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BULLETIN HORAIRE

OF THE

BUREAU INTERNATIONAL DE L'HEURE (B.I.H.)

International Commission of Time (31)

at the Ninth General Assembly of the I.A.U.

in Dublin

(according to notes taken during the session)

A. The first meeting of the International Commission of Time was held on September 1, 1955, at 9 am, under the chairmanship of Sir Harold Spencer Jones, assisted by Mr. H. Smith, Secretary.

1. Report of the Director of the Bureau International de l'Heure.

M. Danjon, director of the B.I.H., read the report on the activity of the B.I.H.

The period of 1952-1954 marked a very important progress in the activity of the B.I.H. compared with the previous period. The number of time signals received increased by 43 % on average and that of astronomical observations by 26 %, as can be seen from the table below :

Year	*1949*	*1950*	*1951*	*1952*	*1953*	*1954*
Rec. sig.	14592	18802	23061	24893	27121	28553
Astr. obs.	404	470	500	458	595	672

Compared with the period 1946-1948 the number of receptions of time signals, and that of astronomical observations has more than doubled.

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Address all communications to the Director of the Bureau International de l'Heure, *Avenue de l'Observatoire*, n° 61, Paris (XIV^{e})

The Bulletin Horaire has appeared regularly. It gave the Semi-definitive Times of all the broadcasts received by the B.I.H. It also published the Final Times of 1950 from 21 observatories, in 1951 from 24 observatories, in 1952 from 24 observatories, of 1953 and 1954 from 27 observatories.

The calculation of the Definitive Time for the first part of 1954 required the use of 514 daily receptions. The Definitive Time is published for 259 daily broadcasts and, in addition, the daily corrections for 27 observatories, which requires considerable work. As can be seen, the number of time signals to be used increases continuously and their reduction to a homogeneous system remains essential.

Since 1953 January 1 the B.I.H. controls seven times a day (instead of 4) automatic or English hourly time signals followed by scientific (rhythmic) time signals at different wavelengths.

The reception of these signals and the external signals is done on Belin chronographs with large cylinder (1 second = 500 mm).

The constant pressure and temperature pendulums and the quartz and diapason clocks are constantly compared with the quartz clocks of the National Radioelectric Laboratory (L.N.R.) in Bagneux on a Belin chronograph.

The astronomical observations were made regularly using two transit instruments (Gautier no. 381 and Bouty) and an impersonal astrolabe of Mr. A. Danjon.

During the period under review the B.I.H. has studied the precision of timepieces (pendulums and quartz clocks), the propagation of radio waves, the accuracy of hourly services, experimental errors, earthquakes, global longitudes, fluctuations in the rotation of the Earth.

During the same period, the following apparatus came into service :

1st An apparatus making it possible to have at the output the frequency 1000 c/s which is the mean of the frequencies of three quartz clocks (Decaux, L.N.R.) ;

2nd Three quartz clocks (Belin);

3rd A new time signal transmitter (Belin) :

4th A synchronous clock with multiple contacts, for the synchronization of chronographs (Belin) :

5th An amplifier for recording the contact of the Shortt pendulum (Bernier);

6th An amplifier for the synchronous clock contacts 61 : 60 et 60 : 60 (Bernier).

All these devices belong to l'Observatoire de Paris.

2. Definition of the unit of time.

The Chairman invited the Commission to discuss the question of the definition of the Unit of Time, taking into account the decision of the International General Conference on Weights and Measures at its meeting in 1954 September :

“ *The second is the fraction 1 : 31 556 925.975 of the tropical year at 1900.0”.*

and invites Mr. Danjon to take the floor.

Mr. Danjon remarks that the official definition of the unit of time which is still in force according to the International Conference of Weights and Measures is as follows : “ *The second is 1 : 86 400 of the mean solar day*’’. The year of the mean solar day to which this definition refers is not indicated. The mean solar day has no invariable physical existence. Its variations can be of the order of 10^{-7}.

For astronomers, the definition of time as a function of the mean longitude of the Sun according to Newcomb is sufficient :

$$L = L_o + 129\,602\,768''.13\,T + 1''.089\,T^2,$$

T being the number of Julian centuries of 36 525 days, counted from 1900 January 1 at noon U.T. But this is not the case for metrologists and physicists.

The Conference on the Fundamental Constants of Astronomy, meeting in Paris in 1950, recommended that "in all cases where it is judged that the variability of the second of mean solar time opposes its use as a unit of time, the sidereal year for 1900.0 is adopted as a unit of time ".

This definition was taken on the proposal of Sir Harold Spencer Jones and Mr. G. Clemence, on the basis of the idea that the duration of the sidereal year is almost invariable. But the definition of the unit of time which relates most to the mean longitude of the Sun is the tropical year and not the sidereal year. The tropical year is equal to the inverse of the coefficient of *T* in the formula of the mean longitude of the Sun, according to Newcomb, multiplied by a constant (number of mean days in the Julian century × number of arc seconds in the circumference).

The General Assembly of Rome of the I.A.U. in 1952 adopted the resolution of the Conference on the fundamental constants of the Paris Astronomy. This resolution should be forwarded to the International General Conference on Weights and Measures of 1954. In preparing the drafting of the proposal for this Conference, G. Clemence, A. Danjon and Sir Harold Spencer Jones noted that it would be preferable to replace the sidereal year by the tropical year in the Rome proposal.

In transmitting the proposal concerning the new definition of the unit of time to the International General Conference of Weights and Measures, the change made in the Rome Resolution was indicated. The General Conference of Weights and Measures adopted the decision transmitted under the condition that the I.A.U. accepts this change at its General Assembly in Dublin. For the members of the Commission, it was a matter of adopting an amendment to the resolution of the General Assembly of Rome.

Mr. Barrell found that the definition proposed was perfectly satisfactory, but using that definition the comparison with the standard-second was not accessible. Mr. L. Essen defines the second with an accuracy of 10^{-9} by comparing atomic standards. For physicists and electricians the definition based on the duration of a physical phenomenon is preferable.

Mr. Danjon noted that we must accept the proposed definition. We will have, on the contrary, as the old legal definition of the second time: "the second is 1: 86 400 part of the mean solar day". This definition determines the second only to 10^{-7}.

Already, for 50 years, the meter has been defined as a function of the wavelength of a certain radiation, but this substitution has not yet been made. Thus, the unit of time must be precisely defined at present, and only afterwards can one speak of the physical standard of time and of its determination.

The Chairman: It is in the interest of physicists to move from the second defined as part of the mean day to the second defined as being a part of the tropical year at 1900,0. For the new definition a memorandum will be added for the physicists explaining how one can move from this definition of the second to the physical second.

Are there any comments to make on this definition ?

Mr. Sadler asked if the number 31 556 925.975 is exact.

Mr. Danjon responded that the number is not entirely exact. The exact value is 31 556 925.974 74.

Mr. Clemence remarked that the Commission had to choose between the two definitions of the second: 1st the second is 1 : 86 400 part of the mean day. It is a variable value, but accessible with measurements; 2nd The second is a fraction of the tropical year. The definition is precise, but difficult to access with measurements.

Mr. Markowitz asked what value would be taken to define the second as a function of the tropical year.

Mr Danjon replied that the approximate definition was sufficient. The error is only $0^s.026$ per century. Physicists will provide the physical definition of the second within 100 years.

The Chairman: It is certain that the definition of the second proposed is not directly accessible to physicists. A subcommittee should be appointed to draft instructions to facilitate the work of physicists using the new definition of the second of mean time.

The sub-committee is composed as follows: Mr. Danjon (Chairman), Brouwer, Clemence, Essen, Markowitz and Subbotin.

Mr. Danjon adds that the International General Conference of Weights and Measures summarized in Paris in 1954 and composed of 70 physicists was fully relevant to astronomers for the definition of the second time.

Mr. Essen gave a communication on a cesium atomic time standard, the frequency of which was 9 192 631 830 c/s. It operates at the National Physical Laboratory in Teddington.

Mr. Clemence: There is a fundamental problem: are the astronomical and physical time scales of the same nature ? This requires long-term experience.

Mr. Danjon: The work of physicists is excellent. Astronomers must follow their example to improve the quality of astronomical observations. Mr. Essen writes for the number of oscillations of the atomic beam of cesium 10 digits. If the measurements were made in another laboratory, it is possible the last three digits could be found different.

The Chairman added that at Columbia University there were two cesium-frequency standards, but that these standards had not yet been compared with the astronomical standard. The mutual precision of these two cesium standards is 10^{-10}. We are currently working in different laboratories with cesium standards. Thanks to these standards, it will be possible to determine the irregularity of the rotation of the Earth.

In a letter to *Nature*, Sir Edward Bullard writes that it is possible that the precision of atomic standards may be very great, but it is not known whether there will be an agreement between the atomic and astronomical standards. It is possible that there is here a function due to the age of the Universe (T). This requires lengthy experiments.

3. International Operation of Longitude

The Chairman noted that between this meeting in Dublin and the Moscow meeting in 1958 there would be a new international operation of longitude. Many of the members here will participate in this work. He asks Mr. Danjon when his impersonal astrolabe will be ready.

The Optical and Precision Society of Levallois (O.P.L.) was asked to construct a series of astrolabes. The study of the instrument was long. At present, some parts of the astrolabe O.P.L. are machined. We will have the first copy at l'Observatoire de Paris before the end of November. O.P.L. is committed to supplying 10 to 15 astrolabes for the month of October 1956. The price of the apparatus is not known exactly: about 5 000 000 francs. (the price does not include chronographic equipment). It is desirable that observatories wishing to buy astrolabes should contact O.P.L. directly to conclude the contract.

The Chairman added that in Rome, in 1954, the Special Committee of the Geophysical Year reported on the future operation of longitudes. Mr. Danjon prepared the memorandum for the astronomical part and Mr. Decaux for the radio part.

Mr. Danjon noted that it was difficult to discuss instructions on instruments in a Commission. The instructions must be published. Written remarks from the different observatories on these instructions will be given, and only afterwards, they can be summarized in order to have the final text.

Mr. Decaux added that the final text could be drawn up only by general co-operation. The astronomical part will probably not be changed, while the radio part may be changed because of the different studies that are underway. The instructions for radio may be drawn up in final form only at the last moment.

Sir Harold Spencer Jones said that a new antenna had recently been tested for reception of radio signals in Greenwich.

Mr. H. Smith adds that this type of antenna has better directivity than the ordinary antenna and costs less expensive than the rhombic type. The antenna mast is 24 to 30 meters high. The antenna is made up of 2 wires that go from the top of the mast and go down to 25-30 cm. of the ground. The earth connections are interconnected. The length of the wires is 160 meters. The angle between two wires is 30 to 35 degrees. The direction of maximum audibility passes in the middle of the two wires. The gain of this antenna is 3 db lower than the rhombic antenna with four poles. An advantage is the possibility of using the same mast for different directions.

Mr. Decaux asks for the range of frequencies that can be used with this antenna.

Mr. H. Smith replied that this range was from 10 to 17 Mc / s.

The Chairman reported on Mr. Decaux's letter concerning the cancellation of the Annapolis (NSS) time signals on 17 kc / s. It is regrettable that these signals are suppressed, especially because of the possible study of the propagation of long waves by these signals.

Mr. Markowitz notes that the issuance of NSS signals does not depend on the Naval Observatory. Thus, he can say nothing about the restoration of the emission of these signals during the geophysical year, but he will nevertheless write to the responsible authorities.

Mr. Clemence proposed that the Special Committee of the Geophysical Year send a resolution to the American Committee of the Geophysical Year in favor of the restoration of the long-wave signals of Annapolis.

The Chairman added that, taking into account the considerable sums spent on the Geophysical Year in America, one might think that the proposal would be favorably accepted.

4. Reception of time signals from remote stations.

The Chairman proposed to move on to the discussion of the resolutions proposed by Stoyko and Markowitz. Mr. Stoyko's proposal No. 1 is as follows. "It is desirable that the observatories participating in the international time service receive, in addition to the signals emitted by the stations nearby, the broadcasts of remote stations. It is desirable, for example, for North American observatories to receive European signals so that the bilateral link between Europe and America can be established and the apparent rate of propagation of radio waves to be determined regularly ".

Mr. Stoyko adds that currently in Australia they have stopped receiving the European signals. The number of European time signals received in North America is also insufficient. Given the importance of the study of the propagation of radio waves for the determination of longitudes, it is necessary that the observatories participating in the international service of the hour receive, in addition to the nearby stations, the emissions of the remote stations.

Mr. Markowitz noted that the Naval Observatory had resumed receiving European signals. The main difficulty lies in the very large amount of simultaneous emissions. This issue is addressed in Mr. Stoyko's Proposal No. 2 (Draft Reports, p. 264).

The Chairman thinks that the B. I. H. should list the programs it is desirable to receive at each station.

Mr. Danjon added that bilateral reception of time signals was indispensable. This question must be considered by the Special Committee of the International Geophysical Year.

Mr. Stoyko proposed to transmit the resolution to the General Assembly.

The Chairman said that the resolution would be prepared following the views of Mr. Stoyko.

B. The 2nd meeting of the International Commission of Time took place on 3 September at 11 am under the chairmanship of Sir Harold Spencer Jones, assisted by Mr. H. Smith, Secretary.

5. New definition of Universal Time.

On behalf of the Sub-Commission he chaired, Mr. Danjon gave explanations on the definition of the Time Unit.

The mean solar or Universal time, provided by the rotation of the Earth, is deduced in practice from the observation of the stars.

Ephemeris Time, fundamentally the independent variable of the equations of motion of celestial bodies, is the argument of the astronomical Ephemerides.

The second of Ephemeris Time is the unit of time defined by Resolution 1 (page 55).

The comparison of the tabular positions of suitably chosen celestial bodies and the positions observed in Universal Time gives the difference Δt, Ephemeris Time *minus* Universal Time.

In practice, Ephemeris Time is the time for which the observed position of the Moon coincides with the position taken from the ephemeris calculated in the same time scale as the solar ephemeris in conformity with international decisions. For the year 1952-1959 this ephemeris is published in the volume "Improved Lunar Ephemeris, 1952-1959"; from 1960, it will be published annually in the national ephemerides.

To obtain a frequency V_U corresponding to the invariable unit defined by resolution 1, the procedure is the following :

(a) : The frequency V_U is obtained by using as a unit of time the second of Universal Time provided by the radiotelegraphic time signals emitted by the national time services.

(b) : Corrections of these signals, subsequently deduced from the observation of stars, are published regularly by the time services. The Bureau International de l'Heure publishes annually the definitive corrections of the time signals issued by the various observatories..

(c) : The differences Δt : Ephemeris Time *minus* Universal Time, corresponding to the middle of each year, are currently published within two or three years. They are deduced from occultations of stars by the Moon and from meridian observations of the Moon. It is hoped that in the near future a program of observations with Markowitz's "dual-rate Moon position Cameras" developed by the U.S. Naval Observatory will determine the difference Δt more quickly and accurately.

(d) : Let $D\Delta t$ be the annual variation of Δt deduced from a series of annual values of Δt by means of a suitable numerical differentiation formula.

If Δt is expressed in seconds, the frequency V_E which corresponds to the definition of the second contained in Resolution 1 is given by

$$V_E = V_U \left(1 - \frac{D\Delta t}{31\,556\,925.975}\right)$$
$$= V_U \left(1 - 3.1689 \times 10^{-8} D\Delta t\right)$$

(e) : When the frequency of an atomic standard has been reported with sufficient accuracy at the second of Resolution 1, the atomic standard may immediately supply the second.

Remarks. The astronomical determinations of time are affected by the seasonal variations of the rotation of the Earth and by polar motion. These causes lead to discrepancies in the time determinations of the various observatories. At present, these effects can only be corrected definitively after several years. However, provisional corrections can be applied immediately, the resulting uncertainty on Universal Time being at most the order of magnitude of the uncertainty about the annual values of Δt.

The frequency determinations corresponding to the second of Universal Time, variable, made in the laboratory, will contribute effectively to the study of the seasonal variations of the Earth's rotation.

Mr. Danjon adds: There remains one important question: to which time should the name Universal Time (UT) be given? Should this name be given to the time determined by astronomical observations, given the longitude of the place of observation? Or must we add to this astronomical time the influence of the polar motion or even of the seasonal irregularity of the rotation of the Earth in order to have Universal Time?

M. Brouwer gives the corrections Δ*t* that Universal Time needs to have Ephemeris time according to formula :

$$\Delta t = + 24^s.349 + 72^s.3165\, T + 29^s.949\, T^2 + 1.821\, B,$$

where *B* is determined from the observations of the Moon from 1850. Moreover, it adds the corresponding variations of the speed of the rotation of the Earth (Δ*V*:*V*).

Table 1

Year	Δt	$\frac{\Delta V}{V} 10^{-8}$	Year	Δt	$\frac{\Delta V}{V} 10^{-8}$	Year	Δt	$\frac{\Delta V}{V} 10^{-8}$
1850	+2^s.67	+0.6	**1885**	- 7^s.88	+0.3	**1920**	+20^s.36	+2.0
55	+3.31	+0.5	**90**	- 7.17	-0.5	**25**	+22.68	+0.7
60	+4.21	-0.5	**95**	- 6.94	+1.2	**30**	+23.20	+0.5
65	+1.39	-1.4	**1900**	- 3.90	+3.7	**35**	+23.62	-0.1
70	-1.88	-3.8	**05**	+ 3.08	+4.5	**40**	+24.20	+1.2
75	-7.36	-1.7	**10**	+10.50	+4.3	**45**	+26.27	+1.6
80	-8.35	-0.1	**15**	+15.81	+3.2	**50**	+29.31	+1.8
						55	[+32]	[+1.8]

Mr. Markowitz speaks of the influence of latitude variation on the results of time services. To the results of observations of the international latitude stations, it is necessary to add the results of the observations with PZT and with the impersonal astrolabe of Mr. Danjon. For example, stations that determine latitude with these instruments must send their results regularly to the Central Bureau of Latitudes in Turin. Professor G. Cecchini, using all these results, will determine the coordinates of the instantaneous pole. He shall send each week this information to the Director of the Bureau International de l'Heure.

At B.I.H. $\Delta\lambda_j$ will be calculated for all the time stations every 10 days and, in addition, these details will be extrapolated for 40 days in advance. The extrapolated values of the coordinates of the pole will be used for the current work of the time services (signal transmission) and the interpolated values will be used for the publications of the times of the time signals.

Mr. H. Smith asks that the coordinates of the pole be given for Julian days ending with zero. For example, for

30 August 1955, at 12:00 U.T., we have: JD = 2 435 350.0, etc. every 10 days. This will make it easier to compare the various time services. At present, Greenwich is given the *x* and *y* coordinates of the pole every 5 days. They can henceforth be given in Julian dates.

Mr. Clemence remarks that it is expedient to choose the Julian numbers at multiples of the tabular intervals.

Mr. Stoyko adds that the exact interval for the extrapolation of the *x* and *y* coordinates of the instantaneous pole can not currently be indicated. This will depend on the arrival date of the computed values of the coordinates of the pole at B.I.H. For the choice of dates, he sees no inconvenience in using Julian dates at multiples of 10.

Mr. Danjon noted that the Commission of the Variation of Latitudes (Comm. 19) had voted a resolution on the centralization of values $\Delta\varphi$ of the different stations. Commission 31 must make a resolution on the use of these results.

The Chairman said that too detailed instructions should not be given.

Mr. Danjon requested that instructions be given to the B.I.H.

Mr. Markowitz proposed that resolutions 1 and 2 of the Draft Reports (p. 265) be adopted on the communication to B.I.H. by the I.L.S. of the coordinates of the pole and on the extrapolation of these coordinates by the B.I.H.

Mr. Danjon remarked that we can not give instructions to the I.L.S. for the calculation of the coordinates of the pole and, consequently, it is necessary to remove the second part of Resolution No. 1 which speaks of the method of calculation of the coordinates of the pole by the I.L.S.

Mr. Markowitz proposed that the word “variation” should be changed to “motion” in resolution No. 1.

Mr Danjon prefers to communicate the corrections of longitudes ($\Delta\lambda_i$) due to the polar motion to the participating time services.

Mr. H. Smith also wishes to have the instantaneous coordinates of the pole *x* and *y*.

Mr Danjon remarked that it was necessary to calculate $\Delta\lambda_i$ for the participating time services and to publish them in addition to the coordinates *x* and *y*.

The Chairman concluded that the resolution should not mention the internal work of the I.L.S.

Mr Fedorov added that there was one very important point. How will the results of the variation in latitude be taken into account for stations that are not I.L.S. stations? He asked that the I.L.S. publishes the method that it will use for the calculation of the coordinates of the pole.

The Chairman noted that this question depended on Commission No. 19 and could not be discussed here. Since Mr. Fedorov is the current President of Commission No. 19, he is responsible for taking the necessary measures.

Mr. Markowitz read the corrected text of resolutions Nos. 1 and 2:

“ The Commission instructed B.I.H. to calculate for the different observatories which cooperate with the International Time Service the corrections of longitude due to the polar motion, using for this purpose the values of the polar motion provided by the Central Bureau of the International Service of Latitudes: extrapolated corrections for several months in advance must be used for routine service. The *x* and *y* components of the polar motion used for the calculation of these corrections must also be published in the Bulletin Horaire”.

The third issue to be considered here is the seasonal irregularity of the Earth's rotation. If this irregularity is repeated from one year to the next, a resolution can be made for the use of these corrections in order to have more uniform time, since physicists are currently objecting to the use of astronomical time which is non-uniform time.

The Chairman noted that the seasonal variation in Earth's rotation was significantly repeated from year to year. Only, it is the phase problem that comes into play.

M. Danjon adds that there are local variations in the vertical which may distort the determination of the irregularity of the rotation of the Earth. He thinks that the same corrections must be made everywhere for the seasonal variation of the rotation of the Earth, even if these corrections are not entirely exact. Otherwise, the already existing disorder will increase. He was therefore in favor of Mr Markowitz's proposal. We will do the same thing we propose to do for the displacement of the pole.

Mr. Markowitz says that based on the study of quartz clocks in Washington during the last three years, he found discrepancies in the irregularity of Earth's rotation from one year to the next only on the order of 1×10^{-9}.

Mr. Barrell noted the importance of atomic frequency standards.

The Chairman added that the Special Commission would deal with this issue.

Mr. Clemence says that by applying the Markowitz corrections for the irregularity of the rotation of the Earth, we will work in more uniform time.

Mr. Danjon remarks that in this case an agreement will be reached between the results of the different time services when they communicate the time to the physicists. It can be added to the resolution that it is necessary to study the irregularity of the rotation of the Earth by comparing astronomical time with atomic standards.

Mr. H. Smith supports the point of view of the Americans, because in the observations with the P.Z.T. the periodic errors do not exist, whereas in the observations using the fundamental catalog FK3 there are periodic errors of the type $\Delta\alpha_{\alpha}$.

M. Danjon adds that the $\Delta\alpha_{\alpha}$ can be corrected thanks to the impersonal astrolabe: in one hour, the stars are observed distributed over the seven-hour interval in right ascension.

Mr. Markowitz reads the corrected proposal No. 3: “The B.I.H. shall adopt and publish in advance, every year, corrections for the annual fluctuation in the rotation of the Earth. These corrections must be used by all observatories in their determination of universal time. Studies for the fluctuation of the Earth's rotation must be pursued specially using the atomic frequency standards”.

Mr. Stoyko asked for the date of application of that resolution.

Mr. Markowitz replied that 1 January 1956 was the date of application of that resolution.

The Chairman invited discussion of proposal No. 4 from Mr. Markowitz about the form of the publication of the results of the time services.

Mr Danjon said that the observatories should give their results in raw Universal Time (U.T.) and give separately the corrections for the polar motion and the annual fluctuation of the rotation of the Earth.

Mr. Markowitz added that he was in complete agreement with Mr. Danjon.

The following resolutions were adopted: “ The Commission recommends that the Bulletins published by the Observatories co-operating with the International Time Service contain the quantities which must have been added to the hours of reception of the time signals published in Universal Time, to take account of the polar motion and the annual fluctuation of the Earth's rotation ”.

“ The Commission recommends that in order to facilitate the intercomparison of timepieces in various establishments, the intervals between consecutive dates of published results be 5 or 10 days. They must be given for the dates for which the days of the Julian period elapsed at noon of Greenwich are divisible by the interval of the tables ”.

6. Distribution of time signals over time.

The Chairman invited Mr. Stoyko's second proposal on the distribution of radio time signals over time to be discussed.

Mr. Danjon noted that a resolution could not be made, but it was possible to make a request to the observatories issuing the time signals, emphasizing better distribution over time.

Mr. Stoyko adds that when the Rio de Janeiro Observatory changed the time of its broadcasts to half-hours, instead of the round hours, their reception became possible in Paris. On the other hand, it is impossible to receive in Paris the Japanese signals of JJC at 12h U.T., since during their emission (5 minutes) there are 17 other hourly broadcasts. As for the study of the propagation of radio waves, it is important to receive signals from Tokyo in Europe, it is desirable to move the time of their emission.

The Chairman considered that the question of the distribution of time signals over time was very important. It is necessary that the study of the best redistribution of time signals over time be done by B.I.H. in the next three years and that B.I.H. prepares the proposal for Moscow. It proposes to empower the B.I.H. to settle the question of the distribution of time signals over time.

7. Proposals adopted in Rome in 1952.

Discussion of the proposals made by the Commission 31 in Rome in 1952 but not adopted by the General Assembly. Proposal No. 1 on the establishment of a research center for the study and construction of high-precision frequency standards was canceled, as there was a similar center.

Mr. Danjon noted that proposal No. II on the unification of time signals was very important. We must admit the principle of this unification.

The Commission adopted the following resolution: “ The Commission, considering the disadvantage arising from the use of different types of radio signals, recommends the English system for permanent use; the use of the other three systems: American, ONOGO and rhythmic, can continue provisionally ”.

Proposals III, IV and V are adopted as follows:

“ The Commission recommends that all changes in the program for the transmission of time signals be communicated to the Central Bureau of Astronomical Telegrams of Copenhagen and published in the Circulars published by this Office ”.

“ The Commission recommends that observatories participating in the International Time Service do not change their conventional longitudes that they once adopted: these changes compromise the homogeneity of international results ”.

“ Moreover, it is recommended that the longitudes adopted refer to a fixed point in the Observatory and that changes in the position of the instruments used for the determination of the time be communicated to the Bureau International de l'Heure ”.

Mr. Stoyko pointed out that proposal No VI could be deleted as it duplicated Markowitz's proposal No 4.

Mr. Danjon added that proposal No. VII concerning the creation of high-precision time services in the equatorial regions should be retained, given the possibility of establishing an hourly service in Quito.

The Chairman noted that these proposals had already been approved in Rome in 1952, but had not been voted inadvertently.

Mr. H. Smith mentions the articles by Essen, Pierce and Mitchel on the comparison of frequencies and signals through radio waves in *Nature* 1954, No. 174, p. 922 and Essen in the Procedings Inst. Electr. Eng. 1954, No. 101, p. 249. Given the high precision of intercomparison of time and frequency, and for the study of the propagation of waves over 60 kc / s, it proposes the following resolution: “ to extend and develop the emission of standard frequencies frequencies below 100 kc / s. ”.

The President said that the resolution should be transmitted to the competent authorities.

Mr. Decaux, as Chairman of the Frequency Commission of C.C.I.R., requested that this resolution be forwarded to the C.C.I.R. At each C.C.I.R. meeting, the issue of low frequencies is discussed. Therefore, it is very important to send this resolution to the C.C.I.R.

Mr. Essen also stressed the importance of transmitting this resolution to the C.C.I.R.

8. Resolutions of the General Assembly of the I.A.U. concerning Commission 31.

As a result of the resolutions of the International Commission of Time, the General Assembly in Dublin adopted on 5 September 1955 the following resolutions :

1. L'Assemblée Générale de l'U.A.I. approuve la définition de la seconde proposée par la Conférence Générale Internationale des Poids et Mesures, comme suit :

La seconde est une fraction de 1 : 31 556 925,975* de la longueur de l'année tropique pour l'année 1900,0. (* La valeur exacte, pour être en concordance avec les tables du Soleil de Newcomb, est 1 : 31 556 925,974 74).

2. Il est urgent que les observatoires participants au Service International de l'Heure reçoivent, en plus des signaux émis par les stations rapprochées, les émissions des stations éloignées, pour faciliter la détermination de la vitesse apparente des ondes radioélectriques.

3. L'U.A.I. considérant l'inconvénient provenant de l'utilisation de différents types de signaux horaires radioélectriques, recommande pour l'utilisation permanente seulement le système Anglais : l'utilisation des trois autres systèmes, Américain, ONOGO et Rythmé, pouvant continuer provisoirement,

4. L'U.A.I. recommande que toutes les modifications dans le programme d'émission des signaux horaires soient communiquées au Bureau Central des Télégrammes Astronomiques et publiées dans les Circulaires émis par ce Bureau.

5. L'U.A.I. recommande que les observatoires participants au Service International de l'Heure ne modifient pas la

longitude conventionnelle qu'ils ont adoptée : de tels changements détériorent l'homogénéité des résultats internationaux.

Il est recommandé, de plus, que les longitudes adoptées se réfèrent à un point fixe de l'Observatoire et, que les changements des positions des instruments utilisés pour la détermination de l'heure, soient communiqués au Bureau International de l'Heure.

6. L'U.A.I. charge le B.I.H. de calculer pour les différents observatoires qui coopèrent au Service International de l'Heure les corrections de longitude dues au mouvement du pôle, en utilisant, dans ce but, les valeurs du mouvement du pôle fournies par le Bureau Central du Service International des Latitudes : les corrections extrapolées pour plusieurs mois d'avance doivent être utilisées pour le service courant. Les composantes x et y du mouvement du pôle utilisées pour le calcul de ces corrections doivent être publiées aussi dans le *Bulletin Horaire*.

7. Le B.I.H. adoptera et publiera d'avance, chaque année, les corrections pour la fluctuation annuelle de la rotation de la Terre. Ces corrections doivent être utilisées par tous les observatoires dans leur détermination du Temps Universel. Les études pour la fluctuation annuelle de la rotation de la Terre doivent être poursuivies spécialement à l'aide des étalons atomiques de fréquence.

8. L'U.A.I. recommande que les Bulletins publiés par les observatoires participants au Service International de l'Heure contiennent les quantités qu'il aura fallu ajouter aux heures de réception des signaux horaires, publiées en Temps Universel, pour tenir compte du mouvement du pôle et de la fluctuation annuelle de la rotation de la Terre.

9. L'U.A.I. recommande que pour faciliter l'intercomparaison des garde-temps des divers établissements, les intervalles entre les dates consécutives des résultats publiés soient de 5 ou de 10 jours. Ils doivent être donnés pour les dates pour lesquelles les jours de la période julienne écoulés à midi de Greenwich sont divisibles par l'intervalle des tables.

10. L'U.A.I. attire l'attention sur l'établissement de services horaires de haute précision dans les régions équatoriales.

11. Etant donné la grande précision à laquelle on est arrivé dans l'intercomparaison de temps et de fréquences et dans la mesure des variations de temps de propagation des ondes, au moyen des transmissions expérimentales de fréquence sur 60 kc/s, laquelle précision ne peut être atteinte avec les fréquences allouées par le C.C.I.R. aux transmissions de fréquence-étalons, l'U.A.I. désire attirer l'attention du C.C.I.R. sur l'importance que des fréquences soient allouées pour la continuation et l'extension des émissions de fréquence-étalons aux fréquences inférieures à 100 kc/s.

N. STOYKO.

English text of the Resolutions voted by the General Assembly of the I.A.U.

(Dublin, 1955)

1. The General Assembly of the I.A.U. approve the definition of the second proposed by the Comité International des Poids et Mesures, as follows :

The second is the fraction 1 : 31 556 925.975* of the length of the tropical year for 1900.0 (* the more precise value required for exact agreement with Newcomb's Tables of the Sun is 1: 31 556 925.974 74).

2. It is urged that observatories cooperating in the international time service should receive transmissions of radio time signals from distant stations in addition to those from near stations in order to facilitate determination of the apparent speed of propagation of radio waves.

3. The I.A.U. considering the inconvenience arising from the use of many different types of radio time signals, recommends for permanent retention only the English system :

the use of the three systems, American, ONOGO and rhythmic, may be continued for a provisional period.

4. The I.A.U. recommends that all modifications in the program of radio time signal transmissions should be communicated to the Central Bureau of Astronomical Telegrams in Copenhagen and published in the circulars issued by the Bureau.

5. The I.A.U. recommends that observatories cooperating in the international time service, should not change their conventional adopted longitudes: such changes impair the homogeneity of the international results.

It is further recommended that the adopted longitude should refer to a fixed point in the observatory, and that any changes in the positions of instruments used for determination of time should be communicated to the Bureau International de l'Heure.

6. The I.A.U. instructs the B.I.H. to compute for the various observatories cooperating in the international time service the longitude corrections due to the motion of the pole, using for this purpose the values of the polar motion supplied by the Central Bureau of the International Latitude Service : extrapolated corrections for several month in advance shall be provided for current use. The x and y component of the polar motion used for the computation of these corrections should also be published in the *Bulletin Horaire*.

7. The B.I.H. shall adopt and shall publish in advance each year corrections for annual fluctuation in the speed of rotation of the earth. These corrections shall be used by all observatories in the determination of Universal Time. Studies of the annual fluctuations shall be continued, especially with the aid of atomic standards of frequency.

8. The I.A.U. recommends that the bulletins published by observatories cooperating in the international time service should contain the quantities to be added to the times of

reception of radio time signals tabulated in UT to allow for the effects of polar motion and the annual fluctuation in the rotation of the earth.

9. The I.A.U. recommends that, to facilitate intercomparisons between time-keeping establishments, data tabulated at intervals of 5 days, 10 days, and so on should be given for days on which the number of Julian days elapsed at Greenwich noon is divisible by the tabular interval.

10. The I.A.U. draws attention to the importance of the establishment of time services of high precision in equatorial regions.

11. In view of the high precision which has been achieved in intercomparisons of time and frequency, and in the measurement of variations in propagation time, by means of the experimental frequency transmissions on a frequency of 60 kc/s., which precision is not attainable on any of the frequencies allocated by the C.C.I.R. for Standard frequency transmission, the I.A.U. desires to draw the attention of the C.C.I.R. to the importance of frequencies being allocated for the continuation and extension of standard frequency transmissions on frequencies below 100 kc/s.