Bulletin n° 122 July-August-September 1960

International Scientific Radio Union

U. R. S. I.

CONTENTS

C.C.I.R. :

I.U.G.G. :

COMMISSIONS

Information Bulletin

In order to reduce the printing costs of the *Information Bulletin*, it was decided at the last General Assembly to publish henceforth a *single bilingual* issue of the *Information Bulletin.* This issue will contain in original language the text of the documents sent to the Secretary General for publication ; they will be accompanied, when needed, by a brief summary in the other official language of U.R.S.I.

Official texts relevant to the current life of U.R.S.I. will be published in both official languages of U.R.S.I.

XIIIth GENERAL ASSEMBLY

Decisions adopted on proposal of the Executive Committee

1. New National Committee.

The General Assembly recognised the National Committee constituted in Peru.

2. Statutory elections.

On the proposal of the Executive Committee, the General Assembly elected :

2.1. The Board of Officers :

President : Dr. R. L. Smith-Rose.

Past President : Dr. L. V. Berkner (*ex officio*).

Vice-Presidents : Mr. B. Decaux,
Dr. I. Koga (re-elected),
Dr. A. Prokhorov,
Dr. G. A. Woonton (re-elected).

Treasurer : Prof. Ch. Manneback (re-elected).

Secretary General : Ing. E. Herbays (re-elected).

2.2. The Commission Chairmen :

Commission I	: Dr. U. Adelsberger.
Commission II	: Mr. J. Voge.
Commission III	: Mr. J. A. Ratcliffe.
Commission IV	: Prof. R. A. Helliwell (re-elected)
Commission V	: Prof. A. C. B. Lovell (re-elected),
Commission VI	: Mr. J. Loeb.
Commission VII	: Prof. W. G. Shepherd (re-elected).

3. Outstanding Committees.

On the proposal of the Executive Committee :

3.1. The following Committees were established :
Committee on Space Radio Research ;
U.R.S.I./C.I.G. Committee ;
Committee for Frequency Allocation for Scientific Purposes,
The Central Committee on Ursigrams was confirmed.

3.2. Chairmen and Secretaries of the Committees were appointed as follows :

Committee on Space Radio Research :

Chairman : Prof. L. G. H. Huxley.

Secretary : Prof. W. J. G. Beynon.

U.R.S.I./C.I.G. Committee :

Chairman : Prof. W. J. G. Beynon.

Secretary : Dr. G. M. Brown.

Committee on Frequency Allocation for Scientific Purposes :

Chairman : Mr. J. A. Ratcliffe.

Secretary : Dr. J. W. Findlay.

U.R.S.I. Committee for C.C.I.R. Work :

Chairman : Dr. J. H. Dellinger.

The membership of this Committee is as follows :

Members : M. B. Decaux ;
Colonel Lochard,
Dr. F. Horner,
Dr. D. K. Bailey.

4. Appointment of U.R.S.I. representatives to other organizations.

On the proposal of the Executive Committee, the following were appointed as U.R.S.I. representatives :

to I.C.S.U. : Dr. R. L. Smith-Rose ;

to C.I.G. : Prof. W. J. G. Beynon ;

to the Inter-Union Committee on Frequency Allocations for Radio Astronomy and Space Science :

Dr. EMBERSON,
Dr. V. ILYIN,
Dr. J. A. RATCLIFFE,
Dr. H. STERKY,
Dr. R. L. SMITH-ROSE acting as Secretary General ;

to the I.W.D.S. Steering Committee : Mr. A. H. SHAPLEY ;

to the Inter-Union Committee on the Ionosphere :

Prof. W. J. G. BEYNON,
Mr. J. A. RATCLIFFE,
Dr. K. MAEDA,
Dr. VAN ZANDT ;

to the Inter-Union Committee on Radio Meteorology :

Dr. R. BOLGIANO,
Dr. IMAI (NAITO, alternate),
Dr. J. SAXTON,
Dr. R. L. SMITH-ROSE,
Mr. J. VOGE (M. LHERMITTE, alternate) ;

to the Inter-Union Committee on Solar and Terrestrial Relationships :

Commission III : Dr. D. K. BAILEY,
Commission IV : Dr. G. M. ALLCOCK,
Commission V : Prof. R. COUTREZ,
U.R.S.I. Representative : Mr. A. H. SHAPLEY ;

to the S.C.A.R. : Dr. L. HARANG ;

to the F.A.G.S. : Col. E. HERBAYS and Prof. R. COUTREZ.

5. XIVTH GENERAL ASSEMBLY.

It was decided to hold the XIVth General Assembly in Japan in 1963.

6. Unit of subscription.

It was decided to maintain the unit of subscription at its present rate, i. e. U.S. $ 125.

7. Fiscal Year.

It was decided that the U.R.S.I. fiscal year should run from January 1st to December 31st.

8. Bylaws.

Some wording modifications were brought to the Bylaws.

9. Rules for Commissions.

Some slight modifications were brought to the text of the Rules for Commissions as published in *Information Bulletin.* These amended Rules were adopted.

Resolutions and Recommendations of the Commissions

Commission I. — On Radio Measurements and Standards

Resolution I

Since the beginning of 1960 several time and standard frequency transmitters emit a uniform time and a constant frequency. Emitted time and frequency are locked together. The frequency emitted is kept as constant as possible by means of atomic frequency standards. The nominal value of the frequency is chosen so that the time derived from it follows universal time U.T.S. approximately. Before the end of each year it is recommended that the Bureau International de l'Heure (B.I.H.), after having consulted the observatories and compared the astronomical observations of the observatories, should announce a nominal value for the frequency to be emitted during the following year. This value will be expressed in the time scale in which the frequency of the cesium has the value :

$$f(\mathrm{Cs}) = 9\ 192\ 631\ 770\ \mathrm{c/s}.$$

The suggested nominal value will not change during the year. It is recommended that the B.I.H. value of the frequency should be used by the institutions wishing to transmit uniform time and constant frequency without departing too far from UT2.

Resolution II

It is recommended by the U.R.S.I. that extensive efforts be made throughout the world during the entire year 1961 to continuously monitor the phase of standard frequency VLF and LF transmissions. Information on the phase stability from day to day of VLF and LF transmission paths is urgently needed in order to determine the usefulness of such paths for high precision time synchronization and frequency comparison purposes. Where highly stable atomic frequency standards are available care should be taken to make the phase measurements in terms of these standards as accurately as possible. Result for transmissions such as GBR, NBA, MSF, and DCF are of particular immediate interest because of the large areas over which signals from these sources can be obtained. In order to reduce uncertainties due to variations in the transmitted frequencies it is suggested that results be reported for 24 hour periods ending at 1500 UT for areas where sunrise or sunset effects are not serious at this time, as well as in more complete form if possible. Measurements on LF transmissions such as MSF, and DCF, as well as on VLF transmissions are needed in order to compare the day-to day phase stability of LF and VLF transmission paths. It is requested that the results be sent to Mr. W. D. George at the Boulder Laboratories, National Bureau of Standards, Boulder, Colorado, (U. S. A.) for distribution to all other laboratories contributing results and for analysis.

Resolution III

Considering that the value for the velocity of light in vacuo (299, 792.5 $\pm$ 0.4 km/sec) adopted by the XIIth General Assembly at Boulder 1957, has been used in the reductions of electronic measurements of geodetic distances and has been found to give results consistently in agreement with accurately known lengths, and considering that it is desirable also to standardize the formulas for calculating refractive Index which are associated with these reductions of electronic distance measurements.

U.R.S.I. recommends adoption of the following formulae :

(*a*) for light waves (the Barrell and Sears formula) :

$$(nG - 1).10^7 = 2876.04 + \frac{16.288}{\lambda^2} + \frac{0.136}{\lambda^4}$$

where :

λ = the light group wavelengths in microns reduced to ambient conditions by

$$L = \frac{nG-1}{1+\alpha t} \cdot \frac{p}{760} \cdot \frac{0.000\,000\,055\,\varepsilon}{1+\alpha t}$$

where :

L = refractive index in ambient conditions

nG = refractive index in dry air with 0.03 % CO_2 atN.T.P. (0° C, 760 mm Hg) for light of the group wavelength employed, calculated as above

t = temp in °C

p = atmospheric pressure in mm Hg

α = coefficient of expansion of air (0.003661) °Cû$^{-1}$

ε = partial water vapour pressure in mm Hg

(*b*) for radio micro-waves (the Essen and Froome formula) :

$$(n_r - 1).10^6 = \frac{103.49}{T} \cdot (p - \varepsilon) + \frac{86.26}{T} \cdot \left(1 + \frac{5748}{T}\right) \cdot \varepsilon$$

where :

T = Temp in °K

p = Atmospheric pressure in mm Hg

and :

ε = partial water vapour pressure in mm Hg

Resolution IV

In accordance with resolution n° 5 adopted by U.R.S.I. during its XIIth General Assembly, and as a result of subsequent work done by National Commissions n° 1 of Japan, U. K. and U. S. A. in order to activate the recommendations in that Resolution, the

XIIIth General Assembly recommends to members of the U.R.S.I. the following :

1. — The first electronic quantity to be considered for the purpose of promoting agreement in accuracy of measurement shall be cw power over various frequency bands within the frequency range of dc to 140 kMc/s. Other quantities as follows shall be considered over the same frequency range as soon as possible :

(1) cw voltage ;

(2) cw attenuation ;

(3) cw field strength and antenna coefficients ;

(4) surface conductivity of metals ;

(5) rectangular-wave guide VSWR ;

(6) impedance ;

(7) complex permittivity and permeability.

2. — Tables stating ranges of magnitude, ranges of frequency and accuracies obtainable for cw power and for other quantities are invited from various countries. These tables shall be published in existing U.S.R.I. periodic publications and circulated among member nations via any other means at the disposal of U.R.S.I. These tables shall also contain desirable accuracies for those ranges for which available accuracies are deemed inadequate and for those ranges for which satisfactory measurement techniques are not as yet available.

3. — Organizations desiring to intercompare accuracies of standards and measurements shall request their respective U.R.S.I. National Committees to establish contact and make necessary arrangements up to the point of actual shipment of equipment ; the latter and subsequent contacts should be the responsibility of the particular laboratories involved. When justified, the U.R.S.I. may place notices in the *U.R.S.I. Bulletin* and technical organs of various member countries inviting them to participate in an impending program of inter-comparison of two or more specific countries.

4. — Representatives of organizations may conduct preliminary exploratory correspondence in order to locate laboratories interested in specific intercomparisons. For this purpose the Chairman of U.R.S.I. Commission I may be consulted.

5. — The paper approved by U. S. A. Commission I on May 2nd, 1960, may be used as a guide and general pattern in implementing this program. This paper is entitled « Working Paper Concerning U.R.S.I. Resolution nº 5. Proposed U. S. A. — Commission I Suggestion for Electronic Quantities for International Standardization ». It is recommended that the text of this paper be published in the proceeding of the XIIIth U.R.S.I. General Assembly after its final approval by the U. S. A. National Committee.

6. — Results of satisfactory implementation of this resolution shall be published in the *U.R.S.I. Bulletin*. These results concerning measurements of a specific range of a quantity may establish the de facto state of the art on an international basis. Similarly, a specific accuracy designated by two or more administrations as desirable for the measurement of a quantity may be recognised as a bona fide international need.

Resolution V

It is recommended that the national laboratories continue to intercompare their microwave standards of power measurements and to include power measurements at other radio frequencies, the comparisons to be coordinated by the Chairman of Commission I.

As proposed by the Executive Committee, the above resolutions were adopted by the General Assembly.

Commission II. — On Radio and Troposphere

Resolution I

That in further experimental studies of trans-horizon propagation particular attention should be devoted to :

(i) the establishment, by simultaneous radio and meteorological measurements, of the dependence of the signal characteristics (including attenuation, fading range and speed, available bandwidth and spatial distribution) on distance and frequency for various climatological conditions ; and hence to the classification of all clearly identifiable propagation mechanisms ;

(ii) measurements and statistical analysis of the instantaneous structure of the field.

RESOLUTION II

That in studies of the characteristics of the atmosphere relevant to radio wave propagation at very high frequencies problems of particular interest are :

(i) the fine structure of inhomogeneities due both to stratification and turbulence (especially when anisotropic) ;

(ii) the determination of layer parameters and the turbulence spectra (expressed as wave numbers) ;

(iii) the absorption in the atmosphere at centimetre and millimetre wavelengths and the associated noise radiation.

RESOLUTION III

That theoretical studies of propagation should take fully into account the multiplicity of trans-horizon propagation mechanisms, especially diffuse and specular reflection from layers and turbulent scattering ; the significance of multiple scattering should be rigorously examined.

RESOLUTION IV

Since many of the frequencies likely to be used in space research are susceptible to tropospheric influences, the importance of the resultant effects of these should be studied.

As proposed by the Eexcutive Committee the above resolutions were adopted by the General Assembly.

Commission III. — On Ionospheric Radio

RESOLUTION I

On the Sunspot Minimum Programme. — Commission III, noting the intention of several Scientific Unions and of the International Committee on Geophysics (C.I.G.) to organize in 1964-65 a Sunspot Minimum Programme as a companion enterprise to the International Geophysical Year of 1957-58, calls the attention of National Committees to this proposal and urges the fullest participation in the project of all workers and organizations in the field of Ionospheric Radio.

Resolution II

On the Propagation Time of Radio Signals. — To obtain the highest accuracy in synchronizing widely spaced clocks and standard time transmissions, as required for many scientific and technical purposes, such as tracking and navigation, it is strongly recommended that the experiments organized during the past years by the Sub-Commission III*c* and described in the report to the XIIIth General Assembly, should be encouraged and continued by direct contact between interested national laboratories.

Both resolutions were adopted by the General Assemblies on the proposal of the Excutive Committee.

Commission IV. — On Radio Noise of Terrestrial Origine

Recommendation I on Whistler Synoptic Observations

1. *I.G.Y. Dispersion Data.* — The U.R.S.I. recommends that whistler dispersion values from I.G.Y. whistler synoptic recordings be determined as soon as possible, for publication in the *Annals of the I.G.Y.*, together with a statement of the method used for the determination of dispersion from the original recordings.

2. *Special Pulse Transmissions from VLF Stations.* — The U.R.S.I. emphasizes the value of observations of special pulse transmissions from VLF stations for the study of the propagation of VLF radio waves in the whistler mode ; in particular, the study of the positions of entry and exit of the transmissions into and out of the ionosphere, in relation to the position of the source. The U.R.S.I. therefore urges national organizations which operate VLF transmitters, to transmit special pulses between 50 and 54 minutes past each hour U.T. It is noted that the period 50-60 minuted past each hour U.T. has, in many cases, been convenient for the transmission of special test signals.

The advantages of synchronized transmissions are appreciated. Therefore, where special experimental considerations do not apply, it is recommended that the pulse repetition period be three seconds, the first pulse of the series to commence at 50 minuted 0.0. seconds past each hour U.T.

3. *Alteration of Synoptic Whistler Recording Times.* — To enable simultaneous observations to be made of whistlers and of VLF transmissions in the whistler mode, the U.R.S.I. recommends that

whistler recording schedules be changed from the present 35-37 minuted past each hour U.T. to 50-52 *minuted past each hour U.T.*, the change to take place on *October* 1, 1960.

4. *Minimal Synoptic Programme.* — To maintain adequate measurements of the secular variation of whistler dispersions until the forthcoming Sunspot Minimum Period, the U.R.S.I. recommends that the following minimal programme of observations be adopted :

(*a*) Hourly recordings during Wednesdays U.T.

(*b*) Recordings four times per day during Thursday to Tuesdays U.T. for successive schedules, centred near local midnight and chosen from the following schedules.
0050,0350,0650. . . 1850,2150 U.T.

It is recommended that, for effective latitude coverage, at least one station from each of the following groups should operate according to the minimal programme.

(The first-named station is nominated to fulfil this function, and other stations are urged to participate).

Group	Approximate Geomagnetic Latitude	Stations
A	25°	*Toyokawa,* Johannesburg
B	35°	*Wakkanai,* Brisbane, Durban
C	45°	*Wellington,* Stanford, Bermude, Ushaia
D	50°	*Poitiers,* Boulder, Francfort, Greenbank, Moscou, Pruhonice, Unalaska, Dunedin
E	55°	*Seattle,* Dartmouth, Halifax, Kühlungsborn, Ottawa, Stockholm, Kerguelen, Marion Island, Port Lockroy
F	60°	*Moisie*
G	65°	*College,* Knob Lake, Ellsworth

The importance of continuing observations of both whistlers and VLF emissions (ionospheric noise) at latitudes above 65°, is emphasized.

The recommended date of commencement of the above programme is *January* 1, 1961.

It is further recommended that stations participating in the minimal programme supply hourly values of dispersion data to World Data Centres, together with a statement of the method used for the determination of dispersion from the original recordings.

Recommendation II

Commission IV recommends that the report on the characteristics of terrestrial radio noise prepared by a working group and summarised in paper AG60/IV/3, be published, after editing, as an U.R.S.I. Special Report.

Recommendation III

Terrestrial Noise Terminology

Commission IV recommends that the following terminology on terrestrial radio noise be adopted.

Terrestrial Noise.

Natural electromagnetic disturbances originating in the earth's atmosphere are classified into the following groups and subgroups :

A. — Atmospheric noise.

Terrestrial noise originating in natural electrical discharges below the Ionosphere and reaching the receiver by means of normal paths of propagation between the earth and the lower boundary of the ionosphere. An individual event is called an *atmospheric.*

Note. — Lightning discharges are the main source of atmospheric noise. Atmospherics have been classified into various types according to their waveforms. One such classification of waveforms recorded with wideband low frequency receivers includes the following types :

Regular peaked types : result from the successive reflections between the earth and the ionosphere, and are sometimes known as echo-types. In whistler work they are known as tweets because they are audible, with suitable receivers, as very short whistlers of descending pitch.

Regular smooth types : are atmospherics in which, owing to the propagation conditions, there is a concentration of energy in a relatively narrow band of frequencies. Other terms, such as quasi-sinusoidal, are used for particular types of smooth atmospherics.

Long train types : are those of long duration, and may be peaked or smooth. They usually originate at great distances and are propagated with low attenuation. They occur only at night, many other types of atmospherics are recognised and then nomenclature requires standardisation .

B. — IONOSPHERIC NOISE.

Terrestrial noise originating within the ionosphere (1) and not associated with whistlers ; it is usually with magnetic disturbances. An individual event has sometimes been called an *ionospheric*. The following types of ionospheric noise are recognised :

1. *Hiss* : A relatively steady noise which has many of the characteristics of thermal-type noise. Usually the power spectrum of the noise is frequency-dependent, and it may change in shape and intensity (in periods of several seconds or more) with time.

2. *Discrete emissions* : Well-defined noises which may have a tonal quality and have durations of the order of a few tenths to several seconds or more. A definite and repeating frequency-time relation is often observed.

3. *Dawn Chorus* : A series of many discrete emissions, often overlapping, with time separations of less than one second. Often abbreviated simply as *chorus*.

C. — WHISTLERS.

Terrestrial noise which originates in electrical discharges below the ionosphere and which is propagated through the ionosphere along dispersive paths. It is usually characterized by one or more components, of the nature of gliding tones, which descend in frequency through the audible range in a period ranging from a fraction of a second to several seconds.

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(1) The term *Ionosphere* is understood to include the outer ionosphere as well as the regular layers.

The following whistler types are recognized :

1. *Nose* : Whistlers which have simultaneous rising and falling tones joined together in a continuous and smooth manner at the frequency of minimum time delay, called « nose frequency ». Normally this unique property can be defined only by spectrographic analysis. At frequencies near the nose frequency the energy behaves like an impulse ; i. e., the change of frequency with time becomes infinite at the nose frequency. The dispersion characteristics of the descending tone of the nose whistler are similar to those of whistlers which do not exhibit the nose.

2. *Multiple* : Two or more whistler components closely associated in time. Two types are recognized :

(*a*) Multi-path : Each component appears to originate in the same discharge.

(*b*) Multi-source : Each component appears to originate in a separate discharge.

3. *Short* : A whistler which has travelled once along its dispersive path ; often called « one-hop ».

4. *Long* : A whistler which has travelled twice along its dispersive path ; often called « two-hop ».

5. *Hybrid* : The combination of a long and a short whistler produced by a single discharge.

6. *Echo train* : A succession of whistlers resulting from repeated traverses of the original disturbances through the ionosphere. Usually the time delays of echoes of short whistlers are in the ratios 1:3:5:7 etc... while for long whistlers the ratios are 2:4:6:8 etc... Echoes of multi-path whistlers sometimes exhibit delays which are combinations of integral multiples of the basic one-hop delays.

D. — Interactions.

Composite noises which have the combined characteristics of whistlers and ionospheric noise. Interactions may be initated by lightning discharges and can involve either the continuous or discrete forms of ionospheric noise. They are often associated with magnetic disturbances.

Recommendation IV

Terrestrial Noise Terminology

Commission IV recommends that a Sub-Commission be set up to consider further standardization of the terminology used in describing radio noise phenomena.

Professor Helliwell and Dr. Horner have been invited to appoint the membership of this Sub-Committee in consultation of the Official Members of the Commission if needed.

Recommendation V

Commission IV recommends that consideration be given to the more extended use, for propagation studies, of the records being made of the amplitude and phase of standard frequency transmissions from highly stabilised transmitters. It is considered that such studies will be beneficial to both Commission IV, in providing data on the propagation medium, and Commission I in improving understanding of the causes of variation in received amplitude and phase. There should be collaboration in this work between those responsible for recording the transmissions and experts on VLF Propagation.

On the proposal of the Executive Committee the above recommendations were adopted by the General Assembly, Recommendation II was referred to the Board of Officers and Recommendation V to the Coordinating Committee.

Commission V. — On Radio Astronomy

Resolution I

Commission V on Radio Astronomy resolves that its terms of reference should be :

(1) The activities of the Commission shall be concerned with :

(*a*) Radio sources in space, particularly radio emission from the quiet and active sun, from the solar system, from the galaxy and from discrete sources in the Universe.

(*b*) The study of meteors, the sun, moon, planets and other objects in the solar system by the radio echo technique.

(2) The Commission shall study and promote the development of technical methods in relation to the above and shall endeavour to protect the observations from interference.

(3) In connection with (1) the Commission will aim :

(i) to work jointly with other Commissions of U.R.S.I. where there are common interests ;

(ii) to work jointly with Commission 40 of I.A.U. in convening symposia on Radio Astronomy ;

(iii) to cooperate with Commission 40 of I.A.U. on the choice of topics for discussion in order to prevent any undesirable overlapping.

(4) The Commission shall formulate appropriate recommendations to U.R.S.I. on any subjects in relation to the above for consideration by other U.R.S.I. Commissions and other international bodies.

Resolution II

Sub-Commission V*c* on the Basic Solar Index should continue with the following membership :

M. Waldmeier, *Chairman*,
J. Bartels,
A. Covington,
M. Nicolet,
S. F. Smerd,
J. F. Denisse,
C. M. Minnis,
H. Dodson-Prince,
R. N. Bracewell,
A. Maxwell,
R. Gonze, *Secretary*.

Resolution III

Sub-Commission V*e* on Frequency Allocation should continue to represent the views of Commission V on frequency allocation with the following membership :

J. W. Findlay, *Chairman*,
E. J. Blum,

V. Vitkevitch,
W. N. Christiansen,
T. Hatanaka,
R. Coutrez,
A. P. Mitra,
C. Seeger, *Secretary*.

Resolution IV

The Editor of the Proceedings of Commission V should be J. P. Hagen.

Resolution V

The representative of Commission V on the Inter-Union Committee on Solar-Terrestrial Relationships should be R. Coutrez.

Resolution VI

Commission V takes notice of a proposed space communication project which involves the injection of large numbers of resonant dipoles into an orbit around the earth. The Commission views with great concern the possible dangers to astronomical research, both radio and optical, of projects of this nature. Commission V requests that the U.R.S.I., in consultation with the I.A.U., should take urgent steps to ensure that such projects cannot endanger future astronomical research.

Resolution VII

Commission V of U.R.S.I., being aware of the need for a fast radio astronomy abstracting service, recommends the publication of a two-monthly index to the radio-astronomical literature, containing titles of all papers dealing with radio waves from outside the earth, together with very short abstracts indicating the type and general content of each paper. Such a bibliography, if published at short intervals, will usefully supplement a full abstracting service, which because of the large amount of work involved cannot appear within a short space of time.

Commission V is aware of the organisation set up by the Division of Radiophysics, C.S.I.R.O., Sydney, to provide such a fast abstracting service, and has seen the type of abstracts produced by this

Organisation. The Commission recommends that this Organisation under the auspices of U.R.S.I. and I.A.U. publish a two-monthly list of titles with short abstracts, in a form suitable for easy consultation. It recommends that the Secretary General of U.R.S.I. approach the General Secretary of I.A.U., to arrange a joint sponsorship of this publication, and that the publication be on a subscription basis.

Commission V recommends further that the full abstracting service of the Cornell bibliography be continued and brought up to date, and that the Cornell lists of titles be discontinued.

It recommends in addition that of each radio astronomical paper a 50-word abstract be sent by air to the C.S.I.R.O. Radiophysics Laboratory at the time the proofs of such a paper are received, for inclusion at the end of the bi-monthly lists; also, reprints of all papers should be sent by air to the above mentioned organisation.

Resolution VIII

Commission V considered with interest the proposal, made by the Chairman of Commission 40 of I.A.U., to prepare jointly in U.R.S.I. and I.A.U. a Catalogue of distinctive events in solar radio emission. Commission V recommends that the full support of U.R.S.I. be given to this proposal.

On the proposal of the Executive Committee, Resolutions 1 *to* 5 *were adopted by the General Assembly*; *resolutions* 1 *and* 4 *were referred to the Board of Officers.*

It was agreed that Resolutions 6, 7 *and* 8 *should be referred to the Board of Officers for adoption and further action.*

The Board agreed to resolutions 6 *and* 8 *and provisionally to Resolution* 7 *which should be referred to the Chairman of Commission V for a new working taking into account the present status of the existing abstracting services.*

Commission VI. — On Radio Waves and Circuits

On the proposal of the Executive Committee, Commission VI is authorized provisionally to elect three Vice-Chairmen. This Commission shall elect no secretary.

Commission VII. — On Radio Electronics

Resolution I

It is resolved that Commission VII can best promote the interests of scientific radio during the coming triennium by coordination with the pertinent Commissions those aspects of radio electronics which will :

(i) lead to better understanding of electromagnetic processes in the upper atmosphere and space,

(ii) lead to improved instrumentation for the study of these processes, and

(iii) stimulate laboratory investigations of phenomena related to those observed (or believed) to be effective in the upper atmosphere and outer space.

Resolution II

This Resolution was adopted by the General Assembly and referred to the Coordinating Committee. This Committee empowered the Chairman of Commission VII to take the necessary steps in agreement with the Secretary General of U.R.S.I. and in accordance with U.R.S.I. Rules for Scientific Meetings.

Commission VII recommends that U.R.S.I. should give its sponsorship to the Fourth International Congress on Microwave Tubes to be held in 1962.

NATIONAL COMMITTEES

Membership of the Canadian Committee

Dr. J. S. Marshall, *Chairman*, Department of Physics, McGill University, Montreal, Quebec.

Prof. G. A. Woonton, *Vice-President U.R.S.I.*, Chairman, Department of Physics, McGill University, Montreal, Quebec.

Dr. B. G. Ballard, *Vice-President* (Scientific), National Research Council, Ottawa, Ontario.

Prof. R. E. Burgess, Department of Physics, University of British Columbia, Vancouver, B. C.

Dr. J. H. Chapman, Defence Research Telecommunications Laboratory, Defence Research Board, Ottawa, Ontario.

Mr. A. E. Covington, Radio and Electrical Engineering Division, National Research Council, Ottawa, Ontario.

Dr. B. W. Currie, Physics Department, University of Saskatchewan, Saskatoon, Saskatchewan.

Dr. D. R. Hay, Department of Physics, University of Western Ontario, London, Ontario.

Dr. G. A. Harrower, Queen's University, Kingston, Ontario.

Dr. J. T. Henderson, Division of Applied Physics, National Research Council, Ottawa, Ontario.

Dr. J. L. Locke, Dominion Radio Astrophysical Observatory, White Lake, B. C.

Dr. P. M. Millman, Radio and Electrical Engineering Division, National Research Council, Ottawa, Ontario.

Dr. G. Sinclair, *Chairman Commission VI.3*, Department of Electrical Engineering, University of Toronto, Toronto, Ontario.

Dr. D. W. R. McKinley, *Secretary*, Radio and Electrical Engineering Division, National Research Council, Ottawa, Ontario.

Norway

MEMBERSHIP

President : Mr. F. Lied, Director, Norwegian Defence Research Establishment, Kjeller.

Secretary : Dr. B. Landmark, Norwegian Defence Research Establishment, Kjeller.

Members : Prof. L. Grönlie,
Mr. H. Dahl,
Mr. G. Eriksen,
Dr. L. Harang,
Mr. P. Mortensen,
Prof. Dr. S. Rosseland,
Mr. N. J. Söberg,
Dr. A. Tonning.

U. S. A.

NBS — BOULDER LABORATORIES

The *Sixth Summary Report of Boulder Laboratories*, for year ending June 30, 1960 has been issued by the National Bureau of Standards.

COMMISSIONS

Memberships of Canadian Commissions

Six National Commissions of U.R.S.I. have been established as follows :

Commission I : Radio Measurements and Standards.

Chairman : Dr. J. T. Henderson.

Members : J. H. Bradley,
S. M. Kalra,
K. A. Mackinnon,
C. F. Pattenson.

Commission II : Radio and Troposphere.

Chairman : Dr. J. S. Marshall.

Members : S. Bonneville,
R. W. Dobridge,
L. H. Doherty,
I. H. Gerks (1),
W. E. Gordon (1),
D. R. Hay (2),
R. C. Langille,
J. L. Marshall.

Commission III : Ionospheric Radio.

Chairman : Dr. J. H. Chapman (3).

Members : F. T. Davies,
P. A. Forsyth,
C. O. Hines,
A. G. McNamara,
P. M. Millman,
J. C. W. Scott.

(1) From U. S. A. National Committee. — (2) New Chairman of the Commission, 1960. — (3) Also responsible in lieu of a Commission IV.

Commission V : Radio Astronomy.

Chairman : Mr. A. E. Covington.

Members : G. A. Harrower (2),
T. R. Hartz,
D. A. MacRae,
P. M. Millman,
J. L. Locke.

Commission VI : Radio Waves and Circuits.

Chairman : Dr. George Sinclair.

Members : M. P. Bachynski,
M. S. Heaps,
G. A. Miller,
B. R. Myers,
J. Y. Wong,
J. L. Yen.

Commission VII : Radio Electronics.

Chairman : Prof. R. E. Burgess.

Members : G. W. Farnell,
P. A. Redhead,
J. R. Whitehead,
J. L. Yen.

Norwegian Official Members

Commission I : Mr. H. Dahl, Director of Research, Chr. Michelsens Institute, Bergen.

Commission II : Dr. B. Landmark, Norwegian Defence Research Establishment, Kjeller.

Commission III : Dr. L. Harang, Professor, Oslo University, Blindern.

Commission IV : Mr. N. J. Söberg, Director of Division, Board of Telegraphs, Oslo.

Commission V : Mr. G. Eriksen, Radio Astronomy Group, Institute for Theoretical Astrophysics, Blindern.

Commission VI : Prof. L. Grönlie, Norwegian Technical University, Trondheim.

Commission VII : Dr. A. Tonning, Norwegian Defence Research Establishment, Bergen.

SYMPOSIA

Symposium on Electromagnetic Theory and Antennas

Copenhagen, 25-30 June 1962

Preliminary Outline

A « Symposium on Electromagnetic Theory and Antennas » will be held at the Technical University of Denmark, Copenhagen, from Monday June 25th to Saturday June 30th 1962, both days inclusive. This will be a continuation of three previous symposia, namely the « Symposium on Microwave Optics » held at McGill University, Montreal, Canada in 1953, the « Symposium on Electromagnetic Wave Theory » held at University of Michigan, Ann Arbor, Michigan, U. S. A. in 1955, and the « Symposium on Electromagnetic Theory » held at Toronto University, Toronto, Canada in 1959. The symposium will be open to any interested person from any country.

The interest will be focused on a few subjects of paramount importance, but to a minor extent papers on other subjects in electromagnetic theory and antenna theory will also be accepted. The following subjects have been suggested :

Electromagnetic fields in anisotropic media (such as plasmas and ferrites),

Scattering in random media,

Quasi-static electromagnetic problems,

Theory of broad-banded antennas,

Dynamic antenna theory,

Pattern synthesis.

Most of the technical sessions will be opened with an invited, introductory paper and will then be followed by a series of shorter papers with interspaced discussions. It is expected that the U. S. S. R. delegation will undertake the complete arrangement of two of the technical sessions.

The papers should be given in either English or French. It is not planned to operate any simultaneous interpreting system at the conference. The papers should be presented only by the author (or by one of the authors) in person.

Those desiring to present a paper at the conference are requested to submit a three page summary (about 1000 words), to the Committee for the Technical Program. This also applies to the invited speakers. It is planned to issue these summaries as preprints and to mail them some weeks before the conference to those who have pre-registered.

It is planned to publish proceedings of the symposium containing a representative group of the papers presented at the symposium. Authors desiring to submit their paper for consideration for publication in the proceedings should give the manuscript to the chairman of the Editorial Board during the symposium or send it to him before a date to be announced later.

Pending the consent of all the institutions and the persons mentioned below, it is planned to organize the symposium in the following way :

Sponsors

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

The Technical University of Denmark,

The Academy of Technical Sciences in Denmark,

The Danish National Committee of U.R.S.I.

Organizing Committee

V. Fock, Academician, Academy of Sciences, Moscow, U. S. S. R.,

N. E. Holmblad, Det Store Nordiske Telegraf Selskab, Copenhagen, Denmark,

H. Lottrup Knudsen, The Technical University of Denmark, Copenhagen, Denmark, *Secretary*,

J. Oskar Nielsen, The Telephone Company of Copenhagen Inc., Copenhagen, Denmark,

Gunnar Pedersen, The Danish Post and Telegraph Office, Copenhagen, Denmark,

J. Rybner, The Technical University of Denmark, Copenhagen, Denmark, *President*,

K. M. Siegel, University of Michigan, Ann Arbor, Michigan, U. S. A.

Arrangements Committee

The members of this Committee will be appointed by the Danish National Committee.

Committee for the Technical program

Executive Committee

H. Lottrup Knudsen, The Technical University of Denmark, Copenhagen, Denmark, *Secretary*,

N. Marcuwitz, Microwave Research Institute of Brooklyn, Brooklyn, N. Y., U. S. A.,

S. Silver, University of California, Berkeley, California, U. S. A.,

G. Sinclair, University of Toronto, Toronto, Canada,

James R. Wait, The National Bureau of Standards, Boulder, Colorado, U. S. A., *Chairman*,

L. A. Veinstein, Institute for Physical Problems, Moscow, U. S. S. R.

Corresponding Members

G. Barzilai, Electrotechnical Institute, University of Rome, Rome, Italy,

K. Bochenek, Polish Academy of Science, Palac Kultury i Nauki, Varsovie, Poland,

P. Beckmann, Cand. Tech. Soc. Inst. of Radio Eng. and Electronics, Czechoslovak Academy of Sciences, Prague 8, Rude Armady 305, Praha 8, Czechoslovakia,

H. Bremmer, Philips Research Laboratories, Eindhoven, Netherlands,

J. Brown, Department of Electrical Engineering, University College, London, England,

G. Eckart, Institut für Angewandte Physik und Elektrotechnik der Universität des Saarlandes, Saarbrücken 15, Germany,

W. Franz, Institute of Applied Physics, Münster University, Münster, Schlossplatz, Germany,

Z. Godzinski, Institute of Technology, Wroclaw, Poland,

Morris Kline, Institute of Mathematical Sciences, New York University, New York, N. Y., U. S. A.,

A. A. Oliner, Microwave Research Institute, Polytechnic Institute of Brooklyn, 55 Johnson St., Brooklyn 1, New York, U. S. A.,

Julien W. Loeb, 42, rue Saint-Dominique, Paris, France,

P. Mattila, Finland Institute of Technology, Albertinkatu 40, Helsinki, Finland,

M. A. Miller, Radio-Physics Research Institute, 25 Ljadova Street, Gorky, U. S. S. R.,

K. Morita, Tokyo Institute of Technology, O-Okayama Meguroku, Tokyo, Japan.

O. E. H. Rydbeck, Institute of Electronics, Chalmers Institute of Technology, Gothenburg, Sweden,

J. A. Ortusi, Compagnie Générale de Télégraphie sans Fil, Paris, France,

C. L. Pekeris, Weizmann Institute, Rehovot, Israël,

K. M. Siegel, University of Michigan, Ann Arbor, Michigan, U. S. A.,

A. Tonning, Norwegian Defence Research Establishment, Bergen, Norway,

Francis J. Zucker, Electromagnetic Radiation Laboratory, Air Force Cambridge Research Center, Bedford, Massachusetts, U. S. A.

Editorial Board

K. TOMIYASU, General Electric Microwave Laboratory, Palo Alto, California, U. S. A.,

James R. WAIT, The National Bureau of Standards, Boulder, Colorado, U. S. A.

Copenhagen, 26 September, 1960.

H. Lottrup KNUDSEN,

Secretary.

INTERNATIONAL TELECOMMUNICATION UNION

The Final Acts of the Administrative Radio Conference

(GENEVA, 17 AUGUST TO 21 DECEMBER, 1959)

by A. HENRY

(Reprint from the *Journal U.I.T.*, nº 7, July 1960)

The Final Acts of this Conference comprise :

The Radio Regulations ;

The Additional Radio Regulations ;

An Additional Protocol ;

Resolutions and Recommendations.

Twelve years, no less, had elapsed since the previous Administrative Radio Conference in Atlantic City (1947). During that time, technical progress and the evolution of radio operating procedures had been such as to render a review of the Radio Regulations necessary.

I. — RADIO REGULATIONS

The Geneva Conference drew up a new set of Radio Regulations, with forty-five articles (in eleven chapters), and twenty-seven appendices. Clearly, there is no space here to analyse these Regulations in great detail. However, it may not be devoid of interest to examine certain articles and see what new ideas they embody.

ARTICLE 1. — *Terms and definitions.*

Radio engineering has been moving swiftly ahead, and it had become essential to define certain terms currently used by radio specialists. Article 1 gives the following new definitions :

Tropospheric scatter : The propagation of radio waves by scattering as a result of irregularities or discontinuities in the physical properties of the troposphere.

Ionospheric scatter : The propagation of radio waves by scattering as a result of irregularities or discontinuities in the ionization of the ionosphere.

Radiodetermination : The determination of position or the obtaining of information relating to position, by means of the propagation properties of radio waves.

Radionavigation : Radiodetermination used for the purposes of navigation, including obstruction warning.

Radiolocation : Radiodetermination used for purposes other than those of radionavigation.

Space service : A radiocommunication service between space stations.

Earth-space service : A radiocommunication service between earth stations and space stations.

Space station : A station in the earth-space service or the space service located on an object which is beyond, or intended to go beyond, the major portion of the earth's atmosphere and which is not intended for flight between points on the earth's surface.

Earth station : A station in the earth-space service located either on the earth's surface or on an object which is limited to flight between points on the earth's surface.

Radio astronomy : Astronomy based on the reception of radio waves of cosmic origin.

Assigned frequency : The centre of the frequency band assigned to a station.

Assigned frequency band : The frequency band the centre of which coincides with the frequency assigned to the station and the width of which equals the necessary bandwidth plus twice the absolute value of the frequency tolerance.

Necessary bandwidth : For a given class of emission, the minimum value of the occupied bandwidth sufficient to ensure the transmission of information at the rate and with the quality required for the system employed, under specified conditions. Emissions useful for the good functioning of the receiving equipment as, for example, the emission corresponding to the carrier of reduced carrier systems, shall be included in the necessary bandwidth.

Three new services have made their appearance :

the space service,
the earth-space service,
the radio astronomy service.

ARTICLE 44. — *Special services.*

The increase in the number of stations transmitting standard frequencies and time signals in the bands allocated for this purpose has given rise to certain difficulties and, in particular, harmful interference. To remove these difficulties, Section IV of this article lays down the following rules :

1623 To facilitate more efficient use of the radio frequency spectrum and to assist other technical and scientific activities, administrations should endeavour to provide, on a coordinated worldwide basis, a service of standard frequency and time signal transmissions. Attention should be given to the extension of this service to those areas of the world not adequately served.

1624 To this end, each administration shall take steps to coordinate with the assistance of the International Frequency Registration Board, any new standard in existing transmissions in the standard frequency bands. For this purpose, administrations shall exchange between themselves, and furnish to the Board, all relevant information. On this matter, the Board shall consult the Director of the International Radio Consultative Committee who shall also continue to seek the advice and cooperation of the International Time Bureau (B.I.H.), the International Scientific Radio Union (U.R.S.I.) and other international organizations having a direct and substantial interest in the subject.

1626 Administrations shall cooperate in reducing interference in the standard frequency bands in accordance with the recommendations of the International Radio Consultative Committee.

ARTICLE 45. — *Effective date of the Radio Regulations.*

This article says that the new Regulations will take effect on 1st May, 1961, on which date the Agreement reached by the

Extraordinary Administrative Radio Conference (Geneva, 1951) will be abrogated.

*
* *

The Geneva Radio Regulations comprise twenty-six appendices as well. These deal in detail with certain matters, which had they been treated in the body of the Regulations themselves, would have made the Regulations inordinately cumbersome.

Appendix 14. — *SINPO and SINPFEMO Codes.*

To assist in assessing the quality of transmissions, International Radio Consultative Committee Recommendation 251 gives two codes, SINPO and SINPFEMO, thanks to which a coded report can be made using the digits 1 to 5 in a scale for each of the following characteristics :

S Signal strength
I Interference
N Noise
P Propagation disturbance

F Frequency of fading
E Modulation quality
M Modulation depth

O Overall rating

The SINPO code is derived from the SINPFEMO code by dropping the characteristics F, E and M. The best mark that can be awarded is 5, the worst, 1.

IV. — Resolutions and Recommendations

The Administrative Radio Conference also adopted fifteen Resolutions and thirty-seven Recommendations.

The Resolutions deal with matters which could not properly be handled in the Regulations themselves because they are of passing interest, or future interest, only. They do, however, reflect formal decisions taken by the Conference.

RESOLUTION 6. — *Frequency terminology.*

This gives official sanction to the somewhat idiosyncratic frequency usage terminology to be employed in documents of the Union.

* * *

The Recommendations are addressed to the International Radio Consultative Committee, to the administrations of Union Members, to the United Nations specialized agencies and to international organizations. They give vent to ideas incompletely developed at the Conference, set problems for study, and prepare the way for decisions by future conferences.

RECOMMENDATIONS 1 TO 8.

These call on the International Radio Consultative Committee to pursue inquiries already under way, or to undertake fresh investigations into certain technical problems, such as

transmitter frequency tolerances,

the I.F.R.B's « technical standards »,

signal-to-noise ratios and minimum necessary field strengths,

propagation and radio noise,

international monitoring in the bands below 28 000 kc/s,

the technical characteristics of equipment,

the production of cheap radio receivers, and the classification of emissions.

RECOMMENDATION 32. — *The radio astronomy service.*

This service is now counted as a radio service, and certain bands have been allocated to it. Nevertheless, it is important that provision be made for the future of radio astronomy. This is the purpose of Recommendation 32, which indicates the kind of frequency which is useful for radio astronomical observations, and invites administrations to let the Secretary-General know where their national observatories are and what frequency bands are used therein. The Secretary General is to pass this information on to Union Members and Associate Members.

RECOMMENDATION 36. — *Convening of an Extraordinary Administrative Radio Conference to allocate frequency bands for space radiocommunication purposes.*

The Geneva « Table of Frequency Allocations » allocates a number of bands, for research purposes, to the « Space » and « Earth-Space » services. When the outcome of certain space research programmes is known, it should be possible accurately to define the bands of use for space communications. Recommendation 36 provides for the convening of an Extraordinary Administrative Radio Conference towards the end of 1963 to consider the problems involved. The Council, at its ordinary sessions in 1962 and 1963, is to consider whether the time is ripe for convening such a conference.

C. C. I. R.

Report of U.R.S.I. Committee on C.C.I.R. Work

1957-1959 *Progress.* — The responses to C.C.I.R. topics approved by the 1957 (Boulder) General Assembly were coordinated by the Committee and forwarded via the Secretary General to the C.C.I.R. These listed in Appendix were issued by the C.C.I.R. as documents for its 1959 (Los Angeles) Plenary Assembly and were utilized in the preparation of C.C.I.R. Recommendations and other pronouncements.

The U.R.S.I. delegation at the C.C.I.R. 1959 (Los Angeles) Plenary Assembly made special efforts to bring about the use of specific and purposeful language by the C.C.I.R. in referring matters to U.R.S.I. There had been uncertainty in what was desired of U.R.S.I. in some earlier C.C.I.R. pronouncements, which led in turn to some U.R.S.I. responses which were mere statements of approval or determinations to do work in a certain field.

There was not complete success in getting C.C.I.R. requests to U.R.S.I. in exact form giving clearcut statements of the information desired. There was however distinct advance, and most of the 15 topics referred to U.R.S.I. are unambiguous. They are listed in Appendix B. They are discussed in the Report of the U.R.S.I. Delegation published in *U.R.S.I. Information Bulletin* n° 115 (pp. 43-55), and their full texts are given in *U.R.S.I. Information Bulletins* 115 and 117. This Committee has been in touch with the several Commission chairmen in the starting of U.R.S.I. work on these topics, with view to material being ready for completion at the 1960 (London) General Assembly.

Radio Astronomy and Space Research. — The U.R.S.I. delegation was particularly active at the C.C.I.R. (Los Angeles) Plenary Assembly in the matters of radio astronomy (Recommendation 314) and space telecommunication (Recommendation 259, Report 115, Resolution 40, Resolution 47). Resolutions 40 and 47 asked the U.R.S.I. what effects the troposphere and the ionosphere, respectively, have on telecommunication with space vehicles. The C.C.I.R.

now has on its agenda no studies in radio astronomy and it is possible that it may do nothing further in that field. It will be active in space telecommunication; it in fact established a new Study Group to cover this field.

It was realized that actions vitally affecting these fields, particularly as regards frequency allocation, would be taken by the I.T.U. Administrative Radio Conference which was to meet in Geneva in August to December, 1959. Considerable effort was exerted to secure as strong C.C.I.R. recommendations as possible. The effort was successful and was followed up vigorously, before and during the I.T.U. Conference, by U.R.S.I. representatives, particularly the Secretary General and the President, Dr. van der Pol, Dr. J. W. Findlay (Chairman of U.R.S.I. Subcommission V*e*), and the Chairman of this Committee. In the representations to the I.T.U. we had the effective co-operation also of Officers of the I.A.U. and C.O.S.P.A.R.

The I.T.U. Geneva action was to provide limited frequency allocations in which radio astronomy and space research could be carried on, though not with full protection against interference. Great interest was aroused and the I.T.U. representatives of many countries learned of the needs in these fields of which they had been unaware. The U.R.S.I. representatives, on the other hand, learned that they must be active with the I.T.U. people in their own countries in order to lay the groundwork for more adequate protection of radio astronomy and space research in the future. Especially important is work with the national delegations to the I.T.U. Administrative Radio Conferences.

Clarification of C.C.I.R.-U.R.S.I. Relations. — The past twelve years have been marked by steadily increasing co-operation between C.C.I.R. and U.R.S.I. The experience thus accumulated has led to an understanding which it may be worth while to express.

In many of its studies the C.C.I.R. finds basic scientific aspects which are important to it but in which its mode of working is perhaps less suitable than that of U.R.S.I. Some of these are recognized as topics which are under examination or active research in U.R.S.I. At first these were relegated by C.C.I.R. to U.R.S.I. for study without careful consideration of the probability of useful response or indeed of what specific information from U.R.S.I. would be of actual use to the C.C.I.R. As time has gone on, the

C.C.I.R. requests to U.R.S.I. have become more precise, and it has consequently been possible to make the U.R.S.I. responses more valuable to the C.C.I.R. The U.R.S.I., in turn, has profited by securing a clearer view of the applicability of some of its research to the current needs of radio services.

The value of the C.C.I.R.-U.R.S.I. rapprochement was recognized by the Administrative Radio Conference of Geneva, 1959, in its Recommendation n° 4, which invited the C.C.I.R. to continue regular consultation with the U.R.S.I. and to seek the maximum possible degree of coordination. This Recommendation was implemented by the Director of the C.C.I.R. in a letter of June 22, 1960, to the Secretary General of the U.R.S.I., soliciting the continuation of U.R.S.I. interest and participation, and offering to furnish documentation as fully as would aid these aims.

The U.R.S.I., on the other hand, has been increasingly striving to disseminate, via its *Information Bulletin* and otherwise, information among its members on all C.C.I.R. topics of interest, and to stimulate action on suitable responses. It is believed that the U.R.S.I. is now fully aware of C.C.I.R. interests and needs, and is so organized as to provide appropriate aid to the C.C.I.R.

Further improvement in the character and amount of such aid to C.C.I.R. now depends principally upon increasing clarification of C.C.I.R. requests at their source, and increasing recognition of the nature of U.R.S.I. by the C.C.I.R. Study Groups. Many of the problems on which C.C.I.R. wants help in U.R.S.I.'s field are inherently such that no prompt answer can be given but research programs can be consciously oriented so as to reduce the number of years within which answers on specific aspects will be attained. Other problems, of more limited scope and definite character, can be given an exact and prompt answer by U.R.S.I. Members of U.R.S.I., working within the C.C.I.R. Study Groups, can facilitate the needed clarification. This will aid the U.R.S.I. in determining the kind of response it can make and also the effect the C.C.I.R. request should have on U.R.S.I. programs, and will thus aid the C.C.I.R. in securing the earliest, fullest, and clearest responses to its requests.

U.R.S.I. Responses to the 1959 *C.C.I.R. Requests.* — The respective Commissions prepared the responses attached hereto in Appendixes C, D, E, F, G. These were provisionally approved by the 1960 (London) General Assembly. It is recommended that this Report with all the Appendices be published in an early number of the *Information Bulletin* and comments be invited. These comments will be considered by the U.R.S.I. Committee on C.C.I.R. Work and the Secretary General advised before the responses are forwarded by him to the C.C.I.R.

APPENDIX A. — *Responses to C.C.I.R. Topics approved by U.R.S.I.* 1957 (*Boulder*) *General Assembly*

(Commission III). — « Ionospheric Sounding Stations after the I.G.Y. » (Re C.C.I.R. Resolution 26).

(Commission III). — « Identification of Precursors indicative of short-term variations of ionospheric propagation conditions » (Re C.C.I.R. Study Program 93).

(Commission IV). — « Characteristics of terrestrial radio noise determing radio interference » (Re C.C.I.R. Study Program 96).

(Commission V). — « Frequency protection for radio astronomy » (Re C.C.I.R. Recommendation 173).

(Commission VI). — « Communication theory » (Re C.C.I.R. Question 133, Study Program 86, Report 38).

(Commission VI). — « Measurement of field strength in the neighborhood of obstacles » (Re C.C.I.R. Question 137).

APPENDIX B. — *C.C.I.R.* 1959 (*Los Angeles*) *Topics on which U.R.S.I. Action is required*

(For Commission I). — Recommendation 319, « Standard-frequency transmissions and time signals ».

(For Commission I). — Report 166, third paragraph only, « The possibility of using different forms of time markers to indicate physical and astronomical time ».

(For Commission II). — Resolution 40, « Influence of the troposphere on frequencies used for telecommunication with and between space vehicles ».

(For Commission II). — Study Program 138, « Tropospheric-wave propagation ».

(For Commission II). — Report 48, « Temporal variations of ground-wave field strength » (Warsaw).

(For Commission III). — Resolution 44, « Choice of a basic index for ionospheric propagation ».

(For Commission III). — Resolution 45, « Identification of precursors indicative of short-term variations of ionospheric propagation conditions ».

(For Commission III). — Recommendation 313, « Exchange of information for the preparation of short-term forecasts and the transmission of ionospheric disturbance warnings ».

(For Commission III). — Resolution 43, « Radio propagation at frequencies below 1500 kc/s ».

(For Commission III). — Resolution 47, « Effects of the ionosphere on radio waves used for telecommunication with and between space vehicles beyond the lower ionosphere ».

(For Commission IV). — Resolution 46 « Measurement of atmospheric radio noise ».

(For Commission IV). — Resolution 42, « Whistler mode propagation ».

(For Commission VI). — Report 96, « Possibilities of reducing, interference and of measuring actual traffic spectra ».

(For Commission VI). — Question 175, « Usable sensitivity of radio receivers in the presence of quasi-impulsive interference » (Warsaw).

(For Commission VI). — Recommendation 165, « Communication theory ».

(For Commission IV). — Study Programme 86, « Communication Theory » (Warsaw).

Appendix C. — 1960 *Responses of U.R.S.I. Commission I*

The cooperation of U.R.S.I. to the I.T.U. and more particularly to the C.C.I.R. work, as regards standard frequency and time signal transmissions, has been specifically requested by article 44 of the Rules for Radiocommunications, paragraph 1624, and by C.C.I.R. Recommendation n° 319 (art. 17) and Report n° 166.

Besides some items of Recommendation n° 156 are relevant to problems for which U.R.S.I. can provide a contribution.

Discussions and actions of U.R.S.I. Commission I in London can be summarized as follows :

Response to C.C.I.R. Recommendation n° 319. — « Standard frequency transmissions and time signals ».

Item 9 of the Recommendation states « that transmitted frequencies should :

— correspond approximately to U.T.2 and differ from Ephemeris Time by as constant an amount as possible,

— remain constant throughout any one year to $\pm$ 5 parts in 10^9 ».

Various standard frequency stations, and particularly GBR, MSF, NBA, and WWV have followed this recommendations during 1959 and 1960 ; in the whole the results appear to be satisfactory. Still, the value of the quantity mentioned in *item* 9 was left to the choice of each operating service and its base of reference was not explicitely defined. In order to clarify and to unify the omitted values of the frequency, U.R.S.I. Commission I recommended that the choice of the quantity should be left to the Bureau International de l'Heure and that the reference time scale should be related to a conventional value of the caesium frequency. The text of this recommendation is the appended Resolution n° 1 which was adopted by the General Assembly of U.R.S.I.

Response to C.C.I.R. Report n° 166. — « Standard frequency transmission and time signals » :

The third paragraph of this Report reads as follows : « 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 U.R.S.I. ».

A paper submitted to Commission I has shown the benefit of very high quality signals for comparison of very precise standards. The DCF77 transmitter, of which the frequency is adjusted on Ephemeris Time, emits at some fixed times, modulated pulses delayed from this Time by two minutes. Pulse intervals in geometrical progression might be considered. The discussion has, however, shown that part of the delegates agreed to the present second pulse system in U.T.2. Time ; it was not found possible for the time being to draft a statement on the opportunity of using signals differentiating both times. Finally U.R.S.I. response to C.C.I.R. question has been concretized by the following statement :

« The matter is actively investigated and experiments are continued. No final advise can be drafted for the time being ».

Response to C.C.I.R. Recommendation n° 320. — « Standard frequency transmissions and time signals in additional frequency bands ».

Item 1 of this Recommendation suggested a special stability of the stations in Band 4. At the time being two stations, GBR, 16 kc/s, and NBA, 18 kc/s, have a frequency of sufficient stability to allow comparisons of standards and investigations on phase stability as mentioned in *item* 2 of Recommendation n° 320. Such studies are continuing in various countries by means of phase continuous recording. They were able to show that the possible accuracy in comparison of standards at great distances is of the order of 10^{-10}, or better, if the time intervals during which the mean values are computed are suitably selected. The diurnal phase variations due to propagation have been investigated ; a sufficiently regular difference is observed in the phase between nighttime and day-time ; major variations occur during sunrise and sunset periods.

A reduced power experimental station (WWVL) is now operating on the frequency of 20 kc/s allocated to the standard frequency service by the new Rules for Radiocommunications, according to *item* 2 of Recommendation n° 320.

Several stations operating in Band 5 have frequencies specially stabilized as recommended by *item* 5. Their emissions are regularly measured by various laboratories and used for phase stability investigations.

The importance of such transmissions for the time synchronization of scientific observations has been shown, particularly for spatial research.

Appended resolution n° 2, adopted by U.R.S.I. General Assembly stresses the above mentioned considerations and recommends the unification and coordination of measurements.

Response to C.C.I.R. Study Programme n° 156. — « Frequency spectrum conservation for high precision time signals ».

Commission I noted with satisfaction that the United Kingdom will start very soon experimental transmissions of special time signals in order to investigate the possibility of transmitting with the narrow band time signals of high accuracy, according to *item* 2 of Study Programme n° 156.

Resolution I

Since the beginning of 1960 several time and standard frequency transmitters emit a uniform time and a constant frequency. Emitted time and frequency are locked together. The frequency emitted is kept as constant as possible by means of atomic frequency standards. The nominal value of the frequency is chosen so that the time derived from it follows universal time UT2 approximately. Before the end of each year it is recommended that the Bureau International de l'Heure (B.I.H.), after having consulted the observatories and compared the astronomical observations of the observatories, should announce a nominal value for the frequency to be emitted during the following year. This value will be expressed in the time scale in which the frequency of the cesium has the value :

$$f(Cs) = 9\,192\,631\,770 \text{ c/s}$$

The suggested nominal value will not change during the year. It is recommended that the B.I.H. value of the frequency should be used by the institutions wishing to transmit uniform time and constant frequency without departing too far from UT2.

Resolution II

It is recommended by the U.R.S.I. that extensive efforts be made throughout the world using the entire year 1961 to continuously monitor the phase of standard frequency VLF and LF transmissions. Information on the phase stability from day to day of VLF and LF transmission paths is urgently needed in order to determine the usefulness of such paths for high precision time synchronization and frequency comparison purposes. Where highly stable atomic frequency standards are available care should be taken to make the phase measurements in terms of these standards as accurately as possible. Result for transmissions such as

GBR, NBA, MSF and DCF are of particular immediate interest because of the large areas over which signals from these sources can be obtained. In order to reduce uncertainties due to variations in the transmitted frequencies it is suggested that results be reported for 24 hour periods ending at 1500 UT for areas where sunrise or sunset effects are not serious at this time, as well as in more complete form if possible. Measurements on LF transmissions such as MSF, and DCF, as well as on VLF transmissions are needed in order to compare the day-to-day phase stability of LF and VLF transmission paths. It is requested that the results be sent to Mr. W. D. George at the Boulder Laboratories, National Bureau of Standards, Boulder, Colorado (U. S. A.) for distribution to all other laboratories contributing results and for analysis.

APPENDIX D. — 1960 *Responses from U.R.S.I. Commission II*

Response to C.C.I.R., Resolution n° 40. — « Influence of the Troposphere on Frequencies used for Telecommunications with and between Space Vehicles ».

1. The troposphere has two main effects on radio waves being transmitted through it. First there is attenuation which arises either from direct absorption by the atmospheric gases, oxygen and water vapour and to some extent in precipitation particles, particularly water droplets, or from scattering away from the forward direction of propagation by precipitation particles. It has recently been shown that in certain circumstances absorption can occur in carbon dioxide, but this is too small to be significant in tropospheric propagation. Lateral scattering may also be caused by spatial fluctuations of the refractive index of the air, but this again seems likely to be of no great importance in relation to the strength of the forward signal.

The second effect is that of variations in the direction of arrival (in both the vertical and horizontal planes) of radiation at the receiving point due to the fact that the troposphere is a refracting medium. In this case, there is an overall macroscopic effect to be considered, upon which is superimposed a much more variable effect depending upon fluctuations in the refractive index structure of the medium.

2. It is now well known that absorption phenomena of any importance are confined to wavelengths below about 6 cm (frequencies above about 5 Gc/s), and they have been extensively described in published literature (1, 2). Experimental data are available, and there is generally satisfactory agreement with theory except in the case of absorption by water vapour; it is unlikely, however, that this particular problem can be resolved by observations on transmissions from satellites, and it is primarily of academic interest.

The absorption occurring in the atmospheric gases, whilst significant for long transmission paths at centimetre and millimetre wavelengths, is relatively so small that the associated dispersion is not important at all radio frequencies likely to be of interest in space communications. The macroscopic refractive properties of the lower atmosphere may therefore be taken to be the same over this entire range of the spectrum. There is, however, a further feature associated with absorption in the atmosphere which is of importance in space communications for receiving aerials looking at low angles of elevation, and so involving long transmission paths through the troposphere. Noise radiation is an essential accompaniment of the absorption and sets a lower limit to the effective noise temperature of the receiving system (3). Clearly, neither this effect nor the absorption itself is important when the entire transmission path is well outside the earth's atmosphere.

3. Except for variations which are caused in certain meteorological situations, and are therefore time-dependent, and for random relatively small fluctuations, the refractive index decreases monotonically from its value at the surface (itself weather-dependent) to a value approaching unity at great heights in the troposphere. The ray bending caused by this overall variation of refractive index has been evaluated (4, 5), and in any given circumstances may be determined with considerable accuracy, at least for angles of elevation exceeding a few degrees. This general effect of tropospheric refraction is dominant at frequencies less than about 30 Mc/s. At increasingly higher frequencies, however, perturbations from the average gradient of refractive index assume greater and greater significance, and these are of particular importance for transmissions in directions near to the horizontal. It is still possible to evaluate bending effects if the refractive index-height

profile is known (6), but the problem becomes one of some complexity.

Since the water vapour content of the air is the major factor determining the variability of the refractive index for radio waves, it is the lower levels of the troposphere for which the most complete information is required. Here again it would appear that transmissions from satellites would not be particularly useful, and that adequate measurements might perhaps be made using aircraft or other means.

4. Since satellite orbits must inevitably be well outside the troposphere, the uses of transmissions from these vehicles for radio-meteorological research (which cannot be tackled in other ways) appear to be limited, as indicated in the remarks under section 1. However, if frequencies of the order of 1000 Mc/s and higher are used, so that ionospheric refraction effects are negligible, the opportunity could be taken to determine the effects of refraction for paths traversing the entire troposphere at all inclination between horizontal and vertical. With transmissions at the appropriate frequencies atmospheric attenuation measurements could also be made, though there may be little to add here to what is already known.

It is just possible that, with an accurately stabilized satellite, some indication of the fine structure of tropospheric refractive index fluctuations could be deducted from fluctuations in the amplitude of the received signal (at appropriately high frequencies — see above), but once again other methods of attacking the problem are likely to be more fruitful, certainly for regions below the tropopause.

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Response to C.C.I.R., Study Programme n° 138. — « Tropospheric Wave Propagation ».

Much work has been carried out in a number of countries on the correlation between radio field strength measurements and various characteristics of the refractive index of the troposphere, particularly for propagation beyond the horizon. Defining the refractivity N, as $(n - 1)10^6$, where n is the refractive index, correlations have been sought between the field strength and N_s, N_o and ΔN, where N_s and N_o are respectively the values of N at the surface of the ground and the corresponding quantity reduced to the value appropriate to sea level, and ΔN is the difference between the values of N at ground level and at a height of 1000 metres above the ground. These investigations have met with partial success, the various correlations being much greater in some climatic conditions than in others. It seems clear that the validity of the arguments prompting attempts to derive such correlations should be examined more closely, and so to see if the physics of the problem do not suggest better tropospheric parameters with which to seek a relationship. One proposal, which merits further consideration, has already been made ; namely that the usefulness of an « equivalent gradient » should be examined (1). This is defined as the constant refractive index gradient between two heights in the atmosphere which would give the same total ray bending as that actually occurring on a tranmission path between terminals at these two heights. It will be observed that this is in fact a combined feature of the atmosphere and the radio path under examination ; thus, under the same climatic conditions, the equivalent gradient would be smaller for a long trans-horizon path than for a short one, since in the former case higher levels of the atmosphere will influence the transmission than in the latter, and the actual refractive index gradient will in general decrease with height.

Whilst, therefore, it is obvious that wave propagation characteristics are related to variations of refractive index in the lower atmosphere, further work is required to establish the most suitable parameters for comparison. It may be that any single quantity such as N_s or N_o, or one involving the averaging of the tropospheric properties, such as ΔN, could be unsatisfactory if the dominant feature influencing propagation is, for example, a marked elevated inversion layer, and in any circumstances where superrefractive phenomena in general occur. In this connection it should be pointed out that measurements of refractive index must be made at finer intervals than 10-metre spacing (see Study Programme nº 138, Annex 1), not only because it now appears that much sharper refractive index changes occur than was at one time considered likely, but because this fine detail is required in comparisons of the relevance of the various theories of scatter propagation.

A number of countries are now actively pursuing atmospheric refractive index measurements by means of airborne microwave refractometers; and further developments are under investigation with light-weight versions suitable for balloon carriers, and also expendable types. It is by continuing improvements of this nature in the refractometer field that the required detailed information about the refractive properties of the troposphere is most likely to be obtained. In the foreseeable future (as at present), radiosonde observations can only be expected to provide a somewhat crude overall picture of the lower atmosphere from the radio point of view. On this point it may be added that, at least for the time being, it appears that the most satisfactory way of determining rapid humidity variations is by deduction from simultaneous measurements of refractive index and temperature.

Many studies have been made in recent years of temporal and spacial variations of radio fields over a wide range of frequencies, particularly at points beyond the horizon, though some observations have also been made at shorter distances. Whilst it is steadily becoming clearer to U.R.S.I. what factors are limiting progress towards a more complete understanding of tropospheric wave propagation, and therefore in what directions further studies should be pursued, it should be emphasised that much information of practical use is already available to C.C.I.R. in scientific and technical literature. It is true that some of this information is of an empirical nature, rather than being based on a rigorous theoretical understanding of the propagation phenomena, but if it is properly applied it is nevertheless of great value. Members of U.R.S.I. Commission II have been encouraged to ensure that all the data available relating to *items* 1 to 6 of C.C.I.R. Study Programme nº 138 are communicated to their appropriate C.C.I.R. Administrations, together with an indication of the extent to which they are considered truly representative of given climatic and geographic conditions.

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Response to C.C.I.R. Report nº 46. — « Temporal Variations of Ground-Wave Field Strength ».

There having been little research recently by members of the U.R.S.I. on the subject of the above Report, it is not possible at present to communicate to the C.C.I.R. any helpful results relating thereto. It is hoped, however, that a contribution may be available from the U.R.S.I. before the next meeting of Study Group V of the C.C.I.R.

Appendix E. — 1960 *Responses from U.R.S.I. Commission III*

Response to C.C.I.R. Resolution nº 44. — « Choice of a Basic Index for Ionospheric Propagation ».

The subject of ionospheric indices of solar activity is one which has been considered in recent years by a number of bodies including the Mixed Commission on the Ionosphere (M.C.I.), the U.R.S.I.-A.G.I. Committee and Commission III of U.R.S.I. At the XIIth General Assembly in 1957 Commission III received a proposal from the M.C.I. for the development of an ionospheric index (or indices) of solar activity and appointed a Sub-Commission (III*e*) to consider the question. The Report of this Sub-Commission will be submitted to U.R.S.I. at the forthcoming London Assembly. In 1958 the U.R.S.I.-A.G.I. Committee proposed that two ionospheric indices, one for region E and one for region F, should be calculated for each day of the International Geophysical Year. This has been done and the indices are being included in the Calendar Record in the *I.G.Y. Annals*. A detailed discussion of indices required for forecasting ionospheric conditions has been published by Minnis and Bazzard (1959) together with monthly mean values on an E and an F2 layer index for the period 1938-1957.

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Response to C.C.I.R. Resolution n° 45. — « Identification of Precursors Indicative of Short-term Variations of Ionospheric Propagation Conditions ».

During and since the I.G.Y. there have been several advances in successful forecasting of the sudden commencement geomagnetic storms and associated ionospheric propagation disturbances prevalent during sunspot maximum epoch. Some of these have occurred or been recognized since C.C.I.R. Report n° 153 (1) was prepared.

Instead of relying solely on the occurrence of a solar flare of optical importance 3 or 3^+ to predict a storm within two to three days of the flare (2), for instance, the probability of having made a successful forecast of disturbance can be increased if the type of solar radio emission accompanying the solar flare is taken into account. First a strong geomagnetic relationship was demonstrated by H. W. Dodson two to three days after major solar outbursts at 200 Mc/s which occurred before flare maximum and were followed by « a second part » (3). This was confirmed by K. Sinno (4) who showed that the greater the second part, the greater the ensuing magnetic disturbance. C. S. Warwick also confirmed this geomagnetic result using 18 Mc/s solar bursts which preceded S.N.C.A. maxima (5).

It has also been demonstrated that the central meridian passage of « radio noisy » regions at 169 Mc/s can be associated with following geomagnetic disturbance (6). These regions are identified by interferometric recording.

Several studies have been made to establish the type of solar spectral radio emission to be associated with geomagnetic disturbance. One to two days after type II, slow drift bursts, there is an appreciable probability of geomagnetic disturbance, especially if the type II occurs early in relation to the optical flare (6). Stronger probability of disturbance is associated with the occurrence of type IV continuum. This is the Continuum at times associated with type II bursts, but first recognized by Boischot on his 169 Mc/s records.

All the above solar-geomagnetic relationships are enhanced if a polar cap absorption event is observed within six hours of the large optical flare accompanied by major radio outbursts of type IV. These are the absorption events recognized by D. K. Bailey (8) on VHF scatter circuits in the Greenland area and by G. C. Reid and H. Leinbach (9) on the riometers in northern latitudes. The occurrence of polar cap absorption events is strongly related to the presence on the sun of a region of enhanced radio emission at metric (or longer) wavelengths (10). These events are probably the most reliable terrestrial precursors yet recognized of important disturbances to ionospheric radio propagation and lead the disturbance by 18 or more hours. A valuable review and bibliography is given by T. Obayashi and Y. Hakura (11).

Turning to another type of early identifier or possible precursor there is the field of ultrasonics. Travelling atmospheric pressure waves with periods from 20 to 60 seconds and pressure amplitude from about 1 to 8 dynes/cm^2 have been recorded at a microphone station located at Washington, D. C., during intervals of high geomagnetic activity by P. Chrzanowski and others of the National Bureau of Standards (12). There is evidence that the origin of the disturbance can be localized by ultrasonic direction finding.

Finally the preliminary results from the experiments in the space probe Pioneer V (10, 11) indicate that « real » time reporting of observations of space experiments could indicate the presence of solar particle streams and magnetic disturbances before these streams or disturbances reach the earth. P. Rothwell and C. E. McIlwain (15) and R. Arnoldy, R. Hoffman and J. R. Winckler (16) have written on satellite observations during magnetic storms.

Thus, progress has been made in the short-term forecasting of sudden commencement geomagnetic storms and the related radio propagation disturbances. The need is apparent for continuation of rapid interchange of observations from 24 hour patrol of the sun, both optical and radio-noise, which was begun during the I.G.Y. The distribution system established during the I.G.Y. is continuing to this day, but storing support should be given to ensure that the patrol observations are made and that they are promptly interchanged.

In the next few years more research should be concentrated on discovering the reasons for 27 day recurrence patterns of geomagnetic activity that appear during the declining phase of the solar cycle. At present, the main forecasting tool is, once a recurrent pattern is established, forecasting for repetition of geomagnetic and ionospheric conditions after an interval of 27 days.

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Response to C.C.I.R. Resolution nº 43. — « Radio Propagation at Frequencies below 1500 kc/s ».

Most of the information on the questions in C.C.I.R. Resolution nº 43 is now available in published literature. In recent years, effort has been concentrated on the VLF and, to a lesser extent on the LF ranges. A short survey and extensive bibliography on VLF propagation is available (1), covering both theoretical and experimental aspects. A useful survey of the conditions in the lower ionosphere governing the propagation of medium, low and very-low frequencies has been published (2). Propagation curves for the VLF range prepared by Wait (3) will be found useful in practical problems.

To obtain data for medium frequencies it is necessary to refer back to older papers. A review published a few years ago (4) will be of some assistance.

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Response to C.C.I.R. Resolution nº 47. — « Effects of the Ionosphere on Radio Waves used for Telecommunication with and between Space Vehicles beyond the Lower Ionosphere ».

In recent years considerable studies have been made on the influence of the ionosphere on radio signals from artificial earth satellites. The especial significance of such investigations is that they can yield precise information on the physical properties of the ionosphere above the F2-layer peak. Hitherto our knowledge of the atmosphere at these levels has been limited to that deduced from studies of moon-echo signals, of emissions from radio stars and from investigations of whistler type atmospherics. Studies of the magnetic rotation of the plane of polarization of the Doppler frequency shift and of the refraction of the radio signal have all been used to study the integrated electron content up to the level of the satellite. A representative selection of literature on the subject is appended below.

As far as ionospheric studies are concerned, the most useful frequencies of transmission from a satellite to the ground are those which are low enough to be appreciably affected by the ionosphere and yet sufficiently high to be transmitted through the ionosphere. The optimum values will thus vary with time of day, season, sunspot cycle, etc., just as ionospheric conditions vary with these factors. They will also depend on the location of the satellite relative to the observer. For satellite ionospheric experiments in which signals may be radiated from, and received back again, at the satellite after reflection at the top-side of the ionosphere, the information then being telemetered back to ground at a very high radio frequency, the range of useful frequencies will be similar to that used for conventional ground based sounding, i. e. from some tens of kilocycles to about thirty Megacycles. In general, then, the useful band of frequencies for satellite studies of the ionosphere is largely the same as that used for ground based vertical and oblique incidence studies, except that for direct satellite-ground transmission experiments frequencies a few megacycles above the maximum values normally used in oblique incidence work are required.

It is to be noted that the question of allocating frequencies for space research was recently considered at the I.T.U. meeting in Geneva and a preliminary allocation of frequencies near the Standard Frequency Transmission bands was made.

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Response to Recommendation n° 313.

This Recommendation has been referred to the Central Committee on Ursigrams.

APPENDIX F. — 1960 *Responses from U.R.S.I. Commission IV*

Response to C.C.I.R. Resolution n° 46. — « Measurement of Atmospheric Radio Noise ».

The characteristics of atmospherics from individual lightning discharges, and the distribution and frequency of occurrence of these discharges are under continual study.

The noise power radiated by discharges has been measured, and theoretical estimates have also been made. In the measurements the derived values of radiated noise power have depended on assumptions regarding the orientation of the discharge channels, and while this will vary considerably from one discharge to another, the results may be expected to be statistically representative of average conditions. The findings also depend on an accurate estimate of the location of the discharges under observation, and greater attention has been paid to this requirement in the more recent experiments.

As a result of this work there is now considerable information on the noise power radiated by discharges in the VLF range, and some at high frequencies. Data for other frequencies must at present be deduced by interpolation and extrapolation. A review (1) summarising existing data has been prepared for the U.R.S.I. 1960 General Assembly.

Data on the frequency of occurrence of lightning discharges are available in some areas from various types of observation involving, for example, the use of flash counters or direction finders, or the statistical analysis of breakdowns on power lines. Although several investigations have led to results in rough mutual agreement, the data cannot yet be regarded as sufficiently accurate or of wide enough geographical coverage to be used as a basis for estimating noise levels, particularly in view of uncertainties regarding the proportion of discharges which strike the ground in different parts of the world. Investigations designed to provide more accurate information are in progress, the expected variations in received noise basing studied in relation to time, frequency, location and aerial directivity, making use of existing knowledge of thunder storm and radio propagation.

Response to C.C.I.R. Resolution n° 42. — « Whistler Mode Propagation ».

Although gratifying progress has been made in the study of whistler-mode propagation, it is not yet possible to predict the field strength with any certainty. The reason is that the factors which control the location and efficiency of the whistler paths, or « ducts », through the ionosphere are not yet understood.

For the case with both transmitter and receiver on the earth's surface a number of characteristics are known, including the following. The whistler-mode is effective at frequencies at least as low as 400 c/s and as high as 35,000 c/s. It has been observed at most observing locations between latitudes of 24° and 80° geomagnetic. A well-defined upper cut-off frequency is often observed and appears to depend on the latitude of the path of propagation. This cut-off frequency is approximately 0,6 of the minimum gyro-frequency along the path. Middle-latitude observations of signals from a high power VLF station (NSS, 15,5 kc/s) show that a one-

(1) F. Horner : « Sources of Atmospheric Noise in Lightning. A Review of Information on Atmospherics from Near Lightning Discharges », U.R.S.I., Document AG60/IV/11.

hop whistler-mode signal is present over half the time at night. On occasion its strength approaches to within 10 db of the conventional waveguide signal. Similar observations have been made in New Zealand on NPM and in Australia on NDT. Two-hop whistler-mode signals have been detected at several locations on the East Coast of the U. S. A. and Canada from NSS and on the West Coast from NPG. In Great Britain some evidence of two-hop whistler-mode transmission was found in observations of GBR. In general, two-hop transmission is relatively infrequent at frequencies above 15 kc/s, and the field strengths are considerably lower than for one-hop. Little is known about the intensity of daytime whistler-mode signals, but it appears that they are attenuated severely in the D-region.

Several factors appear to be important in the calculation of field strength. These include : 1) radiator polarization and directivity ; 2) properties of the waveguide between the end points of the duct and the transmitter or receiver ; 3) coefficient of transmission across the lower regions of the ionosphere ; 4) spatial divergence in the duct ; 5) multi-path effects resulting from the presence of more than one duct, and 6) possible amplification, or absorption, of signal energy through interaction with charged particles in the plasma.

In the case of one terminal located within the ionosphere, consideration must be given to the behaviour of the antenna in a highly anisotropic dielectric medium. Little information is yet available on this problem. Rocket or satellite experiments may be required to answer this question.

It is perhaps worth noting that future progress in whistler-mode studies will depend on the extent of which existing high power VLF transmitters can be made available for the transmission of test signals.

Appendix G. — 1960 *Responses from U.R.S.I. Commission VI*

Response to C.C.I.R. Study Programme nº 86. — « Communication Theory ».

Methods of communication theory best suited for practical application. — Theoretical analysis of time-varying channels indicates that, in general, channel capacity can be increased by making use of the knowledge of short-time variations of channel characteristics. Such information can be utilized on the transmitting end or the receiving end, or both, by adjusting the characteristics of encoders and/or decoders as a function of instantaneous or short-time-averaged channel parameters. An interesting example of a communication system in which this idea is employed is the Rake system, developed at M. I. T. Lincoln Laboratory and reported on at the U.R.S.I. meeting at Boulder (1957). It combats multipath propagation problems. Such systems appear to be of considerable potential importance and deserve further study on both theoretical and practical levels.

Other schemes which involve coding information in large units, many characters in length, and using error-correcting codes have been developed to a stage where their use should be seriously considered for digital data transmission systems in which the terminal equipment is already expensive, such as long-distance scatter systems.

New results pertaining to Report n° 110 *and Question n*° 133. — Since the writing of Report n° 110 new results on probability of error have been derived by Shannon. Blackwell found exponential bounds for the error rate in probabilistic channels with memory. Following Slepian, error-correcting block-codes have been investigated extensively, e. g., by Peterson and Fontaine. Dobrushin wrote an interesting paper on the transmission of information over channels with feedback. More references to relevant new work can be found in the National Committee Reports.

New results pertaining to Report n° 96. — Attention is drawn to a paper by Pollack and Landau, including new results bearing both on the uncertainty principle and on approximate sampling theorems — i. e., theorems concerning functions which include all but a fraction δ_1, of their energy in a time interval of duration T, and all but a fraction δ_2 of their energy in bandwidth W.

In general, a more precise mathematical formulation of the questions to which Report n° 96 refers, would greatly help their solution.

Co-ordination of time and frequency transmissions

(Extract from the *Journal of the I.E.E.*, Vol. 6, nº 65, page 268, May 1960)

Early in 1960, co-ordination of the time and frequency transmissions of the United Kingdom and the United States was begun, and it is expected that by the end of the year the time signals from participating stations will be emitted in synchronism to a millisecond. The new co-ordinated service will be of great value in radiocommunication, geodesy and the tracking of artificial satellites.

United Kingdom participants in the project are the Royal Greenwich Observatory, the National Physical Laboratory and the Post Office Engineering Department; in the United States the U. S. Naval Observatory, the Naval Research Laboratory and the National Bureau of Standards are concerned. The transmitting stations are : GBR (Rugby), MSF (Rugby), WWV (Beltsville, Maryland), NBA (Canal Zone) and WWVH (Hawaii).

The carrier frequencies of the MSF and GBR transmitters are controlled by the same ring crystal oscillator and calibrated to an accuracy of 2 parts in 10^{10} by the N.P.L. caesium standard. The master oscillator also controls the time-signal dots of GBR and its associated short-wave transmitters. The master oscillators of the United States services will be adjusted to the same common standard agreed between the two observatories, and will be calibrated in terms of American caesium standards which are compared by radio with that of the N.P.L.

Time signals must be adjusted to give the standard of time commonly employed — G.M.T. — which is equivalent to the astronomical time U.T.2. However, since U.T.2 is subject to small unpredictable changes, measures of standard frequencies in terms of it will also vary. Towards the end of each year, therefore, the two observatories will assess the frequencies of U. S. and U. K. caesium standards, in terms of the current value of U.T.2 as fixed by astronomical observations, and use these to control transmitter frequencies and the « rate » of time signals. Time signals will require adjustment perhaps twice a year.

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