
International Scientific Radio Union

U. R. S. I.

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INFORMATIVE PAPER

Historical Account of U.R.S.I.

CHAPTER II. — RADIO WAVE PROPAGATION

At the beginning of this very important chapter of the history of U.R.S.I., it should be recalled the names of some distinguished scientists who increased our knowledge on the features affecting radio wave propagation and who, at the same time, took, and some of them still take, an important part in the development of our Union. Amongst the more eminent we want to name : Appleton, Austin, Dellinger, Ferrié, Heaviside, Kenelly, van der Pol and many others.

Section I. — Commission on Radio Wave Propagation

1. — *Origin*

The Commission on Radio Wave Propagation was constituted in 1922 to study phenomena, ill defined at that time, controlling electromagnetic wave propagation.

The various discoveries made in this field explain the development of the researches carried out by the Commission since it has been founded.

2. — *Chairmen*

At the constitution of the Commission the chairmanship was entrusted to Dr. Austin from 1922 to 1933. After his death Dr. J. H. Dellinger took the leading of the Commission until 1946, when Sir Edward V. Appleton was elected chairman.

3. — *Activities*

The major topics which held the attention of the Commission since its foundation were :

1. Basic phenomena controlling radio wave propagation and as subsequent topics the propagation modes and ranges ;

2. Effects of natural phenomena on the propagation ;

As better understanding of feature controlling the propagation was reached, new problems occurred :

3. Ionospheric propagation ;

4. Radio wave interaction ;

5. Tropospheric propagation.

3.1. — *Basic phenomena controlling radio wave propagation.*

As new and important discoveries were made in consequence of practical development and research in wireless communication, it became necessary to adapt explanation to fit the latest results and, if possible, to reconcile the basic theory with the new turn of events.

At its earliest inception the potential utility of electromagnetic waves as a practical means of communication was looked at askance. Such waves were supposed to have a very limited range : the curvature of the earth alone would, it was predicted, impose a limit to the range over which it would be possible to utilise them and it was thought as most improbable that the use of electric waves would ever develop into a means of communication over long ranges. When greater ranges were attained over sea, it was argued that with waves of greater length the assistance given by diffraction together with the smaller energy losses in transmitting over sea instead of land was a sufficient explanation.

Later in the course of long distance developments, it became evident that the transmission conditions varied from time to time : more favourable conditions existing at some periods and seasons of the year than at others ; difference of propagation was also observed between day and night conditions. This fact indicated an effect of solar radiations on the atmosphere as being at least a contributing factor in the variations. The explanations given at that time left untouched the problem of the deflection of waves from a straight course so that they followed the curvature of the earth. In view of the magnitude of the bending, diffraction no longer afforded a satisfactory solution and an explanation was found necessary.

This standpoint led to the hypothesis of a permanently ionised layer in the upper atmosphere in addition to more transient ionisation of an inner layer during daylight. This permanently

ionised layer was assumed to be capable of reflecting or of refracting the waves, so confining them to an atmospheric shell of which the surface of the earth was the lower boundary. This ionised region was named the « Heaviside layer ».

Although this theory was suggested by Heaviside some years before the Commission on Radio Wave Propagation started its activities, it may be stated that the work of the Commission started with the Heaviside layer as basic theory, but opinions did not agree whether the waves were reflected or refracted by such layer.

At the 1927 General Assembly it was put forward that long waves were reflected while short waves were refracted, and that there were more than one layer in the Heaviside region. This assumption nevertheless, left some unsolved problems. Which was the boundary between long and short wave lengths ? Were all the waves reflected or refracted at the same height ? How long was the path of short waves in the ionised region ?

As showed by the papers submitted at the 1928 General Assembly, researches on the reflecting layer were pursued by most of the National Committees which tested radio techniques to explore the electrical structure of the upper atmosphere : effective height, ionosation gradient, etc. The results reached by such techniques let the Commission suggest at the 1931 General Assembly to the National Committees to organize measurements of the height of the layer known at that time as the Kennelly-Heaviside layer using either the frequency change method or the echo method. Besides, it was decided to appoint a sub-commission to study the consequences of results reached by the above methods for what concerned radio, geophysical and astronomical problems raised by the high atmosphere features.

It would be too long to analyze the various reports and papers submitted to the commission at the 1934 General Assembly, dealing with the results of measurements carried out in various countries. This examination was entrusted by the Commission to a *Sub-Commission on Ionospheric Measurements* under the Chairmanship of Prof. E. V. Appleton.

It seems of some interest to quote the resolutions submitted by this sub-commission to the 1934 General Assembly.

« 1. That the term « Ionosphere » be adopted with the definition given below.

2. Definition of « Ionosphere » :

The ionosphere is that part of the upper atmosphere which is sufficiently ionised to affect the propagation of wireless waves.

3. That the term « region » (and not « layer ») be used in connection with the ionosphere.

4. That « group delay » be used for the time taken by pulse signals in their travel up to and down from the ionosphere.

5. That the terms « virtual » or « equivalent » be used for the product of group delay and the velocity of light.

6. That the following symbols be agreed, viz :

\overline{P} for optical path,

\overline{P}' for virtual or equivalent path,

\overline{f} for frequency.

7. Recommendations for International Ionosphere Recording of $P' - t$ and $P' - f$.

8. That authority should be sought from national administrations for sanction of the use of 3 Mc/s for international ionospheric measurements.

8. Nomenclature :

That the following terms for critical frequencies of the regions of the ionosphere be agreed :

$$f_{E_1}, f_{E_2}, f_{F_1}, f_{F_2}, \text{ etc.}$$

Critical frequencies of ordinary and extraordinary rays should be denoted thus :

$$f^0_{E_1}, f^x_{E_1}, \text{ etc.}$$

These resolutions served as starting basis to a new activity which rapidly became distinct from the other activities of the Commission and became in 1948 the main topic of the Commission on Ionospheric Propagation.

3.2. — *Effects of natural phenomena on radio wave propagation.*

The bibliography of the Commission on Radio Wave Propagation shows that since the beginning, the Commission gave a special attention to the study of effects of natural phenomena.

Which were the natural phenomena which, at that time, were supposed to affect the propagation ? The answer is given in a memorandum « Suggestion for the International Study of Correlation between Radio Transmission Phenomena and Solar Activity »

sent in 1926 by Dr. Austin, Chairman of the Commission to the National Committees. Part of this memorandum is given below :

« It seems to now certain that there is a well marked connection between the strength of radio signal and solar activity. In the study of this correlation the following solar phenomena may be considered ;

1. the general radiation (solar constant) and ultra violet light in particular,
2. sunspots and their 11-years cycle, faculae and prominence,
3. local solar magnetic fields,
4. sudden solar outburst,
5. alternation of magnetic polarity of sunspots in successive 11-years cycles.

There are also the following terrestrial phenomena which are believed to be controlled largely by solar activity and which may perhaps be used to a certain extent as a measure of its intensity :

1. magnetic variations (character of days and diurnal range),
2. earth currents,
3. atmospheric electricity (potential gradient and ionization of the atmosphere),
4. aurora,
5. amount of ozone in the atmosphere.

The study of most of these subjects has been much more highly developed than that of radio signal intensity. The suitable observational radio material is very limited and in any continuous and reliable form it certainly covers no more than the last five years and is confined almost entirely to wave lengths above 5000 m, therefore it seems highly important to undertake the following measurements on signal intensity taken preferably at least three times daily :

1. at various wave lengths,
2. in different portions of the earth,
3. at various distances,
4. in different directions,
5. for all daylight path,
6. for partial daylight path,
7. for all darkness path,
8. at sunrise and sunset.

In comparing signal strength with the other natural phenomena it would seem advisable to make use of :

1. day by day comparisons,
2. short period averages (3-10 days),
3. yearly averages so as to cover eventually the 11-years sunspot cycle. »

When Dr. Austin read this memorandum at the 1927 General Assembly, he made the following comments :

« We are entering upon a field about which very little is known and in this report I have simply enumerated the different observations which may be made and the different phenomena which might be studied and their possible bearing on the radio transmission. We must begin at the beginning. We have to gather together all the information we are able to on this matter of correlation and we ought to interest just as many scientific bodies as possible in this study. »

This report promoted numerous observations in various countries, and in 1928, on the proposal of the French National Committee, the General Assembly adopted an observation programme including the setting up of special transmissions made under the auspices of the U. S. A. and the French National Committees, in view of observations and researches suggested by the Commission on Wave Propagation. A short analysis of the main results was given in a report submitted by Dr. Austin at the 1934 General Assembly. During this meeting the results were considered and discussed and the attention of the Commission was particularly drawn to other features : behaviour of very short signals at short wavelengths, long delay echoes, etc. This Assembly recommended the continuation of the research on phenomena whose effects on radio wave propagation showed more importance as they were better known.

And so, in 1938, Dr. Dellinger, then Chairman of the Commission, could describe as follows the developments reached during the previous years :

« This recommendation that effort be continued to correlate solar phenomena and radio transmission has been particularly fruitful. The appearance of a substantial body of literature along these lines during two or three years indicates the widespread recognition that we must look at the sun as the source and the explanation both of the regular characteristics and the vagaries of radio transmission. »

During the following years, these extra terrestrial phenomena showed more and more than they effect directly the radiowave propagation media and this explains why the study of such phenomena intermingled with the study of the propagation media, the ionosphere and the troposphere.

3.3. — *Ionospheric wave propagation.*

As stated in the paragraph dealing with studies on phenomena controlling wave propagation, radiophysicists soon agreed on the existence of a region surrounding the earth and whose properties affected considerably the propagation of radio waves. We recalled that in 1934, U.R.S.I. recommended to describe the ionosphere as that region of the upper atmosphere which is sufficiently ionised to affect the propagation of radio waves. The same year, the Commission on Wave Propagation appointed, under the chairmanship of Prof. E. V. Appleton, a *Sub-Commission on Ionosphere Measurements*.

During the following years the Sub-Commission :

1. circulated lists of International Days for special ionospheric observations,
2. drawn up a schedule of ionospheric observations in connection with the eclipse of June 19th, 1936,
3. prepared a report on the results of ionospheric observations made on the occasion of eclipses over the period 1934-1936,
4. compiled a register of stations conducting ionospheric observations.

Activities which were analysed in a report drafted by E. V. Appleton and R. Naismith for the 1938 General Assembly. Considering the importance of ionospheric research, during this meeting, the Commission drafted a new research programme and appointed under the chairmanship of Prof. R. Jouaust, a *Sub-Commission on Ionospheric Disturbances* to collect data on such disturbances and to draw conclusions on their behaviour.

When U.R.S.I. resumed its activities in 1946, the Commission appointed, under the chairmanship of Sir Edward V. Appleton, a *Permanent Ionospheric Sub-Commission* which became in 1948 the Commission on Ionospheric Wave Propagation.

3.4. — *Radio Wave Interaction.*

Dr. B. van der Pol and Dr. J. van der Mark submitted at the 1934 General Assembly a paper (Interaction of radio waves) describing a new phenomenon in wave propagation which, according to the authors, might have important consequences both in the scientific and technical radio field.

The authors described as follows the phenomenon which had already been mentioned in 1933 by A. G. Britt and B. D. H. Tellegen.

« When a broadcasting receiving set is tuned to a radio station (here called « the wanted station »), sometimes at night the modulation of another powerful transmitter, whose frequency bears no simple relation to that of the wanted station, this frequency neither being close to that of the wanted station, is heard in the receiver as background on the program of the wanted station. When the modulation of the wanted station is zero, the program of the wanted station is occasionally so loud that the unwanted program can easily be recognised. »

The Commission on Radio Wave Propagation agreed immediately on the importance of the phenomenon and appointed, under the chairmanship of Dr. van der Pol, a *Sub-Commission on Interaction of Radio Waves*. The programme of the Sub-Commission was drafted at the 1934 General Assembly.

During the first part of 1934 tests had already been carried out on the Beromunster and Luxemburg transmitting stations; new tests were undertaken early in 1935 under the auspices of U.R.S.I. : special transmissions were made by Luxembourg and about 30 radiophysicists in Austria, Belgium, Denmark, France, Germany, Great Britain, Holland, Italy, Poland, Rumania, Sweden and Switzerland agreed to observe other European Broadcasting stations. The number of individual observations amounted to 1823 ; 467 trajectories all over the Western half of Europe were studied. The interaction effect by Luxemburg was positively observed on 209 trajectories, while 258 trajectories gave negative results.

Prof. Dr. B. van der Pol gave in 1948 the following conclusions from an analysis of the data.

(a) The interaction effect, due to a long wave station, is of the same order for long wave wanted stations and medium wave wanted stations.

(b) The interaction effect diminishes steadily with the distance between the unwanted station and the mid point (or, in the case of very distant reception, quarter point) of the wave trajectory.

(c) The interaction effect is practically absent when the above defined distance exceeds 600 km.

(d) The fact that high power stations can cause interaction up to the above distance leads one to expect the phenomenon also to be observable with much weaker unwanted stations.

(e) The observations definitively show that the cause of the interaction effect is to be found in non linear properties of the ionosphere, the apparent conductivity being increased in rythm with the modulation of the unwanted station, thus causing a variable absorption for all waves travelling through region of the ionosphere.

(f) A simple theoretical consideration leads one to expect that the same changes in the ionosphere also reacted on the propagation of the wave of the interfering station itself. This reaction would cause the wave of a sufficiently powerful transmitter to be received with a relative reduction in amplitude of the carrier and immediately adjacent side band, thus leaving an increased modulation percentage of the higher modulation frequencies.

(g) A further research along the above lines might enable one to locate more precisely the horizontal extension of the region of the ionosphere which is effective in « reflecting » a wave from a transmitter to a given receiving station. »

Research were also carried out in Great Britain by V. A. Bailey, D. F. Martyn and others and it was deduced that :

- the phenomenon was effected by some characteristics of the interacting station :
- the effect is greater for greater power of the interacting station ;
- it is greater when this station works on a long wave, is disproportionately great when its wavelength is near the gyro-wavelength :
- the interaction modulation coefficient (amplitude) is proportional to the modulation coefficient (amplitude) of the interacting station ;
- the magnitude of the phenomenon depends on the radio frequency of the wanted station, on the relative position of the wanted and the interacting stations and on the time of the day.

On the other hand Bailey and Martyn suggested a theory which was described in a report submitted by the British National Committee to the 1948 General Assembly which constituted the Commission on Ionospheric Wave Propagation. The Sub-Commission on Wave Interaction pursued its activities under the aegis of the new Commission.

3.5. — *Wave propagation in the troposphere.*

Since 1928 the attention of the Commission on Radio Wave Propagation had been drawn to the relationship between the

intensity of the signals and the temperature, between their reception and barometrical pressure, and to the propagation of electromagnetic waves propagating over the earth surface. Most of the investigations carried out aimed to find a relationship between the propagation of waves and the nature of the ground over which they propagated. Such studies, as shown in the Proceedings of the General Assemblies, led to a large literature.

On these topics the research carried out from 1931 and later on in Great Britain should be recalled. An analysis was given in an unpublished report submitted by the British National Committee to the 1931 General Assembly. This report, in a section entitled «Study of wave propagation over the earth surface» described investigations carried out on the attenuation due to the ground for radio broadcasting wave lengths (200-2000 m.) by G. H. Munro, T. L. Eckersley, P. Eckersley and others, together with investigations on the attenuation on short waves (5-30 m) carried out by J. A. Ratcliffe, W. F. B. Shaws, F. W. G. White, R. L. Smith-Rose and others.

Since several years it was agreed that the ranges of short wave communications exceeded largely the optical range and that waves detected in such way were not reflected by the ionosphere. It seemed logical to investigate the space close to the earth surface to find the explanation for the short wave propagation.

Prompted by the various researches carried out and by the various papers published on wave propagation in the lower atmosphere, the Commission on Radio Wave Propagation appointed during the 1938 General Assembly a sub-commission under the chairmanship of R. A. Watson Watt to draft a report analysing the knowledge on the propagation in the lower atmosphere (beneath 50 km) and to organize experiments in view to increase such knowledge. Unfortunately, the Second World War put an end to the activity of this Sub-Commission.

When in 1946 the Union resumed its activities, in the opening address, Sir Edward Appleton, President of U.R.S.I., spoke as follows :

« I turn now from the atmospheric ionosphere to the atmospheric troposphere, and to the influence of meteorological conditions on the propagation of waves of metric and centimetric wave lengths. During the war it was discovered that the radar detection of ships

was often possible, with very short waves, at distances much greater than the optical horizon. This effect has been traced to the existence of powerfully refracting atmospheric layers in the lowest levels of the atmosphere. Such refraction is associated either with temperature inversions or with conditions of marked humidity lapse rate, or with a combination of both. The incidence of these super-refracting conditions is found to vary enormously from place to place on the earth's surface. It is naturally desirable to be able to forecast the occurrence of these super-refracting conditions from the surrounding meteorological environment, but although some progress has been made in this direction, much remains yet to be done. Radio observations, with corresponding meteorological measurements, are especially needed at places where the meteorological conditions are simple and dynamically well understood. In this way it should be possible to check the available theories and proceed to more complicated cases ».

Several papers submitted at that Assembly dealt with phenomena experimentally recorded during short wave transmissions, or suggested theories to explain such phenomena.

To investigate such phenomena and such theories, the Commission decided to appoint a sub-commission under the chairmanship of Dr. G. Booker to study the troposphere effects on wave propagation. In 1948 this Sub-Commission was changed into the Commission on Tropospheric Propagation.

(to be continued)

XIIIth GENERAL ASSEMBLY

Letter from the Secretary General

To : Honorary Presidents,
Members of the Board,
Presidents of National Committees,
Commission Chairmen.

XIIIth General Assembly

Article 31 of the Statutes provides that the Agenda of the General Assembly is drawn up by the Secretary General on the proposals of the Board of Officers, of the Executive Committee, of the National Committees and of the Commissions.

On the other hand, Article 14 of the Bylaws mentions the items on which, in principle, proposals may be submitted by the Executive Committee to the General Assembly. Among such items are proposals for modifications to the Statutes or to the Bylaws.

It is obvious that in order that such proposals for modifications may reach coherent results, members of the Executive Committee should have time to study them and to consult National Committees which they represent. For this purpose, I have been instructed to send to the members of the Executive Committee the Report of the Secretary General at the later on June 1st, 1960.

I want also to draw your attention to the fact that matters not appearing on the agenda of the General Assembly will be considered only if prior approval is given by not less than half of the votes allocated to countries represented at the General Assembly.

In order to have the opportunity of taking in due time the necessary steps, I would appreciate to be informed :

1. *at the later on January 31st, 1960*, of your proposals for modifications to the Statutes and Bylaws of U.R.S.I. It should be recalled that the Board of Officers has drafted new Rules for Commissions which will be formally submitted to the Executive Committee and to the General Assembly ; this draft has been printed in *Information Bulletin n° 111*.

2. *at the later on March 31st, 1960*, of any items you should wish to have on the agenda of the Executive Committee or of the General Assembly.

Moreover, I would be thankful to the *National Committees* to be informed *before March 31st, 1960*, of the names :

1. of the delegates at the Executive Committee (one for each National Committee. Article 15 of the Statutes),
2. of the official delegates to the General Assembly ; the number of such delegates varies according to the category in which the National Committee adheres to U.R.S.I. (Statutes. Article 26).

In thanking you for the consideration you will give to this letter,

I remain,
Yours sincerely,
(s) HERBAYS,
Secretary General.

NATIONAL COMMITTEES

Sweden

ACTIVITIES OF THE NATIONAL COMMITTEE

On May 27th, 1959, the Committee held a full meeting in Stockholm under the chairmanship of Dr. H. Sterky.

Dr. Bengt Hultquist, Director of the Geophysical Observatory at Kiruna was elected adjoint member.

The Committee decided that a Radio Scientific Conference (RVK) should be held during three days in February or March, 1960.

In general such conferences are held some time before the U.R.S.I. General Assemblies in order to collect Swedish Radio Scientific contributions to be presented at the Assemblies. The XIIIth Assembly scheduled for 5-15th September, 1960, in London is thus the main objective for the coming Radio Scientific Conference in Stockholm, 1960.

However, other topics are also to be dealt with by the Conference namely such that are not dealt with by other forums in Sweden, e. g. electronic regulation technics and mathematical machines.

The conference is arranged in cooperation with the Royal Swedish Academy of Engineering Sciences, the Swedish Society of Electrical Engineering and the National Committee of U.R.S.I. For handling organizational matters a special committee was constituted.

Reports from the different sections were read and it was announced that the Royal Board of Swedish Telecommunications had granted continued free Telex service to Swedish Observatories during the International Geophysical Cooperation 1960.

It was also reported that a committee for space research had been constituted in Sweden. In this space committee there are representatives from the Swedish Board of Scientific Research, the Swedish Board of Technical Research, the Swedish Atomic Commission, the Research Institute of National Defence, the Swedish Meteorological and Hydrological Institute, the Board

of Swedish Telecommunications and the National Committees of Physics, Scientific Radio, Geodesy and Geophysics and Astronomy.

Professor Dr. Bertil Lindblad, Director of the Stockholm Astronomical Observatory at Saltsjöbaden, was elected Chairman of the committee.

To begin with the committee should follow the development in the following branches : Direct observations of Satellites, Meteorology, Cosmic Physics and problems of Radio Communications.

The address of the Chairman is : Professor Bertil LINDBLAD, Director of the Stockholm Astronomical Observatory, Saltsjöbaden, Sweden.

Furthermore, at its meeting on 27th May the National Committee decided to support the C.C.I.R. recommendations and reports on frequencies for communication with and between space vehicles and protection of frequencies for radio astronomy researches at the Administrative Radio Conference in Geneva this year.

It was furthermore reported that on the initiative of the Chairman, Dr. Sterky, a proposition had been made to O.E.C. that an atlas of the electrical conductivity of the earth should be established.

U. S. A.

NATIONAL BUREAU OF STANDARDS

(Reprint from *Journal I.U.T.*, n° 7, July 1959)

A new research division, Radio Communications and Systems, has been established at the Bureau's Boulder (Colorado) Laboratories. The new division, together with the radio propagation physics and the radio propagation engineering divisions, makes up the Central Radio Propagation Laboratory (C.R.P.L.).

Mr. R. C. Kirby, formerly assistant chief of the Radio physics division, has been named Division chief.

The new unit will expand the research and development services provided for agencies which use radio communications. In particular, it will deal with research in radiocommunication and navigation techniques, and the application of radio propagation studies in the improvement of radio systems.

The division will also be responsible for the coordination within the Boulder Laboratories of the radio systems problems of other agencies, and for direct liaison with these agencies in providing the services necessary.

(Source : *National Bureau of Standards Technical News Bulletin*).

BIBLIOGRAPHY

Journal of Research of the National Bureau of Standards

The Journal of Research of the National Bureau of Standards now appears in four sections, each devoted to a main field of Bureau research and development :

Section A. — Physics and Chemistry.

Section B. — Mathematics and Mathematical Physics.

Section C. — Engineering and Instrumentation.

Section D. — Radio propagation edited by Dr. James R. Wait, consultant to the Director, Boulder Laboratories. This Section is designed to provide a publication whose subject matter concentrates on research in radio propagation, communications, and upper atmosphere physics. Topics to be covered include propagation in ionized media, scattering by turbulence, the effect of irregular terrain on propagation, diffraction and scattering by solid obstacles, propagation through time-varying media, and antennas.

The editorial scope of section D, as well as that of the other three sections, will be broadened to include publication of solicited papers by qualified scientists, not members of the Bureau staff, whose work is closely related to the Bureau's mission. There will also be survey articles and compilations of information from time to time pertinent to the Bureau's scientific and technical program.

As associate Editors, working with Dr. Wait, are Thomas N. Gautier, consultant, Radio Propagation Physics Division ; Jack W. Herbstreit, assistant chief, Radio Propagation Engineering Division ; Dr. C. Gordon Little, chief, Radio Astronomy and Arctic Propagation Section, and Alvin G. McNish, consultant to the director of NBS, Washington, D. C., I.R.E. advisors are D. G. Fink and K. M. Siegel.

As a new feature, each Journal section will provide a complete record of all publications by Bureau personnel after July 1959 either in full, in abstract, or listed with appropriate reference data, to facilitate library cataloguing and bibliographical reference.

CONTENTS OF JULY-AUGUST 1959 ISSUE

- Preliminary results of the NBS radio propagation observations during the IGY. D. M. GATES.
- The origin of (01) 5577 in the airglow and aurora. F. E. ROACH, J. W. MCCAULLEY and E. MAROVICH.
- A comparison of absolute intensities of (01) 5577 in the auroral and sub-auroral zones. F. E. ROACH, J. W. MCCAULLEY and C. M. PURDY.
- The origin of very low frequency emissions. R. M. GALLET and R. A. HELLIWELL ⁽¹⁾.
- On the climatology of ground-based radio ducts. B. R. BEAN.
- A study of the power requirements and choice of an optimum frequency for a world wide standard frequency broadcasting station. A. D. WATT and R. W. PLUSH.
- Measurements of phase stability over a low-level tropospheric path. M. C. THOMPSON, Jr. and H. B. JANES.
- System loss in radio wave propagation. K. A. NORTON.
- The mode expansion in the low frequency range for propagation through a curved stratified atmosphere. H. BREMMER ⁽²⁾.
- Transmission and reflection by a parallel wire grid. M. T. DECKER.
- On the synoptic variation of the radio refractive index. B. R. BEAN and L. P. RIGGS.
- Observations on some low frequency propagation paths in arctic areas. A. D. WATT, E. L. MAXWELL and E. H. WHELAN.

CONTENTS OF SEPTEMBER-OCTOBER 1959 ISSUE

- Stratification in the lower ionosphere. C. ELLYETT ⁽³⁾ and J. M. WATTS.
- Effect of small irregularities on the constitutive relations for the ionosphere. K. G. BUDDEN ⁽⁴⁾.
- Ionospheric investigations using the sweep-frequency pulse technique at oblique incidence. Vaughn AGY and Kenneth DAVIES.

⁽¹⁾ Radio Propagation Laboratory, Stanford University, California.

⁽²⁾ N. V. Philips Research Laboratories, Eindhoven, The Netherlands.

⁽³⁾ University of Canterbury, Christchurch, New Zealand.

⁽⁴⁾ Cavendish Laboratory, Cambridge, England.

Fields in electrically short ground systems : an experimental study.

A. N. SMITH ⁽¹⁾ and T. E. DEVANEY ⁽¹⁾.

Diffraction of electromagnetic waves by smooth obstacles for grazing angles.

James R. WAIT and Alyce M. CONDA.

Very-low-frequency radiation spectra of lightning discharges. W. L. TAYLOR

and A. G. JEAN.

Radio-wave scattering by tropospheric irregularities. Albert D. WHEELON ⁽²⁾.

Study at 1046 megacycles per second of the reflection coefficient of irregular

terrain at grazing angles. Raymond E. MCGAVIN and Leo J. MALONEY.

Synoptic study of the vertical distribution of the radio refractive index.

B. R. BEAN, L. P. RIGGS and J. D. HORN.

Selected abstracts and of list other publications by the NBS staff.

Details on annual subscription for each section are available at the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

⁽¹⁾ U. S. Navy Electronics Laboratory, San Diego, California.

⁽²⁾ Space Technology Laboratories, Los Angeles, 45, California.

COMMISSIONS

Commission II

LETTER TO OFFICIAL MEMBERS AND OFFICERS
U.R.S.I. XIIIth General Assembly
London 1960

17th August, 1959.

To all Official Members and Officers, Commission II.

Dear Colleague,

PROGRAMME OF MEETINGS OF COMMISSION II

Since I last wrote to you on 27th May, 1959, a meeting has been held of the U.R.S.I. Co-ordinating Committee, and a programme for the General Assembly in London next year has been drawn up.

Such replies as I received to my letter of 27th May indicated general agreement with the proposals therein for the main topics of discussion by Commission II, and the scientific programme for the Commission will therefore be based on these proposals.

Apart from an opening session at which the proceedings of the Commission will be planned and organized, and a closing session at which any necessary business and preparations for the following three-year period will be transacted, it is at present intended to hold six meetings for scientific discussions. Should it prove desirable it may be possible to hold a further meeting. Two sessions each have been allotted to topics 1 and 2 of my original proposals and one session to topic 3 : this makes five sessions in all for the discussion of experimental results from investigations of tropospheric propagation, physical characteristics of the troposphere and propagation theories. If it should appear at the time of the Assembly that a different division of the time available between these three topics is desirable, it is likely that some adjustment will be possible. The remaining session has been allotted to radio meteorology and climatology.

It is now essential that speakers shall be invited as soon as possible to prepare introductory papers for the various topics, and I must remind you of the by-laws of U.R.S.I. which state

that the only individual papers which may be reproduced for the Assembly, and presented, are those which have been invited by International Chairmen or by the Board of U.R.S.I. ; though any Official Member of a Commission may make suggestions to the appropriate Chairman concerning papers to be invited. It is most important that this rule should be adhered to in the spirit as well as in the letter, since it is now the policy of U.R.S.I. that the scientific sessions of Commissions should take the form of discussion meetings after an introductory survey paper (or more than one such paper at the discretion of the Chairman). The time available should not be occupied by the lengthy formal presentation of a series of papers, some of which in the past have not been directly related to the main subject. It is proposed that an account of the discussions at the various meetings should be recorded and subsequently published.

I have myself already given some consideration to the speakers who should be invited to present introductory papers on the following subjects which, as stated in my letter of 27th May, are :

1. Experimental results from investigations of tropospheric propagation.
2. Physical characteristics of the troposphere.
3. Propagation theories.
4. Radio meteorology and climatology.

But before coming to any final decision in the matter I would welcome suggestions from you as to who might be invited to prepare such papers for each of the selected topics. I should be grateful to have your suggestions at the earliest possible date, and in any case by 1st October, 1959, since invitations must be sent to authors in time to enable them to let me have the texts of their papers by 1st March, 1960, at the latest.

Yours sincerely,
R. L. SMITH-ROSE.
Chairman, Commission II.

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(See *Information Bulletin*, n° 114, page 66)

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(To be continued).



C. C. I. R.

List of Study Groups with their terms of reference

Attention is drawn to the fact that the items on the programme of the fourteen C.C.I.R. Study Groups, in so far as they were approved by the IXth Plenary Assembly of C.C.I.R., are indicated by the corresponding Los Angeles document numbers. Items which have been approved at previous Plenary Assemblies appear in Volume I of the Warsaw documents.

All items dealt with at the IXth Plenary Assembly of C.C.I.R. will appear in the appropriate volume of the Los Angeles documents which are in course of publications. These volumes are the following :

Volume I will comprise :

- (a) an index of all the volumes, together with general information about lay-out and numbering of the texts, and the origins of the documents ;
- (b) the recommendations adopted by the Ninth Plenary Assembly, and those appearing in Volume I of the documents of the Eighth Plenary Assembly (Warsaw, 1956), which are still valid.

This volume will run to some four hundred pages.

Volume II will comprise :

- (a) an index of all the volumes, and general information about lay-out and numbering of the texts, and the origins of the documents ;
- (b) a list of Study Groups and their terms of reference, giving the names and addresses of Chairmen and Vice-Chairmen ;
- (c) the Questions, Study Programmes and Resolutions according to Study Groups. These texts are those adopted by the Ninth Plenary Assembly, together with such as were adopted at the Eighth Plenary Assembly (Warsaw, 1956) — see Volume I of the documents thereof — and are still valid ;
- (d) Resolutions of a general kind, or relative to organizations other than the International Radio Consultative Committee, as adopted at the Ninth Plenary Assembly, together with those appearing in Volume I of the Eighth Plenary Assembly (Warsaw, 1956), which are still valid.

This volume will run to some two hundred pages.

Volume III will comprise :

- (a) an index of all the volumes, and general information about lay-out and numbering of the texts, and the origins of the documents;
- (b) the Reports adopted by the Ninth Plenary Assembly, together with those appearing in Volume I of the documents of the Eighth Plenary Assembly (Warsaw, 1956), which are still valid.

This volume will run to some four hundred pages.

Volume IV will comprise :

- (a) the report by the Director of the Consultative Committee;
- (b) the report by the Finance Committee of the Assembly;
- (c) the report by the Organization Committee of the Assembly;
- (d) a list of those who attended;
- (e) a list of documents in numerical order;
- (f) a list of documents classified by Study Groups;
- (g) a statement as to the place at which the Tenth Plenary Assembly will meet.

This volume will run to some two hundred pages.

Volume V will include the minutes of plenary meetings of the Assembly and will run to some hundred pages.

Allocation of Reports, Resolutions, Questions and Study Programmes to the Study Groups of the C.C.I.R.

Note 1. — For Study Groups whose terms of reference are not directly connected with U.R.S.I. activities, only the terms of reference and the names of the Chairman and Vice-Chairman are given.

Note 2. — In the following list, the Questions are followed by the relevant Study Programmes. The Study Programmes which are not derived from any Question at present under study are marked with an asterisk.

Immediately after a Question or Study Programme still under study, are listed the Reports and Resolutions arising from it; other Reports and Resolutions not proceeding from a Question or Study Programme are preceded by an asterisk.

In the list which follows, the texts are arranged in order of subject. Resolutions which do not directly concern the Study Groups have been omitted.

To assist in identification of the texts arising from the Los Angeles Plenary Assembly, the number of the corresponding Los Angeles document has been added in parentheses at the end of the title of the document.

STUDY GROUP I
(Transmitters)

Terms of reference :

1. To make specific studies and proposals in connection with radio transmitters and generally to summarise and co-ordinate proposals for the rational and economical use of the radio spectrum.
2. To study a number of problems concerning telegraphy and telephony from the transmission point of view.
3. To study spurious radiation from medical, scientific and industrial installations.

Chairman : Col. J. LOCHARD (France).

Vice-Chairman : Prof. S. RYZKO (P. R. of Poland).

STUDY GROUP II
(Receivers)

Terms of reference :

1. Measurement of the characteristics of receivers and tabulation of typical values for the different classes of emission and the various services.

Investigation of improvement that might be made in receivers in order to solve problems encountered in radio communication.

Chairman : Mr. P. DAVID (France).

Vice-Chairman : Mr. Y. PLACE (France).

STUDY GROUP III
(Fixed Service Systems)

Terms of reference :

1. To study questions relating to complete systems for the fixed and allied services and terminal equipment associated therewith (excluding radio-relay systems). Systems using the so-called

ionospheric-scatter mode of propagation, even when working on frequencies above 30 Mc/s are included.

2. To study the practical application of communication theory.

Chairman : Dr. H. C. A. VAN DUUREN (Netherlands).

Vice-Chairman : Dr. S. NAMBA (Japan).

Question n° 3 (III) : Revision of Atlantic City Recommendation n° 4.

Study Programme n° 128 (III) : Factors affecting quality of performance of complete systems of the fixed services. Signal-to-noise and signal-to-interference protection ratios for fading signals, bandwidth and adjacent channel spacing (6009).

Report n° 42 : Use of radio circuits in association with 5-unit start-stop telegraph equipment.

Report n° 105 : Bandwidths and signal-to-noise ratios in complete systems. The prediction of telegraph system performance in terms of bandwidths and signal-to-noise ratios (686).

Report n° 108 : The use of automatic error correction of telegraph signals transmitted over radio circuits (648).

Report n° 112 : Transmission loss in radio system studies (660).

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Question n° 43 (III) : Voice-frequency telegraphy on radio circuits.

Study Programme n° 129 (III) : Voice-frequency (carrier) telegraphy on radio circuits (521).

Report n° 19 : Voice-frequency telegraph on radio circuits.

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Question n° 74 (III) : Arrangement of channels in multichannel telegraph systems for longrange radio circuits operating on frequencies below about 30 Mc/s.

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Question n° 81 (III) : Directivity of antennae at great distances.

Report n° 107 : Directivity of antennae at great distances (710).

Study Programme n° 130 (III) : Improvement obtainable from the use of directional antennae (522).

Report n° 106 : Improvement obtainable from the use of directional antennae (717).

Study Programme n° 131 (III) : Directivity of antennae for fixed services using ionospheric scatter propagation (523).

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Question n° 94 (III) : Facsimile transmission of documentary matter over combined radio and metallic circuits.

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Question n° 95 (III) : Transmission of half-tone pictures over radio circuits.

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Question n° 130 (III) : Transmission of meteorological charts over radio circuits by direct frequency-modulation of the carrier.

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Question n° 132 (III) : Radio systems employing ionospheric scatter propagation.

Report n° 109 : Radio systems employing ionospheric scatter propagation (716).

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Question n° 133 (III) : Communication theory.

Study Programme n° 86 (III) : Communication theory.

Report n° 110 : Relation between permissible delay and residual uncertainty and its dependence on bandwidth utilisation (718).

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Question n° 179 (III) : Standardised radiotelephone speech test recordings for the fixed service (520).

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Question n° 180 (III) : Use of intermittent communication in radio telegraphy (524).

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Question n° 181 (III) : Influence on long-distance, high-frequency communication using frequency-shift keying of frequency deviations associated with passage through the ionosphere (525).

Report n° 111 : Influence on long-distance, high-frequency communication of frequency changes due to passage through the ionosphere (492).

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Question n° 182 (III) : Frequency stability required for single-sideband, independent sideband and telegraph systems to make the use of automatic frequency control superfluous (610).

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Question n° 183 (III) : Frequency-shift keying (449).

Study Programme n° 133 (III) : Frequency-shift keying (452).

Study Programme n° 134 (III) : Four-frequency duplex systems (451).

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*Study Programme n° 132 (III) : Telegraphic distortion, quality index error rate, efficiency factor (517).

STUDY GROUP IV

(Space Systems)

Terms of reference :

To study technical questions regarding systems of telecommunication with and between locations in space.

Chairman : Prof. I. RANZI (Italy).

Vice-Chairman : Mr. W. KLEIN (Switzerland).

- *Report n° 115 : Factors affecting the selection of frequencies for telecommunication with and between space vehicles (662).

STUDY GROUP V

(Propagation, including the effects of the earth and troposphere)

Terms of reference :

To study the propagation of radio waves over the surface of the earth, taking into account changes in the electrical constants of the earth and irregularities of terrain, and including the effects of the troposphere.

Chairman : Dr. R. L. SMITH-ROSE, C. B. E. (United Kingdom).

Vice-Chairman : Mr. A. KALININ (U. S. S. R.)

- *Report n° 43 : Review of publications on propagation.

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- *Report n° 138 : Measurement of field-strength, power flux density (field intensity), radiated power, available power from the receiving antenna and the transmission loss (668).

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Question n° 135 (V) : Determination of the electrical characteristics of the surface of the earth.

Report n° 139 : Determination of the electrical characteristics of the surface of the earth (491).

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Question n° 137 (V) : Measurement of field-strength in the neighbourhood of obstacles.

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Question n° 138 (V) : Measurement of field-strength for VHF (metric) and UHF (decimetric) broadcast services including television.

Report n° 142 : Measurement of field-strength for VHF (metric) and UHF (decimetric) broadcast services, including television (714).

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Question n° 184 (V) : Ground-wave propagation (480).

Report n° 46 : Temporal variations of ground-wave field strength.

Study Programme n° 87 (V) : Effect of standard tropospheric refraction on frequencies below 10 Mc/s.

Report n° 45 : Effect of standard tropospheric refraction on frequencies below 10 Mc/s.

Study Programme n° 89 (V) : Ground-wave propagation over irregular terrain.

Report n° 140 : Ground-wave propagation over uneven terrain (715).

Study Programme n° 135 (V) : Ground-wave propagation over inhomogeneous earth (436).

Report n° 141 : Ground-wave propagation over inhomogeneous earth (445).

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Question n° 185 (V) : Propagation data required for radio-relay systems (377).

Report n° 143 : Propagation data required for radio-relay systems (458).

Study Programme n° 136 (V) : Influence of the troposphere on wave propagation across mountain ridges (387).

Report n° 144 : Influence of the troposphere on wave propagation across mountain ridges (376).

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* Study Programme n° 57 (V) : Investigation of multipath transmission through the troposphere.

Report n° 51 : Investigation of multipath transmission through the troposphere.

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* Study Programme n° 137 (V) : Tropospheric propagation curves for distances well beyond the horizon (453).

Resolution n° 23 : Tropospheric-wave propagation curves.

Report n° 145 : Tropospheric propagation curves for distances well beyond the horizon (649).

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* Study Programme n° 138 (V) : Tropospheric-wave propagation (527).

Report n° 146 : Tropospheric-wave propagation (503).

Report n° 147 : Tropospheric-wave propagation. Climatic charts of refractive index parameter ΔN (688).

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* Study Programme n° 139 (V) : Radio transmission utilising inhomogeneities in the troposphere (commonly called « scattering ») (386).

Report n° 148 : Radio transmission utilising inhomogeneities in the troposphere (commonly called « scattering ») (439).

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* Study Programme n° 140 (V) : Propagation at VHF and UHF over distances up to 200 kilometres (482).

Resolution n° 41 : Propagation at VHF and UHF over distances up to 200 kilometres (481).

STUDY GROUP VI
(Ionospheric propagation)

Terms of reference :

To study all matters relating to the propagation of radio waves through the ionosphere insofar as they concern radiocommunication.

Chairman : Dr. D. K. BAILEY (U. S. A.).

Vice-Chairman : Dr. E. K. SMITH (U. S. A.).

*Report n° 149 : Long-distance propagation of waves of 30 to 300 Mc/s by way of ionisation in the E and F regions of the ionosphere (666).

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*Report n° 150 : Questions submitted by the I.F.R.B. (380).

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*Study Programme n° 93 (VI) : Identification of precursors indicative of short-term variations of ionospheric propagation conditions.

Report n° 153 : Identification of precursors indicative of short-term variations of ionospheric propagation conditions (713).

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*Study Programme n° 100 (VI) : Prediction of solar index.

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*Study Programme n° 141 (VI) : Study of the whistler mode of propagation (379).

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*Study Programme n° 142 (VI) : Radio propagation at frequencies below 1500 kc/s (382).

Report n° 154 : Radio propagation at frequencies below 1500 kc/s (667).

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*Study Programme n° 143 (VI) : Propagation by way of sporadic-E region and other anomalous ionisation in the E and F layers of the ionosphere (611).

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*Study Programme n° 144 (VI) : Study of sky-wave propagation on frequencies between approximately 1.5 and 40 Mc/s for the estimation of field strength (381).

Resolution n° 48 : Study of sky-wave propagation on frequencies between approximately 1.5 and 40 Mc/s (535).

Report n° 152 : Study of methods for estimating sky-wave field strength on frequencies between the approximate limits of 1.5 and 40 Mc/s (685).

Report n° 155 : Study of sky-wave propagation on frequencies between the approximate limits of 1.5 and 40 Mc/s for the estimation of field strength (684).

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*Study Programme n° 145 (VI) : Sky-wave absorption on frequencies between the approximate limits of 1.5 and 40 Mc/s (545).

Report n° 156 : Sky-wave absorption on frequencies between the approximate limits of 1.5 and 40 Mc/s (706).

* * *

*Study Programme n° 146 (VI) : Intermittent communication by meteor-burst propagation (317).

Report n° 157 : Intermittent long-distance radio communication in the VHF (metric) band by means of scattering from columns of ionisation in the lower ionosphere produced by meteors (319).

* * *

*Study Programme n° 147 (VI) : Ionospheric scatter propagation (316).

Report n° 158 : Regular long-distance transmission in the VHF (metric) band by means of scattering from inhomogeneities in the lower ionosphere (711).

* * *

*Study Programme n° 148 (VI) : Study of fading (383).

Resolution n° 49 : Study of fading (574).

Report n° 159 : Fading of signals propagated by the ionosphere (730).

* * *

*Study Programme n° 149 (VI) : Basic prediction information for ionospheric propagation (541).

Report n° 160 : Availability and exchange of basic data and reliability of radio propagation forecasts (712).

Report n° 161 : Basic prediction information for ionospheric propagation (709).

* * *

*Study Programme n° 150 (VI) : Choice of a basic index for ionospheric propagation (542).

Resolution n° 50 : Organisation of work on the choice and evaluation of ionospheric indices (536).

Report n° 162 : Choice of a basic index for ionospheric propagation (707).

* * *

*Study Programme n° 151 (VI) : Pulse-transmission tests at oblique incidence (543).

Report n° 163 : Pulse-transmission tests at oblique incidence (708).

Report n° 164 : Long-distance ionospheric propagation without intermediate ground reflections (720).

* * *

*Study Programme n° 152 (VI) : Back-scattering (544).

* * *

*Study Programme n° 153 (VI) : Measurement of man-made radio noise (546).

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*Study Programme n° 153 (VI) : Measurement of atmospheric radio noise (295).

Report n° 65 : Revision of atmospheric noise data (290).

Report n° 165 : Measurement of atmospheric radio noise (289).

* * *

*Resolution n° 51 : Design and use of local lightning flash counters (292).

STUDY GROUP VII

(Standard-frequencies and time signals)

Terms of reference :

Organisation of a world-wide service of standard-frequency and time-signal transmissions. Improvement of measurement accuracy.

Chairman : Mr. B. DECAUX (France).

Vice-Chairman : Prof. M. BOELLA (Italy).

Question n° 140 (VII) : Standard-frequency transmissions and time signals.

Study Programme n° 155 (VII) : Standard-frequency transmissions and time signals.

Report n° 166 : Standard-frequencies and time signals transmissions (701).

* * *

Question n° 142 (VII) : Standard-frequency transmissions and time signals in additional frequency bands.

* * *

Question n° 186 (VII) : Stability of standard-frequency transmissions and time signals as received (314).

Study Programme n° 156 (VII) : Frequency-spectrum conservation for high precision time signals (576).

STUDY GROUP VIII
(International monitoring)

Terms of reference :

To study problems relating to the equipment, operation and methods of measurement used by monitoring stations established for checking the characteristics of radio-frequency emissions. Examples of such measurements are : frequency, field-strength, bandwidth, etc.

Chairman : Mr. J. D. CAMPBELL (Australia).

Vice-Chairman : Mr. G. S. TURNER (U. S. A.).

STUDY GROUP IX
(Radio-relay systems)

Terms of reference :

To study all aspects of radio-relay systems and equipment operating at frequencies above about 30 Mc/s, including systems using the so-called tropospheric-scatter mode of propagation.

Chairman : Mr. W. J. BRAY (U. K.).

Vice-Chairman : Mr. E. DIETRICH (Federal German Republic).

STUDY GROUP X
(Broadcasting)

Terms of reference :

To study the technical aspects of transmission and reception in the sound broadcasting service (except for tropical broadcasting), including standards of sound recording and sound reproduction to facilitate the international exchange of programmes ; to study also the technical aspects of video recording in liaison with Study Group XI.

Chairman : Mr. A. PROSE WALKER (U. S. A.).

Vice-Chairman : Dr. H. RINDFLEISCH (Federal German Republic).

STUDY GROUP XI
(Television)

Terms of reference :

Technical aspects of television.

Chairman : Mr. E. ESPING (Sweden).

Vice-Chairman : Mr. G. HANSEN (Belgium).

STUDY GROUP XII
(Tropical Broadcasting)

Terms of reference :

To study standards required for good quality service in the tropical zone, and for tropical broadcasting systems ; interference in the shared bands ; power requirements for acceptable service ; design of suitable aerials for short-distance tropical broadcasting ; optimum conditions for the utilisation of frequency bands used for broadcasting in the tropical zone ; other associated questions.

Chairman : Dr. M. B. SARWATE (India).

Vice-Chairman : Mr. A. C. RAMCHAMDANI, M. Sc. (Tech.) (India).

STUDY GROUP XIII
(Mobile Services)

Terms of reference :

To study technical questions regarding the aeronautical, maritime, land mobile and radio location and navigation services, and miscellaneous operating questions of concern to several services.

Chairman : Mr. G. H. M. GLEADLE (U. K.).

Vice-Chairman : Mr. J. SOBERG (Norway).

STUDY GROUP XIV
(Vocabulary)

Terms of reference :

To study, in collaboration with the other Study Groups and, if necessary, with the C.C.I.T.T., the radio aspect of the following : vocabulary of terms and list of definitions, lists of letter and gra-

phical symbols and other means of expression, systematic classification, measurement units, etc.

Chairman : Mr. R. VILLENEUVE (France).

Vice-Chairman : Mr. A. FERRARI-TONIOLO (Italy).

*Resolution n° 34 : Definitions of certain basic words used in the International Telecommunication Convention.

Report n° 173 : Possible amendments to the definitions in the Radio Regulations, Art. 1 (774).

* * *

*Resolution n° 62 : Means of expression. Terms, definitions, graphical and letter symbols, and their conventional usage (616).

* * *

Question n° 72 (XIV) : Decimal classification.

Report n° 37 : Decimal classification.

Report n° 95 : Decimal classification.

C. M. T. T.

(C.C.I.R./C.C.I.T.T. Joint Commission for Television Transmissions.
Resolution n° 32)

Chairman : Prof. Y. ANGEL (France).

Vice-Chairman : Mr. FRANKLIN (U. K.).

C. C. I. R.

Commission I of U.R.S.I.

The following report has been accepted by the Administrations which participated in the IXth Plenary Assembly of the C.C.I.R. at Los Angeles.

Study Group VII

Report No. 166 ⁽¹⁾

Standard frequencies and time signals transmissions

(QUESTION N° 140)

(Warsaw, 1957 — Los Angeles, 1959).

On the occasion of the Ninth Plenary Assembly, certain points concerning the establishment and functioning of a world wide

⁽¹⁾ This Report replaces the Report n° 66.

standard frequency and time signal service, in the bands allocated to the service, were resolved. The principal remaining problems are the following :

1. Certain areas of the world have no suitable service.
2. The signal-to-noise ratio is too low in many industrial areas.
3. Many users require higher accuracy ; in the allocated bands, however, deterioration in the course of propagation appears to prevent sufficiently accurate measurements from being made in a period of a few minutes.
4. Optimum characteristics of time signals and receiving equipment, for obtaining the highest accuracy, have not yet been completely determined.
5. The standard frequency service continues to experience interference from stations which are not standard frequency stations but which operate in the bands allocated to this service.
6. The problem of interference between standard frequency stations operating at the same time on the same carrier frequency has not been resolved, and serious difficulties are experienced by specialized users in some locations. The number of stations operating simultaneously has increased. Since the Eighth Plenary Assembly studies and modifications in the services have indicated ways of avoiding a number of the difficulties mentioned above. For example :
 - (a) some stations have a complete break in transmission at regular intervals.
 - (b) two stations on an experimental basis are using one side band only for the modulation.
 - (c) another station transmits modulation with the carrier suppressed.

Several types of time signals have been studied. The form recommended by the Sixth Plenary Assembly of the C.C.I.R., consisting of m cycles of a modulation of 200 mc/s, still appears to be satisfactory for most users ; however, it is hoped that additional experimental work will lead to improvement, e. g. a break of the carrier wave and the insertion of a time signal of short duration may permit better separation of multipath signals ; and improved reception may result from an increase in radiated

power of the time signal. With the present system it appears desirable that each station use a different modulation frequency to form the time signal in order to identify the station.

The possibility of using different forms of time markers to indicate physical and astronomical time was discussed. It was agreed to refer this matter to the U. R. S. I.

It is hoped that it may be possible to publish expeditiously in the *Telecommunication Journal* any new information on standard frequency and time signal transmissions. The transmission characteristics are also given in the List of Special Service Stations. It is important that each Administration should prepare and distribute a booklet kept up to date, describing its technical services in the field of standard frequency transmissions. Information on the exact shape of the time pulse radiated would be particularly useful.

The errors occurring in the course of standard frequency and time signal propagation and the need for a high degree of accuracy in measurements taken over a relatively short space of time, have compelled the Study Group to undertake further studies. Two Questions have been continued : n° 142 (VII), « Standard frequencies and time signals in new frequency bands », and No ... (VII), (Doc. 314), « Stability of standard frequencies and time signals at reception ». The trend toward greater accuracy is becoming more and more apparent.

It may be noted that station GBR on 16 kc/s has for some time been operating with its carrier frequency derived from the same oscillator as that controlling the standard-frequency transmitter MSF. Results of measurements at great distances confirm that great accuracy can be obtained on frequencies of this order.

The Study Group drafted Resolution No... Doc. 434 « That the next Administrative Radio Conference be requested to provide for an international standard-frequency and time signal service in Band 4 ; a suitable frequency being in the neighbourhood of 20 kc/s (15 to 25 kc/s) with a required bandwidth of about 100 c/s ».

The use of atomic resonance devices has resulted in a more constant frequency standard being available. A higher precision is needed in time signals and a new Study Programme No... (Doc. 389) was formulated « Frequency spectrum conservation with high precision time signals ».

Five new stations in the bands allocated have been brought into operation since the Eighth Plenary Assembly of the C.C.I.R. Particulars of all the stations as of April, 1959, are set out in Annex I to this Report entitled « The main characteristics of standard frequency transmissions and time signal stations ». Annex III gives the geographic locations. It is encouraging to note that there are now three stations in the southern hemisphere. It should again be stressed that existence of too many stations in a given region can injure rather than improve the efficiency of the service. There is at present no coordination of the timing of transmission breaks at different stations; a world wide programme of these breaks would lead to an important reduction of mutual interference. The same thing is true concerning the limitation of the number of frequencies sent out simultaneously by a given station. The degree of interference, as well as the extent of the areas served, depends largely on the radio propagation conditions which have not yet been taken into consideration in the proposals for coordination. Audio modulation causes more interference than time signals. Finally, mutual interference would be reduced by the use of various offset carrier frequencies distributed in each allocated band, in combination with single side band modulation. The Chairman of Study Group VII in cooperation with the Director of the C.C.I.R., the Administrations concerned, and the I.F.R.B. has been requested to study the problem of reducing mutual interference e. g. by time sharing and frequency offsetting (Recommendation No... (Doc. 313)). Such methods, if introduced, would result in the modification of some of the characteristics set out in Annex I of the present report.

It is to be noted that Recommendation No... (Doc. 313) calls for an accuracy which is higher than that prevailing at some stations listed in Annex I. It is hoped that the administrations will attempt to meet the Recommendation as soon as possible.

A number of standard frequency and time signal stations operate on frequencies outside the bands allocated to this service. Such stations known in April 1959 are mentioned on Annex II. They are especially interesting since their results could aid in answering the Question No... 142 (VII) mentioned earlier. In this connection the possibility of stabilizing with a high degree of accuracy the carrier frequencies of existing transmitters operating in the bands

between 15 and 500 kc/s should receive careful study. The Recommendation No... (Doc. 263) deals with these problems.

There is still a need for clearing the frequency bands allocated exclusively to the standard frequency service. Recommendation No... (Annex B (VII)) deals with this problem.

The forecasts of propagation, which indicate the present and future state of the ionosphere, for certain parts of the globe have been continued at WWV, WWVH, and JJY. In addition to the important information which they give for radio communication and research work, these forecasts can be utilized in high accuracy work, for determining the possibilities of the reception of standard frequencies and time signals for any specified period.

The use of special transmissions as proposed in Study Programme No... 94 (VI) — «Use of special modulation on the standard frequency transmissions for assessing the reliability of propagation forecasts» was essentially replaced by Study Programme n° 155 (VII). These items were coordinated with Study Group VI and it was decided to continue the study of frequency staggering which will assist propagation measurements.

To sum up, Study Group VII considers that Atlantic City (1947) Recommendation No. 2 has already been satisfactorily implemented in broad outline. Nevertheless, certain problems have not yet been fully solved; moreover, the degree of accuracy required by the user is continually increasing. The work of Study Group VII should be continued.

Note. — According to information received after the IXth Plenary Assembly of the C.C.I.R., the Uccle station does not operate.

ANNEX I

Main characteristics of standard frequency
and time signal stations in April 1959

1	Stations	Buenos Aires Argentina	Hawaii United States of America	Lower Hu' New Zeala	
2	Latitude and Longitude	34° 37' S 58° 21' W	20° 46' N 156° 28' W	41° 14' S 174° 55' E	
3	Call sign	LOL	WWVH	ZLFS	
4	Carrier power to antenna (kW)	2	2	0.03	
5	Type of antenna		vert. dipole		
6	Number of simult. transmissions	6	3	1	
7	Number of carriers used	6	3	1	
8	Transmis- sions	Days per week	6 ⁽¹⁾	7	1 ⁽⁹⁾
9		Hours per day	5 ⁽²⁾	23 ⁽⁵⁾	3 ⁽¹⁰⁾
10	Standard frequencies used	Carriers Mc/s	2.5 ; 5 ; 10 ; 15 ; 20 ; 25	5 ; 10 ; 15 ;	2.5
11		Modulations (c/s)	1 ⁽³⁾ ; 440 ; 1000	1 ⁽⁶⁾ ; 440 ; 600	Nil
12	Duration of audio modulation (minutes)	4 in each 5 ⁽⁴⁾	3 in each 5 ⁽⁷⁾	Nil	
13	Frequency accuracy (parts in 10 ⁹)	±20	±10	±100	
14	Max. value of steps of frequency adjustment (parts in 10 ⁹)	—	5	—	
15	Duration of time signal transmissions (minutes)	4 in each 60	continuous	Nil	
16	Accuracy of time intervals	±20 × 10 ⁻⁹ ±1 μs	±10 × 10 ⁻⁹ ±1 μs	Nil	
17	Method of time signal adjustment	Approx. 20 ms	By steps of 20 ms ⁽⁸⁾	Nil	

1	Moskva U.S.S.R.	Neuchatel Switzerland	New-Delhi India	Olifantsfontein South Africa ⁽²³⁾	Paris France
2	—	46° 58' N 6° 57' E	28° 34' N 77° 19' E	25° 58' S 28° 14' E	48° 46' N 2° 20' E
3		HBN	ATA	ZUO	FFH
4	20	0.5	1 ⁽²¹⁾	4 ⁽²³⁾	0.3
5		Hor. dipole	Hor. dipole	Omnidirectional ⁽²³⁾	Inverted L
6	1	1	1	1 ⁽²³⁾	1
7	2	2	1	1 ⁽²³⁾	3 ⁽²⁷⁾
8	6 ⁽¹⁾	7	5	7	2 ⁽²⁸⁾
9	1'2 ⁽¹¹⁾	24	1 ⁽²²⁾	24 ⁽²⁴⁾	9 ⁽²⁹⁾
10	10 ⁽¹²⁾ 15 ⁽¹³⁾	2.5 ⁽¹⁶⁾ ; 5 ⁽¹⁷⁾	10	5 ⁽²³⁾	2.5; 5 ⁽³⁰⁾ 10 ⁽³⁰⁾
11	1 ⁽¹⁴⁾	1 ⁽¹⁸⁾ ; 500 ⁽¹⁹⁾	1 ⁽³⁶⁾ ; 1000	1 ⁽²⁵⁾	1 ⁽³¹⁾ ; 440; 1000
12	Nil	5 in each 60	4 in each 15	Nil	10 in each 20 ⁽³²⁾
13	±20		±20	±20	±20 ⁽³³⁾
14	20	0.5 ⁽²⁰⁾	20	1	20
15	5 in each 30 ⁽¹⁵⁾	5 in each 10	continuous	continuous	10 in each 20
16		±10 × 10 ⁻⁹ ±1 μs	±20 × 10 ⁻⁹ ±1 ms	±20 × 10 ⁻⁹ ±1 μs	±20 × 10 ⁻⁹ ±1 μs
17		Steering	By steps of 20 ms	By steps of 20 ms ⁽²⁶⁾	By steps of 50 ms ⁽³⁴⁾

1	Praha Czecho- slovakia	Roma Italy	Rugby United Kingdom	Tokyo Japan	Ino Italy	Uccle Belgium	Washingt U. S. A
2	50° 07' N 14° 35' E	41° 52' N 12° 27' E	52° 22' N 1° 11' W	35° 42' N 139° 31' E	45° 03' N 7° 40' E	50° 48' N 4° 21' E	39° 00' 76° 51'
3	OMA	IAM	MSF	JJY	IBF		WWV
4	1	1 ⁽³⁹⁾	0.5	2	0.3	0.02	0.1-10
5	T	Hor. dipole	⁽⁴³⁾	Vert. ⁽⁴⁶⁾	Hor. dipole ⁽⁵¹⁾	Vertical	Vertica dipole
6	1	1	3	3-4	1	1	6
7	1	1	3	4	1	1	6
8	7	6 ⁽¹⁾	7	7	6 ⁽¹⁾	7	7
9	24 ⁽³⁵⁾	1 ⁽⁴⁰⁾	24 ⁽⁴⁴⁾	24 ⁽⁴⁷⁾	1 ⁽⁵²⁾	22 ⁽⁵⁴⁾	24 ⁽⁵⁵⁾
10	2.5	5	2.5 ; 5 ; 10	2.5 ⁽⁴⁸⁾ ; 5 ; 10 ; 15	5	2.5	2.5 ; 5 ; 10 15 ; 20 ; 25
11	1 ⁽³⁶⁾ ⁽³⁷⁾ 1000	1 ⁽⁴¹⁾ ; 440 ; 600 ; 1000	1 ⁽³⁶⁾ 1000	1 ⁽⁴⁹⁾ 1000	1 ⁽⁵³⁾ ; 440 ; 1000	Nil	1 ⁽⁵⁶⁾ ; 440 600
12	4 in each 15	8 in each 15 ⁽⁴²⁾	5 in each 15	4 in each 5	5 in each 10 ⁽⁴⁾	Nil	3 in each 5 ⁽⁷⁾
13	±20	±20	±5 ⁽³³⁾	±20	±20	±10	±5
14	1	20	10	10	20		0.5
15	10 in each 30 ⁽³⁸⁾	5 in each 15	5 in each 15	continuous	5 in each 10	Nil	continuou
16		±20 × 10 ⁻⁹ ±1 μs	±5 × 10 ⁻⁹ ±1 μs	±20 × 10 ⁻⁹ ±0.3 μs	±20 × 10 ⁻⁹ ±1 μs	Nil	±5 × 10 ⁻⁹ ±1 μs
17	Steering	By steps of 50 ms	By steps of 20 ms ⁽⁴⁵⁾	By steps of 10 ms ⁽⁵⁰⁾	By steps	Nil	By steps of 20 ms ⁽⁸⁾

NOTES ON TABLES IN ANNEX I

- (1) Working days.
- (2) From 11.00 to 12.00, 14.00 to 15.00, 17.00 to 18.00, 20.00 to 21.00 hours and 23.00 to 24.00 hours U. T.
- (3) Pulses of 5 cycles of 1000 c/s tone; no 59th pulse of each minute.
- (4) Alternately 440 or 1000 c/s.
- (5) Interruption from minute 0 to minute 3, from minute 15 to minute 18, from minute 30 to minute 34 and from minute 45 to minute 48 of each hour, and from 19.00 to 19.33 hours U. T.
- (6) Pulses of 6 cycles of 1200 c/s tone; no 59th pulse of each minute.
- (7) Alternately 440 or 600 c/s.
- (8) Adjustments are made on Wednesdays at 19.00 hours U. T., when necessary.
- (9) Tuesdays.
- (10) From 01.00 to 04.00 hours U. T.
- (11) From 07.15 to 07.45 hours U. T.
- (12) Even days.
- (13) Odd days.
- (14) Signals A1 keyed. Direction of each signal 100 ms; the first signal of each minute is prolonged.
- (15) From 07.15 to 07.18 and from 07.43 to 07.45 hours U. T.
- (16) From Saturday 07.00 hours to Tuesday 07.00 and from Wednesday 07.00 hours to Friday 07.00 hours U. T.
- (17) From Tuesday 07.00 hours to Wednesday 07.00 hours and from Friday 07.00 hours to Saturday 07.00 hours U. T.
- (18) 5 carrier interruptions, each of 1 ms and spaced by 1 ms. The beginning of the first interruption indicates the exact second. The complete minute signal comprises 250 successive interruptions.
- (19) Square wave modulation.
- (20) Relative to a molecular standard.
- (21) Further 2.
- (22) From 05.30 to 06.00 and from 10.30 to 11.00 U. T. Further during 22 hours.
- (23) Identical transmissions by Johannesburg (26° 11' S, 28° 04' N) with 0.3 kW on 10 Mc/s using a horizontal dipole with a maximum radiation : N-S.
- (24) Interruption from minute 15 to minute 25 of each hour and from 06.30 to 07.00 hours U. T.
- (25) Pulses of 5 cycles of 1000 c/s tone; the first pulse of each minute being prolonged (500 ms).
- (26) Thursdays, if necessary.

- (27) Provisionally 1.
- (28) Tuesdays and Fridays.
- (29) Interruption from minute 25 to minute 30 of each hour.
- (30) Subsequently.
- (31) Pulses of 5 cycles of 1000 c/s tone, the first pulse of each minute is prolonged to 100 ms and followed by 440 c/s tone lasting 100 ms.
- (32) 440 c/s during 1 minute, then 1000 c/s during 9 minutes.
- (33) Relative to an atomic standard.
- (34) If required, the first Monday of each month.
- (35) Interruption from minute 40 to minute 45 of each hour.
- (36) Pulses of 5 cycles of 1000 c/s tone; the first pulse of each minute is prolonged (100 ms).
- (37) The first pulse of each 5th minute is prolonged to last 500 ms. The last 5 pulses of each quarter-of-an-hour last 100 ms. Pulses of 100 cycles of 1000 c/s tone from minute 55 to minute 60 of each hour. The first pulse of each minute is prolonged (500 ms).
- (38) From minute 20 to minute 25 of each hour, no time pulses.
- (39) Peak power during audio modulation with suppressed carrier : 0.8 kW.
- (40) From 07.30 to 08.30 hours U. T.
- (41) Pulses of 5 cycles of 1000 c/s tone; the first pulse of each minute is repeated 4 times.
- (42) Carrier suppressed during audio modulation.
- (43) Vertical monopole for 2.5 Mc/s; horizontal quadrant dipoles for 5 and 10 Mc/s.
- (44) Interruption from minute 15 to minute 20 of each hour.
- (45) If necessary, adjusted on the first day of each month.
- (46) Two half-dipoles on 15 Mc/s; one half-wave dipole on 2.5 and 5 Mc/s.
- (47) Interruption from minute 29 to minute 39 of each hour.
- (48) From 07.00 to 23.00 hours U. T.
- (49) Break in transmission during 20 ms, the break before second 0 lasting 200 ms.
- (50) On Friday, if necessary.
- (51) Maximum radiation : NW-SE.
- (52) From 07.00 to 07.30 and from 11.00 to 11.30 hours U. T.
- (53) Pulses of 5 cycles of 1000 c/s tone; the first pulse of each minute is repeated 7 times at intervals of 10 ms.
- (54) Interruption from 11.30 to 12.30 and from 20.30 to 21.30 hours U. T.
- (55) Interruption from minute 45 to minute 49 of each hour.
- (56) Pulses of 5 cycles of 1000 c/s tone; no 59th pulse of each minute. The first pulse of each minute is repeated 100 ms later.

ANNEX II

**Main characteristics of Standard frequency
and time signal stations operating outside the exclusive bands in August 1958**

1	Stations	Boulder United States of America	Mainflingen Fed. German Republic	Ottawa ⁽⁵⁾ Canada	Podebrady Czecho- slovakia	Rugby United Kingdom	
2	Latitude and longitude	40° 00' N 105° 15' W	50° 01' N 09° 00' E	45° 18' N 75° 45' E	50° 08' N 15° 08' E	52° 22' N 1° 11' W	
3	Call sign	KK 2XEI	DCF 77	CHU	OMA	GBR	MSF
4	Power of carrier-wave in antenna (kW)	2	12	0.3 ⁽⁶⁾ 3 ⁽⁷⁾ 5 ⁽⁸⁾	5	300	10
5	Type of antenna	Omnidi- rectional	Omnidi- rectional	$\frac{1}{2}$ wave folded dipole ⁽⁶⁾⁽⁷⁾ E-W Rhomb. ⁽⁸⁾	T		
6	Number of simult. transmissions	1	1	3	1	1	1
7	Number of carrier frequencies used	1	1	3	1	1	1

1	Stations	Boulder United States of America	Mainflingen Fed. German Republic	Ottawa ⁽⁵⁾ Canada	Podebrady Czecho- slovakia	Rugby United Kingdom		
8	Trans- missions	days per week	5 ⁽¹⁾	6 ⁽¹⁾	7	7	7	
9		hours per day	6.5 ⁽²⁾	11 ⁽³⁾	24	24	22 ⁽¹²⁾	1 ⁽¹⁶⁾
10	Standard frequen- cies used	Carriers (kc/s)	60	77.5	3330 ; 7335 ; 14.670	50	16	60
11		Modulations (c/s)	Nil	1 ⁽⁴⁾ ; 200 ; 440	1 ⁽¹⁹⁾	Nil ⁽¹³⁾	Nil ⁽¹³⁾	1 ⁽¹⁷⁾ ; 1000
12	Duration of audio modulation		Nil		Nil	Nil	Nil	5 in each 15
13	Accuracy of frequencies (parts in 10 ⁹)		±0.5	±10	±10 ⁽¹⁰⁾	±20		±5 ⁽¹⁴⁾
14	Maximum value of fre- quency adjustment hops (parts in 10 ⁹)		0.5		20	1		10
15	Duration of time signal transmissions		Nil	⁽⁴⁾	Continuous	Continuous	⁽¹⁵⁾	5 in each 15
16	Accuracy of time intervals		Nil		±20 × 10 ⁻⁹ ⁽¹⁰⁾			±5 × 10 ⁻⁹ ±1 μs
17	Method of time signal adjustment		Nil		By steps	Steering		By steps

NOTES ON TABLE IN ANNEX II

- (1) Workdays.
- (2) From 15.30 to 22.00 hours U. T. continuous with atomic control; from 15.30 hours U. T. Wednesdays to 22.00 hours U. T. Thursdays.
- (3) From 07.00 to 11.10 and from 19.00 to 02.10 hours U. T. between 1 March and 31 October; from 07.00 to 11.10 and from 19.00 to 00.10 hours U. T. between 1 November and end of February.
- (4) International type A1 telegraph time signals from the Deutsche Hydrographische Institut from 08.00 to 08.10, from 11.00 to 11.10 U. T., and from minute 0 to minute 10 of each hour between 19.00 and 02.10 (or 00.10) and between 19.30 and 19.40 hours U. T.
- A1 telegraph reference time signals from the Physikalisch-Technische-Bundesanstalt from 07.28 to 07.59, from 08.11 to 10.04, from 10.28 to 10.59, from 19.11 to 19.29, from 19.41 to 19.59 hours U. T., and from minute 57 to minute 59 of each hour between 19.57 and 01.59 (or 23.59) hours U. T.
- (5) At the end of 1959.
- (6) On 3330 kc/s.
- (7) On 7335 kc/s.
- (8) On 14 670 kc/s.
- (9) Pulses of 5 cycles of 1000 c/s tone; the first pulse of each minute is prolonged.
- (10) ± 1 when used with published corrections.
- (11) Continuous A1 telegraph time signals during 23 hours a day. From 10.00 to 11.00 U. T.; 50 kc/s standard frequency transmission without any keying, except call sign OMA at the beginning of each quarter of an hour.
- (12) Depending on telegraph traffic.
- (13) A1 telegraphy.
- (14) Relative to a Caesium atomic standard.
- (15) International type time signals from 09.55 to 10.00 and from 17.55 to 18.00 hours U. T.
- (16) From 14.30 to 15.30 hours U. T.
- (17) Pulses of 5 cycles of 1000 c/s tone; the first pulse of each minute is prolonged (100 ms).
- (18) If necessary, adjusted on the first of each month.
- (19) Pulses of 200 cycles of 1000 c/s tone; the first pulse of each minute is prolonged.

ANNEX III

**World-wide distribution of standard-frequency
and time signal stations**

- Station in service.
- Low-power station operating on 2-5 Mc/s.
- Projected station.

C. O. S. P. A. R.

The First International Space Science Symposium

Nice, France

January 11-16, 1960

(SECOND CIRCULAR)

4 AUGUST, 1959

Date and Place : The Executive Committee of C.O.S.P.A.R. has decided that a Symposium will be held in Nice (France) in the week 11-16 January, 1960. The next plenary C.O.S.P.A.R. Meeting is also planned to take place in Nice in the same week, the precise time schedule for both events to be announced later.

Subject : The purpose of the Symposium will be to present and discuss scientific results obtained during and after the International Geophysical Year by means of rockets and satellites. It is suggested that the contributions should centre about the following subjects : *Tracking, telemetering, radiation belts, orbital variations*, and special attention be given to *instrument design* and *instrument performance* in each of these subjects. There will be an opportunity to display instruments as well as charts or photographs in a separate room during the Symposium. Participants are invited to bring any relevant material together with legends.

Reception Committee : The French scientific community warmly welcomes participants from all other countries to this Symposium. A Reception Committee has been formed consisting of :

Professor P. AUGER,

Professor Ch. FEHRENBACH,

Professor M. ROY.

Secretariat : The correspondence concerning this Symposium will be handled by : The C.O.S.P.A.R. Secretariat, Paleis Noordeinde, The Hague, Netherlands.

Until further notice all notes and queries concerning the Symposium should be sent to this address. We shall be particularly grateful to receive at your earliest convenience any of the following information from your institute and/or country, even if the information is not definitive :

Intention to attend the Symposium.

Preliminary titles of papers to be presented.

Plans to bring instruments or other material for display.

Suggestions that may be helpful to the planning committee.

Mailing List : In order to give sufficiently wide publicity to this Symposium in the scientific world, would you please disseminate this information to your colleagues and notify the Secretariat of any individuals or institutions to be put on the mailing list for further announcements.

Funds : No travelling or subsistence costs can be defrayed to the participants of the Symposium by the organizing Committee. The members of C.O.S.P.A.R. and its Working Groups can claim reimbursement of their expenses to attend the C.O.S.P.A.R. Meeting in the usual manner.

Next Circular : The next circular which will contain a provisional programme, hotel information, etcetera, is planned for late October.

Yours sincerely,

VAN STRAELEN.

(for) Professor H. C. VAN DE HULST.
President of C.O.S.P.A.R.

BIBLIOGRAPHY

Unesco

Special issue of the Unesco Courier.

Unesco is devoting the September 1959 number of its monthly illustrated review « The Unesco Courier » to radio in the world, under the title « Broadcasting without Barriers ». These are the principal articles which appear in this issue : The Freedom to listen ; Traffic Jam on the Broadcasting Bands ; Radio « hams » : an international family ; Into outer space on radio waves ; Calling the Flying Doctor in Australia ; Pioneers of Radio ; The Cobra and the Electronic Charmer ; Radio's magic eye on the river Thames ; The museum inside the receiver ; Central Africa's « Saucepan special » ; A little less noise, please - acoustics in a radio studio.

« The Unesco Courier » has now approximately 200 000 readers in its four language editions (English, French, Russian and Spanish), and is obtainable from Unesco's national distributors at the price of 1/-stg, \$ 0.30, or 60 French francs per number, or 10/-, \$ 3.00, 600 French francs per annual subscription (12 numbers).

International Electrotechnical Commission

Publication n° 111, First edition. — Recommendation for the resistivity of commercial hard-drawn aluminium electrical conductor wire.

Publication n° 114, First edition. — Recommendation for heat-treated aluminium alloy busbar material of the aluminium-magnesium-silicon type.

Publication n° 50 (31), Second edition. — International Electrotechnical Vocabulary, Group 31 : Signalling and security apparatus for railways.

These publications are on sale at the Central Office of the IEC at the price of Sw. Fr. 2.— per copy, plus postage, for Publication n° 111, Sw. Fr. 2.— per copy, plus postage for Publication n° 114, and Sw. Fr. 8.— per copy, plus postage, for Publication n° 50 (31).
