Committee proposal nº 8 : Resolved that « having in mind the present satisfactory liaison between U.R.S.I. and I.A.U., the minor importance of radio astronomy in I.U.G.G., and the undesirability of forming new Joint Commissions unless absolutely necessary, recommends no action at present ».

3. — Resolved to recommend that a Special Report nº 3 be prepared on the subject « Dynamics of ionised media », to include oscillatory phenomena and the effects of magnetic fields, by a Committee consisting initially of :

Prof. D. H. MENZEL, *Chairman*,
Prof. H. S. W. MASSEY, *Secretary*,
Prof. H. ALFVÉN,
Dr. G. K. BATCHELOR,
Prof. T. G. COWLING,
Prof. J. SAYERS,

and with powers to co-opt additional members.

4. — Resolved that the sun be continuously observed on radio frequencies near to 200 Mc/s and 3000 Mc/s, and that attempts be made to fill gaps in the world chain by commencing observations in the longitudes of California and Western India (on both frequencies, and in Europe on 3000 Mc/s).

5. — Resolved that Sub-Commission V*a* on the World Chain of Solar Radio Observatories be set up to advise the Commission on the improvement of the chain, with special reference to the standardization of equipment, and the avoidance of interference

from radio senders ; the Sub-Commission to be constituted as follows :

A. H. DE VOOGT, *Chairman* (Netherlands),
J. L. PAWSEY (Australia),
M. LAFFINEUR (France),
G. RIGHINI (Italy),
Y. HAGIHARA (Japan),
G. ERIKSEN (Norway),
R. LINDQUIST (Sweden),
A. H. SHAPLEY (U.S.A.),

6. — Resolved that the Report of the Committee on Terminology be communicated to Commission 40 of I.A.U., and general agreement sought.

COMMISSION VI. — ON WAVES AND CIRCUITS

1. — That the following subjects be placed or remain on the programme of study of Commission VI :

(*a*) Theory of Information.

(*b*) Non-linear oscillation.

(*c*) Linear theory of circuits (including the basic Theory of servomechanisms).

(*d*) Antennas (aerials) and wave guides (including the application of diffraction theory).

2. — That a sub-committee of Commission VI be formed for the study of Information Theory. The work of this sub-committee shall be :

(*a*) to collate all papers on the subject and to explore aspects both of General Theory and of detailed development of Theory ;

(*b*) to consider the practical implications at Information Theory on the practice of telecommunications, and to keep the C.C.I.R. informed of the results of sub-committee's studies in this respect.

3. — That U.R.S.I. be requested to assist in making more readily available the recent invaluable work of Professor HALLÉN on the current distribution in a cylindrical antenna (Bibliography : Cruft Laboratories Reports N° 46 and 49).

COMMISSION VII. — ON ELECTRONICS

There should be four main sections of special study, an international secretary being appointed for each section.

SECTION I. — Fundamentals of vacuum tubes, including :

(*a*) Vacuum tube noise,

(*b*) Travelling wave tubes, including electron wave tubes,

(*c*) Magnetrons,

(*d*) Other new developments.

Secretary : to be nominated by the United States National Committee.

SECTION II. — Fundamentals of Gas Discharges, and particularly :

(*a*) Recombination and de-ionization in ionized gases,

(*b*) The study of discharges in gases in the presence of magnetic fields,

(*c*) Laboratory study of the interaction of micro-waves with ionized gases.

(*d*) Plasma oscillations and noise.

Secretary : Prof. J. SAYERS, of England.

SECTION III. — Fundamentals of semi-conductors with application to radio physics.

Secretary : Dr. STEELTJES, of Netherlands.

SECTION IV. — Micro-wave spectroscopy.

Secretary : Mr. ABADIE, of France.

UNESCO

(Document NS/81)

Committee on Physics Abstracting

REPORT OF FIRST SESSION

London, 26, 27 September 1950

Introduction

The International Conference on Science Abstracting, which met at Unesco House, Paris, in June 1949, recommended that Unesco invite appropriate international bodies to co-operate with Unesco in setting up a committee of users and publishers of abstracts of physics and engineering to deal with abstracting problems at the international level. The Conference also recommended that a committee composed of representatives of the organizations responsible for the existing general abstracting services in physics, and of the interested international scientific unions, be convened to consider and take action upon a proposal for the publication, under the auspices of a single internationally controlled organization, of a single international general abstracting journal for physics.

In view of these recommendations, Unesco suggested to I.C.S.U. (the International Council of Scientific Unions) that it set up a Joint Commission on Physics Abstracting. I.C.S.U. did this at its meeting in September 1949, the following Unions being included in the Joint Commission :

International Union of Pure and Applied Physics,
International Astronomical Union,
International Union of Geodesy and Geophysics,
International Scientific Radio Union,

International Union of Cristallography,
International Union of Theoretical and Applied Mechanics,
International Union of the History of Science.

The I.C.S.U. Joint Commission on Physics Abstracting held its first meeting in Unesco House on 20 December 1949 and designated four of its members to represent it on any committee on physics abstracting that Unesco might establish.

Also in December 1949, a group of engineers met at Unesco House to discuss engineering documentation. This Study Group did not think it advisable to set up a single committee to deal with the abstracting of both physics and the engineering sciences.

In view of the foregoing, Unesco invited the I.C.S.U. Joint Commission on Physics Abstracting, and the two organizations which publish abstracting journals covering the whole field of physics, to form a Committee on Physics Abstracting. The following individuals were present at the first session of the committee, which took place in the building of the Institution of Electrical Engineers, London, on 26, 27 September 1950 :

Members :	*Representing* :
Dr. Paul BOURGEOIS Prof. G.A. BOUTRY Mr. J.H. AWBERY Dean Elmer HUTCHISSON	I.C.S.U. Joint Commission on Physics Abstracting.
Dr. S. WHITEHEAD Dr. A.C. MENZIES	Committee of Management of « Science Abstracts », London.
Prof. Jean WYART Mr. G. KERSAINT	« Bulletin Analytique », Centre de Documentation, Centre National de la Recherche Scientifique, Paris.

Unesco Secretarial. — Mr. J.B. REID, Department of Natural Sciences.

Observers :

Dr. B.M. CROWTHER, Editor, « Science Abstracts » ;
Dr. Ronald FRASER, I.C.S.U.-Unesco Liaison Officer (27 September only).

The following recommendations were adopted :

Recommendations

1. — In the spirit of recommendations 10.1 and 10.3 of the International Conference on Science Abstracting (document Unesco/NS/SAC/27), the Committee agrees that the first realistic step would be to encourage the extension of co-operation between the established services.

2. — The Committee welcomes the assurances it has received from the representatives of « Science Abstracts » and the « Bulletin Analytique » that they wish to collaborate closely with the aim of facilitating the editorial work and improving the efficiency of these two journals, without at first changing their internal structure. The co-operation will initially take the form of :

(*a*) Exchange of lists of periodicals received and of information on methods of work.

(*b*) Mutual assistance in the acquisition of periodicals, particularly those difficult to obtain, through such action as :

(i) Use of the good offices of each journal, in favour of the other, in obtaining publications with which it has close connexions ;

(ii) Joint approaches, preferably with official support, to certain periodicals, with a view to obtaining favourable conditions of subscription.

3. — The Committee recommends that the two journals consider progressively unifying the classifications of their abstracts and the principles of indexing them.

4. — The Committee invites the I.C.S.U. Joint Commission on Physics Abstracting to continue to press strongly through the National Committees of its constituent Unions for the application by all periodicals of physics and related sciences of the rules for the preparation of synopses recommended by the International Conference of Science Abstracting. In this connexion the responsibilities of the editors of periodicals are emphasized.

5. — As the most appropriate immediate way of speeding up the publication of abstracts, without endangering their accuracy and their bibliographic references, the Committee recommends that journals of physics send to « Science Abstracts » or the

« Bulletin Analytique », and if possible to both, their corrected final page proofs ; or in the case of distant countries, the synopses only, with bibliographical references, by airmail. Last-minute corrections must also be notified. In cases where proofs are made available to only one of the two abstracting journals, the Committee recommends that that editor send copies of the synopses to the other journal ; and that the editor explore the possibility of mutual assistance by correcting, classifying and indexing the synopses before passing them on.

6. — The Committee recommends that the I.C.S.U. Joint Commission on Physics Abstracting consider periodically the working and possible development of these arrangements, and make such recommendations to its constituent Unions as may be required.

7. — The Committee invites the International Council of Scientific Unions and the constituent Unions of the I.C.S.U. Joint Commission on Physics Abstracting to endorse these recommendations, and to take appropriate action with respect to :

(*a*) Publication of synopses with original papers (recommendation 4) ;

(*b*) Supply of proof copies to abstracting journals (recommendation 5) ;

(*c*) Favourable conditions for acquisition of publications by abstracting journals.

8. — The Committee recommends to I.C.S.U. that abstracting services co-operating in accordance with the preceding recommendations, should receive the official recognition of the Council.

This recognition might take the form of permitting the abstracting service to describe itself, in prescribed terms, as so recognized.

Bibliography

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Study Group on Engineering Documentation, Unesco House, Paris, 15-16 December 1949, *Final Report.* Unesco/NS/SA/4, 18 January 1950.

Committee of Users of Abstracts of Physics, Unesco House, Paris, 19 and 20 December 1949, *Final Report.* Unesco/NS/SL/Conf. 4/3, 20 January 1950.

Provisional Advisory Committee on Science Abstracting, Unesco House, Paris, 13-14 March 1950, *Final Report.* Unesco/NS/SL/Conf. 5/3, 30 June 1950.

(Copies of these documents may be obtained on application either to Unesco, 19, avenue Kléber, Paris-16e, France, or to the General Secretariat of U.R.S.I.)

INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

Meeting of Bureau and Executive Board I.C.S.U.

Bern, 9-11 August

(Reprint from *I.C.S.U. Monthly Bulletin of Information*, N° 27, July-August 1950)

The *Bureau* of the Council met all day on 9 August. The following chief decisions ware arrived at :

1. — *A Committee of the Bureau* (Professor A. VON MURALT, Prof. STRATTON, Col. HERBAYS) was nominated to frame such amendments to the 1949 Statutes as may be necessary to meet certain legal requirements, or as experience of the application of the Statutes may show to be desirable ; and to bring them forward to the General Assembly in 1952.

2. — *Application for admission* as an adherent to I.C.S.U. was received from Israel, through its National Research Council. Israel was admitted.

3. *Publicity.* — It was decided to adopt a more vigorous policy in publicizing the activities of I.C.S.U. by means of periodical contributions to *Experientia*, *Nature*, and *Science*, or by an active exchange of information between the Council and its Unions and the national adhering organizations.

The *Executive Board* of the Council met on 10 and 11 August. The following are the chief points arising from the discussions :

1. *Admission of New Unions.* — After careful consideration of the report of a Policy Committee appointed by the Bureau and of the comments on the report received from adhering organizations,

the Board considered a number of fresh and outstanding applications for admission, the final decisions on which are still the subject of correspondence between I.C.S.U. and the organizations concerned.

2. *Relations with the Council of Europe.* — Correspondence with the Council of Europe was tabled. After discussion, the Board instructed the General Secretary to inform the Council of Europe that I.C.S.U. was prepared to give its advice on scientific questions whenever so requested.

3. *New Rules for Joint Commissions.* — New rules for Joint Commissions and their relations to I.C.S.U. and their Mother-Unions were adopted (1).

4. *Future Status of the Committee on Science and its Social Relations.* — The proposal put forward by the Committee on Science and its Social Relations (C.S.S.R.), that it should be reconstituted as a Joint Commission of I.C.S.U. and the International Council of Philosophy and Humanistic Studies (C.I.P.S.H.), with I.C.S.U. as the « Conseil-Père », was referred to the Inter-Council Co-ordinating Committee (I.C.C.C.), with the unanimous approval of the Board.

Joint Commissions

Attention of U.R.S.I. delegates to Joint Commissions is drawn upon the following Rules as approved at the second session of the Executive Board of I.C.S.U. at Bern, August 1950.

The Rules will come into force after their final ratification by the Executive Board at its third session in 1951.

RULES FOR JOINT COMMISSIONS

1. — Joint Commissions to study specific topics in borderline fields covering subjects appropriate to more than one Union may,

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(1) See below.

with the concurrence of the Unions concerned, be set up by the Executive Board of I.C.S.U., under Article V.19 of the 1949 Statutes.

2.1. — The Executive Board shall invite the appropriate Unions to nominate each a certain number of members to serve on such Joint Commissions.

2.2. — *Membership* of a Joint Commission shall not ordinarily exceed ten. The final decision on the strength of each individual Commission rests with the Executive Board, and is subject to revision at the annual meeting of the Board.

3. — The Executive Board shall designate a *Mother Union* to foster the work of each Joint Commission.

4.1. — On the formation of a Joint Commission, the Mother Union shall appoint a *Provisional Secretary.*

4.2. — The Provisional Secretary is responsible for obtaining the nominations to membership of the Joint Commission from the Unions concerned, and for calling the first meeting of the Commission.

5.1. — The *First Meeting* of the Joint Commission shall elect a President and Secretary, both from among its members, of which at least one shall be a nominee of the Mother Union.

5.2. — The initial term of Office of both President and Secretary shall be three years, when both are eligible for re-election for at least one further term of three years.

5.3. — A Joint Commission may continue in being for three years, counted from the date of the first session, without reference to the Executive Board. It then rests with the Executive Board to decide wheter or not the Joint Commission should continue its work for at least a further period of three years.

5.4. — Each Joint Commission, on the termination of its mandate, shall either be dissolved or be replaced by a Commission of the Mother Union, if necessary with members co-opted from other Unions.

6. — A Joint Commission may appoint a number of *Advisory Councillors* if it is considered that the work of the Commission requires their assistance.

7.1. — *Advisory Councillors* who may attend a meeting of the Commission can receive transportation and *per diem* expenses only if they take the place of full members of the Commission who are unable to attend.

7.2. — If a meeting of a Joint Commission should coincide with another meeting organized by the Council or one of the Unions, transportation expenses and *per diem* for members of the Commission can be claimed on one count only.

7.3. — *Travelling Expenses* are normally claimable in respect of second class railway or steamer tickets. Air transport is claimable where large distances or notable time saving are involved.

7.4. — *Per Diem Expenses* to members and advisory councillors attending a meeting of the Commission with the assistance of Unesco subventions are payable according to the funds available, ordinarily for a maximum period of three days, or of five days in the case of members or advisory councillors coming from distant countries, at a rate to be determined from time to time by the Bureau.

8.1. — Funds for *Regular Meelings* of a Joint Commission are available at most in alternate years.

8.2. — Joint Commissions may suggest *Symposia* on topics falling within their domain, to be held in any year. The total number of such symposia in any one year for which subventions may be allocated is however contingent on the funds available in that year from Unesco and I.C.S.U. sources.

9.1. — In order that applications for subventions from Unesco may be submitted in time, each Joint Commission shall submit a list of meetings and symposia two years in advance for scrutiny by the Bureau of I.C.S.U. on the occasion of an annual meeting of the Executive Board, for submission to the Board for its approval.

10.1. — Request for suventions from Unesco or I.C.S.U. either for regular meetings or symposia approved by the Board as in 9.1., or towards the cost of publications, shall be submitted by the Mother Union.

10.2. — All subsequent dealings with Unesco or I.C.S.U. in respect of subventions are the responsibility of the Mother Union.

10.3. — Secretarial and minor administrative expenses of Joint Commissions will be borne by I.C.S.U. Any individual item of expense exceeding $ 100 must be approved by the Mother Union and by I.C.S.U. before being incurred.

11.1. — The Mother Union is responsible to the Executive Board for the conduct of the work of any Joint Commission attached to it.

11.2. — Joint Commissions shall render full reports of all meetings and other activities to the Mother Union.

11.3. — The Mother Union shall submit an interim Report on the work of any Joint Commission attached to it at the annual meeting of the Executive Board ; and a summarized report of the work of its Joint Commissions triennially to the General Assembly, through its representatives designated under Article VI.25 of the 1949 Statutes.

Joint Commission on Ionosphere

BRIEF PRELIMINARY REPORT ON THE PROCEEDINGS AT THE SECOND MEETING held at Brussels, September 4th.-6th. 1950

1. — The Second Meeting of the above Commission was held at the Académie Royale de Belgique, Brussels, on September 4th.-6th., 1950. The following were present :

Sir Edward Appleton (*Chairman*),
Mr. L.V. Berkner,
Father P. Lejay,
Dr. D.F. Martyn,
Professor H.S.W. Massey,
Dr. D.M. Menzel,
Mr. A. H. Shapley (representing Dr. Newbern Smith),
Professor L. Vegard,
Lt.-Col. E. Herbays (Secretary U.R.S.I.),
Dr. W.J.G. Beynon (Secretary, Mixed Commission).

Dr. Y. Aono (Japan),

Dr. H.G. Booker (U.S.A.),
Dr. C.R. Burrows (U.S.A.),
Professor Y. Hagihara (Japan),
Professor S. Hamada (Japan),
Dr. M. Kotani (Japan),
Dr. K. Maeda (Japan),
Dr. M. Nicolet (Belgique),
M. M. Nuyens (Belgium),
Professor A.H. Waynick (U.S.A.).

2. — Five sessions of the Commission were held. The subdivision of the field of work and brief summaries of the remarks of the opening speakers are given below. A full report of the discussions at the meetings together with the papers submitted to the Commission will be published in due course.

2(*a*). First Session. 4th. September, 1950.

The Formation of the Ionosphere (Professor H. S. W. Massey). — Professor H.S.W. Massey surveyed existing knowledge concerning the composition and formation of the principal ionospheric layers and stressed the uncertainties which still exist with regard to both the precise sources and constituents of the layers. Assuming the layers to be formed by solar ultra violet radiation, we can assume as a starting point a black body radiation at 6000° K but account must also be taken of radiation from both the chromosphere and the solar corona, the latter possibly providing a soft X ray radiation. The main constituents of the upper atmosphere are nitrogen and oxygen in molecular and atomic states — the change from molecular oxygen to atomic oxygen occur ing at about the level of the E layer. There is evidence too for the presence of Na and NO. It is not yet certain whether atomic oxygen is the main constituent of region E or region F1. If region E is assumed to be principally O then N_2 is a possibility for region F1 but a difficulty arises from the fact that studies of the twilight flash only give a concentration of about 10 ions per cc for N_2. If region F1 is N then this requires that a very large proportion of the nitrogen in the upper atmosphere shall be in the atomic state. For the D layer Vassy and Vassy have suggested Na but the possibility of NO should also be considered. Professor Massey emphasised the value of new information

which might be forthcoming from rocket experiments, the need for data on the state of the E layer at night, and also the need for extended laboratory experiments on atomic processes in ionised gases.

2. (*b*) Second Session. 4th. September 1950.

Movements in the Ionosphere (Dr. D.F. Martyn). — Dr. Martyn outlined the development in the theory of oscillations in the atmosphere, beginning with the early work of Laplace and of Lamb which was later extended by Taylor and Pekeris. This work showed that in the atmosphere there should be a great increase in the amplitude of atmospheric oscillations with height. In the case of the ionised layers of the atmosphere the motions are profoundly influenced by the presence of the earth's magnetic field. In particular due to the effect of the field, the vertical and horizontal components of the motion of the ionised constituents may be of comparable magnitude. Dr. Martyn explained the type of current diagrams to be expected in the upper atmosphere as a result of tidal motion, and concluded with a brief review of the outstanding problems of atmospheric motions.

2. (*c*) Third Session. 5th. September 1950.

(i) *Ionospheric Disturbances and Solar Phenomena* (Dr. D.H. Menzel). — The high correlation between sunspot numbers and geomagnetic and ionospheric activity has long been established but there is now an increasing tendency to regard sunspots as secondary characteristics. The relationship between sunspot numbers and terrestrial phenomena is most pronounced when monthly mean rather than daily values of the parameters are correlated. This suggests that some feature other than sunspots, although directly or indirectly correlated with them is really responsible for many terrestrial effects. A new and quantitative study of solar variability, based on motion pictures and coronal spectra taken at the High Altitude Observatory of Harvard University and the University of Colorado, Climax, Colorado, may partially clarify the problem. The most active features of solar activity, the observations show, are centered in the neighbourhood of the solar poles. Frequent eruptions, discovered and discussed by Dr. Walter O. Roberts, occur in high solar latitudes, where large quantities of highly ionized gas shoot into the solar atmo-

sphere. Thse eruptions are generally called the polar spicules. These high-velocity jets of gas rise to great heights, to form the faint background of the solar corona. The sun's general magnetic fields tends to support the material. However, when too great an accumulation of the material is present, the magnetic lines of force sag and matter cascades back to the solar surface, forming various types of prominences and, in the extreme case, actually producing the sunspots.

This theory, which attributes sunspots almost completely to a special type of coronal rain, seems to clarify the picture of solar activity and its terrestrial effects. Gaseous masses, cascading downward, are focused and condensed in the magnetic field. They release large quantities of ultra-violet light, which can exert an important effect on the earth's upper atmosphere.

The bent and twisted lines of magnetic force can, under certain circumstances, act like catapults to toss masses of gas upward, but indications are that very little matter actually escapes from the sun. If the sun does emit streams of atoms, the polar spicules are probably the main source of material reaching the earth. The aurora borealis and other so-called corpuscular effects, associated with magnetic storms, may result from the interaction of the terrestrial atmosphere with the solar stream. Under some circumstances, the released ultraviolet light may be responsible for a part of the observed phenomena, as in the case of sudden ionospheric disturbances.

Although many details still remain to be clarified, the indications are that the primary M regions are associated with variable spicule activity near the poles.

(ii) *Sporadic E Ionisation* (Dr. D.F. MARTYN). — Dr. MARTYN discussed the type of sporadic E ionisation which is observed in tropical and moderate latitudes and in particular referred to observations made at Brisbane, Australia. The seasonal variation at Brisbane show a maximum in summer but also a secondary maximum in winter with minima near the equinoxes. It is suggested that this type of variation results from the superposition of two types of sporadic E ionisation. The summertime sporadic E ionisation is found to originate at levels well above 100 km level and its progress can be traced down to this level. On the other hand the winter sporadic E ionisation appears *in situ* at the

100 km level — it has a more patchy appearance, is easily penetrated and is similar to the fringe E ionisation observed at Huancayo. Dr. MARTYN outlined an explanation for these results in terms of tidal theory. It is suggested that all the summertime sporadic E ionisation results from movement of ionisation carried down from the F1 to the E level but that below this level the ionisation disappears by attachment or some other dissipation process. The wintertime sporadic E is explained as a reverse process wherby banks of negative ions are slowly lifted up and at the 100 km level the electrons may be freed, giving rise to the observed ionisation. Dr. MARTYN stated that the fact that no lunar tide has been observed in normal E layer critical frequency but that such a tide has been detected in the critical frequency of the sporadic E layer lends support to the theory outlined.

2. (*d*) FOURTH SESSION. 5th. SEPTEMBER 1950.

Solar particles at the earth (Dr. D.F. MARTYN). — Dr. MARTYN outlined a new theory which he had developed concerning magnetic storms and aurorae. The theoretical work of CHAPMAN and FERRARO could explain the first phase but not the later phases of a magnetic storm. Treating the stream of particles from the sun as a conducting fluid it can be shown that around the earth a streamlined flow is established with a hollow space, the radius of this space being determined by an energy balance between the moving particles and the earth's magnetic field. Simple considerations of the energy of the particles and the strength of the field show that the radius of this hollow will be about 5.5 earth radii for all reasonable values of the number density in the stream. Dr. MARTYN explained the formation of a ring current around the earth and the manner in which particles from this ring current may be expected to reach the earth in the neighbourhood of the auroral zones. In conclusion he considered the form of the current sheets to be expected during a magnetic storm and the ionospheric effects which accompany such storms.

2. (*e*) FIFTH SESSION. SEPTEMBER 6th. 1950. — The final Session of the Commission was devoted to the formulating the resolutions (1).

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(1) See p. 5.

CO-OPERATION WITH C.C.I.R.

In order to keep National Committees and Commissions informed of our co-operation with C.C.I.R. we publish a letter sent by the Director of C.C.I.R. to the President of U.R.S.I. for the IX General Assembly.

Genève, September 4 th. 1950.

Sir EDWARD V. APPLETON,
President of International Scientific
Radio Union (U.R.S.I.)
IXth. General Assembly
Zurich

Dear Sir EDWARD,

At the occasion of the IXth. General Assembly of the U.R.S.I. the International Radio Consultative Committee (C.C.I.R.), in keeping with the spirit of collaboration which since long has existed between the two organizations, wishes to draw the attention of the U.R.S.I. to work done by C.C.I.R. Study Group 6.

In particular we would like to stress certain points made at the joint meeting of C.C.I.R. Study Groups 6 and 10 held last March in Washington. Study Group 6 (ionospheric propagation), under the Chairmanship of Dr. J. H. DELLINGER, especially featured points of interest to the U.R.S.I.

Whilst the meeting of Study Group 6 was attended by Mr. H. W. WELLS of the Carnetie Institution of Washington, as representative of the U.R.S.I., we believe that it is appropriate to draw the attention of the IXth. General Assembly of the U.R.S.I. to certain parts of the following documents, issued in Washington :

1. *Doc. 108-E* (Recommendation for Adoption by the VIth. Plenary Assembly of the C.C.I.R. Non Linear Effects in the Iono-

sphere). — In this document it se recommended that the U.R.S.I., amongst others, be advised that there is urgent requirement for further fundamental information on the properties and conditions of occurrence of all forms of ionospheric wave interaction (Annex I).

2. *Doc. 124-E* (Partial Report on C.C.I.R. Question 7, Sec. 3. Long Distance Propagation of Waves 30-300 Mc/s by Means of E and F Regions of the Ionosphere). — In this document the attention of the U.R.S.I. is invited to a survey of the problems presented (Annex II).

3. *Doc. 136-E* (Recommendation for Adoption by VIth. Plenary Assembly. Regarding C.C.I.R. Question nº 9). — This document refers to the study of objective methods of noise measurement (Annex III).

4. *Doc. 141-E* (Statement — C.C.I.R. Question nº 5). — In this document the attention of the U.R.S.I. is drawn to a survey of the problems presented in the study of medium and long wave propagation (Annex IV).

5. *Doc. 144-E* (Recommendation for Adoption by the VIth. Plenary Assembly of the C.C.I.R. Recording of Ionospheric Data). — This document recommends, amongst others, the co-ordination with U.R.S.I. of work appertaining to new forms of automatic recording of ionospheric data (Annex V).

For your information, the relevant part of the texts of the documents cited above is given in Annexes I-V to this letter.

We hope, and trust, that it will be possible to bring this letter with its annexes to the attention of the IXth. General Assembly of the U.R.S.I., as a contribution to the co-operation between U.R.S.I. and C.C.I.R.

Yours faithfully,

(*Sgd.*) Prof. Dr. B. VAN DER POL
Director, C C I R

ANNEX I Doc. 108-E
29 March, 1950

STUDY GROUP 6
RECOMMENDATION FOR ADOPTION BY THE VIth. PLENARY ASSEMBLY OF THE C. C. I. R.

Non-linear Effects in the Ionosphere

The C.C.I.R.,

considering,

(*a*) that numerous examples of intermodulation and of the generation of spurious signals in the ionosphere have been observed in the very low, low, medium and high frequency bands;

(*b*) that non-linear effects during ionospheric propagation can produce unwanted modulation of radio communications (including broadcasting);

(*c*) that these phenomena can impose limitations on the usefulness of systems and cause mutual interference between different circuits;

(*d*) that the magnitude of these phenomena may increase with the signal intensity in the ionosphere and with the complexity of the system in use;

(*e*) and that, in particular, there is no quantitative data available on high frequency wave interaction,

recommends,

1. that U.R.S.I. and other organizations concerned with fundamental research be advised that there is an urgent requirement for further fundamental information on the properties and conditions of occurrence of all forms of ionospheric wave interaction;

2. that all participating administrations and agencies be invited to collect information on the times of occurrence, magnitude, and conditions under which ionospheric wave interaction has been or is being observed.

ANNEX II Doc. 124-E

13 March, 1950

STUDY GROUP 6

PARTIAL REPORT ON C.C.I.R. QUESTION 7, SEC. 3 [1]

Long-distance propagation of waves 30-300 Mc/s by means of E and F regions of the ionosphere

FOREWORD. — It was suggested that :

(*a*) the attention of the U.R.S.I. participant in Study Group 6 be directed to the material in Part II of this document;

. . . . . .

II. SURVEY OF THE PROBLEMS PRESENTED. — Fundamentally, it would be desirable to be able to give an estimated value for the density of the various above-named types of ionization occurring at any time, and at any place on earth, as well as an estimate of the accuracy of this value. This knowledge is desirable for the allocation of frequencies and the intelligent use of allocated frequencies, since it affords a means of knowing the probability of transmission at any given time, for any frequency, over any transmission path.

It is well recognized that the critical frequencies of the regular ionospheric layers vary with general solar activity, season, time of day, and geographic location, as well as with geomagnetic activity (resulting from abnormal solar activity) and, to a small extent, with lunar phase. The variation with solar activity being such that there is an approximately linear relationship between sunspot number and critical frequency, prediction of these critical frequencies has been fairly successful, provided that a suitable sunspot number was selected for the time of prediction.

For determination of the maximum usable frequency for transmission, by means of a given layer, over a given transmission distance, the critical frequency for the midpoint, or the control points (Cf. methods outlined in the CRPL-D series publications) for the transmission path must be multiplied by the maximum

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[1] *U.R.S.I. Inf. Bull.*, 59, p. 26.

usable frequency factors pertinent to these locations and to the transmission distance. These factors (the secants of the corresponding angles of ionospheric incidence, modified to allow for such factors as earth and ionosphere curvature, etc.) also vary with solar activity, season, time of day, and geographic location, although generally their variation is much less than that of corresponding critical frequencies. For the E and F1 layers, their variation is practically negligible, and for the F2 layer, the variation is approximately linear, decreasing with increasing sunspot number.

Much of our present poverty of knowledge concerning ionospheric radio transmission above 30 Mc/s stems from insufficient data of certain types. Additional data especially needed are :

(*a*) F2-layer critical frequencies in the region between $\pm$ 20° geomagnetic latitude. In this region the *fo*F2 changes rapidly with latitude, and day-to-day changes are great. There is dearth of welltaken data in this region.

(*b*) E*s* data, especially in high latitudes, at many more stations than now exist.

(*c*) Consistently-taken field-intensity data, on high frequencies (above 30 Mc/s) over practical transmission paths, having general geographic distribution.

1. *Regular E layer ionization.* — There seems extremely low probability that maximum usable frequencies for long-distance radio transmission by means of regular E-layer reflection should ever exceed 30 Mc/s. The characteristics of this layer conform rather well to Chapman's theory showing variation of *fo*E with the one-fourth power of the cosine of the solar zenith angle. Average subsolar values of critical frequency for this layer during the recent period of maximum solar activity are indicated as being below 5 Mc/s. Day-to-day variation indicates a value as high as 6 as being extremely improbable. The pertinent maximum usable frequency factor for maximum one-hop transmission distance is currently considered to be slightly less than 5, therefore indicating average subsolar values of maximum usable frequency under 25 Mc/s and very low probability for values as high as 30 Mc/s.

2. *Regular F1 layer ionization.* — The F1 layer does not conform to Chapman's theory as well as does the E layer, but, however, shows fairly good adherence to the same basic laws of behavior. Corresponding average subsolar values of *fo*F1 for maximum solar activity are indicated as being somewhat lower than 7 Mc/s, with a slightly higher day-to-day variability than that for the E layer. Values as great as 1 Mc/s in excess of 7 Mc/s for subsolar *fo*F1, however, are still rather improbable. The pertinent maximum usable frequency factor for maximum one-hop transmission distance is seldom in excess of 4, so that values of maximum usable frequency for this layer are seldom likely to equal or exceed 30 Mc/s.

The conditions where this may be possible are near noon, in the tropics, at maximum solar activity. In general, however, F2-layer maximum usable frequencies, under the same conditions, may be expected to exceed those for the F1 layer.

3. *Regular F2 layer ionization.* — F2-layer variations with solar activity are much more pronounced than are those of the E and F1 layers. Moreover, the slope of critical frequency *vs* solar activity is, very roughly, linearly related to the critical frequency of this layer at sunspot minimum, other variational factors being constant. F2-layer critical frequencies may be said, with rough approximation, to double their value with an increase of sunspot number from 0 to 100.

It is notable, therefore, in the prediction of F2-layer critical frequencies, that errors in the prediction of sunspot number have especially large undesirable resulting errors in the cases of the higher transmission frequencies. The prediction of sunspot number is rather poor in accuracy for several reasons. The time series of sunspot numbers which are available for study is insufficiently long to determine whether cycles longer than the prominent approximately 22-year cycle exist. The data in this series prior to 1849 were obtained in a much less rigorous manner than those beginning in that year, and give some evidence of forming a notably inhomogeneous series with the latter. Possibly the greatest inherent defect, at the outset of predicting, lies in the fact that sunspot number is an extremely rough and rather arbitrary measure of the solar activity which generates and maintains the ionospheric reflecting layers.

Granted the accurate prediction of a sunspot number, the prediction of transmission frequencies depends upon the knowledge of the following variations, for both critical frequencies and maximum usable frequency factors :

(*a*) Variation with smoothed sunspot number (at each location, season, time of day), i. e., variation with general solar activity.

(*b*) Variation with season.

(*c*) Variation with time of day.

(*d*) Variation with geographic location.

(*e*) Variation with lunar phase.

(*f*) Variation with abnormal solar activity.

(*g*) Day-to-day « random » variation.

Obviously the knowledge of these variations depends upon the acquisition and pertinent analysis of a long-time series of data from a large number of suitably distributed observing stations. These data, moreover, should be taken by means of carefully standardized procedures, so that they represent, as far as possible, only natural variations, and not those due to variation of interpretation and of measurement methods.

A fair estimate of the times and places where monthly-median maximum usable frequencies may be expected to equal or exceed 30 Mc/s, for June and December, at sunspot numbers of 0 and 125, is given by the charts, Figs. 133-156, inclusive, of the report CRPL-1-2, 3-1, « High Frequency Radio Propagation Charts for Sunspot Minimum and Sunspot Maximum », prepared for the Provisional Frequency Board, International Telecommunications Union. These charts were constructed so as to entail the variational trends exhibited by all pertinent data accumulated and analyzed at CRPL up to the time of their issuance. More up-to-date estimates of F2-layer median maximum usable frequencies, for all months, are published in the CRPL-D series publications, « Basic Radio Propagation Predictions, Three Months in Advance ». These later entail estimates of sunspot number for the time of prediction, and thus are subject to errors inherent in this estimate. All the charts above mentioned are subject to the errors inherent in the lack of sufficient basic data upon which to establish accurate ionosphere trend estimates ; lacking sufficient data, especially

in certain regions, the values given are the result of subjective methods of estimation.

In order to determine the probability of transmission at frequencies other than the median frequencies indicated on the above charts, it is necessary to know the expected distribution of values about these monthly medians. Unfortunately, rather little work has been done on this type of analysis, although with increased crowding of the frequency spectrum, this subject becomes increasingly important.

Future improvement in prediction methods could well be directed toward the following objectives :

(*a*) Predictions of ionospheric critical frequencies and maximum usable frequencies in a form in which revised estimates of sunspot number could be easily applied up to the moment of use. Present methods entail an estimate of sunspot number made five months before the time for which prediction is made ; correction for a better estimate of sunspot number is difficult. This is especially important for frequencies about 30 Mc/s.

(*b*) Predictions of useful transmission frequencies in a form in which the *probability* of transmission at any frequency is stated, or may be evaluated readily. Present charts giving median values only are not helpful when estimates must be made of the probable amount of interference to be expected from other stations, etc. This might be effected by publication of two charts, one giving median values, the other giving standard-deviation values, from which probability of transmission on a given frequency might be obtained by simple nomographic, or other means. For E*s* transmission, and for transmission by scatter of by anomalous ionization patches, such charts would only be meaningful if standardized for radiated power, sensitivity of reception, and antenna directivity.

(*c*) Machine methods of synthesizing ionospheric trends for the solution of practical problems. Current methods, for example, of obtaining maximum usable frequencies by control-point considerations are only a very rough approximation to actuality, adopted as a convenient procedure because of the war-time emergency. Actually, much more detailed, mode-by-mode, analysis is needed ; this is only possible for practical use, if machine methods of solution are adopted.

Much time and effort have been expended on the study of the effects of abnormal solar activity upon F2-layer ionization (ionospheric « storminess »). Moderate success has been obtained in the prediction of times of occurrence and degree of severity of storms of the type which follow a 27-day (solar rotation period) pattern of recurrence. The prediction of extremely severe storms, which usually do not follow this pattern, is not as yet notably successful.

In recent years a number of studies have been made concerning lunar effects on F2-layer ionization. These studies have been pursued chiefly for their possible value in the development of a theory for F2-layer ionization variations. Lunar effects on *fo*F2 attain a maximum value of approximately $\pm$ 1 Mc/s, at certain times and places, notably near the geomagnetic equator. This entails a maximum variation of about $\pm$ 3 Mc/s in long-distance maximum usable frequency. Such variations occur in regions which may reflect radio waves of frequencies above 30 Mc/s; their maximum magnitudes are comparable with the usual magnitudes of errors in predicting monthly-average maximum usable frequencies for these regions. Therefore the consideration of these effects is of some practical value.

4. *Sporadic-E ionization.* — Radio propagation above 30 Mc/s by means of E*s* ionization is especially important because of its frequent occurrence, particularly in high-latitude regions where radio propagation at these frequencies may not be possible by means of reflection from the regular ionospheric layers.

The prediction of transmission by means of E*s* reflection is of rather poor accuracy for a number of reasons. Foremost among these is that the current method of measuring and reporting E*s* data leaves much to be desired; data as reported from ionosphere observing stations consist of the virtual heights and upper-limit reflection frequencies observed at vertical incidence. These latter are dependent upon both the radiated power and the sensitivity of reception of the measuring apparatus, which are not standardized from station to station, and are not standardized throughout the frequency range for any single station. Such standardization is necessary in order that an array of homogeneous data be secured for the making of predictions.

Until about 1944, very few stations reported Es data, so that few long-time series of these data are available for analysis, and these subject to some doubt whenever they entail changes in measuring equipment.

Inherently, Es ionization manifests far more irregularity in both time and spatial variations than does the ionization of the regular ionospheric layers, so that its prediction is likely to remain less accurate than that for the regular layers.

Because of the patent difficulties involved in analysis of such data, and the low probability of successful prediction with comparable accuracy to that for the regular layers of the ionosphere, this field of investigation has not appealed to most investigators as a profitable one upon which to expend their efforts, despite its importance for practical communication.

5. *Meteoric ionization.* — In recent years, considerable attention has been given to the investigation of meteoric ionization. This has not been because of its primary importance in radio communication, which is negligible, and limited at most to the consideration of scanty occasional interference with regular communication by signal bursts from other stations normally outside the range where such interference was possible by other means of signal reflection. Rather, it has been hoped that such studies would be of value in obtaining more information concerning the properties of the atmosphere at altitudes where reflection of radio waves from meteor trails occurred.

6. *Anomalous and irregular ionization of other sorts.* — With the development of high-speed ionosphere recording methods, it has become increasingly apparent that, even during so-called ionospherically « quiet » times, there appear many evidences of ionization at virtual heights different from those of the regularly recognized layers, usually having irregular characteristics which vary rapidly with time.

Data concerning such ionization is customarily reported from manually operated stations in a qualitative manner only ; to what extent such phenomena provide ambiguity and error in the recording of data pertinent to the regular ionospheric layers affords matter for some concern.

A great amount of data on such anomalous ionization phenomena have been accumulated in the photographic records made at many observing stations. Unfortunately these have been given no thorough-going analysis to date.

While the importance of these anomalous types of ionization for radio communication at frequencies above 30 Mc/s is not nearly as great as is that of F2 and Es ionization, these anomalous ionizations have shown evidences, in many cases, of being related to variations in both *fo*F2 and *fo*Es, and practically, have some importance in their own right, in considerations of signal interception and interference.

ANNEX III Doc. 136-E

29 March, 1950

STUDY GROUP 6
RECOMMENDATION FOR ADOPTION BY 6th. PLENARY ASSEMBLY

(Regarding C.C.I.R. Question 9) (1)

The C.C.I.R.,

considering,

that results of subjective methods of noise measurement are difficult to interpret and to apply for practical purposes

and

that evaluation of subjective effects may usually be made, when needed, from objective measurements,

recommends :

that objective methods of noise measurements be studied for contemplated future work. Such study should include consideration of

(*a*) the parameters necessary for adequate description of radio noise ;

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(1) *U.R.S.I. Inf. Bul.*, 59, p. 27.

(*b*) what should constitute specifications for « standard » measuring equipment ;

(*c*) optimum methods of adaptation of results of other methods of measurement for comparison with those obtained by « standard » methods.

Note. — (*a*) above, should be brought to the attention of U.R.S.I. by the Chairman of Study Group 6.

(*b*) above, should be correlated with C.I.S.P.R. by the Director of the C.C.I.R.

ANNEX IV Doc. 141-E

29 March, 1950

STUDY GROUP 6. — STATEMENT

(C.C.I.R. Question nº 5) (1)

FOREWORD. — It is suggested that :

(*a*) the attention of the U.R.S.I. delegate to Study Group 6 be called to the material in Part II.

. . . . . .

II. SURVEY OF THE PROBLEMS PRESENTED. — The problems presented in the study of medium and long-wave propagation are among the most difficult in the entire domain of radio-propagation research. Although the ionospheric region generally responsible for such propagation is notably that below about 100 km height, — a region believed to have fairly regularly varying ionization properties — yet the problems presented are extremely difficult. Medium-frequency radiation may be propagated within the ionized region for a considerable distance before being turned earthward, with consequent absorption, variations in its amplitude, polarization, and direction of propagation, greatly complicated by effects of the earth's magnetic field. At lower frequencies, the ionized region reflects the incident radiation in increasingly, but not quite, mirrorlike fashion, so that the propagation problem

(1) *U.R.S.I. Inf. Bul.*, 59, p. 25.

presented is extremely complex because of the need for evaluation of the summed effects of very many more, only slightly absorbed, modes of reflection, in order to obtain the received field intensity at any point. Most important of all, an adequate theoretical treatment of the problem requires the solution of the wave equation for a non-homogeneous medium with characteristics which are not slowly varying but which change markedly with changes in height comparable to the wavelength.

While theoretical work on these problems has certainly been illuminating, evaluation of results for comparison with observation, has suffered at every turn, from the lack of sufficiently accurate knowledge of upper atmospheric properties. Consequently, only very general theoretical results, — the outcome of combinations of various fairly probable hypotheses —, have been checked experimentally. Moreover, extreme mathematical complexity presented by the theoretical solutions, as well as lack of hope for any but a vague check with observation, has served as a deterrent for much numerical evaluation of theoretical results.

A considerable quantity of observed data, chiefly records of received field intensities at these frequencies, has been amassed. The preponderance of these data, especially for very-low frequencies, was taken during the years when little was known concerning ionospheric behavior. Consequently, many auxiliary data pertinent to the evaluation of these observations were not recorded, and little use may be made of them.

Such data as can be used exhibit considerable dispersion. It is, therefore, necessary to have extensive time series of these observations in order to know diurnal, seasonal, and solar-activity variations in them. Only a few such series have ever been obtained.

Nearly all of the very-low-frequency observations are for North-Atlantic transmission paths, so that variations with geographic location, or other types of terrain, are only slightly known.

Worthwhile series of very-low-frequency observations have been made at only a very few frequencies, chiefly at or below 57 kc/s.

Transmissions in these frequency bands can generate serious mutual interference by means of the non-linear properties of the

absorbing strata in the ionosphere. This phenomenon, which is known as ionospheric wave interaction (Luxembourg effect), has been studied recently in great detail in the United Kingdom and Italy, and the main results of these investigations may be found in the literature. (J. A. RATCLIFFE, I. J. SHAW, *Proc. Royal Soc. A.*, 1948, 193-311 ; HUXLEY and RATCLIFFE, « A Survey of ionospheric cross modulation wave interaction or Luxembourg effect », *J.I.E.E.*, Sept. 1949, 96 part III.) These results are also reviewed in Documents 75-E, Annex D (Italy), of the March, 1950 meeting, and 28-E (United Kingdom), of the March, 1950 meeting, Study Group 6. Since the percentage of transferred modulation due to wave interaction varies as the power of the interacting wave, this phenomenon imposes a natural limit to the maximum power which it is desirable to use in these wave bands.

In summation, it thus may be said that the problems presented are of the following general types :

(*a*) Need for accurately known auxiliary data, so that theoretical results may be evaluated for comparison with observation (and, if agreement is found, so that interference may be drawn for extending the theory to coverage of practical problems). Values are needed, for example, for

1. Ground conductivities, and dielectric constants for various types of terrain, throughout the frequency range.

2. Variation of atmospheric density with height.

3. Variation of atmospheric ionization with height and, especially at night, with location, time and geomagnetic activity.

4. Variation of collision frequency with height, etc. (as above).

5. Variation of recombination times with height, etc. (as above).

(It is realized that values for some of these have been presented ; more certain knowledge is, however, needed.)

(*b*) Need for simplification of numerical computation of theoretical results.

(*c*) Need for carefully taken, extensive time series of observations including all pertinent auxiliary data (such as current, effective height, radiation pattern of antennas, etc.), over various terrain

types, over various geographically located transmission paths, of

1. Field intensity,
2. Direction of arrival,
3. Polarization,
4. Time of arrival of signal by different modes,
5. Extent and rate of phase variation,

of received radio waves, at various frequencies, throughout the frequency range under discussion.

(*d*) Need for further work on ionospheric wave interaction particularly in more parts of the world.

ANNEX V Doc. 144-E

March 29, 1950

STUDY GROUP 6

RECOMMENDATION FOR ADOPTION BY THE VIth. PLENARY ASSEMBLY OF THE C. C. I. R.

Recording of Ionospheric Data

The C.C.I.R.,

considering :

(*a*) that the list of symbols pertinent to the recording of ionospheric data, as given in Recommendation 6 [1], while apparently affording the best present means of expressing the results of ionospheric soundings, is so large as to be inconvenient for use ;

(*b*) that the list of symbols, as given in Recommendation 6, is nevertheless far from adequate for the complete expression of observed ionosphere characteristics which are of importance for practical radio transmissions ;

recommends :

that organizations responsible for studying the characteristics of the ionosphere consider :

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[1] *U.R.S.I. Inf. Bul.*, 56, p. 7.

(*a*) automatic recording of ionospheric data in such form that the complete results (all reflections, not just those of the ordinarily recognized ionosphere layers) of ionospheric sounding may be analyzed, directly and with facility, and so that derived quantities germane to practical radio transmission (such as maximum usable frequencies for a given transmission distance, etc.) may be evaluated by non-subjective means ;

(*b*) co-ordination and standardization of the development of any devices resulting from (*a*), so that by duplication of transfer of records among laboratories co-operative analytical work may be made possible ;

(*c*) co-ordination of the work under this recommendation with the U.R.S.I.