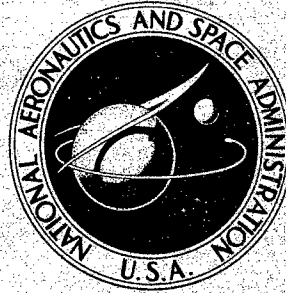


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**TRANSACTIONS OF THE MEETINGS OF  
THE ELEVENTH GENERAL CONFERENCE  
ON WEIGHTS AND MEASURES**

October 11-20, 1960  
*Paris, France*

**20010910 006**

TRANSACTIONS OF THE MEETINGS OF THE  
ELEVENTH GENERAL CONFERENCE ON WEIGHTS AND MEASURES

Translation of "Comptes Rendus des Seances de la Onzieme  
Conference Generale des Poids et Mesures,  
Paris, 11-20 octobre 1960."

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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TRANSACTIONS OF THE MEETINGS  
OF THE  
ELEVENTH GENERAL CONFERENCE ON WEIGHTS AND MEASURES

Held in Paris, 1960

Under the Presidency  
of  
Mr. Émile-Georges Barrillon  
President of the Academy of Sciences of the French Institute

Delegates of the signatory nations of the Meter Convention: (The names of members of the International Committee on Weights and Measures are preceded by an asterisk.)

ARGENTINA

\*Mr. T.R. Isnardi, Professor in the Faculty of Sciences, Buenos Aires.

Mr. S.M.A. Del Carril, President, National Institute of Industrial Technology, Buenos Aires.

AUSTRALIA

\*Mr. N.A. Esserman, Director of the National Standards Laboratory, Chippendale, N.S.W.

Mr. G.J. Price, Second Secretary of the Embassy of Australia, Paris.

AUSTRIA

\*Dr. J. Stulla-Götz, Privy Counsellor of the Bureau of Weights and Measures, Vienna.

Mr. F. Bernhardt, Engineer, Secretary of the Federal Ministry of Commerce and Reconstruction, Vienna.

BELGIUM

Baron Jaspar, Ambassador of Belgium, Paris.

Mr. M. Jacob, Chief Metrologist-Director, Chief of the Belgian Department of Metrology, Brussels.



Mr. J. Claesen, Chief Metrologist, Chief of the Scientific Division of the Belgian Department of Metrology, Brussels.

#### BRAZIL

Mr. A. Camardella, Engineer, Director of the Service of Metrology of the National Institute of Technology, Rio de Janeiro.

Mr. S. Thompson Flôres, Third Secretary of the Embassy of Brazil, Paris.

#### BULGARIA

Mr. T.V. Kovachev, Chief of the Weights and Instruments of Measure Department in the Internal Commerce Department, Sofia.

#### CANADA

\*Dr. L.E. Howlett, Director of the Applied Physics Division of the National Research Council, Ottawa.

Mr. G. Bertrand, Second Secretary of the Embassy of Canada, Paris.

#### CHILE

N.

#### CZECHOSLOVAKIA

Mr. J. Dostál, Engineer, President of the Office of Standardization, Prague.

\*Dr. J. Nussberger, Professor at the Polytechnic School, Prague.

Mr. P. Tenk, Engineer, Chief of the Service of Measuring Instruments, Prague.

Mr. L. Smrž, Engineer, Chief of the Service of Measuring Instruments, Department, Prague.

Mr. I. Prokop, Engineer in the Office of Standardization, Prague.

#### DENMARK

Mr. H. Højgaard Jensen, Professor at the Polytechnic School, Copenhagen.

Mr. A.K.F. Christiansen, Director of the Bureau of Weights and Measures, Copenhagen.

## DOMINICAN REPUBLIC

N.

## FINLAND

Mr. J. Mäkinen, First Secretary, Chargé d'Affaires at the Embassy of Finland, Paris.

## FRANCE

Mr. A. Pérard, Member of the Institute, President of the National Scientific and Permanent Bureau of Weights and Measures, Paris.

\*Mr. A. Danjon, Member of the Institute, Director of the Paris Observatory, Paris.

Mr. P. Fleury, Director General of the Institute of Optics, Paris.

Mr. M. Bellier, Director of the Research Laboratory of the National Museum of Arts and Crafts, Paris.

Mr. J.P. Nicolau, Director of the Superior Institute of Materials and Mechanical Construction, Paris.

Mr. F. Viaud, General Engineer, Chief of the Department of Measuring Instruments, Paris.

Mr. J.H. Gosselin, Engineer-in-Chief of the Measuring Instruments, Paris.

Mr. J.-P. Pascuel, Vice-Director of the International Unions, Department of Foreign Affairs, Paris.

## GERMANY

\*Professor Dr. R. Vieweg, President of the Physikalisch-Technische Bundesanstalt, Braunschweig.

Dr. G. Von Schmoller, Advisor at the Federal Foreign Office, Bonn.

Dr. (Mrs.) E. Von Puttkamer, Advisor at the Federal Foreign Office, Bonn.

Professor Dr. U. Stille, Director of the Physikalisch-Technische Bundesanstalt, Braunschweig.

Professor Dr. M. Kohler, Member of the Council of the Physikalisch-Technische Bundesanstalt, Braunschweig.

Dr. W. Bammer, Counsellor of Legation at the Federal Foreign Office, Bonn.

The following were unable to attend:

Professor Stanek, President of the German Bureau of Weights and Measures, Berlin.

Dr. H.-G. Laporte, Vice-President of the German Bureau of Weights and Measures, Berlin.

Dr. E. Blechschmidt, Chief of Laboratory of the German Bureau of Weights and Measures, Berlin.

Dr. B. Zipprich, Director of the German Bureau of Weights and Measures, Berlin.

Mr. Kemnitz, Engineer, Chief of Laboratory of the German Bureau of Weights and Measures, Berlin.

Mr. Liers, Engineer, Director of the German Bureau of Weights and Measures, Berlin.

Mr. Rose, Legal Advisor of the German Bureau of Weights and Measures, Berlin.

#### HUNGARY

Mr. P. Honti, Vice-President of the National Bureau of Measures, Budapest.

#### INDIA

\*Dr. K.S. Krishnan, Director of the National Physical Laboratory, New Delhi.

#### IRELAND

Mr. J.W. Lennon, Counsellor of the Embassy of Ireland, Paris.

#### ITALY

\*Professor G. Cassinis, Member of the Accademia dei Lincei, Principal of the Polytechnic School, Milan.

Mr. E. Perucca, Member of the Accademia dei Lincei, Professor of Physics at the Polytechnic School, Turin.

Mr. M. Oberziner, Professor of Special Mechanical Technologies at the University of Rome.

Mr. G. Fontana, Director of the Central Bureau of Metrology, Rome.

Mr. F. Lo Prinzi, Commercial Attaché of the Embassy of Italy, Paris.

#### JAPAN

Mr. K. Sato, Secretary of State, Counsellor of the Embassy of Japan, Paris.

Mr. A. Kitera, Second Secretary of the Embassy of Japan, Brussels.

Mr. N. Kumagai, Secretary of the Minister for Foreign Affairs, International Conventions Division, Tokyo.

#### KOREA

Mr. Young Choo Kim, Chargé d'Affaires at the Embassy of Korea, Paris.

Mr. Yoon Mo Lee, Director of the Bureau of Weights and Measures, Department of Commerce and Industry, Seoul.

Mr. Chong Wo Lee, Chief of the Inspections Division, Bureau of Weights and Measures, Department of Commerce and Industry, Seoul.

Mr. Kee Heum Shin, Third Secretary of the Embassy of Korea, Paris.

#### MEXICO

\*Dr. M. Sandoval Vallarta, Member of the National Nuclear Energy Commission, Mexico City.

#### NETHERLANDS

\*Professor Dr. J. de Boer, Director of the Theoretical Physics Institute at the University, Amsterdam.

Professor G. W. Ratheneau, Director of the Physical Sciences Laboratory, Amsterdam.

Mr. G.W. Maas Geesteranus, of the Treaties Division of the Foreign Office, The Hague.

#### NORWAY

Mr. S. Koch, Director of the National Bureau of Weights and Measures, Oslo.

## POLAND

Mr. W. Wojtyla, Engineer, President of the National Bureau of Measures, Warsaw.

Mr. J. Osiecki, First Secretary of the Polish Embassy, Paris.

Professor Dr. J. Rolinski, Scientific Advisor at the National Bureau of Measures, Warsaw.

## PORTUGAL

Mr. F.A. de Alcantara Carreira, Inspector General of Agricultural and Industrial Products, Lisbon.

Mr. E. Correia de Sousa, Engineer-in-Chief, Bureau of Weights and Measures, Lisbon.

## ROUMANIA

Mr. D. Cizmas, Director General, General Directorate of Energy, Metrology, Standardization and Inventions, Bucharest.

Mr. N. Illoiu, Engineer, Deputy Director General, General Directorate of Energy, Metrology, Standardization and Inventions, Bucharest.

Mr. E. Georgescu, Engineer, Director of the Office of Metrological Inspection, General Director of Energy, Metrology, Standardization and Inventions, Bucharest.

Mr. P. Vintila, Engineer, Chief of Timișoara Center No. 5 of Metrology, General Directorate of Energy, Metrology, Standardization and Inventions, Bucharest.

Mr. L. Adrian, Engineer, Member of the Staff, General Directorate of Energy, Metrology, Standardization and Inventions, Bucharest.

## SPAIN

Mr. A. de Torrontegui Y Suarez de la Vega, Engineer-in-Chief at the National Department of Legal Metrology, Secretary of the Permanent Commission of Weights and Measures, Madrid.

Mr. J.M. López Azcona, Delegate of the Department of Industry in the Permanent Commission of Weights and Measures, Madrid.

Mr. L. Iparraguirre, Engineer in Charge of Weights and Measures Affairs in the General Directorate of Industry, Madrid.

## SWEDEN

Mr. E.G. Rudberg, Professor and Secretary of the Royal Academy of Sciences, Stockholm.

Mr. B.O.T. Swensson, Director of the Royal Bureau of the Mint and of the Bureau of Weights and Measures, Stockholm.

## SWITZERLAND

Mr. H. König, Director of the Federal Bureau of Weights and Measures, Bern.

Mr. L. Bischoff, First Secretary of the Embassy of Switzerland, Paris.

## THAILAND

General A. Chaya-Rochana, Ambassador of Thailand, Paris.

Mr. W. Watanakun, Second Secretary of the Embassy of Thailand, Paris.

## TURKEY

Mr. T. Çarikli, Commercial Advisor of the Embassy of Turkey, Paris.

## U.S.S.R.

Professor V.O. Arutunov, Director of the D.I. Mendeleyev, Institute of Metrology, Leningrad.

Mr. V.I. Yermakov, Director of the Scientific Institute of Physico-technical and Radiotechnical Measurements, Moscow.

Mr. I.V. Makarevich, Division Secretary in the Foreign Office, Moscow.

Mr. P.J. Alianaki, Superior Engineer of the Committee on Standardization of Measures and Instruments of Measure of the U.S.S.R. Cabinet Council, Moscow.

## UNITED KINGDOM

Sir Gordon Sutherland, Director of the National Physical Laboratory, Teddington.

\*Dr. H. Barrell, Superintendent, Standards Division, National Physical Laboratory, Teddington.

Mr. J.H.G. Leahy, Second Secretary, Delegate for Commercial Affairs, Embassy of Great Britain, Paris.

Mr. D.H. Anderson, Legal Advisor, Foreign Office, London.

#### UNITED STATES OF AMERICA

\*Dr. A.V. Astin, Director of the National Bureau of Standards, Washington, D.C.

Mr. B. Bock, First Secretary of Embassy.

Mr. M. Van Heuven, Attorney, Office of the Legal Advisor, Department of State, Washington, D.C.

Dr. E. Hutchisson, Director of the American Institute of Physics, New York.

Mr. A. McNish, Chief of the Metrology Division, National Bureau of Standards, Washington, D.C.

Mr. L. Polk, President, Schefffield Division, Bendix Aviation Corporation, Dayton, Ohio.

Dr. T. Osgood, Scientific Attaché, U.S. Embassy, London.

#### URUGUAY

Dr. E. J. Palacios, Minister-Counsellor of the Embassy of Uruguay, Paris.

#### YUGOSLAVIA

Mr. J. Gizdič, Director of the Administration of Measures and Precious Metals, Belgrade.

Mr. E. Lazar, Engineer, Deputy Director of the Administration of Measures and Precious Metals, Belgrade.

\*Mr. C. Kargachin, Advisor in the Administration of Measures and Precious Metals, Zagreb.

Dr. F. Avčin, Professor in the Technical Faculty of the University, Ljubljana.

The following also attended the conference:

Mr. A. Pérez-Vitoria, Delegated by the UNESCO (Scientific Research Division), Paris.

Mr. Ch. Volet, Director of the International Bureau of Weights and Measures.

Mr. J. Terrien, Deputy-Director of the International Bureau of Weights and Measures.

The following attended the conference by invitation:

Mr. A. Trabelsi, Director of General Administration, Ministry of Commerce, Industry, Mines, Handcraft and Merchant Marine, Rabat.

Messrs. M. Costamagna, Director, and J. Jasnorzewski, Assistant, International Bureau of Legal Metrology, Paris.

Mr. J. Rey, Director of the Revue de Métrologie Pratique et Légale, Paris.

The scientific personnel of the International Bureau of Weights and Measures.

#### CONVOCATION

The Eleventh General Conference on Weights and Measures is convoked for Tuesday, 11 October 1960.

#### CONSTITUTION OF THE GENERAL CONFERENCE ON WEIGHTS AND MEASURES

##### Convention of the Meter: Article 3

"The International Bureau will operate under the exclusive direction and supervision of an International Committee on Weights and Measures, itself under the authority of a General Conference on Weights and Measures composed of delegates of the contracting Governments."



# Annexed Regulation to the Convention of the Meter: Article 7

"The General Conference mentioned in Article 3 of the Convention will meet in Paris upon convocation by the International Committee, at least once every six years.

"Its mission is to discuss and promote the necessary steps for the propagation and perfecting of the Metric System, as well as to approve the new fundamental metrological determinations that may have been carried out in the interval between meetings. It receives the report from the International Committee on the work accomplished, and it then proceeds to elect by secret ballot one half of the International Committee.

"The votes within the General Conference are by nations, each nation having the right to one vote.

"The members of the International Committee have the right to seats at the meetings of the Conference; they may be delegates of their Governments at the same time."

## AGENDA AND PROVISIONAL PROGRAMS

Inaugural Session at the Ministry of Foreign Affairs  
Paris, Tuesday, 11 October 1960, at 15:00 hours

Speech of His Excellency the Minister of Foreign Affairs of the French Republic.

Response by the President of the International Committee on Weights and Measures.

Opening speech of the President of the Academy of Sciences of Paris, President of the Conference.

Subsequent meetings at the Ministry of Foreign Affairs, Paris:

Second Session at 15:00 hours, Wednesday, 12 October.

Third Session at 15:00 hours on Friday, 14 October.

Fourth Session at 15:00 hours on Tuesday, 18 October.

Fifth Session at 15:00 hours on Thursday, 20 October.

PROVISIONAL PROGRAM<sup>1</sup>

1. Presentation of credentials by the delegates.
2. Appointment of the Secretary of the Conference.
3. Establishment of a list of the nations belonging to the Convention and represented at the Conference; indication of the names of the delegates authorized to vote for each of the nations.
4. Report of the President of the International Committee on the work accomplished since the Tenth General Conference.
5. Proposal of the International Committee: modification of the Convention of the Meter and of the Annexed Regulation.
6. Proposal of the International Committee: creation within the International Bureau of a Section for Standards for Measures of ionizing radiations; funds for installation.
7. Proposal of the International Committee: change in the definition of the meter.
8. Confirmation of the change in the definition of the second.
9. Determination of the absolute value of the weight of the normal atmosphere.
10. Other works of the International Bureau.
11. Activity of the Consultative Committees.
12. Presentation of the new edition of the text of the International Temperature Scale of 1948; designation of this scale. Scale of the helium vapor-tension thermometer.
13. International System of Units.
14. Report on recent progress of the Metric System.
15. Additional contributions.
16. Other proposals of the Delegates and of the International Committee.
17. Signing by the Delegates of the new Convention containing the modification of the Convention of the Meter and of the Annexed Regulation.

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<sup>1</sup>See page 22 of the Definite Agenda.

18. Endowment of the International Bureau. National populations. Establishment of the table of distribution of the contributions.

19. Partial renewal of the International Committee.

20. Miscellaneous questions.

#### PROPOSALS OF THE INTERNATIONAL COMMITTEE

(5) Convention Containing the Modification of the Convention of the Meter and of the Annexed Regulation

In 1954, the Tenth General Conference instructed the International Committee to continue with the examination of the intended modifications. After an inquiry, the International Committee proposes to the General Conference the signature of a new Convention containing the modification of the Convention of the Meter and of the Annexed Regulation; this new Convention will supersede the International Convention signed at Sèvres on 6 October 1921 for the purpose of modifying for the first time the initial Convention of 20 May 1875.

The following are the two principal changes proposed in the Convention of the Meter:

1. The "Convention" and the "Annexed Regulation" should be clearly differentiated: thus the Convention cannot be modified except by common accord, which is to say by unanimous vote (Article 12 of the Convention), whereas the Annexed Regulation should be voted by the General Conference by a majority of three-quarters of the votes so that the adaptation of the operation of the International Bureau to the progress of science may not be delayed.

2. The role of the International Bureau defined in Article 6 (1875) of the Convention, which was limited originally to measures of length and mass, was extended by Article 7 (1921) to include electrical measures. The extension to the standards of measure for ionizing radiation, standards necessary for research on nuclear energy, is now requested by several nations. The International Committee proposes as a result that Article 7 (1921) be replaced by a less limiting article.

The following are the principal changes proposed in the Annexed Regulation:

The annual endowment of the International Bureau has always been decided by the General Conference, but its decision was valid only provided none of the contracting nations expressed a contrary view (Article

6 (1921) of the Regulation). Since this right of veto is considered beyond the scope of an organization of a purely scientific character, the International Committee proposes that the majority of three-quarters of the votes be required to approve the amount of the endowment.

In response to a number of requests, the International Committee proposes after due study to include in the new Article 6 of the Regulation a method of calculation of the contributions that will be more flexible and more equitable than the one prescribed at present by Article 20 (1921). In the proposed method of calculation, each nation is charged with a number of contributive units determined from a table drawn up on the basis of the populations of the member nations. The General Conference may grant to the nations requesting it reductions up to 50 percent, account being taken of the national income.

A modification is proposed to Article 8 (1921) of the Regulation in order to make more effective the renewal of the members of the International Committee by replacing the drawing of lots by considerations of seniority.

The election of a Vice President of the International Committee should be included in Article 9 (1921).

It is proposed in Article 12 (1921) of the Regulation that in votes taken within the International Committee, the vote of the Director of the Bureau should be consultative and not deliberative.

In Article 19 (1875) of the Regulation, the Committee proposes that the financial report be accompanied by a report by an approved certified public accountant, and that the Committee should decide which resolutions should be translated and published in languages other than French.

Article 20 (1921) is eliminated and replaced by the clauses proposed for Article 6.

Article 21 (1875) has become useless.

Article 22 (1875) of the Regulation is eliminated; its text is incorporated in the first paragraph of Article 5 of the Convention.

The complete text of the proposed modifications is given in Annex 1, page 106.

The Governments of the high contracting parties are invited to give their delegates at the Eleventh General Conference the necessary instructions and powers to permit them to discuss and sign validly the

new Convention. This new Convention will be submitted, as the previous ones were, for the ratification of each signatory nation.

(6) Creation of a Section for Standards of Measure for Ionizing Radiations; Funds for the Installation

At its session of October 1958, the International Committee approved the following Resolution:

The International Committee on Weights and Measures,

informed of the need felt with increasing sharpness by national laboratories and by various other scientific organizations for an improvement in the international situation concerning the coordination of standards of measure of ionizing radiations,

recognizing that this need could be met by an extension of the activities of the International Bureau,

decides to appoint a Consultative Committee on Standards of Measure for Ionizing Radiations, its immediate mission to be the establishment of a program of work for the International Bureau and of an inventory of the material and personnel together with an estimate of the funds needed for the installation and its operation, and requests the Consultative Committee to present its report to the International Committee before 1 July 1959.

This Consultative Committee met in April 1959; its report to the International Committee (Minutes C.I.P.M., 27, 1960, p. R 44) contains Recommendation No. 1 as follows:

The Consultative Committee for Standards of Measure for Ionizing Radiations recommends that the duties of the International Bureau of Weights and Measures be extended to include the domains of radioactivity and ionizing radiations and that it be the central organism for:

1. the definition of measures and units,
2. the establishment of international standards of measure for ionizing radiations, including neutrons,

taking into account the results of laboratories and national, international, and other organizations.

The International Bureau gives full support to this recommendation; the International Bureau is actually the most desirable place of

centralization and coordination, because it already possesses standards of other physical dimensions that will be required for the new mission that it contemplates, and because the relations it maintains with national laboratories can be extended immediately to cover this new domain.

Since this has already been done at the time of the recent extensions to electricity and photometry, the role of the Committee of the International Bureau will be limited to the definition of measures and units and to the coordination of the standards of fundamental measures; as in electricity and photometry, the effectiveness of the action of the International Bureau will be achieved by means of competent personnel and a laboratory.

Consequently, the International Committee proposes the creation at the International Bureau of Weights and Measures of a laboratory composed of three sections, as follows:

A section of X-ray and  $\gamma$ -ray dosimetry equipped with material estimated to cost 225,000 gold francs;

A section for the absolute measurement of activities equipped with material estimated to cost 180,000 gold francs;

A section for the measurement of neutron flux equipped with material estimated to cost 150,000 gold francs, to be completed shortly by material for the measurement of thermal neutrons at an estimated cost of 240,000 gold francs.

The building required to house this laboratory covers 500 square meters, its estimated cost being 600,000 gold francs.

The International Committee proposes, then, that the member nations make available a special contribution of 1,395,000 gold francs for building and equipping the proposed laboratory.

#### (7) Change in the Definition of the Meter

In its Resolution No. 1, in 1954, the Tenth General Conference renewed its invitation to the great laboratories of the International Bureau to continue as actively as possible its research on monochromatic radiations so that the Eleventh Conference would be able to make a definite decision. These studies have been made successfully by the International Bureau. Though future progress is foreseen, the International Bureau proposes the immediate adoption of a standard 10 to 100 times more precise on which tests have already proved satisfactory. Therefore, it submits the following proposed resolution to the Eleventh Conference:

## Proposed Resolution No. 1

The Eleventh Conference on Weights and Measures, considering,

that the International Prototype does not define the meter with sufficient precision for the actual needs of metrology,

that it is, in addition, desirable to adopt a natural and indestructible standard, decides:

1. The meter is the length equal to 1,650,763.73 wavelengths in a vacuum of the radiation corresponding to the transition between the levels  $2p_{10}$  and  $5d_5$  of the atom of krypton 86.

2. The definition of the meter in force since 1889 based on the International Prototype in iridium-platinum is abrogated.

## Proposed Resolution No. 2

The Eleventh General Conference on Weights and Measures invites the International Committee on Weights and Measures to:

1. establish instructions for putting into practice the new definition of the meter;

2. continue the studies undertaken for the purpose of improving the standards of length.

## (8) Confirmation of the Change in the Definition of the Second

Pursuant to instructions it received from the Tenth General Conference, the International Committee adopted, at its meeting in October 1956, Resolution No. 1 as follows:

In view of the powers conferred on it by the Tenth General Conference on Weights and Measures by its Resolution No. 5,

The International Committee on Weights and Measures, considering,

1. that the Ninth General Assembly of the International Astronomic Union (Dublin, 1955) issued a favorable opinion for the adoption of the second of the tropical year;

2. that, according to the decisions of the Eighth General Assembly of the International Astronomic Union (Rome, 1952), the second of time of the Ephemerides (T.E.) is the fraction

$$\frac{12,960,276,813}{408,986,496} \cdot 10^{-9}$$

of the tropical year for 1900 January 0 to 12 hours T. E.,

decides:

"The second is the fraction

$$1/31,556,925.9747$$

of the tropical year 1900 January 0 to 12 hours of the time of the Ephemerides."

The Eleventh General Conference is requested to ratify this definition.

#### (18) Budget of the International Bureau

The International Committee finds it is impossible for the International Bureau to fulfill its task satisfactorily without an increase in its budget. The situation is that the precision of measurement to be demanded of it now is beyond the possibilities of the instruments it possesses; for example, the comparator for standards of the divisions of the meter and of the full meter to be installed in 1960 will cost some 233,000 gold francs, and installation costs, with extra equipment, will be approximately 125,000 gold francs. A more serious problem is that physicists of high quality should be employed forthwith: they are very hard to obtain.

At the same time, a further staff of ten persons should be foreseen for the new laboratories for measurement of ionizing radiations, four of them to be physicists of the highest possible qualifications. The International Committee proposes, therefore, that the annual budget of the International Bureau be increased to 900,000 gold francs during the next six years.

#### OBSERVATIONS ON SOME OF THE OTHER POINTS OF THE PROGRAM

##### (9) The Absolute Determination of Gravity and the Normal Atmosphere

A new absolute determination of  $g$  was achieved in 1958 by the International Bureau. According to these measurements, the values of  $g$  expressed in the Potsdam system would be too great by 13 milligals.



Analogous measurements are being made presently at different laboratories; it would be best to await the results before changing the base of the international gravimetric system. The General Conference may, however, wish to consider the repercussions of this future change on the value of the normal atmosphere and make a decision on the matter.

(10) Other Work of the International Bureau

The following tasks were carried out from 1954 to date in addition to the measurement of  $g$ :

- a) New determinations of the meters of the Bureau in comparison to the International Meter; comparisons of national meters before and after marking off.
- b) Comparisons of kilograms of different nations and of the Bureau.
- c) International electrical comparisons from 1955 and 1957. Organization of international comparison of the standards of electric capacity. Construction and study of prototypes of ohm standards of pure metals.
- d) International photometric comparisons of 1957.
- e) Organization of the international comparison of thermometers based on the resistance of platinum. Continuation of studies of precision mercury thermometers of fused quartz.
- f) Research on monochromatic radiations envisaged for the definition of the meter, the conclusion being that krypton 86 radiation is superior to the others tested; research on the methods of production and utilization of this radiation.
- g) Study of the design of a comparator using photoelectric microscopes with interferential measurement for standards of measure of the divisions of the meter and of the full meter.
- h) Study of the design of an absolute mercury manometer.

(11) (12) Activity of the Consultative Committees

The International Bureau organized the sessions of the six consultative committees that are preparing the coordination of the work of the International Bureau with other laboratories and supplying the technical information necessary for preparing the resolutions of the International Committee.

Within the work done by the consultative committee on thermometry, the International Bureau participated in preparing an amended text of the International Temperature Scale of 1948. In addition, the International Committee approved in 1958 the new scale for the helium vapor-tension thermometer (Scale  $^4\text{He}$  1958).

(13) International System of Units

The General Conference will examine the proposals adopted by the International Committee in 1956 and 1958 concerning:

- a) the denomination "International System of Units;"
- b) the abbreviation "SI" in all languages to denote this system;
- c) the list of supplementary and derived units;
- d) the prefixes: tera, giga, nano, pico.

(15) Additional Contributions

Two other nations made their voluntary contribution after the Tenth General Conference. An accounting will be presented of the use to which the funds received by the International Bureau were put.

(16) Other Proposals of the Delegates and of the International Committee

The delegates from the member nations are requested to immediately make known their wishes and the proposals they wish to submit to the Eleventh General Conference by sending them to the International Committee on Weights and Measures as soon as possible.

February 1960

For the International Committee on Weights and Measures,  
Pavillon de Breteuil, Sèvres (Seine-et-Oise):

G. Cassinis,  
Secretary

A. Danjon,  
President

## COMPLEMENT TO THE CONVOCATION OF FEBRUARY 1960

Proposal for the Modification of the CONVENTION OF THE METER and of its Annexed Regulation (Point 5 of the provisional program)

At the February 1960 Convocation (pages 12 to 14), we had the honor to present to the Governments of the high contracting parties the proposals of the International Committee on Weights and Measures for the modification of the Convention of the Meter and its Annexed Regulation. The new texts proposed by the International Committee are given in Annex 1, page 106.

The International Committee examined at the sessions held on 10 and 11 May 1960 the observations received by the members of the International Committee regarding these proposals.

The International Committee has been requested by two of its members to transmit to the high contracting parties the following proposal made by the U.S.S.R. regarding the first paragraph of Article 8 of the proposed Regulation.

## Proposal of the U.S.S.R.

"The International Committee mentioned in Article 3 of the Convention is made up of 20 representatives of the nations elected by the General Conference on the basis of an equitable geographic distribution. Each nation so elected names its representative, who should be a specialist in the domain of scientific metrology, to work with the International Committee. Each elected state names a single representative. The nations elected as members of the International Committee continue their functions until the elections by the General Conference of new member-nations on the Committee."

The International Committee studied this proposal of the U.S.S.R. and decided to make no decision on it before the next session set for 4 October 1960.

The International Committee wishes to state, however, that it does not foresee any change in the spirit of Article 3 of the International Convention of 6 October 1921, which states the following:

"Each nation may adhere to the present Convention by signifying such adhesion to the French Government, which will inform all the participating nations as well as the President of the International Committee on Weights and Measures of the adhesion. Every new accession to the Convention of 20 May 1875 will carry with it automatically adhesion to the present Convention."

Only the wording should be edited so that this article may be inserted correctly in the new Convention.

The International Committee reminds the high contracting parties of its request for them to address their commentaries on the proposal for modification of the Convention of the Meter and Annexed Regulation before 1 June 1960 to the Director of the International Bureau of Weights and Measures, Pavillon de Breteuil, Sèvres (Seine-et-Oise).

Considering the importance of the questions to be studied, the International Committee decided to postpone until 1 July 1960 the time limit for presentation of these commentaries.

Creation of a Section of Standards of Measure of Ionizing Radiations; Funds for its Installation (Point 6 of the provisional program)

Convocation of February 1960 gave an estimate (pages 14 and 15) of the cost of construction and of equipment of a Section of Standards of Measure of Ionizing Radiations, stating: "The building required to house this laboratory covers 500 square meters, its estimated cost being 600,000 gold francs. The International Committee proposes, then, that the member nations make available a special contribution of 1,395,000 gold francs for building and equipping the proposed laboratory."

This estimate may be changed by the rapid evolution of technology and by a more detailed study of the project based on the exact location where the laboratory will be built and on the particular uses to which its different sections may be put. The International Committee requests the Consultative Committee on Standards of Measure for Ionizing Radiations to meet in September 1960 for the purpose of establishing a detailed plan of the laboratory. It feels it necessary, however, to impose a limit to the outlays that will be borne by the high contracting parties, since this was already done at the time of the creation of the International Bureau in 1875 (Article 5 of the Annexed Regulation).

Therefore, the International Committee proposes to the Governments to determine that the cost for construction and equipment of the new laboratory shall not exceed a total of 1,800,000 gold francs.

#### Miscellaneous Information

In reminding everyone that the Eleventh General Conference on Weights and Measures will open at 15:00 hours on Tuesday, 11 October 1960, at the Ministry of Foreign Affairs, Paris, the International Committee wishes to indicate that the working sessions will be held at 19 Avenue Kléber, Paris 16<sup>e</sup>, and that simultaneous or deferred interpretation will function

in three languages: French, English, and Russian.

30 May 1960

For the International Committee on Weights and Measures,  
Pavillon de Breteuil, Sèvres (Seine-et-Oise):

G. Cassinis,  
Secretary

A. Danjon,  
President.

#### AGENDA OF THE GENERAL CONFERENCE

##### Eleventh Session - 1960

1. Presentation of credentials by the Delegates.
2. Appointment of the Secretary of the Conference.
3. Establishment of the list of nations belonging to the Convention of the Meter and represented at the Conference; indication of the names of the Delegates authorized to vote for each nation.
4. Approval of the agenda.
5. Report of the President of the International Committee on the work accomplished since the Tenth General Conference.
6. Proposal of the International Committee: Creation at the International Bureau of a Section for Standards of Measure of Ionizing Radiations; funds for installation.
7. Proposal of the International Committee: a) Endowment of the International Bureau; b) Establishment of the allocation of contributions (national populations).
8. Proposal of the International Committee: Modification of the Convention of the Meter and its Annexed Regulation.
9. Proposal of the International Committee: Change in the Definition of the Meter.
10. Confirmation of the change in the definition of the second.
11. Absolute determination of gravity. The normal atmosphere.
12. Other works of the International Bureau.

13. Activities of the Consultative Committees.

14. Presentation of a new edition of the text of the International Temperature Scale of 1948; designation of this scale. Scale of the helium vapor-tension thermometer.

15. International System of Units.

16. Report on recent progress of the Metric System.

17. Additional contributions.

18. Other proposals of the Delegates and of the International Committee.

19. Partial renewal of the International Committee.

20. Signing by the Delegates of the new Convention containing the modification of the Convention of the Meter and of the Annexed Regulation.

21. Miscellaneous questions.

FIRST SESSION  
OF THE GENERAL CONFERENCE ON WEIGHTS AND MEASURES

Held at the Ministry of Foreign Affairs  
19 Avenue Kléber, Paris  
at 15:00 hours on Tuesday, 11 October 1960

Mr. Couve de Murville, Minister of Foreign Affairs, opens the session with the following address:

'Mr. President, Gentlemen:

"Tradition reserves to the Minister of Foreign Affairs of the French Republic, guardian of the Convention of the Meter, the privilege of opening the General Conference of Weights and Measures. This is what confers on me the honor of receiving you here today in the name of the French Government and of wishing you a most hearty welcome.

"If I read correctly the Annexed Regulation of this Convention, your conference 'has for its mission to discuss and to promulgate measures aimed to promote the use of and the perfection of the Metric System, as well as to approve the new fundamental metrological determinations that may have been made in the interval between conferences.'

"This present conference is invested with a special importance within the framework just outlined, because two essential subjects are contained in its agenda:

"the adoption of a new definition of the Meter;

"the creation of a Section of Measure of Ionizing Radiations.

"Science and technology have evolved prodigiously since 1875: the result is that the International Bureau of Weights and Measures is called upon to determine increasingly more precise units of measure in a constantly greater scientific domain.

"Thus, after having approved at the First General Conference in 1889 the International Prototypes of the Metric System established at the International Bureau, particularly that of the celebrated Standard Meter in iridium-platinum kept at the Pavillon de Breteuil at Sèvres, your predecessors were called upon to continue their work on these units for the purpose of attaining an ever greater precision as well as to extend

the field of their activities to domains that had not been foreseen when the International Bureau was founded.

"So far as metric measure is concerned, technological progress and studies carried out by the International Bureau have brought you today to abandon the definition of the meter as a standard measure made of iridium-platinum and to replace it with this natural and indestructible prototype consisting of the wavelength of a specific ray of light. With the new equipment specially built for the purpose, which will be put to work at once, it will be possible to obtain a precision of measurement never before equalled of the order of one millionth of a millimeter.

"Within the field of heat, the work carried out according to the instructions of your Conference on very high and very low temperatures has led to the establishment of an International Temperature Scale of constantly greater precision and scope.

"Your predecessors occupied themselves very early in the history of research on the subject with measurements of the wavelengths of light, opening up perspectives for measurements of very high precision that have not yet reached their end.

"In the domain of photometry, a fundamental international unit of measure has been determined, and the coordination of the works of great laboratories has been assured.

"In work on expansion of metals, the efforts of metrologists have resulted in the discovery of Invar, an alloy of highly useful properties that has had a multitude of scientific and industrial applications.

"In electricity, the progress achieved has led the International Bureau to envisage the determination and conservation of units of electric measure. This activity was sanctioned officially in 1921 by a modification to that effect in the Convention of the Meter by which the competence of the International Bureau was extended to cover this field.

"More recently, as a result of the request from the International Astronomic Union, the International Committee on Weights and Measures has taken on the task of resolving the definition of the second. Its work has resulted in a new and more precise determination of this unit.

"Finally, by the natural development of its activity, when the study of ionizing radiations took on a preponderant place in science, the International Bureau was brought at the request of a number of member nations to study the definition of the units of measure and the establishment and conservation of the international standards of measure of these radiations.



"I take this opportunity to recall to you that it was in France that the determination of the first unit of radiation was made, a feat for which the entire world has honored the scientists who established it by giving the unit their name: the curie.

"The question of the measure of ionizing radiations is contained in the agenda of your Conference in the form of a proposal to authorize the International Bureau to create a special section for this measure.

"The international organization founded by the Convention of the Meter in 1875 has thus been directly associated with the progress of science and with its industrial applications. The generalized use of machine tools under their most recent form of automation, the standardization of industrial processes on an international scale, all these achievements result to some extent from the activities of the International Bureau and of your General Conference: for it is thanks to the ever more precise definitions of the units of measure, of the international standards established by the International Bureau, to the work carried on for the account of Governments and of private entities, that the high-precision measuring instruments and apparatus at the base of this industrial expansion have seen the light of day.

"It is well to underline this aspect of international cooperation achieved thanks to the entirely disinterested activities you are good enough to undertake in assembling here every six years to ratify the work of the International Bureau.

"I have no doubt that the dispositions you will adopt will continue to contribute valuable assistance to science and industry. I am equally sure your recommendations will help the Governments of the member nations to adopt dispositions of their own that will improve their legislation in matters concerning metrology. In this respect, I am able to announce to you that France is about to put into effect the resolution adopted at the Tenth General Conference concerning the international system of units of measure.

"Gentlemen, I have the honor to declare open the Eleventh General Conference on Weights and Measures, and I wish you every success in the pursuit of your work."

Mr. A. Danjon, President of the International Committee on Weights and Measures replies as follows:

"Mr. Minister:

"Ever since the month of September 1889, the date of the First General Conference, our sessions have been held at the Pavillon de

Breteuil, which France placed at the disposal of the International Bureau of Weights and Measures in 1876. Since then, however, the importance of scientific metrology has continued to grow, and the number of nations adhering to the Convention of the Meter has continued to increase; as a result, the auditorium at the Pavillon de Breteuil has become too small to hold its delegates. We turned once more to the French Government, and you, Mr. Minister, have been kind enough to place at our disposal for the duration of the Conference this auditorium in which you do us the honor of receiving us. Allow us to thank you for this gracious hospitality and for the moral and material aid you have given us in such generous measure.

"Basic science tends more and more by its applications to govern the world economy; it even influences decisions of a political order. Its progress depends closely on the precision of physical measurements, whence the interest aroused by our work. We are not responsible for the increase in our activity at the same rhythm as the present physical requirements. My predecessors often deplored the modesty of the resources of the International Bureau of Weights and Measures whose role is not only to improve the methods of metrology, but also to unify, by means of comparisons repeated unceasingly, the standards of the various physical measures used in national laboratories. It has been found, moreover, that the development of nuclear research and the competition it has engendered throughout the world have made indispensable the unification of measures of different ionizing radiations, which up to now have not benefited from the international convention, itself limited heretofore to the classic measures of length, mass, temperature, and so on. The International Committee on Weights and Measures hopes the present General Conference will authorize the International Bureau to proceed with the verification of precise measurements in the area of radioactivity of natural elements and radio-nuclides, and of ionizing radiations--X-rays,  $\gamma$ -rays--on neutrons, as well as to conserve their corresponding standards of measure. This proposal answers an imperious need and is supported by an unvarying tradition. All governments look to our decisions in order to establish in their respective countries the laws concerning weights and measures. This confidence accorded our organization for the past 85 years has been merited by the high quality of its personnel and methods, as well as the fact that its operation is free from all non-scientific influence.

"The so greatly desired expansion in our activities will require, of course, an increase in our resources, of which the annual budget is far from following the upward sweep of budgets for science throughout the world these past ten or twenty years. This may bring about a revision of the treaty of 1875, which was amended once in 1921. If it is not necessary to rewrite it completely, it may be useful to revise it under a form to be determined. The conference will be called upon, therefore, to examine a proposal prepared by the International Committee. The enlargement of the laboratories is included also on the agenda.

"I shall speak later at the General Conference of the events that have intervened in the six years since our previous conference. I should like to mention now, however, that India and the Republic of Korea have adhered to the Convention of 1875; Japan, which signed the treaty in 1885, has made the metric system obligatory as from 1 January 1959; India, which adopted the metric system in 1956, is now carrying out a reform of its system of weights and measures that it hopes to complete in 1966. If we take note of these adhesions and decisions, we regret, on the other hand, that Peru, one of the first members, has resigned its collaboration with us. The expansion of a coherent system of units of measure is a collective work in which all countries benefit, even those that do not make a direct contribution to this task. For a country to withdraw is for it to disregard its own true interests as well as those of science.

"During the past six years, the International Committee replaced provisionally by co-optation three of its members: Mr. C. Stănescu, one of our delegates since 1929, because of his death; Mr. R. H. Field and Nobel Prize winner, Mr. M. Siegbahn, by resignation. Their replacements are Messrs. Howlett, Krishnan and Sandoval Vallarta. We mourn the loss of several honorary members of the International Committee: Messrs. J.E. Sears, E.C. Crittenden, M. Chatelain, W.J. de Haas, and M. Dehalu. All of them have rendered signal services to the Committee, J.E. Sears having been its President from 1946 to 1954 and M. Dehalu its secretary from 1946 to 1952.

"I cannot dwell too long on the scientific work carried out at the Pavillon de Breteuil under the direction of Mr. Volet, as directed by preceding Conferences; but how can I pass over in silence the research directed to prepare for the adoption of a new standard of measure of the meter? The International Meter of iridium-platinum no longer meets the demands of contemporary metrology. The Tenth General Conference requested the great national laboratories to continue their study of monochromatic radiations for the purpose of eventually establishing a new definition of the meter based on the wavelength of a light ray. This research has been pushed forward in various countries as well as at the Pavillon de Breteuil, where Mr. Terrien made a complete study of different radiations. He confirmed with specific details the metrologic advantages of the radiation  $6,057 \cdot 10^{-10}$  m of krypton 86. If the Eleventh General Conference concurs with the Consultative Committee and the International Committee, the International Meter at the Pavillon de Breteuil will be replaced by a krypton lamp and an interferometer. The idea put forth in 1827 by J. Babinet of using a wavelength of light as an indestructible and easily duplicated standard of length will have become a reality after 133 years of effort, and 67 years after the first precise comparison of the length of a light wave to the International Meter. If we want to call this a revolution, we must agree it was one long in the making.

"Already, as a result of the decision of the Tenth General Conference, the standard of time has received a new definition, one that school children may have trouble in remembering "the second is the fraction  $1/31,556,925.9747$  of the tropical year for 1900 January 0 to 12 hours of time of the Ephemerides." Of the three fundamental measures of mechanics, only that of mass is still represented by an artificial standard: the kilogram in iridium-platinum at the Pavillon de Breteuil. At the same time, without bringing down on our heads one of these cataclysms that haunt us and that could well send everything up in smoke, it must be confessed that the invariability of this standard smacks somewhat of the miraculous. It is used only rarely in practice for fear of altering it. Here is a weakness in the metric system that metrologists must overcome sooner or later.

"But there are other more urgent tasks. They must first resolve various problems left unsolved in 1954, as well as certain others that circumstances have brought before us since then. The kind words of welcome you have been good enough to pronounce in opening the Eleventh General Conference are for us, Mr. Minister, a great encouragement for which we are deeply grateful to you."

Mr. É.-G. Barrillon, President of the Conference, delivers the following speech:

"Mr. Minister: Gentlemen:

"The Academy of Sciences salutes you through the voice of its President. It is a great honor for me to find myself in contact with an assembly of scientists in which the spirit of the metric decimal system remains active and alive: the spirit of the French law of 1795.

"Rising to an international level, the Convention of the Meter signed 80 years later is probably the oldest union devoted to the satisfaction of a humanity anxious to understand with precision and to arrive at this understanding by means of debates conducted with complete sincerity and loyalty.

"The articles of the 1875 Convention are still in force for the most part; they have enabled the International Bureau to develop, to fulfil the role assigned to it by Article 7, and to expand in consonance with the progress of science and with the demands to be filled.

"Articles that have proved effective for 85 years may, however, be improved, and one of the points on the agenda of your conference foresees a modification in the Convention of the Meter, a modification for which you should draw up your directives by accepting the responsibility of decisions embracing a span of 80 years; for such is the duration of the valuable steps in the development of the principles so dear to you.

"A scientifically more important question will be put to you: it is that of the meter. The Ninth General Conference had already recommended the continuation of research in search of a new definition of the meter based on the wave length of a light ray. Technically, the results may be summarized in a few words.

"One hundred years after J. Babinet, the direct comparison was possible of a material length with a light wave for a path difference of 100 millimeters. This path difference was brought to 500, then to 750 millimeters, and even to one meter, by the use of a radiation approaching infrared. Such was the situation at the time of the Ninth and Tenth General Conferences.

"The Tenth Conference renewed the invitation to continue the research on monochromatic radiations in order for the present Conference to be able to make a definite decision. These studies have now been finished, and you will be asked to express your confidence in the International Committee on Weights and Measures, which proposes, with full knowledge of what it is doing, a new definition of the meter. This definition extends to nine figures.

"The definition of the second of time, which has already been adopted, contains 12 figures. It will thus be easier for school children to remember the definition of the meter than that of the second; and if we consulted them, it is probable they would vote in favor of the new definition of the meter!

"I hope you will show by your votes that if the truth comes often from the mouths of babes, it comes always from those of metrological scientists. I also hope you will join with me on this occasion in recognizing the value and the perseverance of the scientists who have at last reached this long-awaited result, and especially in thanking the President of your International Committee. You have had the occasion to appreciate his qualities as stimulator and organizer. He knows better than anyone the difficulties that arise when it is desired to obtain from foreign colleagues results of their observations that can be compared directly to those a person makes himself. He knows better than anyone at the International Bureau of Weights and Measures how to stimulate physicists and metrologists; he knows better than anyone at the Bureau International de l'Heure how to stimulate astronomers and radio-electricians. In placing him at the head of the International Committee, you have obtained for yourselves the man you need; this man has given himself over to your service.

"I conclude by welcoming the representatives from India and from the Republic of Korea, who join for the first time in your austere work. They are certainly animated, as you are, with the spirit of our family: 'For all of time and for all peoples.'"

After a short intermission, Mr. É.-G. Barrillon, as President of the Academy of Sciences of the French Institute, takes over the presidency of the working sessions.

Mr. Gascuel informs the Delegates of the invitation of the Minister of Foreign Affairs to a reception to take place at 18:00 hours on 11 October, and to the Opera on 19 October.

At the suggestion of Mr. Danjon, the Conference decides to address a message expressing their wishes for speedy recovery to Mr. A. Pérard, Honorary Director of the International Bureau of Weights and Measures, who presided with great success over the working sessions of the Tenth General Conference. Mr. Pérard had been designated as Chief of the French Delegation; however, immobilized at a distance from Paris by his state of health, he was forced to excuse himself from the appointment<sup>1</sup>.

1. The delegates of the member nations deposit their credentials at the office of the Conference.

Mr. Arutunov (U.S.S.R.) makes the following statement:

"The Soviet Delegation salutes the Eleventh General Conference and wishes it success in its important work.

"The U.S.S.R., which is one of the founding nations of this organization, has always followed with profound respect and great attention the work of the International Committee of the International Bureau; and it has always considered it a duty to participate in its work. We are sure that the work of the present Conference will be crowned with success.

"Nevertheless, it is regrettable that there are not among us, to take part in our deliberations, the representatives of the German Democratic Republic, because the French Ministry of Foreign Affairs has not thus far granted an entrance visa to the scientists from that nation.

"This fact is even more regrettable for our being very well acquainted with the scientists from the German Democratic Republic, who have made their own contribution to the solution of a whole series of problems in metrology. This is not a case, moreover, of tourists coming to France, but of the participation of the delegation of a sovereign state in the work of an international organization of great importance, of which the activities are guaranteed by the Convention of the Meter that is in force.

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<sup>1</sup>The International Bureau learned with great sadness of the death of Mr. A. Pérard at Valence on 21 October 1960.

"In expressing our regret on this subject, we believe it is not yet too late, however, to remedy this state of affairs; and we hope that the competent French authorities will reconsider their decision and make it possible for the delegation from the German Democratic Republic to take part in the work of this General Conference.

"Allow me to salute once more the General Conference and to wish it success in its work."

The President remarks that efforts have been made by the International Committee on Weights and Measures to make it possible for all members of the Conference to take part in it; the office of the Conference will do all it can to facilitate the arrival of the absent delegates.

2 and 3. Mr. Cassinis, Secretary of the International Committee on Weights and Measures, is elected Secretary of the Conference by acclamation. He proceeds forthwith to the roll call of the nations participating in the Conference, asking as he does so that each delegate who has received the right to vote indicate his name.

The list of delegates authorized to vote is as follows:

Argentine (Republic of)	Messrs. Isnardi
Australia	Esserman
Austria	Stulla-Götz
Belgium	The Ambassador or, in his absence, Mr. Jacob
Brazil	Camardella <sup>1</sup>
Bulgaria	Kovachev
Canada	Howlett
Czechoslovakia	Dostal
Denmark	Jensen
Finland	Mäkinen
France	Fleury or, in his absence, Mr. Viaud
Germany	Vieweg
Hungary	Honti
India	Krishnan
Ireland	Lennon
Italy	Cassinis (delegates his powers to Mr. Perucca)

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<sup>1</sup>Mr. Camardella arrived a few moments after the establishment of this list.

Japan	Messrs. Sato or, in his absence, Mr. Kitera
Korea (Republic of)	Kim
Netherlands	de Boer
Norway	Koch
Poland	Wojtyla
Portugal	de Alcantara Carreira
Roumania	Cizmas
Spain	Torrontegui
Sweden	Swensson
Switzerland	König
Thailand	The Ambassador or, in his absence, Mr. Watanakun
Turkey	Çarikli
U.S.S.R.	Arutunov
United Kingdom	Sutherland
United States of America	Astin
Uruguay	Palacios <sup>1</sup>
Yugoslavia	Gizdic

Thirty-three nations are represented, therefore, out of the thirty-six adherents to the Convention of the Meter.

#### 4. Approval of the Agenda

The International Committee proposes to change the order of presentation of the different points on the provisional agenda (page 11), in order to clarify discussions. The new agenda established by the Committee (page 22) is approved unanimously.

Mr. Danjon remarks that the proposals concerning the revision of the Convention of the Meter are numerous and varied; it would be useful, therefore, to appoint a work group charged with studying and presenting to the Conference a proposal capable of achieving unanimous acceptance. In order for this work group to get under way with its task without delay, he proposes that it be named immediately. The Conference accepts the creation of this work group and its composition as proposed by the International Committee.

#### Composition of the Work Group

President: Mr. de Boer, Member of the International Committee  
Messrs. Camardella (Brazil)  
Van Heuven (United States of America)

<sup>1</sup>Mr. Palacios arrived only for the second session.



Gascuel (France)  
Krishnan (India)  
Barrell (United Kingdom)  
Makarevich (U.S.S.R.)

5. Mr. Danjon, President of the International Committee on Weights and Measures presents the following report:

Report of the President of the International Committee on the  
Work Accomplished Since the Tenth General Conference

"In compliance with the Annexed Regulation of the Convention of the Meter, the International Committee on Weights and Measures 'is in charge of the direction of the metrological work that the high contracting parties may decide to execute jointly'; it may also 'call on specialists in metrological questions and coordinate the results of their work'; and finally it is required to present a report of the work accomplished to the General Conference. It is this report that I have the honor to present to you now.

"The activity of the International Bureau of Weights and Measures has continued to increase during the six years just ended. This is the normal consequence of technological developments throughout the world and of the increasingly greater demands for precision. But the outstanding feature of present tendencies is that the role of international coordinator of our organization is being constantly increased. The International Bureau has become the accepted and uncontested center where the delegates of the metronomic laboratories of the different nations meet to coordinate their efforts and to discuss the results of their metrological work. This cooperation of specialists takes place in the consultative committees created by the International Committee, six of which are now in existence. Each of these consultative committees is presided over by a member of the International Committee. It is the International Bureau that prepares and organizes the meetings at the Pavillon de Breteuil; it assures also the publication of the minutes of the sessions and of the papers presented at them.

"The means at the disposal of the International Committee are not limited, therefore, to the laboratories of the International Bureau: it is able to execute its coordinating function by collaborating with the great national laboratories in defining units, in choosing physical standards, in perfecting methods of measurement, and in maintaining uniformity in the results of measurements. As you will be informed shortly, this function is exercised today in the following domains of physical dimensions: length, mass, time, electric and photometric measures, and temperature. It will be extended without difficulty, provided you accept

our proposals, to measures of ionizing radiations, X-rays,  $\gamma$ -rays, radiations of radionuclides, and neutrons.

"Having recalled to you the means at our disposal, let me now report on the principal results obtained during the past six years.

Length. You requested that a new definition of the meter be prepared. In 1957, the Consultative Committee for the Definition of the Meter presented its unanimous conclusions, which allows us to submit for your approval the proposal for a definition of the meter based on the wavelength in a vacuum of a nondisturbed atom of krypton 86. This choice from among the different radiations proposed by various national laboratories is justified by a comparative study made at the International Bureau. Other studies made at the International Bureau as well as in Germany have provided us with the necessary results to permit recommendation of the regulations for the use of the krypton lamp.

"The International Bureau has prepared itself to meet the requirements of increased precision demanded by this new definition. After several years of study, an interferential comparator has been perfected to achieve the direct measurement of the standard graduated measure by means of the standard wavelength. This comparator is equipped with photoelectric microscopes with a sensitivity of one micron. It will be enclosed in a hermetically sealed unit in which the temperature will be maintained uniform and constant to within a few thousandths of a degree. You may inspect the comparator at the Pavillon de Breteuil.

"The possibility of an even more precise definition of the meter should be foreseen as a result of the recent work at the U. S. Bureau of Standards in Washington. Therefore, the International Bureau is preparing to carry out further experimental work. It will be able to produce interferences in a vacuum for testing and comparison of visible, ultraviolet, and infrared radiations.

"A number of national standard meters have been recalibrated; namely, Nos. 18 and 23 (Germany), No. 20 (Australia), No. 1 C (Belgium), No. 22 (Japan), No. 19 C (Holland), No. 6 C (Roumania), No. 16 (Great Britain), and No. 11 (U.S.S.R.). The International Bureau measured the length of these standards before and after recalibration. The precision of these measurements was improved thanks to a complete comparison with the meters in use at the Bureau, several of which were also recalibrated, and to a new addition to the International Prototype Meter.

"All these determinations, together with those made on measures in steel, nickel, or various alloys show that the imminence of adopting a wavelength as the expression of the meter has not diminished the interest in standard graduated measures.

"In addition, 732 geodesic tapes were measured. The International Bureau will soon be able to measure its 24-meter geodesic base line by means of light interferences.

Masses. The six examples of the international prototype of the kilogram: K 1, Nos. 7, 8(41), 32, 43, and 47, were compared with each other. Two new national standards were examined: No. 56 (Union of South Africa) and No. 57 (India); several others were checked.

"Comparative measurements of the volumetric mass of a stainless steel cylinder were extended to laboratories in Canada, the United States, and Great Britain.

Time. The International Committee promulgated a new definition of the second in 1956 in accordance with the authority given to it by the Tenth General Conference. A Consultative Committee for the Definition of the Second was created in 1956 to discuss the questions of interest to astronomers and physicists concerning a standard time; at the first session held in 1957, this Consultative Committee carefully examined the possibilities offered by standards based on atomic frequencies and considered the research program to be carried out to improve the standard of time.

Electricity. In 1955 and 1957, the International Bureau compared in its laboratories standards representing the ohm and the volt from the great national laboratories; it is now about to begin the succeeding comparison. The Bureau checked the electric standard measures of a number of countries by referring the mean values they maintain to the standards of the Bureau.

"The standards of electric resistance used for the ohm are of Manganin, an alloy that is certainly less stable than pure platinum or mercury. The bureau is patiently improving standards in pure metals and seems on the brink of achieving precise standard measures in spite of the high temperature coefficient of these metals, which has been the cause of failure of previous attempts.

"The Bureau is organizing a comparison of standards of electric capacity through an exchange program with national laboratories as decided on by the Consultative Committee on Electricity in 1957.

Photometry. The International Bureau made comparisons in its laboratories in 1956-1957 of the candela and the lumen of the great national laboratories. The Consultative Committee on Photometry investigated the differences of  $\pm 1$  percent between the measurements based on the primary standard of measure of the candela and studied the research to be undertaken to discover the causes and their remedies. The International Committee approved the proposal of its Consultative Committee

to confide to the International Bureau the task of comparing the standards of temperature colors in addition to those of photometric units.

"The International Bureau assisted a number of nations by means of photometric calibrations and by supplying standard photometric lamps and receivers of approved quality.

Temperature. Research made by the International Bureau has already showed the advantages in stability of precision mercury thermometers encased in fused quartz. Capillary tubes of practically uniform cross-section, which have long been needed, have been obtained recently.

"These thermometers are insufficient, however, for the determination of the temperature of standard measures of length with the degree of precision demanded by the most modern methods of measurement. The International Bureau has just installed a Smith bridge to make possible the use of platinum-resistance thermometers in order to achieve a Practical International Temperature Scale with a precision of better than one one-thousandth of a degree. The bridge is hooked up to all the main rooms of the laboratory.

"The usefulness of the Practical International Scale, which was adopted in 1927 only with reservations, has become more and more evident. Great effort has been expended in its improvement by means of research carried on in different countries and by discussions in the Consultative Committee on Thermometry. You will find in the documentation to be distributed to you the amended 1960 edition of the text of this scale, which the Consultative Committee on Thermometry of the International Bureau has practically completed. Experiments are under way that will make it possible for this scale to match better the thermodynamic scale.

System of Units. The International Committee has established in close collaboration with the national laboratories of the member nations an international system of units whose use will assure uniformity of the legal units of measure.

Ionizing Radiations. The International Committee proposes to include in the program of the International Bureau the coordination of measures of X-rays and  $\gamma$ -rays, radioactive radiations and neutrons, and the definition of the corresponding units. The International Commission of Radiological Units and Measures itself expressed the opinion in 1958 that this field of activity should be turned over to the International Bureau. All the principal national laboratories of standards have expressed also the desire that the International Bureau should become the sole center of official international coordination in the domain of measures of ionizing radiations, and that it should carry out its unifying

activities with the same effectiveness as for lengths, masses, electric and photometric measures, and temperatures. In response to this urgent demand, the International Committee created in 1958, as authorized by the Convention of the Meter, a Consultative Committee for Standards of Measure of Ionizing Radiations, which met twice, in 1959 and in September 1960. In accordance with the recommendations of this consultative committee, a proposal will be made to you by the International Committee at a following session for a program of activity and for the equipment needed at the International Bureau.

"The matters to be discussed at this Eleventh General Conference are too numerous and too important for me to impose further on your time. I shall limit the extent of this report, therefore, and remind you that the work of the International Committee of the International Bureau is published in the minutes of the International Committee for your perusal.

"I shall add only a few words on the absolute measure of the acceleration due to gravity achieved at the International Bureau by the method of free fall in a vacuum as proposed by C. Volet. You know, of course, that any uncertainty of the value of this unit affects the determination of the ampere and of the units of force, of energy, of power, and so on. I shall mention, finally, the experiments of J. Terrien, which will permit the construction of an interferential mercury manometer.

"Whether these achievements were the result of experimental work in the laboratories of the International Bureau or the fruit of collaboration organized by the International Bureau as a center of coordination, the quality and devotion of the scientific personnel of the Bureau and our method of carrying on international tasks with the help of consultative committees are the principal reasons for their success.

"If you decide to extend the field of our activities to include standards of measure of ionizing radiations, we are entirely certain that our activity will be efficacious through the same methods of performing the work, because it will be supported by the small group comprising the permanent staff of the International Bureau for certain laboratory work and by the scientific secretariat of the consultative committees, and because it assures a harmonious collaboration among the national laboratories and the International Bureau.

"I shall finish by citing, as is the custom, the list of official publications of the International Bureau published since 1954, as follows:

- Transactions of the sessions of the Tenth General Conference (1954)
- Recent Progress of the Metric System (1948-1954), by H. Moreau
- Minutes of the International Committee on Weights and Measures, Vol. 24 (1954) to Vol. 26 (1958).

Volume 24 contains the minutes of the 45th session (1954) of the International Committee with 10 annexes; that of the first session (1953) of the Consultative Committee for the Definition of the Meter with 16 annexes; and that of the fourth session (1954) of the Consultative Committee on thermometry with 28 annexes.

Volume 25 contains the minutes of the 46th session (1956) of the International Committee with 12 annexes.

Volume 26-A contains the minutes of the 47th session (1958) of the International Committee with 5 annexes, and that of the fifth session (1958) of the Consultative Committee on Thermometry with 27 annexes. Volume 26-B groups the minutes of the Consultative Committee for the Definition of the Second (first session, 1957) with 14 annexes, of Electricity (eighth session, 1957) with 17 annexes, for the Definition of the Meter (second session, 1957) with 28 annexes, and of Photometry (fourth session, 1957) with 12 annexes.

The minutes contain also the obituaries of deceased members of the International Committee.

The minutes of the first session (1959) of the Consultative Committee on Standards of Measure of Ionizing Radiations were also published.

The minutes of the 48th session (May 1960) of the International Committee will be off the press shortly.

Mr. Arutnov (U.S.S.R.) congratulates the Committee of the International Bureau on its work and predicts that the development and importance of their work will increase rapidly.

He proposes to the Conference a resolution aimed at encouraging other nations to join the Convention of the Meter, especially those in Asia and Africa that have recently achieved their independence.

After a discussion in which Messrs. Jacob (Belgium), Astin (U.S.A.), Gascuel (France), Volet (International Bureau), and de Boer (Holland) take part, it is agreed that this proposed resolution be deposited in written form at the second session for its subsequent examination.

Mr. Danjon invites the delegates who wish to submit to the Conference proposed resolutions to deposit their written texts as soon as possible so the International Committee may have time to examine them and present them to the Conference when point 18 of the Agenda (various proposals of the delegates) is brought up.

6. Creation at the International Bureau of a Section for Standards of Measure of Ionizing Radiations; Funds for the Installation.

The President invites Mr. Astin, President of the Consultative Committee on Standards of Measure of Ionizing Radiations to explain the reasons for the proposals of the International Committee.

Mr. Astin recalls the circumstances that led the International Committee to create a Consultative Committee for Standards of Measure of Ionizing Radiations; he reads Recommendation No. 1 (page 14) issued by the Consultative Committee at its first session (April 1959) and approved by the International Committee in May 1960, which tends to make the International Bureau the sole center for the unification of the units of measure of ionizing radiations and for the establishment of the corresponding international standards of measure.

A second session of this Consultative Committee took place on 22 and 23 September 1960; the report of the International Committee (minutes C.I.P.M., 1960, 28) have been distributed to the delegates. This report and the recommendation contained in it were approved by the International Committee at its session of 10 October 1960. It is noted among other things that the International Committee, thanks to the generous aid from national laboratories, is ready to begin immediately the urgent coordinating action. Specifically, the National Research Council of Canada has agreed to place at the disposal of the International Bureau for a period of one year one of its chiefs, Mr. C. Garrett, a recognized expert in the field of measurement of ionizing radiations. While waiting for the permanent personnel of the International Bureau to be increased by the number of necessary experts, small working groups have been established made up of the finest specialists in the world, who will be able to meet from time to time at the International Bureau in order to counsel the Director in the conduct of the work.

The extent of the laboratories to be built, their geographical situation, and their equipment were studied at the first session of the Consultative Committee; the results of this study were used as the basis for the evaluation of the funds required, which were calculated in a realistic and moderate fashion, and of the proposals presented by the International Committee (pages 14 and 21).

Following these explanations, Mr. Danjon submits to the Conference in the name of the International Committee, which has approved them unanimously, four proposals for resolutions, which are distributed to the delegates.

After an intervention by Mr. Jacob (Belgium) and a discussion in which Messrs. Vieweg (Germany), Volet (International Bureau), and Mr. Cassinis (Italy) take part, Mr. Danjon agrees to add an amendment to the fourth proposed resolution.

In view of the short time remaining for the session, a number of the delegates are of the opinion that the discussions on these four proposed resolutions and the voting on each one of them should be held over to the second session. It is thus decided.

Mr. Danjon calls attention to the document just distributed that contains the list of members leaving the International Committee. This list contains the following names:

-- three members co-opted by the International Committee since the Tenth General Conference: Messrs. Howlett, Krishnan, and Sandoval Vallarta;

-- six members whose names were drawn by lot at the session of 7 October 1960 of the International Committee: Messrs. Astin, Bourdoun Danjon, Esserman, Otero, and Stulla-Götz.

Mr. Danjon expresses the hope that in conformity with tradition, the Conference will agree to reelect these nine department members. These elections will be taken up in point 19 of the Agenda. He requests the delegates to indicate as soon as possible the names of candidates they may wish to propose eventually.

The session adjourns at 1755 hours.



SECOND SESSION  
OF THE GENERAL CONFERENCE ON WEIGHTS AND MEASURES

Held at the Ministry of Foreign Affairs  
19 Avenue Kléber, Paris  
on Wednesday, 12 October 1960, at 15:00 hours

Under the Presidency of Mr. E.-G. Barrillon  
President of the Academy of Sciences of the French Institute

6 (continued). Creation at the International Bureau of a Section for Standards of Measure of Ionizing Radiations; Funds for its Installation

The President opens the discussion on the four proposals for resolutions prepared by the International Committee that were distributed at the first session. He recognizes Mr. Danjon for the reading of these proposals.

The first resolution, which requests the International Committee to organize at the International Bureau a section for standards of measure of ionizing radiations, does not result in any discussion and is adopted unanimously (Resolution No. 1, page 95).

After the reading of the second proposed resolution concerning a supplementary contribution of 1,800,000 gold francs destined to the enlargement and equipment of the laboratories for standards of measure of ionizing radiations, the Japanese delegation proposes an amendment as to the way in which this supplementary contribution should be distributed, with the object of taking into account national income. The Turkish delegation requests also that the distribution be discussed at the same time as the total amount of the supplementary contribution.

Mr. Danjon makes the point that, according to the Agenda, the method of distribution of the contributions belongs to point 7. The present question before the Conference concerns the creation of a section for ionizing radiations and the total funds necessary for it; it is independent of the mode of distribution. The contribution under discussion contains nothing exceptional except for its limited duration of two years; it is added to the annual budget, and it is clear that the text of the proposed resolution implies an identical distribution with the annual contribution. It is, therefore, at point 7 that the Conference should discuss the mode of distribution of the contributions in accordance with the Agenda it adopted at the first session.

Mr. Astin supports the preceding observation and insists on the need to determine separately the total contribution the International Bureau will need, without considering for the moment the mode of distribution, which will be examined under point 7.

The vote on the proposed resolution presented by the International Committee is 27 in favor and 3 against. However, all three of the delegations that voted against it, those of Japan, the Argentine Republic and Turkey, state they did not wish to express an opinion contrary to the principle of the creation of the laboratory; their vote expresses only a reserve as to the mode of distribution<sup>1</sup>. In view of these explanations, there is no longer any opposition to the proposal of the International Committee, which is thus approved without an opposing voice (Resolution No. 2, page 96).

The third proposed resolution concerns taking charge of the international standard of radium by the International Bureau.

Mr. Volet (International Bureau) explains that a first international standard of radium was deposited at the Pavillon de Breteuil in 1913. This standard was replaced in 1939 by a second international standard, No. 5430, which remained in the custody of the International Bureau of Weights and Measures until 1940, at which time it was transferred to a safer place. It was brought back later to the Radium Institute of the University of Paris, which is its legal owner. Standard No. 5430 is at present without a well-defined international status; therefore, the Radium Institute has stated that it is willing to place it in the hands of the International Bureau under conditions that remain to be determined. The International Bureau proposes that the Conference adopt the proposed resolution that has just been read in order to legitimize this operation.

Put to vote, this resolution is adopted unanimously (Resolution No. 3, page 96).

The fourth proposed resolution distributed at the first session "requests the International Committee to undertake without delay the research necessary to determine in precise fashion certain units and notions utilized in the field of ionizing radiations and gives the International Committee the power to decide on these points."

Taking into account the observations of Mr. Jacob (Belgium) and the discussion that took place at the end of the first session, the International Committee modified the end of its proposed resolution as follows:

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<sup>1</sup>This reserve ceased to have any reason for being after the adoption at the fifth session (page 84) of a new mode of distribution.

"gives the power to the International Committee on Weights and Measures to make decisions on this matter, which will be submitted for approval to the Twelfth General Conference."

Thus amended, the resolution is adopted unanimously except for Belgium, which declares it abstains from voting (Resolution No. 4, page 97).

As a complement to the four resolutions that have just been adopted, the delegation from Great Britain proposes the adoption by the Conference of the following resolution:

"The General Conference on Weights and Measures,

"accepts the offer of the International Atomic Energy Agency to co-operate with the International Bureau for the purpose of establishing standards of measure of ionizing radiations,

"and requests the Director of the International Bureau to initiate conversations as soon as possible with the Director of the International Atomic Energy Agency in order to decide on the best way to coordinate the programs of the two organizations and to render a report to the International Committee on Weights and Measures."

Mr. Danjon makes the point that the International Committee took the initiative in requesting the participation of the International Atomic Energy Agency in the work of the Consultative Committee on Standards of Measure of Ionizing Radiations; it neglected nothing that might promote this participation and decided not to depart from this line of conduct. The Agency remains inscribed as a member of the Consultative Committee. If this Agency has not believed it should be represented on the Consultative Committee other than by an observer, this is no fault of the International Committee. Mr. Danjon proposes, therefore, that the examination of the proposed resolution of the United Kingdom be held over to point 18.

The delegation from the U.S.S.R. feels it is useless to return to this subject, which is stated in general but sufficiently specific terms in Resolution No. 1 concerning the creation of a section for ionizing radiations as adopted by the Conference.

Mr. Astin as President of the Consultative Committee on Standard Measures of Ionizing Radiations and Mr. Danjon as President of the International Committee insist once more that the desire to maintain relations with the Agency is specifically mentioned in the official texts approved by the International Committee, and that the General Conference has approved the action already undertaken by the International Committee.

The delegation from Great Britain, finding that three delegates have expressed opinions contrary to its proposal and that nobody has come forward to support it, withdraws the proposal.

Examination of the Proposed Resolution of the U.S.S.R. and of Roumania Presented at Point 5 of the Agenda. At the request of the delegation of the U.S.S.R., the following resolution, the text of which has been distributed to the delegates, is examined:

"The Eleventh General Conference on Weights and Measures,

"taking into consideration the report of the President of the International Committee on Weights and Measures on the activity of the Committee during the period 1954-1960,

"considering that the development of contemporary sciences and technology requires the increasingly greater use of the metric system,

"expressing satisfaction for the increasing number during recent years of Asiatic and African nations that have embarked on the path of independent development,

"invites all nations that are not yet members of the Convention of the Meter to adhere to this Convention,

"and suggests that all member nations of the Convention exercise their influence in this direction by using their scientific, technical, and economic relations."

Mr. Danjon reports the conclusions of the International Committee, which studied this proposal and modified it in the following manner:

The third paragraph "expressing satisfaction..." is deleted and replaced by the words "and especially the nations that have been formed recently," which are added to the succeeding paragraph in order to eliminate any risk of interpretation in a political sense, since the General Conference on Weights and Measures should maintain carefully its position of neutrality, which is one of the reasons for its authority in metrology.

The delegations from the U.S.S.R., Roumania, Hungary, and Poland do not wish in any way for this resolution to have political overtones; their desire is that an official appeal be launched by the Conference to all nations that are not yet members of the Convention of the Meter.

Mr. Astin (U.S.A.) is of the opinion that this resolution is of no interest to the urgent work of this Conference and adds nothing to the possibilities of the Convention, which is and remains open to all nations.

The delegation from Canada considers that this proposed resolution has nothing to do with point 5 of the Agenda (approval of the report of the President of the International Committee) and that it should be examined under points 16 or 18.

The delegation from Great Britain supports this proposal for adjournment to point 18. Brought to vote, the adjournment is decided by 21 votes against 6.

#### 7a. The Endowment of the International Bureau

Mr. Cassinis begins the discussion with the following statement:

"Article 6 of the Annexed Regulation to the Convention of the Meter stipulates in its first two paragraphs:

'The annual budget of the International Bureau is composed of two parts, one fixed, the other supplementary.

'The fixed portion is, in principle, 250,000 gold francs, but it may be raised to 300,000 gold francs by unanimous decision of the Committee.'

"Since the sum of 250,000 gold francs became insufficient after World War II as a consequence of the devaluation of gold and the increase in the cost of living, the International Committee proposed, and the General Conference decided, in 1954 to increase the fixed portion to 300,000 gold francs.

"The end of the second paragraph and the third paragraph of Article 6 establish among other things:

'It (the fixed portion) is payable by all the nations and autonomous colonies adhering to the Convention of the Meter before the Sixth General Conference.

'The supplementary portion is made up of contributions of the nations and autonomous colonies that entered the Convention subsequent to the said General Conference.'

"It is because of these dispositions that the contributions from the following ten nations: Australia, Brazil, Korea, Dominican Republic, India, Ireland, Holland, Poland, Czechoslovakia, and Turkey, which adhered to the Convention of the Meter between 1921 and 1960, are computed separately.

"These contributions, which are calculated according to the population of each state as for the fixed portion, come to a total of 113,134 gold francs for the year 1961.

"It is thus that the International Bureau can count today on an annual endowment of some 413,000 gold francs.

"This endowment, however, has become totally insufficient, both because of the general economic situation and the need to supply the laboratories of the International Bureau with new instruments and apparatus that will permit them to accompany the present progress in science, and also because of the need to increase the number of physicists and technicians, who are insufficient in number at present.

"These needs have become even more keenly felt and urgent as a result of the creation of the section for Standards of Measure of Ionizing Radiations, which the Eleventh General Conference has just decided on.

"For these reasons, the Committee proposes to the nations an increase in the annual endowment to 900,000 gold francs. This proposal is in accordance with the fifth paragraph of Article 6 of the Regulation, which states:

'If the Committee should judge it necessary either to increase beyond 300,000 gold francs the fixed part of the annual endowment or to modify the calculation of the contributions as determined in Article 20 of the present Regulation, it should inform the nations accordingly with sufficient anticipation for them to be able to give the necessary instructions to their delegates to the succeeding General Conference and thus to allow the delegates to deliberate with the required authority. The decision will be valid only in case no contracting nation will have expressed, or expresses at the Conference, its opposition to it.'

"The proposal concerning the increase in the annual endowment to 900,000 gold francs was transmitted to the member nations in February 1960 in the convocation to the Eleventh General Conference (see page 17); the dispositions of the above-mentioned Regulation have thus been complied with, and the Eleventh General Conference is in a position to decide and approve the proposal that has been submitted to it by the International Committee in the form of a resolution."

The President puts this resolution setting the total of the fixed and supplementary parts of the annual endowment of the International Bureau to a vote; it is adopted unanimously (30 votes in favor and no abstentions) and by acclamation of the Conference (Resolution No. 5, page 97).

Mr. Danjon thanks the Conference in the name of the International Committee for this vote of confidence. He informs the Conference, furthermore, that the Ford Foundation has made a gift of U.S. \$32,500 destined to permit the immediate start of a program of comparison of standards of measure of ionizing radiations at the International Bureau, before the payment of the contributions to be paid in 1962. It is hoped that this example will not only be approved and appreciated, but also imitated; the Conference applauds.

#### 7b. Establishment of the Table of Distribution of Contributions

Mr. Cassinis states that the International Committee, after having been approached by certain nations having a large population and a limited national income, prepared and presented a new scale of distribution of the annual endowment of the International Bureau among the member nations.

This proposal was made in February 1960 in the convocation to the General Conference (see page 13) and was included in the proposal for modification of the Convention of the Meter to which it was annexed (see Annex No. 1, page 106).

The new proposed scale remains based on population and establishes a number of contributive parts ranging from two (for populations of less than five millions) to 30 (for the largest countries). The annual contributions of the nations as calculated by this scale are shown in the table already distributed to the delegates (Table A, page 170).

The proposal of the International Committee considers also the possibility that the General Conference may accord to certain nations that request it a reduction of up to 50 percent in their contribution.

Mr. Jacob (Belgium) reports on the instructions received from the Belgian Government, which forbid him to accept any change in the present rules for distribution.

Mr. Stulla-Götz (Austria) says he finds the increase caused by the new distribution intolerable because it carries a disproportionate surcharge on nations with populations between 7 and 20 millions.

The delegates from Japan and Turkey request that the regulations for distribution based on population be corrected and completed by taking into account national income.

The delegate from Portugal feels also that the distribution proposed by the International Committee increases excessively the

contribution of his country; he is ready, however, to examine other proposals.

Mr. Honti (Hungary) considers that time is lacking for the examination of the large number of proposals that have been submitted, which differ even in their basic principles, and wishes debate to be adjourned.

Mr. Arutunov (U.S.S.R.) supports the request of Hungary for adjournment.

The delegate from Czechoslovakia finds unacceptable the proposal of the International Committee and would like the Roumanian proposal to be examined (Annex 2, page 124).

Mr. Krishnan (India) thinks that population should not be used as a criterion in the contributions; another criterion should be found.

The delegation from Spain feels it logical to consider the income per inhabitant rather than the nation's capacity to pay (a term employed by the United Nations to designate what is called at this session the overall national income).

Mr. Danjon says that the International Committee was obliged to present first the proposal that had been communicated to the nations, but that he is ready to support other proposals. The Committee would look favorably, for example, on a distribution of the contributions established according to the scale of the United Nations with a maximum of 15 percent and a minimum of 0.5 percent (Table B, page 170), or with a maximum of 10 percent and a minimum of 0.5 percent (Table C, page 170), both of these modes of distribution being based on national income.

The session is then adjourned temporarily to allow the delegations time to examine the various scales of distribution that have been proposed and to consult on them.

When the session reconvenes, Mr. Danjon proposes that a vote be taken successively on three of the proposed scales (Annex No. 4, page 170): Table A established according to the regulations of the initial proposal of the International Committee, Table B, and Table C.

He points out that a single contrary vote suffices to stop the entire project.

Mr. Arutunov (U.S.S.R.) maintains that only the proposal of the International Committee was presented in advance in conformity with Article No. 6 of the Regulation; unanimity does not exist, however, on this proposal.



The only solution in his opinion is for the International Committee to reexamine the question, and to make a new proposal; then, perhaps, it will be possible to arrive at a conclusion without having to wait six years because of one vote sent in by mail. He points out also that other proposals exist, that of Roumania, for example (page 150).

Referring to Article 6 of the Regulation, Mr. Danjon deduces that the vote on the distribution should take place at the Conference and not by correspondence. If unanimity is not reached, it will be necessary to wait for the Twelfth General Conference.

He wishes to eliminate the proposals that have no chance of being accepted by means of a provisional orientational vote in order to simplify the task of the International Committee in searching for a solution.

Mr. Jacob (Belgium) requests that time be left to the delegations to come to a decision at leisure rather than during an intermission of the session.

Mr. Astin (U.S.A.) is in full agreement with Mr. Danjon; in order for the Committee to be able to work, objections must be known.

Mr. Vieweg (Germany) returns to the proposal of Mr. Danjon for an expression from the General Conference by means of provisional votes of orientation.

Mr. Arutunov (U.S.S.R.) thinks it would then be necessary to vote on all the proposals, but in this case the consultation would risk taking too great a time.

The President then requests the delegations that do not accept the proposal for distribution of the International Committee (Table A) to raise their hands. This vote reveals 10 nays.

He asks the same question on Table B; there are 10 nays. On Table C, there are 8 nays.

The delegation from Roumania supports the distribution proposed by it (page 150).

Mr. Jacob (Belgium) recalls the precedent at the General Conference of 1921. After a proposal of the Committee submitted in advance to the nations, the Conference has the right to deliberate, which signifies that it has the right to examine validly the amendments.

The delegation from Poland insists that account be taken of national income and it supports the request for adjournment of Hungary and the U.S.S.R.

Mr. Krishnan (India) concludes that it will be necessary to correct the present distribution based only on population. The delegates in attendance are scientists, who should be able to find among themselves an equitable criterion for the distribution. Taking Tables B and C as the starting point, it should be possible to find a formula acceptable to everyone. He would like the Conference to be consulted on the upper limit of the contributions.

The delegate from the United Kingdom states that his negative vote on Tables B and C expressed an opinion; he is prepared to revise it and supports the remarks of the delegate from India.

Mr. König (Switzerland) indicates that identical problems were met at the International Commission on Illumination. The solution was for half of the contribution to be based on population, the other half on national income; this mode of distribution might be examined by the Conference.

Mr. Volet (International Bureau) expressed the hope that a solution may be found in order to avoid maintaining the status quo until the next General Conference.

Mr. Khrishnan (India) does not accept that the status quo should be maintained; the mode of distribution of 1875 based on population is no more reasonable than if it were based on the amount of rainfall; to give up is unworthy of the scientists gathered here; he is sure a solution can be found.

Mr. Danjon would have liked for the delegate from India to indicate why Tables B and C, which take account of national income were not accepted. He regrets that India does not support the distribution of Table C. The amounts being discussed at present are minute in comparison to the contributions to other inter-governmental organizations. Since Table B has been rejected formally by certain delegations, it cannot be considered. Such is not the case with the distribution in Table C; he requests, therefore, that the delegate from India say what he thinks of this table.

Mr. Jacob (Belgium) sees no reason for not being able to convoke the next General Conference in less than six years.

Mr. Cassinis remarks that a General Conference can cost the nations more than the differences in the contributions that are being discussed at present.

Mr. Krishnan confesses his preference for Table C and states he is willing to accept it.

The delegation from Spain renews its proposal to take into consideration the income per inhabitant rather than the total income of the nations.

Mr. Stulla-Götz (Austria) would like to know what reasons those opposed had for rejecting Tables B and C.

Mr. Arutunov (U.S.S.R.) rejected Tables B and C because it was his opinion that Article 6 of the Regulation does not permit a vote. He again requests that the debate be adjourned.

The delegation from Finland voted against Table C because it prefers Table B; it does not, however, wish to oppose either one formally.

The delegation from Spain is ready to approve Table C after having heard the opinions that have been expressed.

Mr. de Boer (Holland) states that the objections of the USSR on the admissibility of Tables B and C do not appear to him to be valid.

Mr. Astin (USA) thinks the same as Mr. de Boer, that the Conference has the right to deliberate on Table C, for example, and requests that this examination be taken up at another session.

Mr. Danjon asks those opposed to deliver in writing their objections to Table C before the meeting of the International Committee on Friday, 14 October so that the Committee may be informed on the subject. It seems to him that only Table C has any chances of obtaining a unanimous vote and becoming of any use.

The delegate from India requests a second vote of orientation on Table C because the discussion can have changed the attitude of the delegates.

The President then asks what delegates are opposed to Table C or believe it necessary to consult their Government before having the right to express an opinion. They are Belgium, Poland, Sweden, and Switzerland.

The delegation from Poland declares, however, it is not opposed in principle.

Mr. Danjon reminds the Conference that these nations should deposit their explanations before 14 October.

Mr. Isnardi (Argentina) would like a longer delay, four days for example, and that the question be postponed until some of the other items on the Agenda have been examined in order to achieve a complete agreement. Mr. Jacob (Belgium) presents the same request.

Mr. Danjon agrees to adjourn on 18 October, the date which he had previously set at the 14th.

Mr. Gascuel (France) responds to the objection of admissibility of the USSR and states that in his opinion the Conference has the right, according to Article 6 of the Regulation, to deliberate; it is quite obvious that the Conference would find it impossible to work if it were required to limit its examination to proposals made previously by the International Committee without being able to bring up any amendment. It is normal also for the delegates to have to consult with their Government.

Mr. Danjon thanks Mr. Gascuel for the authoritative explanations he has just given to the Conference and expresses the hope that the delegates will have instructions from their Government and be in a position to reply categorically on Tuesday, 18 October.

The meeting adjourns at 18:45 hours.

THIRD SESSION  
OF THE GENERAL CONFERENCE ON WEIGHTS AND MEASURES

Held at the Ministry of Foreign Affairs  
19 Avenue Kléber, Paris  
on Friday, 14 October 1960 at 15:00 hours

Under the Presidency of Mr. E.-G. Barrillon  
President of the Academy of Sciences of the French Institute

At the opening of the session, Mr. Cassinis, Secretary of the Conference, excuses himself for not being able to present the minutes of the two previous sessions.

The President asks Mr. Danjon to open the discussion on the following item on the Agenda:

8. Modification of the Convention of the Meter and Annexed Regulation

Mr. Danjon reminds the members that a work group presided over by Mr. de Boer was set up at the first session. In order to continue its studies, this group needs to receive general directives from the Conference. Its President, therefore, is going to put certain questions of principle to which the Conference will be able to reply by orientational votes. Mr. Danjon insists that the discussion be limited to general directives without discussing in detail the first report of the work group (Annex 3, page 159).

Mr. de Boer wishes to know first of all which are the contracting parties who will agree that the Regulation may be modified by the Conference by means of a unanimous vote if the most important articles in this Regulation, especially those to do with finance, were transferred to the Convention of the Meter itself.

Mr. Arutunov (USSR) indicates that a modification of the Convention is a serious matter requiring reflection. Time is lacking to study all the proposals; neither the delegations nor the work group will have the leisure necessary to examine with the care they require all of the problems that have been put forth. He refuses to make a hasty decision and feels that the work should be continued after the close of this Conference.

The delegation from Roumania would prefer that the modification of the Regulation be decided unanimously by the Conference rather than by a three-quarters majority.

Mr. Danjon recalls that the International Committee sent the first proposal for revision of the Convention to the embassies in February 1960, and that it agreed to study a second proposal after receiving the observations of the nations. Although it had expected to receive them before 1 June, only one had been received by 1 July, the others having arrived too late to make it possible to prepare a second proposal before the Conference.

The intervention of Mr. Arutunov has priority; the Conference should examine it first, that is, it should choose between continuing the study of the Convention or adjourn any decision.

For Mr. Jacob (Belgium), it would be wise to follow the advice of Mr. Arutunov; this, however, would not prevent proceeding with the consultation requested by Mr. de Boer in order to orient the task of his work group. It would be desirable that the powers possessed by the delegates be used to their full extent up to the signature at this Conference of a new Convention; but these powers do not oblige them to sign if the new text is not ready. Mr. Jacob repeats that he would have preferred the creation of a Consultative Committee authorized to obtain the opinion of various other organizations rather than that of an internal work group.

Mr. Fleury (France) exhorts the Conference to advance as much as it can in the task it has been given.

The delegate from Portugal expresses the hope that the Conference will advance in its work; he replies to the question put by Mr. de Boer by giving his agreement to the modification of Article 5 proposed by the work group.

Mr. Astin (USA) stresses the importance of the revision of the Convention and insists also that nothing be done that might possibly hinder the progress of the work of the Conference; he refuses to start out by saying the Conference will be unable to agree on a new Convention.

Mr. Vieweg (Germany) gives his full support to the preceding statement and insists that the President present to the Conference the questions that Mr. de Boer believes useful to the completion of the project.

At the request of Mr. Isnardi (Argentina), Mr. de Boer states again the points on which he would like to know the opinion of the Conference.

Mr. Danjon, after having obtained from Mr. Arutunov confirmation that he would like to postpone the examination of the Convention, observes that this motion for adjournment is incompatible with the desire to continue the consultations as of now. He regrets the time lost uselessly with this discussion and repeats the question of Mr. de Boer: will a modification of the Regulation be accepted on the basis of a majority of three-quarters or unanimity if all the most important articles are included in the Convention?

Mr. Perucca (Italy) would like to know first of all which are the articles of the Regulation that will be transferred to the Convention.

Mr. de Boer foresees that this transfer would embrace, in principle, those dealing with finance.

Mr. Stulla-Götz (Austria) does not feel he can vote without having seen the complete text.

Mr. Krishnan (India) having requested an intermission, the President suspends the session.

When the session reconvenes, Mr. Arutunov requests a vote on the proposal for adjournment.

Mr. Danjon then expresses his wish to examine the situation in consultation with his colleagues of the International Committee; the session is suspended anew.

After this consultation, the unanimous conclusions of the International Committee are presented by Mr. Danjon when the session reconvenes; the International Committee proposes the following:

- 1) that the Conference pass on immediately to the next item on the Agenda;
- 2) that the work group continue its study of the project and remit a new report to the International Committee and to the Conference;
- 3) that the discussion of the revision of the Convention be taken up after all the other items on the Agenda have been completed.

The President having consulted with the Conference, this method of procedure is approved unanimously. (Applause.)

## 9. Change in the Definition of the Meter

The President invites Mr. Howlett, President of the Consultative

Committee for the Definition of the Meter to initiate the discussion of this important question.

Mr. Howlett reads the following report:

"It is a great pleasure and a great honor for me to have the opportunity to make a few observations on the two resolutions the International Committee on Weights and Measures is presenting to you now. If you approve them, we shall realize a dream of metrological science dating back to 1827: the definition of the meter in terms of a wavelength of light. These two resolutions are the product of important work by the Consultative Committee on the Definition of the Meter, and it seems convenient, therefore, to give you a summary of this work.

"At the first session of the Consultative Committee in 1953, certain decisions were taken regarding the road to take in passing from the international prototype of the meter to a new definition based on the length of a spectral wave. Among other things, it was decided to use as the starting point the value of the wavelength in the air of the red ray of cadmium, a value adopted by the Seventh General Conference on Weights and Measures in 1927 and a standard since that time on which all the spectroscopic wavelengths and all the standards of integral measure in the industrial world have been based. The Consultative Committee found it preferable to define in a vacuum the wavelength chosen as the new base for the meter. In order to attain this result, the formula for dispersion of normal air adopted in Rome in 1952 by the Mixed Commission on Spectroscopy was accepted for the purpose of reducing the wavelength of the red ray of cadmium to its value in a vacuum. Since the wavelength of the red ray of cadmium adopted in 1927 was the result of numerous conclusive experiments and since the value agrees with the results of some other experiments effected since that time, it seemed that the continuity of the international meter would not be affected.

"At the second session of the Consultative Committee in 1957, a number of important reports were submitted by national laboratories and by the International Bureau. These reports treated all aspects of the problem concerning the choice of the spectral ray to be used as the new base for the meter. Three spectral rays were suggested: the red ray of cadmium, the green ray of mercury, and the orange ray of krypton. These reports furnished all the information needed to establish the advantages and disadvantages of each ray and the influences of certain disturbances (electric current, pressure, temperature, impurities, and so on) on the length of the wave and on the symmetry of the rays. After numerous serious discussions, the Consultative Committee decided unanimously to recommend to the International Committee that the orange ray of krypton be chosen as the new definition of the meter. The wavelength of this ray in a vacuum was compared with very great precision with the wavelength of the red ray of cadmium, using the decisions mentioned above on the value of



the refraction of the air, and it was possible to establish the number of wavelengths contained in the length of the international meter. After a thorough study, the International Committee accepted the recommendation of the Consultative Committee and prepared the resolution that is now submitted for your consideration.

"Another experiment in this area is of great interest. Recently, the national Research Council of Canada has put into operation a new interferential comparator that makes possible the direct measurement of a graduated meter by wavelengths. Using the new definition of the meter, K. M. Baird of the National Research Council of Canada was able, thanks to this apparatus, to measure four graduated meters, which have recently been verified by the International Bureau. Most happily, these results, even though they are few in number, give assurance that the new definition of the meter will maintain the continuity of the international meter with a precision of better than  $0.2 \mu$  meters.

"Another point is worth stressing; namely, the resolution that will define the new basis of the meter has been prepared in terms that are general and at the same time very precise in order to avoid any possible confusion between the ideal definition and the practical application of its realization. The International Committee intends to recommend from time to time a practical application, taking into account the latest scientific knowledge acquired on this point. The new definition will permit the definition of the meter with a precision of the order of  $10^{-8}$ , which will soon be brought to  $10^{-9}$ .

"In finishing, it is my great pleasure to congratulate and to thank all the scientists of the numerous countries whose research has made it possible for the International Committee on Weights and Measures to prepare the two proposed resolutions that have been submitted to you (see page 16)."

Mr. Arutunov (USSR) presents an amendment to the second proposed resolution; he requests that the following text be added after paragraph 1:

(invites the International Committee) "2) to choose the secondary standards of wavelength for the interferential measure of lengths and to establish instructions for their use."

Mr. Danjon is of the opinion that the International Committee can accept this addition. It does not actually require the International Bureau to prepare lengthy tables of wavelengths, a task that falls to the spectroscopists, but rather to study some of the useful radiations for the interferential measurement of standards of integral measure and

graduated measure, as well as to measure with the greatest possible exactitude the wavelength of these radiations under the specified conditions of the lamp that produces them.

Mr. Lopez-Azcona (Spain) remarks regarding the first proposed resolution that it seems contradictory to him to start with a less precise standard in order to arrive at a more precise one. He proposes, therefore, to eliminate the paragraphs stating: "that the international prototype does not define the meter with sufficient precision for the present needs of metrology," and to modify the succeeding paragraph as follows: "that it is desirable to adopt a more precise natural and indestructible standard."

Mr. Danjon expresses the opinion of the International Committee: the paragraph it is proposed to eliminate is, on the contrary, a justification for the change in the definition of the meter; this paragraph can and should be maintained.

He requests the delegates to examine also the amendment that the International Committee proposes to add to the first proposed resolution in the form of the following supplementary paragraph in which the words between brackets should be eliminated:

"3) The international prototype of the meter authorized by the First General Conference on Weights and Measures in 1889 [is declared to be a historic piece. This standard] will be conserved at the International Bureau of Weights and Measures in the same conditions as those established in 1889."

Mr. Jacob (Belgium) would like it to be mentioned also that the International Bureau remains the custodian of the official measure on request of the nations, of the prototypes of the meter in function of the new definition, and that the Conference authorize the equations of these prototypes; this seems to him important.

Mr. Volet states that the International Bureau has never wished to deny this essential mission; it has consecrated its efforts of recent years to the study of a photoelectric and interferential comparator, perfected quite recently, thanks to which the measure of the prototypes will benefit from the precision accruing from the new definition of the meter.

Mr. Arutunov (USSR) thinks Mr. Jacob's proposal is unnecessary since it is already included in the second proposed resolution in a more general though sufficiently explicit form.

Before the vote on the two resolutions, Mr. Danjon asks the Conference solemnly to realize the scientific importance of its decision.

The 1889 definition of the meter is now 71 years old; the new definition that is proposed is the result of lengthy work of national laboratories and of the International Bureau to all of which he renders his homage.

Mr. Perucca (Italy) recalls that the idea of defining the meter by means of a wavelength of light dates back more than a century. Much work has been done since then, and the precision given by the new definition leaves an incertitude of only a few diameters of the atom.

The President submits to the vote of the Conference the first proposed resolution, completed by the amendment of the International Committee, which establishes the adoption of a wavelength of light as the primary standard of length.

This resolution is adopted by a vote of 31 yeas and no nays or abstentions (Resolution 6, p. 98).

Mr. Danjon points to the time of this historic decision: the definition of the meter has been changed on 14 October 1960, at 18:00 hours.

Then, Mr. Arutunov's proposed amendment to the second project of resolution is voted on; the amendment is unanimously adopted.

The second resolution so amended is unanimously adopted by the Conference with no abstention (Resolution 7, p. 98).

In its enthusiasm, the Conference acclaims and congratulates the President of the International Committee, Mr. Danjon, for this remarkable success.

Mr. Danjon thanks the assembly and reminds them that the success is the result of the efforts of the President of the Consultative Committee for the Definition of the Meter, Mr. Howlett; of the Director and personnel of the International Bureau; especially of Mr. Terrien, who experimented doggedly until the respective qualities of the different radiations proposed as standards were definitely established; and of the national laboratories whose research made possible the production of these radiations.

The sum of this work, which is registered in the publications of the International Bureau, will remain as a more important monument without doubt than the sum total of all the work that preceded the definition of the meter of 1889.

Mr. Jacob (Belgium) having renewed his request for an adjunction specifying that the International Bureau remain in charge of the measure of the equations of the prototypes, Mr. Cassinis observes that Resolution 7 just voted shows clearly that the role of the International Bureau

has not been overturned; it is on the contrary confirmed and extended. In order to be sure that Mr. Jacob's adjunction will not result in a hindrance to the metrological work of national laboratories, Mr. Danjon wishes the International Committee to study the written text at its leisure before giving its opinion (see p. 68).

#### 10. Confirmation of the Change in the Definition of the Second

The President calls on Mr. Danjon, who informs the Conference of the decision the International Committee has taken in accordance with the powers conferred on it by the Tenth General Conference. The change in the definition of the second was ready, or almost ready, in 1954. This is why the Conference gave the order at that time to the International Committee to come to a decision as soon as possible, which it did in October 1956, in adopting a new astronomical definition of the second (p. 16).

The International Committee submits to the Conference, out of courtesy, a proposed resolution destined to ratify this decision.

Mr. Vieweg (Germany) reads a proposed amendment he has prepared in order to support the work proving that the standard of the interval of time based on a transition between two levels of energy of an atom or a molecule can be put in concrete form and reproduced with a very high degree of precision; he requests the International Committee to cooperate with the international organizations interested and to coordinate the work in order to permit the Twelfth General Conference to come to a decision on this point.

Mr. Danjon prefers not to annex any amendment to the proposed resolution of the International Committee, which ratifies a past action. What Mr. Vieweg proposes is of interest to the future. Moreover, the International Committee has already prepared for this future in creating in 1956 a Consultative Committee for the Definition of the Second, grouping together physicists and astronomers, who met in 1957. The conclusion of the Consultative Committee was that an International Radio-Scientific Union (U.R.S.I.) was needed for the comparison of standards of atomic frequency. According to a recent report from Mr. Decaux, President of Commission 1 of the U.R.S.I., the results of comparisons made up to now are encouraging, since the reproduction of these standards

is  $2 \cdot 10^{-11}$  to  $3 \cdot 10^{-11}$ , but the studies have not yet been concluded. At the same time, the number of these standards is still very small, and many of them are under construction; the value of the frequency of the standard of cesium is only provisional, not having yet been accepted by the astronomers. There remains, therefore, a great deal to do, and it

would be regrettable for the Conference, by some sort of ultimatum, to require the International Committee to conclude its work within a strictly limited length of time.

If the definition of the meter has been changed to the satisfaction of everybody, it is because sufficient time was allowed for a thorough study of the disturbances in the wavelength of radiations. This is an example of wisdom to be copied.

Mr. Arutunov (USSR) makes no objection to the amendment of Mr. Vieweg; he prefers, however, to wait until its written text has been examined, and to pass immediately to vote on the proposed resolution of the International Committee. He thinks also that the International Committee should enjoy a certain latitude in its research on the physical definition of the second.

Mr. Astin (USA) considers also that, by analogy with what has been done on the subject of defining the meter, the two proposed resolutions should be separated: first, ratification of the astronomical definition of the second; second, orientation of future work.

Mr. Danjon agrees that after it has been examined by the International Committee, Mr. Vieweg's text should become the subject of a second resolution requesting the International Committee to go to work without delay, but not imposing on it any too rigid instructions (see p. 68). He thinks, moreover, that the Consultative Committee for the Definition of the Second could meet to advantage at the beginning of 1961.

Mr. Danjon reads once more the proposed resolution of the International Committee and finishes by stating that the astronomers are awaiting a physical definition of the second with great interest, since it will allow them to get out of a kind of vicious circle: the movement of the stars can be studied at present only on the basis of time, which itself is defined by the movement of the stars.

The proposed resolution ratifying the astronomical definition of the second decided on by the International Committee is finally adopted unanimously with 29 yeas and no abstentions (Resolution 9, p. 99).

Mr. Jacob (Belgium) insists on the importance of this action by the Conference: it confirms that the General Conference on Weights and Measures is the supreme authority for the basic units of all sizes, since the International Astronomic Union itself recognizes, along with other organizations, this primacy. He hopes this primacy may be extended without hindrance to the domain of ionizing radiations.

The session adjourns at 18:30 hours.

FOURTH SESSION  
OF THE GENERAL CONFERENCE ON WEIGHTS AND MEASURES

Held at the Ministry of Foreign Affairs  
19 Avenue Kléber, Paris  
on Tuesday, 18 October 1960, at 15:00 hours

Under the Presidency of Mr. E.-G. Barrillon  
President of the Academy of Sciences of the French Institute

At the opening of the session, the President indicates that Mr. Cassinis has been delayed in his plane flight and asks to be excused for not being present at this session.

At the proposal of Mr. Danjon, the Conference approves the appointment of Mr. Terrien to fulfill temporarily the function of secretary. Mr. Terrien presents immediately the minutes of the three previous sessions, which have just been distributed to the delegates.

After interventions by Messrs. Mäkinen (Finland) and Arutunov (USSR), the Conference decides that the discussion of the minutes will be preceded by an intermission, and that this discussion will be held over to the end of the present session.

7b (continued). Establishment of the Table of Distribution of the Contributions

Mr. Danjon reminds the delegates that they were asked at the session of 12 October to acquaint this session with their objections to the different tables proposed for the distribution of the contributions of the nations (Annex 4, p. 170). He opens the discussion on this point.

Mr. Mäkinen (Finland) indicates that his country prefers Table B, but will accept Table C if it receives a unanimous vote. He wishes the vote to be taken first on Table B.

Mr. Danjon indicates that he has received from the Belgian delegation the following aide-memoire:

"1) Belgium is in agreement on the extension of the attributes of the International Bureau on Weights and Measures as well as on the repercussions resulting from it in the total amount of the annual operating expenses and of those of the initial installation.

"2) Belgium is opposed to a change in the previous mode of distribution of the contributions of each of the member nations.

"It is, however, ready to accept certain particular modifications of the previous regime of distribution of the contributions, but only on condition that its own share should not be noticeably changed."

This note is equivalent to a veto of the distributions foreseen in Tables B and C.

The delegates from Sweden and Switzerland give their agreement in principle to Tables B and C; the delegate from Poland gives his agreement to Table C.

Mr. Danjon reminds the Conference that Belgium accepts no modification of Article 20 of the Regulation; a change in the distribution of contributions is not longer possible, since unanimity is required for any modification according to Article 6 of the Regulation.

Mr. Isnardi (Argentina) adopts the same position as Belgium.

Mr. Bertrand (Canada) indicates that his Government is in favor of adoption of the scale in force at the United Nations, but it is not in agreement with the establishment of a maximum contribution. If the scale of the United Nations were to be used, it should be used integrally. If, nevertheless, it is the wish of the majority that a limitation of 10 percent or 15 percent be adopted, the delegation from Canada will vote in favor of this proposal in order not to hinder the realization of important scientific work.

Sir Gordon Sutherland (United Kingdom) proposes that before abandoning the study of the question, the Belgian and Argentine delegates should indicate whether their Governments would not be willing to modify their positions.

Mr. Jacob explains the reason for Belgium's decision: the modes of distribution under discussion at present were not mentioned in the proposals sent out in advance by the International Committee to the nations; the Conference cannot, therefore, follow the procedure foreseen in Article 6, paragraph 5 of the Annexed Regulation. These modes of distribution could be discussed, he says, only as a part of the revision of the Convention of the Meter.

Mr. Koch (Norway) presents the following observations:

"It is not a question of procedure, and I would like to say immediately that I am not attempting to influence the mode of distribution of the contributions in one way or another.

"I would like merely to be convinced of the validity of what we have decided and of what we shall decide hereafter; that once this Conference is ended, the lawyers will not find that there is a lack of validity in our decisions.

"Article 9 of the Convention in force at present says: 'that the annual expenses will be covered by contributions of the contracting nations, established according to a scale based on their population.' Fortunately, we read also in Article 12 of the Convention: 'The high contracting parties reserve the right to bring to the present Convention, by common agreement, all the modifications that experience may show to be useful.'

"This is thus, in my opinion, the way for us to respect the clauses of the present Convention and to succeed at the same time in our tasks. But do we not need an appropriate procedure toward this end?

"In spite of all the interest in the studies made by the work group under Mr. de Boer, I fear this work will not help us. I do not believe we shall be able to arrive at the point of signing the final text of the new Convention of the Meter, as Mr. Arutunov said at the beginning of this discussion.

"It is better, therefore, to act in accordance with the Convention in force at present. We are, as Mr. Krishnan said, scientists, and we should be able to arrive at a solution; and I will add a valid solution. With the help of the lawyers present at this Conference, we should be able to succeed."

Taking these observations into consideration, the delegate from Norway indicates that his Government is not opposed to Table C.

Mr. de Boer (Holland) states that the work group he presides over examined the possibility of applying Article 6 of the Regulation and arrived at the conclusion that it is possible to modify the calculation of the contributions, but on condition that there is unanimity on the subject.

Mr. Gascuel points out that the French delegation does not share the point of view of the Belgian delegation concerning the impossibility of modifying the calculation of the contributions. A precedent was established at the time of a previous General Conference, where the total endowment requested by the International Committee was modified by the Conference. He examines paragraph 5 of Article 6 of the Regulation, in which the obligation does not exist in any way for the General Conference to discuss only the proposal of the International Committee.



Mr. Jacob agrees that if the old method of calculation of the contributions is maintained, the part corresponding to India will be very large. He proposes that this nation should benefit from a reduction, but Mr. Danjon remarks that the President of the International Committee does not have the right to decide. Mr. Jacob proposes, then, that a loan be agreed upon for India, which this nation could pay back after the signature of the new Convention.

Mr. Danjon then reminds Mr. Isnardi that the proposal of Argentina is equivalent to a veto.

Mr. de Boer proposes that Belgium and Argentina accept the new distribution of contributions of the nations, and that in exchange they be offered a reduction sufficient for their contributions not to be raised. This would permit avoiding a veto.

Mr. Mäkinen (Finland) considers that the question is not one of making favors to India, but of establishing an equitable scale.

Mr. Isnardi (Argentina) points out that Article 9 of the Convention states that the "contributions of the contracting nations" are "established according to a scale based on their present population." This forbids any modification in the mode of calculation of the contributions.

Mr. Volet (International Bureau) points out that the coefficients adopted by the United Nations take account also of population, which is one of the factors in its calculation.

Mr. Gascuel (France) states that the interpretation he proposed for Article 6 of the Regulation was provided by the legal service of the Foreign Ministry, and that Article 6 of the Regulation has the same weight as Article 9 of the Convention.

The delegate from Portugal recalls that the General Conference should examine also the proposed modifications of the Convention and of the Annexed Regulation; the present discussion could, therefore, be adjourned and taken up again after examination of these other questions.

Mr. Çarikli (Turkey) remarks that an agreement was in prospect and proposes that the two nations in opposition attempt to find a solution between now and the next session.

Mr. Mäkinen (Finland) supports this proposal and hopes in the meantime the General Conference will vote on Table B.

Mr. de Boer (Holland) supported by the delegate from Japan asks if his proposal concerning the contributions of Belgium and Argentina could not achieve a unanimous vote. Mr. Astin (USA) supports this proposal and notes that the amounts in question are quite modest.

Mr. Isnardi states that he has the power to vote on all questions, but that his Government may immediately review his vote. If he voted differently on the mode of calculation of the contributions, his Government might not ratify his vote.

Mr. Astin notes that the same situation exists for the United States where Congress must approve the allocation of the funds representing the contribution of the U.S. to the endowment of the International Bureau.

Mr. Volet feels that the proposal of Turkey is very wise and insists on the fact that Table C is the result of a laboriously studied compromise. He thanks Canada for its understanding position and notes that the nation suffering most from the proposed system, Switzerland, has agreed to accept it and submits to it. As for Argentina's contribution, it would be only slightly modified by the new mode of calculation.

Mr. Vieweg (Germany) thinks the position of Argentina would correspond to that of an approval subject to confirmation by the Government. Such a position already existed at the 1954 General Conference. Mr. Isnardi agrees with this interpretation.

Mr. Danjon finds, therefore, that Argentina does not oppose "the contrary opinion," which would be equivalent to a veto. Addressing himself to the delegate from Belgium, he asks him if he could not reconsider his position; Mr. Jacob replies that this cannot take place before the conclusion of a new Convention.

Mr. de Boer suggests that Belgium could abstain, which would permit application of Article 6 of the Regulation.

Mr. Wojtyla (Poland) indicates that he has received orders to vote in favor of the proposals most useful to Poland. He prefers the proposal presented by Roumania (p. 150), but he would be in favor of Table C, which has the majority in favor of it. Belgium could, therefore, make a conciliatory gesture by abstaining from voting.

Mr. Jacob refuses and points out that the proposals of Austria (p. 125) and of Roumania have not yet been discussed.

Mr. Gascuel, noting that the increase foreseen for Belgium is minimal, asks if the proposal of Mr. de Boer could not be successful; he asks Mr. Jacob to attempt to obtain from his Government through the good offices of the Belgian Ambassador, the authority to abstain.

Mr. Danjon suggests that the French Ambassador in Brussels intervene with the Belgian Government, and Mr. Gascuel then asks Mr. Jacob for authority to effect an intervention in this sense. Since Mr. Jacob has no objection to this, and since the General Conference gives its approval, Mr. Gascuel undertakes this mission.

10 (continued). The Standard of Time: Examination of the Proposal Presented by Mr. Vieweg

Mr. Danjon submits the proposed resolution established by the International Committee on the atomic standard of measure of the interval of time, in deference to the proposal presented by Mr. Vieweg at the third session (p. 61). He indicates in this respect that the International Committee intends to convoke in the near future the Consultative Committee for the Definition of the Second in order to examine the results obtained in this domain.

Mr. Højgaard Jensen (Denmark) would prefer that the word unit rather than standard be employed in this resolution. Mr. Danjon gives the reasons for which it is convenient to preserve the word standard, since there is no question of a modification in the unit of time, and since the situation concerning the second is entirely similar to the one that existed for the meter. Mr. Højgaard Jensen states that although he would have preferred the word unit, he will not oppose the proposed text.

Mr. Avčin (Yugoslavia) would like that there be a text explaining to the public at large the new definition of the second. He requests Mr. Danjon to be good enough to prepare such an explanatory note.

Mr. Danjon indicates that he wrote an article in an Indian magazine (New Astronomical Definition of Unit of Time, Metric Measures, 2, No. 5, pp. 3-5, 1952) and that it could be used for the proposed purpose.

Mr. Jacob indicates that this article has been retranslated and published in French by the Belgian Metrological Service. He hopes, at the same time, that the General Conference will agree to give the primary schools the old approximate definitions of the meter and the second, reserving the exact definitions for the students in secondary schools and universities.

Mr. Avčin thanks Mr. Danjon for his information and would like to have the article in question widely disseminated among teaching staffs in high schools<sup>1</sup>.

No other observations being presented, the resolution of the International Committee regarding the atomic standard of the interval of time is adopted unanimously (Resolution 10, p. 100).

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<sup>1</sup>Mr. Danjon's article was mimeographed and put at the disposition of the delegates at the fifth session.

9 (continued). Definition of the Meter; Examination of the Amendment Proposed by Mr. Jacob

Mr. Danjon presents a proposed resolution prepared by the International Committee according to the amendment proposed by Mr. Jacob at the third session (p. 59). Mr. Jacob is in agreement with the proposed resolution, of which the last paragraph is changed slightly during the session to conform to a suggestion by Mr. Volet. This resolution is adopted unanimously (Resolution 8, p. 99).

Mr. Howlett presents the first instructions established by the International Committee for the practical application of the new definition of the meter (p. 98, footnote 1).

Mr. Arutunov (USSR) makes certain remarks concerning the use of the krypton lamp and proposes that account be taken of them when the International Committee comes to prepare more complete instructions. Messrs. Danjon and Howlett give their agreement on this point.

11. Determination of the Absolute Value of Gravity. The Normal Atmosphere.

Mr. Volet (International Bureau) reads the proposed resolution prepared by the International Committee concerning the gravimetric system referred to. He stresses that it would be preferable to await the results of measurements being made at present before proposing a new reference value for  $g$ .

Mr. Arutunov would prefer making as of now a correction of 13 milligals in the values expressed in the Potsdam System. The USSR has already adopted for its own internal use a modification of 12.8 milligals; this modification could be very useful for metrological work in which  $g$  intervenes.

The delegate from Denmark agrees with the proposed text of the International Committee, but he would not like to see any change in the definition of the normal atmosphere in newton per square meter.

The resolution on the gravimetric reference system is finally adopted unanimously (Resolution 11, p. 100).

Mr. Volet makes certain observations regarding the normal atmosphere. He notes that this unit of pressure does not form part of the International System of Units (SI) and that every modification in the gravimetric reference system will cause a slight change in the value of

certain fixed thermometric points if the numerical expression of the normal atmosphere is not modified.

## 12. Work of the International Bureau

Since the overburdened Agenda of the Conference does not permit a detailed report of the work carried out at the International Bureau from 1954 to 1960, Mr. Volet requests the General Conference to refer to the report presented by the President of the International Committee (p. 34) in which the principal activities of the International Bureau during this period were passed in review.

## 13. Activities of the Consultative Committees

Mr. Vieweg, President of the Consultative Committee on Electricity presents the following report:

"The report presented to the Tenth General Conference on the work of the electrical section of the International Bureau ends thus: 'Thanks to its equipment and to the standards in its custody, the International Bureau can determine with great precision the value of standards of resistance of  $1\Omega$  and of the Weston elements it has been asked to study.'

"It is on the basis of this pleasing situation that the Consultative Committee on Electricity held its eighth session in 1957 at the International Bureau. This Consultative Committee, composed of specialists from eleven countries, examined carefully the results of the international comparisons of electric standards made in 1953 and 1955. According to the reports presented, it was possible to observe that the units conserved at national laboratories are practically identical.

"There was a general desire, for this reason, to maintain intact the present values of the units until the results of new absolute measures could be examined, and to postpone until 1953 the unification of electric units on the basis of improved values, or--foreseeing the accumulation of work before the Eleventh General Conference--to put it off until a later date (1961).

"Regarding future international comparisons of electric standards, the question was discussed of the frequency of this work, which has been set at every two years up to now. In view of the excellent stability of the standards, it was decided to increase the period between comparisons to three years in order to expose the traveling standards less frequently to the risks of transportation, and not to start the new

comparisons before the results of the previous ones had been examined. In accordance with a decision of the International Committee in 1958, an international comparison of standards of resistance and of electromotive force will take place in 1960.

"Within the framework of realization of comparison of electric units, it was decided to organize, in liaison with the International Bureau, a circular comparison of traveling standards of capacity. Seven standards of the same nominal value (0.1  $\mu$ F), furnished by four of the large national laboratories, will be measured obligatorily by nine laboratories interested in this comparison. This important comparison, started by the Leningrad Institute of Metrology, then by the Deutsches Amt fur Mass und Gewicht (German Bureau of Mass and Weight) in Berlin, is being carried out at present by the Physikalische-Technische Bundesanstalt (Federal Physical-Technical Institute) in Braunschweig; it will probably continue for some years, since the participating laboratories have their headquarters in different regions of the world.

"The work on the absolute units has made progress in several laboratories as a result of research carried out on materials used for the standards and on measuring devices, as well as on new fundamental principles of measure. Seventeen communications were presented on these subjects at the 1957 session of the Consultative Committee.

"In the very near future, the Consultative Committee will certainly have to consider increasing needs for more precise measures, scientific as well as technical, in the domain of magnetism, where the possibilities offered by the gyromagnetic relations of the proton will be examined. The Consultative Committee foresees a meeting in 1961."

Mr. Arutunov having asked the Consultative Committee on Electricity if it intended to study questions relating to magnetism, Mr. Vieweg replied in the affirmative; this intention has already been mentioned in the minutes of the 1958 session, page 76, of the International Committee.

In the absence of Mr. Otero, President of the Consultative Committee on Photometry, Mr. Terrien reports on the work of this Committee:

"During the fourth session, held in September 1957 at the Pavillon de Breteuil, the Consultative Committee on Photometry examined the results of the comparison of secondary standards of the candela and the lumen of seven of the large national laboratories, a comparison made by the International Bureau in 1956-1957. This comparison was particularly interesting because, for the first time since 1939, almost all these laboratories had recently calibrated their standard lamps by means of absolute measures on a primary standard: the black body at the fusion point of platinum.

"It was necessary to recognize that the method of achieving and utilizing this primary standard should be improved if it was desired to have photometric units with a precision of better than  $\pm 1$  percent. The necessary studies to achieve the black body have begun; the representatives of the laboratories have communicated their projects, their hopes, and their results, but the task remains difficult. The National Physical Laboratory of the United Kingdom is orienting its research in a different direction to determine if the measure of energy of radiation in watts might not be a surer base for photometric definitions.

"In view of the differences between the photometric calibrations of the national laboratories, the International Bureau attempted to have average values of the units adopted; this proposal was accepted by the laboratories of Germany, France, and Japan, but not by the others, who preferred waiting for the standards to conform more closely to the definitions. The International Bureau is preparing for the fourth international comparison, which will begin in early 1961.

"The heterochrome passage of the candela and the lumen at a higher color temperature can be accomplished by several means: one spectroscopic method, directly inspired by the definitions and probably more exact, was attempted with initial success by the International Bureau; other laboratories have used it, and it seems that systematic errors of 1 percent to 2 percent exist in the results of the old methods. Here again research must continue.

"The comparisons by the International Bureau are made at times on lamps that have come from far away, from Japan for example; specially constructed lamps are perfected there that retain better their photometric calibration; a number of these lamps will be used in the coming comparisons.

"The Consultative Committee proposed, and the International Committee accepted, that the International Bureau organize these comparisons of standards of color temperatures; these standards are actually very useful in laboratories and in taking color photographs. This new work required of the International Bureau represents an important additional burden; it will be undertaken probably in 1962.

"Finally, the Consultative Committee discussed at the 1957 session some ten original papers presented by the International Bureau and the laboratories concerning directly the definition of the units and the methods of measurement in photometry."

After this report, the President proposed the intermission decided on by the Conference so that the delegates may examine the minutes of the preceding sessions.

Before the intermission, Mr. Volet recalls that the Conference will proceed to a partial renewal of the International Committee at the next session; the only proposals for new candidates received up to the moment are those of Messrs. Ferreira (Portuguese) and Georgescu (Roumanian).

#### 14. Practical International Temperature Scale. Scale of the Helium Vapor Tension Thermometer

When the session reconvenes, the President requests Mr. de Boer, President of the Consultative Committee on Thermometry, to present his report on the activity of the Committee, as follows:

"The Consultative Committee on Thermometry held its fifth session in September 1958 at Sévres. A report of the work of this session was published (Minutes C.I.P.M., 26-A, p. T-29, 1958). I will indicate briefly its most important conclusions:

1. Thermodynamic temperature of fixed points of definition on the Practical International Scale. The results obtained in Japan and Germany for the solidification points of gold and silver were discussed; in view of the discrepancy of about one degree in the two results, it was recognized that new experiments were required on the thermodynamic temperature of fixed points on the Practical International Scale. There are probably important deviations in this region between the thermodynamic temperature and the practical international temperature, the former being higher by about  $1.5^{\circ}$  at  $1000^{\circ}\text{C}$  according to German results. This has been confirmed by recent results obtained in the USSR. It is evident that new measurements of the points of solidification of gold and silver will be necessary in order to determine these divergencies with greater precision and to draw conclusions from them for the purpose of a new definition of the practical international temperature within the near future.

"Agreement was reached also to recognize that the solidification point of zinc furnishes a fixed point more easily reproduced than the boiling point of sulfur, and it was decided to adopt the value  $419.505^{\circ}\text{C}$  (Int. 1948).

2. Extension of the Scale beyond the boiling point of oxygen. According to the reports from the Kamerlingh Onnes Laboratorium and from the National Physical Laboratory, it is possible to reproduce a temperature scale with an approximation of  $0.01^{\circ}$  to  $0.02^{\circ}$  by means of a platinum resistance thermometer calibrated at the boiling points of oxygen and of hydrogen. If a third fixed point for an intermediate temperature is



used, for example, the triple point of oxygen, it becomes possible to improve the reproducibility to an approximation of  $0.002^{\circ}$  to  $0.003^{\circ}$ .

"It was agreed to organize an intercomparison of thermometers between the laboratories specializing in this area of temperature, to carry out new measurements of gas thermometers at the triple point of oxygen, and to develop a project for the extension of the Practical International Temperature Scale between the boiling points of  $O_2$  and  $H_2$ .

"It was agreed to use for this work the value of  $20.38^{\circ}K$  for the thermodynamic temperature of the boiling point of hydrogen.

"It was agreed also to adopt for general use between  $0.5^{\circ}$  and  $5.2^{\circ}K$  a temperature scale based on the vapor tension of helium, in accordance with a request from the Commission on Low Temperatures of the International Union of Pure and Applied Physics (Paris, September 1955). This scale is called "Scale <sup>4</sup>He 1958" (Minutes C.I.P.M., 26-A, p. T-190, 1958).

3. Change of name of the International Scale. The International Committee decided in 1956 to give the name of "International System of Units" to the system based on the basic units: meter, kilogram, second, ampere, Kelvin degree, candela. It was noted that this denomination could lead to confusion, since the International Temperature Scale does not form part of the International System of Units. The International Committee, therefore, approved unanimously the new denomination "Practical International Temperature Scale" after consultation in writing with all the members of the Consultative Committee on Thermometry.

4. Revision of the text of the International Temperature Scale. Even though the recent measurements are not yet sufficiently complete to put in force a new definition of the practical international temperature based on new values of fixed points with, if possible, extension up to the boiling point of hydrogen, the Consultative Committee considered nevertheless that the text of the 1948 Scale should be amended. Apart from small details, the most important changes are the following:

1) The Chapter 'Introduction' was abridged by the elimination of the portions of purely historic interest, which are no longer necessary.

2) The fusion point of ice was replaced by the triple point of water in giving it the temperature  $+0.01^{\circ}C$  (Int. 1948).

3) Elimination of the distinction between 'fundamental fixed points' and 'primary fixed points' by adopting the unique designation 'fixed points of definition.'

4) Unification of the equations occurring in the text in order that they all be equations of size and not of numerical values.

5) Use of the symbols  $T$  and  $t$  to designate Kelvin and Celsius thermodynamic temperatures, and the symbols  $T_{\text{int}}$  and  $t_{\text{int}}$  to designate practical Kelvin and Celsius international temperatures.

6) The maintenance of the boiling point of sulfur as a fixed point of definition on the Scale, but recommending the use of the solidification point of zinc with the value  $419.505^{\circ}\text{C}$  (Int. 1948), this point permitting the establishment of this same scale on a more reproducible basis.

"Since all these changes concern only the text and not the numerical values of the temperatures, which remain the same as in the Scale of 1948, the new text was called the Practical International Temperature Scale of 1948, amended edition of 1960."

Mr. Perucca (Italy) proposes that a vote be taken on the amended text of the Temperature Scale, which has been distributed to the delegates in the form of printer's proofs. The "Practical International Temperature Scale of 1948, amended edition of 1960" is adopted unanimously (Annex 5, p. 172)<sup>1</sup>.

## 15. International System of Units

In the absence of Mr. Bourdoun, President of the Commission on the System of Units, Mr. Stulla-Götz presents the report on the International System of Units, as follows:

"One of the tasks foreseen by the Convention of the Meter was the improvement of the metric system and the promotion of its expanded use. This task includes, as was found necessary, the establishment of a practical system of units for international use capable of adoption by all the member nations of the Convention.

"As far back as 1913 at the time of the Fifth General Conference, Charles-Edouard Guillaume, previous director of the International Bureau

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<sup>1</sup>Mr. Astin (USA) abstained from this vote, but after a private conversation with Mr. de Boer, certain misunderstandings were explained to the entire satisfaction of Mr. Astin, who then changed his vote at the fifth session from abstention to a vote of approval.

gave his special attention to the meter-kilogram-second system completed by an electrical unit.

"Presented with a request from the International Union of Pure and Applied Physics, in 1948, the Ninth General Conference took up anew the question and instructed the International Bureau to conduct an official inquiry of the opinion in scientific, technical, and pedagogical circles of all the nations and to report its recommendations regarding the establishment of a practical system of units. In 1954, the Tenth General Conference established the base units of this system, which are well known: the meter, kilogram, second, ampere, Kelvin degree, and candela.

"The International Committee then formed within its body a "Commission on Systems of Units" made up of seven members of the Committee and of the Director of the Bureau, and presided over by Mr. Bourdoun, Vice-President of the Committee on Norms, Measures, and Measuring Instruments of the USSR. The Committee regrets exceedingly that illness has prevented Mr. Bourdoun from presenting personally the report on the work of this Commission and of summarizing the very complete report he prepared (Annex 6, p.189) on the problems involved in establishing an International System of Units.

"The results of the Commission's deliberations and the decisions taken by the International Committee have been assembled in the proposed resolution that will be submitted to you (see p. 101).

"I would like to mention finally that in 1958 the International Committee on Legal Metrology declared its adherence to the resolution of the International Committee on Weights and Measures concerning the establishment of an International System of Units; the Committee on Legal Metrology foresees that the member nations of its organization will adopt this system in their legislation on units of measure."

Mr. Højgaard Jensen (Denmark) proposes that in the list of recommended derived units, the unit of magnetic induction remain expressed in weber per square meter ( $\text{Wb/m}^2$ ), and that the name "tesla" be eliminated. He believes it useful to limit the use of special names for the units; it is not a question of eliminating well-known names of units such as the farad, the henry, and so on, but it is not at all the same for tesla.

Mr. Arutunov (USSR) is not in agreement with the proposal and points out on the contrary the tendency to give a particular and fairly short name to each unit; this is the reason for his nation's proposing the name of "lantz" for the unit of intensity of the magnetic field (amperes per meter). The name tesla, approved in 1956 by the International Electrotechnical Commission and adopted the same year by the International Committee, is employed in Soviet schools.

Mr. de Boer (Holland) supports, on the other hand, Mr. Højgaard Jensen's thesis; he considers that introduction of special names for derived units can only lessen the clarity of the international system. Mr. Perucca (Italy) is of the same opinion.

Mr. Vieweg (Germany) is also of the opinion that the use of new names should be limited; he believes at the same time that the name tesla is already in sufficiently widespread use for it to be conserved.

Mr. Avcin (Yugoslavia) intervenes in favor of conserving the use of the name tesla, which is already contained in the laws of some countries. If its elimination is requested, he would also propose the elimination of the newton.

Mr. Jacob (Belgium) indicates that his nation cannot accept paragraphs 3 and 4 of the proposed resolution, unless a less imperative character is given to them. The decisions of the General Conference have the force of law in Belgium, and this would oblige the Belgian Government to prepare a new law.

Mr. Danjon feels that the General Conference cannot follow the directives of a government. Mr. Volet points out on this subject that there is certainly no international police force to enforce the application of the resolutions of the Conference; these resolutions have the value of recommendations to each of the nations.

Mr. Astin (USA) considers that this discussion is complicating the task of the Conference; this is why he would abstain at the time of the vote on this resolution, even though he approves paragraph 3.

Mr. Stulla-Götz (Austria) points out that the decisions of the General Conference engage the member nations morally; thus, for example, the accepted symbol of the prefix deca (da) is accepted by Austria even though it is bothersome. He asks the Conference, therefore, to adopt the resolution submitted to it.

Mr. de Boer (Holland) intervenes again against the tesla and regrets the tendency of electro-technologists to introduce many special names for units. The physicists are of an opposite opinion, and since opinion is divided on the application of a particular name to a unit, it is better to abstain from doing it.

Mr. Arutunov is not of the same opinion as Mr. Perucca, who maintained that it was preferable for schools not to have too many names for units. He grants it would be wise to study these questions carefully and to put off until later certain proposals, such as that of the lentz for example, but such a proposal is not justified for the tesla.

After a last intervention by Mr. Avcin in favor of the tesla, the maintenance of this name for the unit of magnetic induction is approved by 11 yeas against 6 nays, with 12 abstentions.

Mr. de Boer feels it is unfortunate to use a name for a unit that has obtained so few votes in its favor.

Mr. Honti (Hungary) remarks that a simple majority is sufficient and that it has been obtained; he proposes with Mr. Arutunov that the Conference decide on the complete resolution as presented.

Before this vote, Messrs. Perucca (Italy) and Carreira (Portugal) call attention to the name of the unit of mass, the kilogram, for which the symbol (kg) is not suitable for a basic unit; how is it possible to think of adjoining to the symbol kg the prefixes of the multiples and submultiples? He regrets that this question has not been taken into consideration.

After these discussions, the resolution of the International Committee on the International System of Units is adopted in its totality by 18 yeas against one nay, with 11 abstentions (Resolution 12, p. 101).

#### EXAMINATION OF THE PROVISIONAL TRANSCRIPTIONS OF THE FIRST THREE SESSIONS

The President asks if there are any observations the delegates would like to make regarding these provisional transcriptions.

Mr. Arutunov (USSR) asks the Secretary of the Conference a question about the transactions of the first session. There were two documents: a summary of the transactions and a provisional transcription, the latter making no further mention of the German Democratic Republic.

Mr. Volet (International Bureau) replies in stressing that the situation is very delicate. A *modus vivendi* has been in existence for ten years making it possible for the two Germanies to coexist within the International Bureau. He cites on this occasion the words spoken at the Eighth General Conference in 1933 (p. 66) by Mr. Zalutzky of the USSR:

"...the General Conferences on Weights and Measures are convoked for the purpose of discussing purely scientific questions. If among them there are found any of a political nature, these should be adjourned to a more favorable moment, discussing in the meantime the other scientific questions that do not have this characteristic."

In replying to Mr. Arutunov's question, he states that the working of the second document is deliberate.

Mr. Arutunov points out that at the first session Messrs. Danjon, Cassinis, and Vieweg recognized that there was only the representative of the German Federal Republic. This results from the refusal of the French authorities to admit the representatives from East Germany into the country. There are, nevertheless, two Germanies that contribute each one to the International Bureau of Weights and Measures. It is inadmissible that there can be a nation whose only right consists in paying contributions. The documents of the International Bureau are certainly sent to the national laboratories in Berlin and Braunschweig. He concludes by requesting the modification of the transactions.

Mr. Volet regrets that the solution adopted is not acceptable to all the nations.

Mr. Bammer presents the point of view of the German Federal Republic:

"Regarding the statement made by the delegate from the USSR, I would like to make the following observation: the scientific and technical cooperation of the two great German laboratories within the International Convention of the Meter is carried on harmoniously, as is well known at the Pavillon de Breteuil. But here our assembly acts as a conference of nations. Since only a single Germany is member of the Convention of the Meter, only the delegate of the German Federal Republic has the right to vote for Germany.

"Any further discussion having necessarily as its object only questions of a political nature would undoubtedly exceed the framework of this Conference, which should concern itself only with scientific and technical problems."

Mr. Arutunov protests categorically against this declaration of Mr. Bammer, who proposes without reason to speak in the name of the German Democratic Republic. He stresses that there are two German nations that should be represented at the Conference.

Mr. Mäkinen (Finland) makes the following statement:

"I regret, Mr. President, that a political dispute of this kind has thrown its shadow across the work of this Conference, which should be able to concentrate first and foremost on its high scientific mission. Since it has happened, however, I should like to summarize briefly the position of Finland on this question.

"Although regretting that up to the present Germany has been unable to endow itself with a single government, Finland is pleased to be able to maintain--in accordance with its concept of neutrality--friendly relations with the two governments existing at present in Germany, with that of the Federal Republic as well as with the Democratic Republic.

"I can only regret, therefore, that the French authorities have seen fit to refuse to the delegates of the latter government the visas necessary for them to enter France and take part in the work of the General Conference. I do not see how such an attitude can conform to the principles of operation of an international institution or how it can be of profit to that institution."

Mr. Arutunov indicates that he cannot approve a document that encroaches on the rights of the German Democratic Republic.

Mr. Thomson Flôres (Brazil) feels that since there is only a single Germany that is a member of this Conference, it is useless to modify the transactions, especially to mention a so-called nation that is not present at the discussions, not having qualified to take part in them.

Mr. Honti (Hungary) remarks that it is not a question of mentioning a nation that is not present, but of indicating in exact fashion the name of the nation that is present: the German Federal Republic.

After the remarks of Messrs. Isnardi (Argentina) and Carikli (Turkey) supporting the statement made by Mr. Bammer in the name of the German delegation, Mr. Astin (USA) requests a vote on the transactions of the first session.

The transactions are adopted by a vote of 19 yeas and 7 nays. The delegate from Finland explains his reasons for abstaining.

After making some changes requested by certain delegates, the transactions of the second and third sessions are adopted by a vote of 28 yeas without opposition.

The session adjourns at 19:15 hours.

#### VISIT TO THE INTERNATIONAL BUREAU AND TO THE VAULT OF THE PROTOTYPES OF THE METER

Wednesday, 19 October 1960, at 15:30 hours

The delegates visited the laboratories of the International Bureau at the Pavillon de Breteuil at Sèvres, especially the recently acquired apparatus:

- The interferential longitudinal comparator with photoelectric microscopes developed by the International Bureau in collaboration with

the Société Genevoise d'Instruments de Physique and presented by the engineers of that company;

- The hermetically sealed isothermal unit destined to receive the comparator;
- the isothermal vacuum compartment for the Michelson interferometer;
- the Smith bridge for measuring temperatures by means of resistance thermometers.

This visit and that to the vault containing the prototypes of the meter were followed by a reception in the conference hall of the Pavillon de Breteuil offered by the President of the International Committee on Weights and Measures and by the Director of the International Bureau to the delegates and the ladies accompanying them.

At the end of the reception, the delegates were invited by the Roumanian delegation to a showing of the film "Man and Measurement" made by the Directory of Metrology at Bucharest. This projection took place at the International Center of Pedagogic Studies at Sevres.

#### MINUTES OF THE VISIT TO THE PROTOTYPES DEPOT

On 19 October 1960 at 16:00 hours, the delegates to the General Conference and the scientific personnel of the International Bureau visited the depot of the international prototypes of the meter at the Pavillon de Breteuil.

The three keys needed to open the depot were brought together, the first one remaining in the custody of the director of the International Bureau, Mr. Charles Volet; the second, deposited at the Archives de France, was brought by Mr. A. Chamson, Director of the Archives; and the third was delivered by the President of the International Committee, Mr. A. Danjon.

The two steel doors of the vault having been opened, as well as the safe containing the prototypes, the presence of the metric prototypes and their controls were observed.

The following readings were taken from the thermometers placed in the safe:

Present temperature	18.5°C
Maximum temperature	20.0°C
Minimum temperature	17.5°C



The safe as well as the doors of the vault were then closed.

The Secretary of the Conference and  
of the Committee

G. Cassinis

The President of the Committee

A. Danjon

The President of the Conference

E.-G. Barrillon

FIFTH SESSION  
OF THE GENERAL CONFERENCE ON WEIGHTS AND MEASURES

Held at the Ministry of Foreign Affairs  
19 Avenue Kléber, Paris  
on Thursday, 20 October 1960 at 15:00 hours

Under the Presidency of Mr. E.-G. Barrillon  
President of the Academy of Sciences of the French Institute

7b (continued). Establishment of the Table of Distribution of the Contributions

The President requests that the Conference proceed to vote on the mode of distribution of the endowment of the International Bureau of which the discussion had been interrupted in the preceding session. This vote will take place by means of a nominal ballot on the basis of Table D (p. 170).

Mr. Jacob (Belgium) presents a note from his Government on the subject of this distribution:

"The amplification of the activity of the International Bureau results in a corresponding increase in the present expenses of the International Bureau by a coefficient of 2.25. Belgium accepts the multiplication of its annual contribution by this coefficient in order to alleviate the new contributions of the underdeveloped nations with large populations.

"It is opposed, at the same time, to the proposal increasing materially the coefficient of the medium-sized nations in order to reduce the contributions of the large nations with a high national income, especially when this reduction is such that its consequence is to diminish the coefficient of the large nations below the average coefficient of 2.25.

"If Belgium, however, is alone and not supported in this domain, it is willing to transform its negative vote into an abstention under reserve."

Mr. Arutunov (USSR) is surprised to note that the new document distributed to the delegates on the mode of distribution contains only a single item concerning Germany.

Mr. Cassinis points out that the two Germanies will arrange between themselves the distribution of the contribution; but Mr. Arutunov wants the two German nations to be mentioned in the table of contributions. Finally, Messrs. Cassinis and Arutunov agree on a presentation that is acceptable.

Mr. Volet (International Bureau) asks the delegation from the USSR if it approves the presentation used up to now for the table "Situation of the Payments by the Nations" shown in the "Annual Report to the Governments of the High Contracting Parties." Mr. Arutunov accepts this presentation. Mr. Vieweg also gives his agreement, making reservations, however, as to the coefficients adopted for the two Germanies, which should be specified. The Conference approves these decisions without objections.

A vote is now taken on Table D; all the delegations pronounce themselves in favor of this table except that of Belgium, which first votes "no, with reserves," and then changes its vote immediately to an abstention. The Argentine delegate votes in favor of Table D but states he cannot guarantee acceptance by his Government.

The mode of distribution of the annual endowment of the International Bureau (Table D, p. 170) is adopted without opposition but with the abstention of Belgium. The contribution of each nation will be calculated, therefore, according to the coefficients of the scale of the United Nations, but with a maximum of 10 percent and a minimum of 0.5 percent of the total endowment.

Mr. Arutunov proposes to pass immediately to item 19 of the Agenda: the election of the members of the International Committee. He feels this is an important matter for which sufficient time should be reserved.

Mr. Danjon, supported by Mr. Cassinis, indicates that the elections are not held until the end of the last session in order for the International Committee to be able to exercise its functions up to the close of the Conference.

Mr. Vieweg then proposes that the ballots be distributed immediately, but that the vote not take place until item 19 of the Agenda comes up.

Mr. Volet indicates that the elections concern, in addition to the members leaving the International Committee, three other nominations: those of Messrs. Ferreira (Portuguese) and Georgescu (Roumanian) already announced at the preceding session, and that of Mr. Niewodniczanski (Polish), which has just been received. He presents the curriculum vitae of these three candidates.

The delegation from the United Kingdom suggests that the vote take place in the middle of this session. The delegation from France requests

that the succeeding item of the Agenda be taken up immediately. The President requests a vote on this last request, which is passed by 21 votes to 6. The Agenda is thus maintained.

#### 16. Report on Recent Progress of the Metric System

At the invitation of the President, Mr. Volet (International Bureau) presents the following report:

"Several nations have adopted the metric system since the General Conference in 1954. In other nations where both the metric system and other systems are in use, steps have been taken to impose more strictly the use of the metric system.

"The traditional report the International Bureau has prepared will show the results of the investigation we have made on the progress of the metric system throughout the world<sup>1</sup>. We shall summarize only the essential points.

Europe. In Greece, the only nation in Europe except the United Kingdom and Ireland where the use of the metric system is not obligatory, a ministerial commission decided in 1959 to adopt metric units as the only measures for all transactions. Steps have been taken also in Albania to enforce the use of the metric system, the use of which was made obligatory in 1951.

Africa. All African nations formerly under French or Belgian administration now possess legislation on weights and measures founded on the metric system. The same is the case in Tunisia and Morocco, the latter nation having extended the use of metric measures, in 1959, to the old zone of the Spanish Protectorate and to the zone of Tangier. Metric reform is being carried forward also in Egypt and the Sudan.

Asia and Oceania. Two great Asiatic Nations have gone over recently to the metric system: Japan, where the system was adopted officially in 1921, has now made its use obligatory as of 1 January 1959; India, which adopted it by the law of 28 December 1956, and where the reform of measures is at present being carried out vigorously.

"The employment of the metric system is developing also in China and in Korea; it is used effectively and currently in Israel and in the

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<sup>1</sup>This report prepared by H. Moreau, Head of Operations of the International Bureau, will be issued, as was the previous one, as a separate publication of the International Bureau.

Philippines, and its employment has been confirmed by recent laws in Cambodia, Indonesia, and Vietnam. Pakistan also foresees the adoption of the metric system, and efforts are being made in Burma to familiarize the population with metric measures. Lebanon has requested an expert metrologist to reorganize its service of weights and measures on the basis of modern metric legislation.

Mexico, Central and South America. Efforts are being made in these countries of the metric system, not only with a view to developing their services of weights and measures and to modernizing their legislation, but also to impose a more extensive use of the metric system in order to eliminate progressively the other systems of measure still in use.

The Anglo-Saxon Countries. As is known, the metric system is legal but not obligatory in most of the Anglo-Saxon countries. Its use is generalized in the scientific field and in certain specialized areas such as pharmacy, medicine, optical and scientific instruments industries; it is used very little, on the other hand, in the mechanical industries. Thus, in a world where the increasingly close interdependence of peoples pleads in favor of a single system of measures, the Anglo-Saxon scientists and technicians do not speak the same language when it comes to measures. This duality of metric and Anglo-Saxon systems feeds a controversy that has been going on for a century and a half, a controversy rekindled recently by the putting into execution of economic agreements made between certain European countries.

"In the United Kingdom, some years after the recommendation in favor of the metric system put out by a committee of the Board of Trade in 1951, an investigation by the British Association for the Advancement of Science and the Association of British Chambers of Commerce brought out unfavorable verdict in 1960, favoring maintenance of the status quo but recognizing the need, nevertheless, of following attentively the evolution of the question in view of the worldwide tendency toward adoption of the metric system.

"In Ireland, a similar investigation in 1959 made under the auspices of the Ministry of Commerce and Industry reported, on the contrary, in favor of the adoption of the metric system.

"In the United States and in Canada, the metric question has also been the cause of countless discussions and assumed positions, both private and official; we mention particularly the position taken in May 1959 by the U.S. Department of Commerce in favor of a change.

"All these investigations and discussions recognize the incontestable merits of the metric system, but all of them arrive also at the conclusion that the principal obstacle to the abolition of the Anglo-Saxon system lies in difficulties of a financial and industrial nature; these

difficulties can, unfortunately, only get worse with the passage of time and make reform more and more onerous, a reform that many Anglo-Saxons consider inevitable, however, at a more or less distant date.

"In conclusion, these last years have been marked by a slow and continuous progress of the metric system throughout the world. Nations once "technologically underdeveloped" are now on the road to economic and industrial development, and they are turning definitely toward metric measures; this evolution in world economic conditions would appear to be the essential factor capable of overcoming the last hesitations in favor of a world one hundred per cent metric.

"Let us hope that the use of decimal monetary units decided on by some Anglo-Saxon countries and recommended by others may also be a sign of the first step toward adoption of the international language of measure that is the metric system."

Following this report, Mr. Lopez Azcona (Spain) points out that the metric system was introduced into the Philippines by Spanish law in 1849.

#### 17. Additional Contributions

The Director of the International Bureau, Mr. Volet, summarizes the situation of this initiative taken by the Ninth General Conference (1948) with the object of obtaining supplementary financial resources for the International Bureau. Since the 1954 Conference, two other nations, Hungary and Switzerland, have made voluntary contributions. The sums received from 24 nations add up to 80,749 gold francs; they have been very useful in financing a modern electric power installation and in paying the first installments on the interferential comparator with photo-electric microscopes. The International Bureau thanks warmly once more the donor nations.

#### 18. Miscellaneous Proposals

Mr. Danjon recalls that the USSR and Roumania presented at the second session a proposed resolution (p. 45) intended to encourage the adhesion of further nations to the Convention of the Meter. This proposal has been studied and modified by the International Committee as follows:

"The Eleventh General Conference on Weights and Measures,

"considering that all nations benefit from the successful results of the work of the International Committee and of the International

Bureau of Weights and Measures, particularly demonstrated by the report of its President on the activity of this committee during the period 1954-1960,

"considering that the development of contemporary science and technology would be favored by a larger and larger extension of the use of the metric system throughout the world,

"invites all nations that are not yet contracting parties to the Convention of the Meter to adhere to this Convention."

Speaking for the delegation from the United States, Mr. Astin proposes that the last paragraph be modified as follows:

"hopes that the nations that do not yet belong to the Convention of the Meter, especially those nations that have only just recently gained their independence, may not delay in adhering to this Convention."

Mr. Honti (Hungary) agrees in principle with this amendment, but he requests that after the word "nations" be added "of Africa and Asia," in order to indicate clearly to what nations this resolution is addressed.

Mr. Sato (Japan) supports the amendment of the United States. He considers in effect that the General Conference cannot invite nonmember nations, but do no more than express a hope.

Mr. Arutunov (USSR) requests that the discussion take place also on the Soviet-Roumanian proposal. He proposes, therefore, that the resolution contain the following: the first paragraph of his proposition (p. 45), the first and second paragraph of the above proposal of the International Committee, the amendment of the United States, and the last paragraph of his proposal, which should be acceptable to all delegates.

Mr. Danjon recalls that the last paragraph of the Soviet-Roumanian proposal gave rise to objections by the International Committee, the reference to an economic influence being capable of interpretation as a political pressure.

Mr. Arutunov agrees not to conserve anything more than the words "scientific and technical relations;" but Mr. Astin states he cannot accept this text.

The President requests a vote first of all on the amendment proposed by the United States. This amendment is adopted,

An examination is made of the amended Soviet-Roumanian proposal, but Mr. Astin insists once more on the fact that the last paragraph of this proposal represents an intrusion into the domestic affairs of other nations.

After an intervention by the delegates from France and Italy in favor of the amended Soviet-Roumanian proposal, Mr. Astin puts a question of procedure and requests that this amended proposal be discussed first. In an effort at conciliation, Mr. Arutunov agrees on a vote on this resolution to include the following: the first two paragraphs of the International Committee's proposal, the amendment of the United States, and the last paragraph of the Soviet-Roumanian proposal from which the word "economic" would be eliminated.

Put to a vote, this resolution is adopted by 18 yeas against 9 nays (Resolution 14, p. 103).

Mr. Danjon reads a proposed resolution of the International Committee containing the definitions of the cubic decimeter and of the liter.

Mr. Perucca (Italy) observes that the duality of these units has already been discussed at great length within the International Committee on several occasions; it seems useless to him to come back to this question since nothing new has intervened.

Put to a vote, the resolution as presented is adopted by 29 votes, Italy abstaining (Resolution 13, p. 103).

Mr. Danjon presents in the name of the International Committee a proposed resolution concerning the negotiation of a headquarters agreement with the French Government.

Mr. Gascuel (France) explains the reasons for this agreement and stresses its usefulness.

Mr. Jacob (Belgium) would hope that the headquarters agreement will not be limited to the International Bureau of Weights and Measures, but that all the organisms created by the Convention of the Meter will receive certain privileges, which will have the result among other things of making it impossible to refuse visas, except in the case of persona non grata.

Mr. Dostal (Czechoslovakia) requests the floor for the following statement:

"Allow me in the name of the Czechoslovakian delegation to make a statement concerning two questions we consider capable of helping with the solution of the problems confronting our international organization. It is in order to facilitate our collaboration to the maximum that I dare to speak.



"1) The Czechoslovakian delegation feels that all the participants at our sessions should enjoy the diplomatic immunity that would be granted for a French diplomatic entrance visa without distinction as to the character of the delegate's passport. If the French regulations for authorizing visas do not permit granting a diplomatic visa to the holders of nondiplomatic passports, the French Government, as the depositary of our Convention, should declare that it concedes the privilege of diplomatic immunity to the participants in our conferences during their stay in France to attend our sessions.

"The Czechoslovakian delegation proposes the right to immunity in order to have the guarantee that all the member nations will be able to participate in the work of our organization without any obstacles.

"2) The German Democratic Republic is also a member of our organization, a member that complies regularly with the obligations required of it by our Convention. However, the nation that is host to our organization, the French Government, prevents the German Democratic Republic from attending our sessions and by this act makes it impossible for the German Democratic Republic to work actively within the framework of our organization. We feel that the Government of the French Republic violates the engagements accepted by it as depositary of our Convention. This attitude surprises us because the French Government authorizes entry visas to other citizens of the German Democratic Republic traveling in France.

"The Czechoslovakian delegation feels that the political relations between our countries should not be reflected in discriminatory measures that disturb the activity of our international organization. The Czechoslovakian delegation is informed that the majority of the governments, those of the United States and Spain for example, authorize entry visas for participants in conferences of international organizations, even if the participants come from countries with which these governments do not have normal diplomatic relations. This is also the practice in Czechoslovakia, and we feel that every truly democratic nation that gives its consent to the holding of an international conference on its territory should accept the same practice.

"We have discussed the question of the construction of new laboratories for our organization. This program foresees fairly large investments. We would build these laboratories in a country that refuses an entry visa to members of our organization. Today it is the German Democratic Republic; tomorrow it might be Czechoslovakia, Spain, or another nation. In other words, anybody at all among us can be prevented by the French Government from participating in the work of our organization, which is an international organization and not a French one. If the French Government refuses to fulfill the obligations of a nation that is host to our organization, it would be well to reconsider the construction

of laboratories here, and perhaps some other country should be asked to accept us. I believe many nations would feel honored by the presence of such an important international organization and would fulfill their obligations in exemplary fashion.

"Many among us have already visited the laboratories of the German Democratic Republic and have had an opportunity to verify their quality and their importance to our organization.

"In view of these circumstances, I feel it indispensable that an official note be dispatched to the Government of the French Republic regarding the attitude taken by it toward the German Democratic Republic, and requesting at the same time the fulfillment of the obligations the French Government accepted as depositary of the Convention of the Meter.

"So long as the French Government may not be able to fulfill its engagements, it would be well to consider the possibility of changing the headquarters of our organization.

"I believe, Mr. President, that you may trust the intent of this declaration to be truly praiseworthy and constructive."

Mr. Gascuel remarks in reply to the two preceding interventions that it is not the place of the French delegation to discuss the refusal of visas by the French Government. At the same time, it is impossible to foresee what may be arranged on the subject of diplomatic visas in the headquarters agreement. The office of the International Committee is doing all in its power for this agreement to be drawn up on a non-discriminatory basis in consonance with agreements already concluded by the French Government with other international institutions.

Mr. Jacob declares himself satisfied with the explanations given by Mr. Gascuel.

Mr. Arutunov approves without reservations the observations of the delegate from Czechoslovakia.

The proposed resolution on the headquarters agreement is finally adopted by unanimous vote (Resolution 15, p. 104).

Mr. Volet (International Bureau) thanks the General Conference for having authorized this agreement, which may result in a useful simplification of the relations of the International Bureau with the French authorities.

After an intermission, the provisional transcription of the transactions of the fourth session is examined. After some observations that will be taken into account, this transcription is approved unanimously.

Mr. Cassinis requests that the secretariat be trusted with the transcription of the transactions of the last session.

#### 19. Partial Renewal of the International Committee

The President recalls that the renewal concerns half of the International Committee, and that votes may be cast for the reelection of any of the nine members leaving it. The names of three other candidates have been received. The voting will be by nation and secret ballot.

The count of the balloting by three delegates (Korea, Spain, and Czechoslovakia) gives the following results:

Number of votes: 32. Votes per candidate are:

Departing members eligible for reelection:

Messrs. Astin	31 votes
Bourdoun	28 "
Danjon	31 "
Esserman	29 "
Howlett	32 "
Krishnan	32 "
Otero	22 "
Sandoval Vallarta	23 "
Stulla-Götz	32 "

Other candidates:

Messrs. Ferreira	7 votes
Georgescu	8 "
Niewodniczanski	9 "

All the departing members are reelected. Mr. Danjon thanks the General Conference in the name of the International Committee and declares his retirement from the presidency of the International Committee as of the end of the present session.

8 (continued). Modification of the Convention of the Meter and of the Annexed Regulation

The President requests the Conference to return to this question of which the discussion was interrupted at the third session (pp. 54-56).

Mr. Cassinis states that he has been instructed by the International Committee in unanimity to make the following statement to the Conference:

"At the beginning of 1960, the International Committee distributed a proposed revision of the Convention of the Meter (Annex 1, p. 106); it drew up this proposal after a long study during which a commission was created, presided over by Mr. Astin and composed of several members of the International Committee. The comments of the nations were expected by June or July 1960, after which the Committee expected to prepare a second proposal. However, these comments arrived later than foreseen, some of them even during this session of the Conference.

"At the proposal of Mr. Danjon, this Conference appointed at its first session a work group composed of delegates, whose mission was to prepare a synthesis of the comments received and to find an acceptable formula. Mr. de Boer was appointed President of the group. After several days of assiduous labor, Mr. de Boer's group obtained a sizable result concretized in the proposal handed to you (Annex 3, 2nd report, p. 162). The International Committee wished to have this proposal distributed in the form of a document, even before it had been seriously examined. In this way, each of the delegates will be able to study this document and think of other modifications he may judge it useful to propose.

"The International Committee found that the problem of a satisfactory revision of the Convention of the Meter cannot be taken up in the few remaining moments before adjournment of the session, much less can a unanimous agreement be reached. The Committee established, therefore, a proposed resolution by which the Conference would request the International Committee to continue its studies until it is able to prepare a second proposal which would be submitted to the Governments, and to continue in this way until unanimous agreement is reached.

"The International Committee proposes, obviously, to proceed by the same processes as previously, which is to say with the help of the already existing commission presided over by Mr. Astin. The delegates are requested to remit their proposals before 1 February 1961; this time limit will leave sufficient time for careful consideration of the whole matter and to obtain legal and other advice on it.

"These observations will thus have greater value than if they were prepared hastily, and the International Committee counts greatly on them for its commission to be oriented as to the course to take in its work, and for the second proposal to have better chances of being approved by all the nations."

Mr. Cassinis reads the proposed resolution (p. 104).

Mr. Jacob (Belgium) agrees with its text and asks that the International Committee be given full freedom in its work. Mr. Cassinis points out that this is not a question of a closed commission, but that it will be free to collect all the opinions that may be useful.

Put to a vote, the resolution presented by the International Committee is adopted unanimously (Resolution 16, p. 104).

The Agenda having been completed, Mr. Astin proposes a motion of thanks to the persons and organizations that have helped in the success of this General Conference. First of all to Mr. E.-G. Barrillon for his wisdom and patience toward us; then to the French Minister of Foreign Affairs for having put at our disposal the installations of the Ministry's Center of International Conferences, and for the reception and evening at the Opera offered to the delegates; then to the International Committee on Weights and Measures and to its eminent President, Mr. A. Danjon, and to his devoted secretary, Mr. G. Cassinis; and finally to the Director, Mr. Charles Volet, and to all the personnel of the International Bureau for the efforts they made to assure the full success of this important Conference.

The Conference denotes its full agreement with the motion proposed by Mr. Astin by its applause.

In his turn, the President thanks the delegates and declares the Eleventh Session of the General Conference on Weights and Measures ended.

The session adjourns at 18:20 hours.

## RESOLUTIONS ADOPTED

## Extension of the Activities of the International Bureau to the Area of Standards of Measure of Ionizing Radiations

## RESOLUTION 1

The Eleventh General Conference on Weights and Measures,

## CONSIDERING

that the development of atomic energy and of nuclear research requires that the uniformity of standards of measure of ionizing radiations be assured,

that the international uniformity of measure of the principal physical dimensions has been obtained, maintained, and improved with uncontested success over the past 85 years by the activity of the International Committee of the International Bureau of Weights and Measures,

that the great national laboratories of standards charged with the uniformity of measures in their respective countries, having found at the International Bureau and in the meetings of the Consultative Committees the facilities it desired to be able to work in common for the worldwide uniformity of physical measures, have expressed their desire that the laboratories and the scientific personnel of the International Bureau be increased and completed in order that the common work of unification of measures be extended to standards of measure of ionizing radiations,

that the International Commission of Radiological Units and Measures (I.C.R.U.), which plays a preponderant role in the choice of standards and their comparisons in the field of ionizing radiations, states now that it wishes to relinquish this part of its activities, provided it be taken up by the International Bureau, because this Bureau is the only one capable of carrying on this activity with incontestable authority,

that the work of international unification of the standards of measure of ionizing radiations requires a permanent and unique scientific directive center established and supported by an inter-governmental agreement free of political implications, and that the International Bureau of Weights and Measures fulfills these conditions,

that the physical experiments for the preparation and execution of comparisons of standards of measure of ionizing radiation require the employment of standards of measure of other physical dimensions, that these latter standards exist in their most exact forms at the International Bureau, and that the personnel of the Bureau, enriched by a long tradition, know thoroughly the general rules of metrology and the special rules applying to each form of standard,

RATIFIES the action already undertaken by the International Committee on Weights and Measures in the field of ionizing radiations, and

REQUESTS the International Committee to organize at the International Bureau a section of standards of measure of ionizing radiations equipped with a laboratory and scientific personnel, and to work on the unification of the standards of measure of ionizing radiations and the corresponding units, taking into account the results obtained by national, international and other laboratories and organizations.

#### RESOLUTION 2

The Eleventh General Conference on Weights and Measures,

DECIDES to devote to the enlargement of the laboratories of the International Bureau of Weights and Measures and for their equipment for standards of measure of ionizing radiation the sum of 1,800,000 gold francs, covered by a special contribution of 900,000 gold francs added to the annual endowment of the years 1962 and 1963,

HOPES that the French Government will grant an increase in ground put at the disposal of the International Committee on Weights and Measures and surrounding the Pavillon de Breteuil,

HOPES that the Governments will consent to an anticipation in payments to facilitate the immediate enlargement of the laboratories of the International Bureau.

#### RESOLUTION 3

The Eleventh General Conference on Weights and Measures,

THANKS the Radium Institute of the University of Paris for having been willing to confide to the International Bureau of Weights and Measures the custody of the international standard of radium No. 5430, and

AUTHORIZES the International Bureau to take charge of this standard.

## RESOLUTION 4

The Eleventh General Conference on Weights and Measures,

CONSIDERING the need to establish in a precise manner certain units and notions used in the field of ionizing radiations,

REQUESTS the International Committee on Weights and Measures to undertake without delay the necessary studies,

GIVES AUTHORITY to the International Committee on Weights and Measures to take decisions on this point to be submitted for approval to the Twelfth General Conference.

Endowment of the International Bureau

## RESOLUTION 5

The Eleventh General Conference on Weights and Measures,

CONSIDERING

that the precision required in the measures in the custody of the International Bureau on Weights and Measures increases constantly and requires ever more expensive equipment,

that the fields of activity of the International Bureau have increased to include standards of measure of ionizing radiations,

that in all its activities the International Bureau should be served by personnel of high scientific qualifications, who are difficult to find,

ACCEPTS without contrary opinion the proposal of the International Committee, duly notified in advance to the Governments in accordance with Article 6, paragraph 5, of the Annexed Regulation of the Convention of the Meter of 1875, modified in 1921.

DECIDES to increase the fixed part of the annual endowment, so that the total of the fixed and supplementary parts of the annual endowment covering the operating expenses of the International Bureau and of the International Committee on Weights and Measures will amount to 900,000 gold francs. The amount of the fixed part thus calculated will be applied to the contributions payable in 1962 and the following years.



## Definition of the Meter

## RESOLUTION 6

The Eleventh General Conference on Weights and Measures,

## CONSIDERING

that the international prototype does not define the meter with sufficient precision for the present needs of metrology,

that it is desirable in addition to adopt a natural and indestructible standard,

## DECIDES:

1) The meter is the length equal to 1,650,763.73 wavelengths in a vacuum of the radiation corresponding to the transition between the levels  $2p_{10}$  and  $5d_5$  of the atom of krypton 86.

2) The definition of the meter in force since 1889, based on the international prototype in iridium-platinum, is abrogated.

3) The international prototype of the meter authorized by the First General Conference on Weights and Measures in 1889 will be conserved at the International Bureau of Weights and Measures under the same conditions as were established for it in 1889.

## RESOLUTION 7

The Eleventh General Conference on Weights and Measures,

## REQUESTS the International Committee

1) to establish instructions for the practical use of the new definition of the meter<sup>1</sup>.

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<sup>1</sup>At its session in October 1960, the International Committee on Weights and Measures adopted the following recommendation regarding the first instructions on the practical use of the definition of the meter:

"In conformity with Paragraph 1 of Resolution 7, adopted by the Eleventh General Conference on Weights and Measures (October 1960), the International Committee on Weights and Measures recommends that the radiation of krypton 86, adopted as the fundamental standard of length, be obtained by means of a hot-cathode discharge lamp containing krypton 86

2) to choose the secondary standards of wavelength for the interferential measurement of lengths and to establish instructions for their practical use;

3) to continue the studies it has undertaken to improve the standards of length.

#### RESOLUTION 8

The Eleventh General Conference on Weights and Measures,

CONSIDERING the initial instructions prepared by the International Committee on Weights and Measures on the practical use of the new definition of the meter,

CHARGES the International Bureau of Weights and Measures, as in the past, with the determination of the national prototypes.

#### Definition of the Unit of Time

#### RESOLUTION 9

The Eleventh General Conference on Weights and Measures,

CONSIDERING

the power given by the Tenth General Conference on Weights and Measures to the International Committee on Weights and Measures to come

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(footnote continued from preceding page)

of not less than 99 percent purity, in sufficient quantity to insure the presence of solidified krypton at a  $64^{\circ}\text{K}$  temperature, this lamp being supplied with a capillary having the following characteristics: internal diameter: 2-4 mm, walls' thickness: approximately 1 mm.

"It is estimated that the wavelength of the radiation emitted by the positive column is equal to within one hundred-millionth ( $10^{-8}$ ) of the wavelength corresponding to the transition between the undisturbed levels when the following conditions are fulfilled:

1) the capillary is observed at the end so that the light rays that are used travel from the cathode side to the anode side;

2) the lower part of the lamp, including the capillary, is immersed in a cooling bath maintained at the triple point of nitrogen temperature,  $\pm 1^{\circ}$ ;

3) the density of the current in the capillary is  $0.3 \pm 0.1 \text{ amp/cm}^2$ ."

to a decision on the definition of the fundamental unit of time,

the decision taken by the International Committee on Weights and Measures at its session of 1956,

RATIFIES the following definition:

"The second is the fraction  $1/31,556,925.9747$  of the tropical year 1900 January 0 to 12 hours of time of the Ephemerides."

#### RESOLUTION 10

The Eleventh General Conference on Weights and Measures,

APPRECIATING the experimental results obtained by competent laboratories during recent years, which prove that a standard of time interval based on a transition between two levels of energy of an atom or of a molecule can be achieved and reproduced with very high precision,

CONSIDERING that such an atomic standard of time interval is indispensable to the requirements of high quality metrology,

REQUESTS

the national and international laboratories that are expert in this field to continue their studies as actively as possible,

the International Committee on Weights and Measures to cooperate without delay with the international organizations interested, and to coordinate the work to make it possible for the Twelfth General Conference to adopt a resolution on this point.

Gravimetric System

#### RESOLUTION 11

The Eleventh General Conference on Weights and Measures,

having learned with satisfaction of the progress in the absolute measure of acceleration due to gravity, thanks to the work of the International Bureau of Weights and Measures and of the national laboratories, but noting that a number of important determinations are still under way,

1) DECIDES to conserve provisionally the so-called Potsdam gravimetric system;

2) REQUESTS the International Bureau and the National Laboratories to continue their measurements;

3) GIVES THE POWER to the International Committee on Weights and Measures to decide on the change from the Potsdam system, when it will have decided that the value of this acceleration is known with sufficient exactitude.

## International System of Units

### RESOLUTION 12

The Eleventh General Conference on Weights and Measures,

#### CONSIDERING

Resolution 6 of the Tenth General Conference on Weights and Measures adopting the six units to serve as a basis for the establishment of a practical system of measures in international relations:

Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric current intensity	ampere	A
Thermodynamic temperature	degree Kelvin	°K
Luminous intensity	candela	cd

Resolution 3 adopted by the International Committee on Weights and Measures in 1956,

the recommendations adopted by the International Committee on Weights and Measures in 1958 concerning the abbreviation of this system's name, and the prefixes to be used for the formation of multiples and sub-multiples of the units,

#### DECIDES:

1) the system based on the six basic units mentioned above is designated by the name of International System of Units;

2) the international abbreviation of this system's name is: SI;

3) the names of multiples and submultiples of the units are formed by means of the following prefixes:

Factor by which the unit is multiplied	Pre-fix	Sym-bol	Factor by which the unit is multiplied	Pre-fix	Sym-bol
$1,000,000,000,000 = 10^{12}$	tera	T	$0.1 = 10^{-1}$	deci	d
$1,000,000,000 = 10^9$	giga	G	$0.01 = 10^{-2}$	centi	c
$1,000,000 = 10^6$	mega	M	$0.001 = 10^{-3}$	milli	m
$1,000 = 10^3$	kilo	k	$0.000001 = 10^{-6}$	micro	$\mu$
$100 = 10^2$	hecto	h	$0.000000001 = 10^{-9}$	nano	n
$10 = 10^1$	deca	da	$0.000000000001 = 10^{-12}$	pico	p

4) the units shown below are used in this system, without prejudice to other units that may be added in the future.

#### Additional Units

Plane angle	radian	rad
Solid angle	steradian	sr

#### Secondary Units

Area	square meter	$m^2$
Volume	cubic meter	$m^3$
Frequency	hertz	$H_z$
Density (volumetric mass)	kilogram per cubic meter	$kg/m^3$
Velocity	meter per second	$m/s$
Angular velocity	radian per second	$rad/s$
Acceleration	meter per sec. squared	$m/s^2$
Angular acceleration	radian per sec. squared	$rad/s^2$
Force	newton	$N$
Pressure (mechanical tension)	newton per sq. meter	$kg \cdot m/s^2$
Kinematic viscosity	square meter per second	$N/m^2$
Dynamic viscosity	newton-second per sq. meter	$m^2/s$
		$N \cdot s/m^2$

Work, energy, quantity of heat	joule	J	N·m
Power	watt	W	J/s
Quantity of electricity	coulomb	C	A·s
Voltage, difference of potential, electromotive force	volt	V	W/A
Intensity of electric field	volt per meter	V/m	
Electrical resistance	ohm	$\Omega$	V/A
Electrostatic capacitance	farad	F	A·s/V
Magnetic flux	weber	Wb	V·s
Inductance	henry	H	V·s/A
Magnetic induction	tesla	T	Wb/m <sup>2</sup>
Magnetic field intensity	amperes per meter	A/m	
Magnetomotive force	ampere	A	
Luminous flux	lumen	lm	cd·sr
Luminance	candela per sq. meter	cd/m <sup>2</sup>	
Illumination	lux	lx	lm/m <sup>2</sup>

Cubic Decimeter and Liter

#### RESOLUTION 13

The Eleventh General Conference on Weights and Measures,

##### CONSIDERING

that a cubic decimeter and a liter are not equal but differ by about 28 millionths,

that the determination of physical dimensions involving measures of volume are becoming more and more accurate, aggravating the consequences of a possible confusion between the cubic decimeter and the liter,

REQUESTS the International Committee on Weights and Measures to study this problem and to present its conclusions at the Twelfth General Conference.

Adhesion of Nations to the Convention of the Meter

#### RESOLUTION 14

The Eleventh General Conference on Weights and Measures,

## CONSIDERING

that all countries benefit from the successful results of the work of the International Committee and of the International Bureau of Weights and Measures, particularly as illustrated by the report of its President on the activities of this Committee during the period 1954-1960,

that an increasingly greater use of the metric system extended throughout the world would be favorable to the development of modern science and technology,

HOPES that the nations not yet adhering to the Convention of the Meter, and especially the countries that achieved their independence very recently, will not delay in joining this Convention, and

SUGGESTS to all the member nations of the Convention that they use their influence to this end, availing themselves of their scientific and technical relationships.

Negotiation of a Headquarters Agreement with the French Government

## RESOLUTION 15

The Eleventh General Conference on Weights and Measures,

CONSIDERING that the International Bureau of Weights and Measures benefits from the generous hospitality of France, but that in accomplishing its mission it may encounter certain difficulties due to the application of regulations established for the French and foreign nationals and establishments within France,

INSTRUCTS the International Committee on Weights and Measures to negotiate with the French Government a headquarters agreement on a non-discriminatory basis in consonance with agreements of this kind already concluded by this Government with other international institutions, and

HOPES that this agreement may be put in force immediately on a provisional basis while awaiting the approval of the Twelfth General Conference.

Revision of the Convention of the Meter

## RESOLUTION 16

The Eleventh General Conference on Weights and Measures,

NOTING that the agreement on the changes to be incorporated in the Convention of the Meter and its Annexed Regulation was unobtainable during the present session, in spite of the conciliatory efforts worthy of praise of the work group created at the first session and presided over by Mr. de Boer,

GIVES POWER to the International Committee on Weights and Measures to continue its studies with a view to preparing as soon as possible a proposal that may receive the assent of all the contracting parties.



## ANNEX 1

PROPOSAL FOR MODIFICATION OF THE CONVENTION OF THE METER ESTABLISHED  
BY THE INTERNATIONAL COMMITTEE ON WEIGHTS AND MEASURES<sup>1</sup>

## CONVENTION

## Present Text

Article 1 (1875). The high contracting parties engage themselves to found and maintain at their common expense an International Bureau of Weights and Measures to be scientific and permanent, of which the headquarters is in Paris.

Article 2 (1875). The French Government will take the necessary steps to facilitate the acquisition or, if it is required, the construction of a building specially reserved for this purpose, under conditions to be determined by the Regulation annexed to the present Convention.

Article 3 (1875). The International Bureau will function under the exclusive direction and surveillance of an International Committee on Weights and Measures, itself placed under the authority of a General Conference on Weights and Measures made up of delegates of all the contracting governments.

## Proposed Text

No change

No change

No change

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<sup>1</sup>This proposed modification: (1) of the Convention signed at Paris on 20 May 1875, (2) of the Regulation annexed to this Convention, (3) of the Convention signed at Sèvres on 6 October 1921, was submitted to the member nations in February 1960 at the same time as the convocation to the  
(continued)

## Present Text

## Proposed Text

Article 4 (1875). The presidency of the General Conference on Weights and Measures is attributed to the current President of the Academy of Sciences in Paris.

No change

Article 5 (1875). The organization of the International Bureau as well as the composition and attributes of the International Committee and of the General Conference on Weights and Measures are determined by the Regulation annexed to the present Convention.

Article 5. 1. The organization of the International Bureau as well as the composition and the attributes of the International Committee and of the General Conference on Weights and Measures are determined by the Annexed Regulation, which has the same force and value as the present Convention.

2. The Annexed Regulation may be modified by the General Conference by majority vote of three-quarters of the votes cast within the General Conference. The proposed modifications should be communicated to the contracting governments one year at least before the opening of the General Conference.

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(footnote continued from preceding page)

General Conference (see pp. 12 and 20). The governments of the member nations were requested to send their comments on the proposal before 1 July 1960.

The four articles of the International Convention of 1921 carrying a modification of the Convention of 1875 and its Annexed Regulation and indicating the conditions for adhesion, accession, and ratification (Sixth General Conference on Weights and Measures, 1921, p. 69), were not the object of proposals by the International Committee.

It should be noted, moreover, that certain articles of the Annexed Regulation were modified at different times by the General Conferences:

1889: modification of Article 6 (First Conference, pp. 56-60).

1901: modification of the endowment (Third Conference, pp. 53-57).

1907: modification of Articles 6, 19, and 20 (Fourth Conference, pp. 28-29).

1913: modification of Articles 6 and 20 (Fifth Conference, pp. 23-27).

1927, 1948, 1954: modification of the endowment (Seventh Conference, pp. 61-63, Ninth Conference, pp. 58-59, Tenth Conference, pp. 64-67).

## Present Text

Article 6 (1875). The International Bureau of Weights and Measures is responsible for the following:

1) All comparisons and verifications of the new prototypes of the meter and the kilogram;

2) The conservation of the international prototypes;

3) Periodic comparisons of the national standards with the international prototypes and their controls, as well as of the standard thermometers;

4) The comparison of new prototypes with the fundamental standards of nonmetric weights and measures employed in the different countries and in the sciences;

5) The calibration and comparison of geodesic measuring devices;

6) The comparison of standards and precision scales of which the verification may be requested either by the governments or by the learned societies or by artists and scientists.

Article 7 (1921). After the Committee will have proceeded to the coordination of the measures relative to electrical units, and when the General Conference will have decided it by unanimous vote, the International Bureau will be charged with the establishment and conservation of the standards of electric units and their controls, as well as the comparison

## Proposed Text

Article 6. The International Bureau of Weights and Measures is responsible for the following:

1) The conservation of the international prototypes of physical dimensions.

(The present paragraphs 3, 4, 5, and 6 would become paragraphs 2, 3, 4, and 5.)

Article 7. Moreover, in conformity with the resolutions of the General Conference, the Committee instructs the International Bureau as follows:

1) to establish the fundamental standards and scales of the physical dimensions;

2) to effect the coordination

## Present Text

with these standards of national and other precision standards.

The International Bureau is charged, in addition, with the determinations concerned with physical constants of which the more exact knowledge may serve to increase the precision, and better ensure uniformity in the fields to which the units mentioned above belong (Article 6 and first paragraph of Article 7).

It is charged finally with the work of coordination of analogous determinations effected at other institutions.

Article 8 (1921). The international prototypes and standards as well as their controls will remain deposited at the International Bureau; access to the place of deposit will be reserved exclusively to the International Committee.

Article 9 (1875). All the establishment and installation expenses of the International Bureau of Weights and Measures, as well as the annual operating expenses and those of the Committee, will be covered by contributions from the contracting nations established according to a scale based on their present population.

Article 10 (1875). The sums representing the contributive part of each contracting state shall be paid in at the beginning of each year through the intermediary of the French Ministry of Foreign Affairs, at the Caisse des Dépôts

## Proposed Text

of the corresponding measuring techniques;

3) to effect and coordinate the determinations concerning the fundamental physical constants.

No change

Article 9. All the establishment and installation expenses of the International Bureau of Weights and Measures, as well as those of the Committee, will be covered by contributions of the contracting nations established according to a scale fixed in the Regulation annexed to the present Convention.

No change

## Present Text

et Consignations in Paris, from which they will be withdrawn as they may be needed by authority of the Director of the International Bureau.

Article 11 (1875). The governments which would make use of the right reserved to every nation of acceding to the present convention will be required to make a contribution, of which the amount will be determined by the Committee on the bases established in Article 9, which will be employed for the improvement of the scientific material of the International Bureau.

Article 12 (1875). The high contracting parties reserve the right to make by common agreement all the modifications to the present Convention that experience may show to be useful.

Article 13 (1875). At the expiration of the term of twelve years, the present Convention may be denounced by any one of the high contracting parties.

The government that may make use of this right of withdrawal from the Convention will be required to give notice of its intention one year in advance, and will renounce by this act all rights of co-ownership of the international prototypes and of the International Bureau.

Article 14 (1875). The present Convention will be ratified in conformity with the particular constitutional laws of each

## Proposed Text

No change

Article 12. The high contracting parties will accord to the International Bureau of Weights and Measures the same privileges and immunities they concede to the most favored of similar organizations.

Article 13. The present Convention may be denounced by any one of the high contracting parties by notifying the French Government of its decision one year in advance. The government that may make use of this right will renounce all rights of co-ownership of the property of the International Committee.

No change

## Present Text

## Proposed Text

nation; the ratifications shall be exchanged in Paris within a term of six months, or sooner if possible. It shall be put into execution as from 1 January 1876.

As evidence of which, the respective plenipotentiaries have signed and affixed their seals.

## ANNEXED REGULATION

Article 1 (1875). The International Bureau of Weights and Measures shall be established in a special building fulfilling all the necessary guarantees of stability and quiet.

No change

In addition to the place suitable for the storage of the prototypes, it will include rooms for the installation of comparators and balances, a laboratory, a library, an archives room, offices for the employees, and living quarters for the service and guards.

Article 2 (1875). The International Committee is charged with the acquisition and the adaptation of this building, as well as the installation of the services for which it is destined.

No change

In case the Committee should not find a suitable building to acquire, one will be built under its direction and according to its plans.

Article 3 (1875). The French Government will, upon the request

No change

## Present Text

of the International Committee, take the necessary steps to have the International Bureau recognized as in the public interest.

Article 4 (1875). The International Committee will have the necessary equipment prepared, such as the following: comparators for the standards of line measure and of end length, apparatus for the determinations of absolute dilatations, balances for weighing in the atmosphere and in a vacuum, geodesic measuring apparatus, etc.

Article 5 (1875). The costs of the acquisition or construction of the building and the expenses for the purchase and installation of instruments and apparatus shall not exceed a total sum of 400,000 francs.

Article 6 (1921). The annual endowment of the International Bureau is composed of two parts: one fixed, the other supplementary.

The fixed part is, in principle, 250,000 francs, but it may be raised to 300,000 francs by unanimous decision of the Committee. It is chargeable to all the nations and autonomous colonies who have adhered to the Convention of the Meter before the Sixth General Conference.

The supplementary portion is made up of the contributions of the nations and autonomous colonies that joined the Convention after the above-mentioned Conference.

## Proposed Text

No change

No change

Article 6. 1. Each General Conference fixes the endowment destined to cover the expenses of the International Bureau and of the International Committee for the six-year period starting on the 1st January following a period of one year after the meeting of the General Conference.

2. A majority of three-quarters of the votes cast within the General Conference is required for the vote on the amount of this endowment.

3. The International Committee is charged with establishing at the request of the Director of the International Bureau the annual budget, but without

## Present Text

The Committee is charged with establishing at the request of the Director an annual budget, but without surpassing the sum calculated according to the stipulations of the two above paragraphs. This budget is sent each year in a special financial report to the governments of the high contracting parties.

In case the Committee judges it necessary either to increase beyond 300,000 francs the fixed part of the annual endowment or to modify the calculation of the contributions determined by Article 20 of the present Regulation, it should inform the governments with sufficient anticipation to allow them to give the necessary instructions to their delegates to the succeeding General Conference, so that they may be able to deliberate validly. The decision will be valid only in case none of the contracting nations will have expressed or expresses at the Conference a contrary opinion.

If a nation has made no payment of its contribution during a period of three years, it shall be distributed among the other nations pro rata to their own contributions. The supplementary sums thus paid by the nations in order to complete the endowment of the International Bureau are considered as an advance made to the nation in arrears and are reimbursed to those nations if the former liquidates its overdue payments.

## Proposed Text

exceeding the endowment. This budget is sent in an annual report to the governments of the high contracting parties.

4. The General Conference establishes the contributive share of each of the member nations, taking into account their population at the time of the General Conference as is explained hereafter. Moreover, it can decide by a majority of three-quarters of the votes cast within it to allow nations that may request it reductions up to 50 percent, taking into account their national income.

5. Each nation is attributed a number of contributive parts determined by the table on page 122. The relation of the contribution of each nation to the total endowment is equal to the relation of the number of contributive parts of this nation to the sum of the contributive parts of all the member nations.

6. The annual contributions are due at the beginning of each year. If a nation makes no annual contribution during the year in which it is due, the amount of this contribution may be divided among the other nations. The supplementary amounts thus paid by the nations in order to make up the total of the endowment of the International Bureau are considered as an advance made to the nation in arrears and will be reimbursed to those nations if the former liquidates its overdue payments.



## Present Text

The advantages and prerogatives conferred by adhesion to the Convention of the Meter are suspended in the case of nations in arrears three years with their contributions.

After three further years, the nation in arrears may be excluded from the Convention, and the calculation of contributions is reestablished according to the dispositions of Article 20 of the present Regulation.

Article 7 (1875). The General Conference mentioned in Article 3 of the Convention will meet in Paris upon convocation by the International Committee at least once every six years.

Its mission is to discuss and promote the necessary measures for the propagation and improvement of the metric system, as well as to ratify the new fundamental metrological determinations that may have been made in the interval

## Proposed Text

7. The advantages and prerogatives conferred by adhesion to the Convention of the Meter are suspended in the case of any nation that has not paid its contributions during three consecutive years.

8. After three further years, the nation in arrears may be excluded from the Convention

9. If the General Conference is unable to convene on the regular date, the former contributions are maintained until the 1st of January following a one-year term after the new session of the General Conference.

10. If new nations adhere to the Convention between two sessions of the General Conference, their contribution for each year or fraction of a year is equal to that which would be paid by a nation in the same category previously belonging to the Convention. The amount of these new contributions is added to the total endowment.

Article 7. 1. The General Conference mentioned in Article 3 of the Convention meets in Paris upon convocation by the International Committee at least once every six years.

2. Its mission is to discuss and promote the necessary measures for the propagation and improvement of the metric system, as well as to ratify the new fundamental metrological determinations that may have been made in

## Present Text

between its meetings. It receives the report of the International Committee on the work accomplished and proceeds by secret ballot to the renewal of one-half of the International Committee.

The votes within the General Conference are by nation; each nation has the right to one vote.

The members of the International Committee rightfully attend the meetings of the Conference; they may at the same time be delegates from their governments.

Article 8 (1921). The International Committee mentioned in Article 3 of the Convention shall be composed of eighteen members, all belonging to different nations.

At the time of the renewal of one-half of the members of the International Committee, the departing members shall be first those who, in case of vacancies, shall have been elected temporarily in the interval between two sessions of the Conference; the others shall be designated by drawing lots.

Departing members are eligible for reelection.

## Proposed Text

the interval between its meetings. It receives the report of the International Committee on the work accomplished and proceeds by secret ballot to the renewal of the International Committee, in conformity with Article 8 of the Regulation.

3. The votes within the General Conference are by nation; each nation represented has the right to one vote. The majority required for the votes is the absolute majority of the votes cast, except in the case foreseen in Article 5 of the Convention and Article 6 of the Regulation.

4. The members of the International Committee rightfully attend the meetings of the Conference; they may at the same time be delegates from their governments.

Article 8. 1. The international Committee mentioned in Article 3 of the Convention is composed of eighteen members, all belonging to different nations.

2. The International Committee shall be partially renewed at each session of the General Conference; the members of the International Committee elected for the first time by the Conference at the preceding session remain in office. The departing members shall be those elected or reelected at sessions previous to the last session and those who, in case of vacancies, have been elected temporarily by the International Committee in the interval between

## Present Text

Article 9 (1921). The International Committee shall be constituted by choosing itself by secret ballot its President and Secretary. These elections shall be communicated to the governments of the high contracting parties.

The President and the Secretary of the Committee and the Director of the International Bureau shall belong to different nations.

Once constituted, the Committee may proceed to new elections or nominations three months only after all members shall have been informed of the vacancy giving rise to a vote.

Article 10 (1921). The International Committee directs all the metrological work that the high contracting parties shall decide to execute in common.

It is charged, moreover, with the surveillance of the conservation of the prototypes of international standards.

It may, finally, arrange for the cooperation of specialists in questions of metrology, and coordinate the results of their work.

Article 11 (1921). The Committee shall meet at least once every two years.

## Proposed Text

two sessions of the General Conference.

3. Departing members are eligible for reelection.

Article 9. 1. The International Committee shall be constituted by choosing itself by secret ballot its officers who shall be composed of a President, a Vice-President, and a Secretary. These elections shall be communicated to the governments of the high contracting parties.

2. The President, the Vice-President, and the Secretary of the Committee and the Director of the International Bureau shall belong to different nations.

3. Once constituted, the Committee may proceed to new elections or nominations three months only after all members shall have been informed of the vacancy giving rise to a vote.

No change

No change

## Present Text

Article 12 (1921). The votes within the Committee shall take place by majority vote; in case of a tie, the vote of the President shall prevail. Decisions shall not be valid unless at least half of the elected members making up the Committee are present.

Subject to this condition, absent members shall have the right to delegate their votes to members who are present, who must show evidence of such delegation. The same shall apply to nominations by secret ballot.

The Director of the International Bureau shall have a deliberative voice within the Committee.

Article 13 (1875). In the interval between one session and another, the Committee shall have the right to deliberate by correspondence.

In this case, in order for the decision to be valid, all members of the Committee must have been called upon to express their opinions.

Article 14 (1875). The International Committee on Weights and Measures shall fill temporarily the vacancies that may occur within it; elections shall take place by correspondence, each of the members being called upon to take part in it.

Article 15 (1921). The International Committee shall

## Proposed Text

Article 12. 1. The votes within the International Committee shall take place by majority vote; in case of a tie, the vote of the President shall prevail. Decisions shall not be valid unless at least half of the elected members making up the Committee are present.

2. Subject to this condition, absent members shall have the right to delegate their votes to members who are present, who must show evidence of such delegation. The same shall apply to nominations by secret ballot.

3. The Director of the International Bureau shall have a consultative voice within the Committee.

No change

No change

Article 15. 1. The International Committee shall prepare

## Present Text

prepare detailed regulations for the organization and the work of the International Bureau, and it shall set the charges to be paid for the special services foreseen in Articles 6 and 7 of the Convention.

These charges shall be applied to the improvement of the scientific material of the International Bureau. An annual appropriation may be taken from the total of the charges received and paid into the pension fund.

Article 16 (1875). All communications of the International Committee with the governments of the high contracting parties shall take place through their diplomatic representatives in Paris.

For all matters whose solution depends on a French administrative unit, the Committee will have recourse to the French Ministry of Foreign Affairs.

Article 17 (1921). A regulation to be established by the Committee shall set the maximum workforce in each category of personnel of the International Bureau.

The Director and his assistants shall be chosen by secret ballot by the International Committee. Their nomination shall be communicated to the governments of the high contracting parties.

The Director shall name the other members of the personnel within the limits established by the above-mentioned regulation.

## Proposed Text

regulations for the organization and the work of the International Bureau, and shall set the eventual charges to be made for this work.

2. These charges shall be applied to the improvement of the scientific equipment of the International Bureau.

Article 16. 1. All communications of the International Committee with the governments of the high contracting parties shall be through diplomatic channels.

2. For all matters whose solution depends on a French administrative unit, the Committee will have recourse to the French Ministry of Foreign Affairs.

No change

## Present Text

Article 18 (1921). The Director of the International Bureau shall have access to the place of storage of the international prototypes only by means of a resolution of the Committee, and only in the presence of at least one of its members.

The place of storage of the prototypes may be opened only by the use of three keys, of which one shall be in the possession of the Director of the French Archives, the second in that of the President of the Committee, and the third in that of the Director of the International Bureau.

Only the standards of the category of national prototypes shall be used for the routine work of comparison of the International Bureau.

Article 19 (1875). The Director of the International Bureau shall present to the Committee at each session the following:

1) A financial report of the accounts of the preceding period, the Director's responsibility being discharged after its verification;

2) A report on the state of the material;

3) A general report on the work accomplished since the preceding session.

The office of the International Committee shall, for its part, address an annual report to

## Proposed Text

No change

Article 19. 1. The Director of the International Bureau shall present to the Committee at each session the following:

a. A financial report accompanied by an audit by a certified public accountant of the accounts of the preceding period, the Director's responsibility being discharged after its verification;

b. A report on the state of the material;

c. A general report on the work accomplished since the preceding session.

2. The office of the International Committee shall, for its

## Present Text

the governments of the high contracting parties on the administrative and financial situation of the service, including in it an estimate of the expenses for the succeeding period as well as a table of the contributive parts of the contracting nations.

The President of the Committee shall report to the General Conference on the work accomplished in the period since the last meeting.

The reports and the publications of the Committee and of the International Bureau shall be written in the French language and communicated to the governments of the high contracting parties.

Article 20 (1921). The scale of contributions mentioned in Article 9 of the Convention is established as regards the fixed part on the basis of the endowment indicated in Article 6 of the present Regulation, and on that of the population; the normal contribution of each nation cannot be less than 5 per 1000 nor more than 15 per 100 of the total endowment, whatever the number of inhabitants may be.

To establish this scale, it is first determined which are the

## Proposed Text

part, address an annual report to the governments of the high contracting parties on the administrative and financial situation of the service, including in it an estimate of the expenses for the succeeding period as well as the table of contributive parts of the contracting nations.

3. The President of the Committee shall report to the General Conference on the work accomplished in the period since the last meeting.

4. The reports and publications of the Committee and of the International Bureau shall be written in the French language and communicated to the governments of the high contracting parties.

5. The Committee decides what resolutions should be translated and published in other languages. In case of disagreements, the French text shall be conclusive.

Eliminated

## Present Text

nations in the desired conditions for this minimum and maximum; and the balance of the contributive sum is distributed among the other nations in direct proportion to the number of their inhabitants.

The contributive parts calculated in this fashion are valid for the entire period of time between two consecutive General Conferences and cannot be modified in the interval except in the following cases:

a. If one of the adhering nations has allowed three successive years to pass without making any contribution;

b. If, on the contrary, a nation previously in arrears for more than three years pays in its overdue contributions, the advances made by the other governments must be returned to them.

The supplementary contribution is calculated on the same basis of population and is equal to the amount the nations that first entered the Convention pay under the same conditions.

If a nation that has adhered to the Convention states that it wishes to extend the benefit to one or more of its nonautonomous colonies, the number of inhabitants of said colonies shall be added to that of the nation for the calculation of the scale of contributions.

When an autonomous colony wishes to adhere to the Convention,

## Proposed Text

Eliminated



## Present Text

it shall be considered so far as its entrance into this convention is concerned, as may be decided by the mother country, either as a dependent of it or as a contracting nation.

Article 21 (1875). The expense of manufacture of the international prototypes as well as the standards and their controls destined to be used with them shall be paid by the high contracting parties according to the scale established in the preceding article.

The expenses for comparison and verification of standards requested by nations that do not participate in the present Convention shall be stipulated by the Committee in conformity with the rates established by Article 15 of the Regulation.

Article 22 (1875). The present Regulation shall have the same force and value as the Convention to which it is annexed.

## Proposed Text

Eliminated

Eliminated

Eliminated

Table of Distribution of the Contributive Parts of the Nations  
(Article 6, paragraph 5 of the Regulation, proposed text)

N = number of contributive parts  
P = population in millions

N	P		N	P
2	less than	5	7	9 to less than 10
3	5 to less than	6	8	10 " " " 11
4	6 " " "	7	9	11 " " " 12
5	7 " " "	8	10	12 " " " 14
6	8 " " "	9	11	14 " " " 16

Table (continued)

N	P				N	P			
12	16	to	less	than	18	22	70	to	less than 80
13	18	"	"	"	20	23	80	"	" " 90
14	20	"	"	"	25	24	90	"	" " 100
15	25	"	"	"	30	25	100	"	" " 110
16	30	"	"	"	35	26	110	"	" " 120
17	35	"	"	"	40	27	120	"	" " 130
18	40	"	"	"	45	28	130	"	" " 140
19	45	"	"	"	50	29	140	"	" " 150
20	50	"	"	"	60	30	more than		150
21	60	"	"	"	70				

## ANNEX 2

COMMENTS OF THE NATIONS ON THE PROPOSED MODIFICATION OF THE  
CONVENTION OF THE METER

Embassy of Canada

Paris 2 June 1960

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The text of Article 10 of the Convention would be clearer if it specified that the Gregorian calendar is involved.

Article 14 seems to indicate that there exist at present two modes of ratification: one by the original Convention of 1875, and another and slightly different one by the Convention of 1921. A single mode of ratification would be preferable, and the one contained in Article IV of the Convention of 1921 could be adopted profitably since the designation of a depository is foreseen in conformity with the usage adopted for multilateral agreements.

In addition to these modifications themselves, it might be well to think of adding some articles on the following subjects:

a) Settlement of Disputes. Modern practice in the matter of treaties provides that international agreements contain a clause regarding settlement of disputes that may arise from their application, even though such a clause may not be strictly required by law. If the Eleventh Conference should decide to study this possibility, the following text might be envisaged:

"If a dispute should arise between the high contracting parties on the interpretation or application of the present Convention, and if this dispute could not be resolved satisfactorily through diplomatic channels, it shall be settled according to the terms of agreements in force between the high contracting parties for the settlement of international disputes. In the absence of such an agreement between the high contracting parties, the dispute shall be submitted to settlement by arbitration or court of justice."

b) Amendment or revision of the Convention. Article 12 of the original Convention of 1875 foresaw ways for revision. This clause,

which no longer appears in the proposed revision, should be conserved as provided by modern practice in the matter of treaties.

c) Accession to the Convention. Article III of the Convention of 1921 foresaw the accession of nonsignatory nations. The proposed revision that was submitted does not indicate clearly if a similar clause will be included in the new Convention.

d) Reserves. It might be desirable to study the possibility of including in the new Convention a clause on the admissibility or non-admissibility of reserves by the signatory nations and of the importance to be given to them, in conformity with Resolution 5-9-8 (VI) adopted on 12 January 1952 by the General Assembly of the United Nations.

Article 6 of the Regulation joined to the proposed revision should also, as should Article 10 of the Convention, indicate if the Gregorian calendar is involved. Furthermore, the words "ipso facto" or "automatically" might be added after the word "excluded" in paragraph 8 of this article.

Article 11 of the Regulation might well specify who should assume responsibility for the expenses of the members of the Committee who should attend the meetings.

(Signed) The Ambassador

Embassy of Austria

Paris 1 July 1960

.....

1. Article 5 (Convention) of the proposal foresees the modification of the Regulation by the General Conference by majority vote of three-quarters of the votes cast. Since the Austrian Constitution accepts exclusively as law only those dispositions emanating from an organization of which the competence has been established by the regulation of this Constitution, this proposal is not acceptable, therefore, to Austria. At the same time, the Regulation, which should enjoy the same importance as the Convention according to Article 5, should be changed only with the consent of the said Austrian organization in order for it to be binding on Austria.

In view of the constitutional difficulties that will certainly arise also among other member nations, it might be well to consider eliminating the separation between the Convention and the Regulation.

Since most of the dispositions contained in the Regulation in force at present are of such importance, it is impossible to waive a contractual regulation. Principally, the distribution of the financial charges among the member nations pro rata their population should continue to be regulated by contract and agreement.

The distribution should not depend on a majority of three-quarters of the General Conference, particularly since the quorum is not indicated in the present text or in the proposal, and the maximum amount of the total endowment, which was established by contract, should be eliminated from this proposal.

2. Article 6 (Regulation). The distribution of the contributions established for the nations as provided for in this article and the annexed table would represent a disproportionate charge for nations having a population of less than 20 million inhabitants, as was mentioned by the Austrian delegate, Mr. Stulla-Götz, at the time of the 1960 session of the International Committee on Weights and Measures. A copy of his counterproposal presented at that time (see the following annex) could serve as a basis for establishing a regulation in the text of the Convention concerning the contributions.

In any case, in view of the fundamental reserves on the subject of these proposals for modification, the Austrian authorities do not believe it useful to take a position at this time on the details of the proposal.

It may be pointed out that the "Convention instituting an International Organization of Legal Metrology" (O.I.M.L.) was signed and ratified in 1956 by Austria and 24 other nations without any constitutional difficulties having been raised. It would be a satisfaction if the modification of the Convention of the Meter could also be achieved without provoking constitutional difficulties. Attention is called to this subject in Articles XXXIV and VIII of the Convention of the O.I.M.L. and to those concerning the rights and duties of the Conference, of the Committee, and of the Bureau of this organization, which should be considered in the present situation.

(Signed) The Chargé d'Affaires

ANNEX. Austrian Proposal Concerning the Distribution of the Contributive Parts

The contributions of the member nations of the Convention of the Meter are calculated so that the contribution of each nation may be proportional to its population, without exceeding in any case the established limits, which are in the ratio of 1 to 30. With the present endowment

of 400,000 gold francs per year, the smallest nations thus pay 1500 gold francs, and the largest 45,000 gold francs; the contributions of the other nations lie between these two. An increase of the present endowment of 400,000 gold francs to 900,000 gold francs would multiply uniformly the contribution of all the nations by a factor of 2.25.

The nations with large populations have criticized this mode of distribution because they are required to carry a heavy part of the contribution while having only a single vote as other member nations.

This objection was taken into consideration in the proposed modification of the Convention of the Meter established by the International Committee on Weights and Measures (C.I.P.M.) in 1958. According to Article 6 of the Regulation in that proposal, a table of distribution establishes the contributions by means of a scale based on population within limits that are in the ratio of 1 to 15. This table of distribution is reproduced in the following Table 1. In Table 2, the contributions of all the nations for 1960 are shown in column 4 as proportional to their population, the total sum being about 400,000 gold francs. The three following columns contain the contributive parts calculated according to the proposal of the C.I.P.M. (column 5), the sum of the corresponding contributions with a total of approximately 900,000 gold francs (column 6), and the relative increase (column 7) in relation to the contributions of 1960 shown in column 4. It is seen that the nations whose population lies between 7 and 25 million inhabitants suffer an increase of more than triple. The contribution of Czechoslovakia, in particular, is multiplied by 4.35.

For this reason, Austria takes the liberty of presenting two counterproposals (Proposals 1 and 2) that avoid an excessive surcharge on small and medium-sized nations by means of a more equal distribution without, however, neglecting the desired improvement in favor of nations with large populations. Table 1 shows the distributions with our Proposals 1 and 2; Table 2 contains the relative increase for both proposals (columns 10 and 13) in relation to the contributions of the year 1960. According to Proposal 1, five nations (the smallest) would have their contributions increased by more than triple. The contributions in Proposal 1 would be increased by a factor of between 1.67 and 3.34 (column 10).

Compared to Proposal 1, Proposal 2 would avoid heavy increases for the small nations, but it does not conform to the decision of the C.I.P.M. not to exceed a ratio of 1 to 15 between the smallest and the largest contributions.

Table 1  
Distribution of Contributions

N = number of contributive parts

P = population in millions

N	C.I.P.M. Proposal	Proposal No. 1	Proposal No. 2
	P	P	P
1	—	—	less than 4
2	less than 5	less than 6	4 to less than 6
3	5 to less than 6	6 to less than 8	6 to less than 8
4	6 to less than 7	8 to less than 10	8 to less than 10
5	7 to less than 8	10 to less than 12	10 to less than 12
6	8 to less than 9	12 to less than 14	12 to less than 14
7	9 to less than 10	14 to less than 16	14 to less than 16
8	10 to less than 11	16 to less than 18	16 to less than 18
9	11 to less than 12	18 to less than 20	18 to less than 20
10	12 to less than 14	20 to less than 22	20 to less than 22
11	14 to less than 16	22 to less than 24	22 to less than 24
12	16 to less than 18	24 to less than 26	24 to less than 26
13	18 to less than 20	26 to less than 28	26 to less than 28
14	20 to less than 25	28 to less than 30	28 to less than 30
15	25 to less than 30	30 to less than 33	30 to less than 33
16	30 to less than 35	33 to less than 36	33 to less than 36
17	35 to less than 40	36 to less than 39	36 to less than 39
18	40 to less than 45	39 to less than 42	39 to less than 42
19	45 to less than 50	42 to less than 45	42 to less than 45
20	50 to less than 60	45 to less than 50	45 to less than 50
21	60 to less than 70	50 to less than 55	50 to less than 55
22	70 to less than 80	55 to less than 60	55 to less than 60
23	80 to less than 90	60 to less than 65	60 to less than 65
24	90 to less than 100	65 to less than 70	65 to less than 70
25	100 to less than 110	70 to less than 80	70 to less than 80
26	110 to less than 120	80 to less than 90	80 to less than 90
27	120 to less than 130	90 to less than 110	90 to less than 110
28	130 to less than 140	110 to less than 130	110 to less than 130
29	140 to less than 150	130 to less than 150	130 to less than 150
30	more than 150	more than 150	more than 150

Table 2

			1 contributive part = 2,227.7 gold francs			C.I.P.M. Proposal			Proposal No. 1			Proposal No. 2		
			1 contributive part = 2,507.0 gold francs			C.I.P.M. Proposal			Proposal No. 1			Proposal No. 2		
			1 contributive part = 2,535.2 gold francs			C.I.P.M. Proposal			Proposal No. 1			Proposal No. 2		
No.	Nations	Population (thousands)	Contri- bution 1960 (gold francs)	Contri- butive Parts	Contri- bution	Relative Increase	Contri- butive Parts	Contri- bution	Relative Increase	Contri- butive Parts	Contri- bution	Relative Increase	Contri- butive Parts	Contri- bution
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
1	Dominican Republic	2,136	1,500	2	4,455	2.97	2	5,014	3.34	1	2,535	1.69		
2	Ireland	2,961	1,500	2	4,455	2.97	2	5,014	3.34	1	2,535	1.69		
3	Uruguay	3,000	1,500	2	4,455	2.97	2	5,014	3.34	1	2,535	1.69		
4	Norway	3,400	1,500	2	4,455	2.97	2	5,014	3.34	1	2,535	1.69		
5	Finland	4,030	1,650	2	4,455	2.70	2	5,014	3.04	2	5,070	3.07		
6	Denmark	4,300	1,760	2	4,455	2.53	2	5,014	2.85	2	5,070	2.88		
7	Switzerland	4,715	1,930	2	4,455	2.31	2	5,014	2.60	2	5,070	2.63		
8	Chile	5,931	2,428	3	6,683	2.75	2	5,014	2.07	2	5,070	2.09		
9	Bulgaria	7,022	2,875	5	11,139	3.87	3	7,521	2.62	3	7,606	2.65		
10	Austria	7,060	2,847	5	11,139	3.91	3	7,521	2.64	3	7,606	2.67		
11	(up to now)	(6,954)												
11	Sweden	7,192	2,944	5	11,139	3.78	3	7,521	2.55	3	7,606	2.58		
12	Belgium	8,798	3,602	6	13,366	3.71	4	10,028	2.78	4	10,141	2.82		
13	Australia	8,962	3,669	6	13,366	3.64	4	10,028	2.73	4	10,141	2.76		
14	Portugal	9,098	3,725	7	15,594	4.19	4	10,028	2.69	4	10,141	2.72		
15	Hungary	9,632	3,943	7	15,594	3.95	4	10,028	2.54	4	10,141	2.57		
16	Holland	9,756	3,994	7	15,594	3.90	4	10,028	2.51	4	10,141	2.54		
17	Czechoslovakia	12,500	5,117	10	22,277	4.35	6	15,042	2.94	6	15,211	2.97		
18	Canada	15,235	6,237	11	24,505	3.93	7	17,549	2.81	7	17,746	2.85		



Table 2 (Continued)

No.	Nations	Population (thousands)	Contri- bution 1960 (gold francs)	C.I.P.M. Proposal			Proposal No. 1			Proposal No. 2		
				Contri- butive Parts	Contri- bution	Relative Increase	Contri- butive Parts	Contri- bution	Relative Increase	Contri- butive Parts	Contri- bution	Relative Increase
				(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1)	(2)	(3)	(4)									
19	Roumania	15,900	6,509	11	24,505	3.76	7	17,549	2.70	7	17,746	2.73
20	Argentina	16,318	6,680	12	26,733	4.00	8	20,056	3.00	8	20,282	3.04
21	Yugoslavia	16,927	6,930	12	26,733	3.86	8	20,056	2.89	8	20,282	2.93
22	Thailand	17,317	7,089	12	26,733	3.77	8	20,056	2.83	8	20,282	2.86
23	Turkey	20,935	8,570	14	31,188	3.64	10	25,070	2.93	10	25,352	2.96
24	Poland	24,977	10,225	14	31,188	3.05	12	30,084	2.94	12	30,422	2.98
25	Mexico	25,781	10,554	15	33,416	3.17	12	30,084	2.85	12	30,422	2.88
26	Spain	27,977	11,453	15	33,416	2.92	13	32,591	2.85	13	32,958	2.88
27	Italy	46,738	19,134	19	42,326	2.21	20	50,140	2.62	20	50,704	2.65
28	United Kingdom	50,674	20,745	20	44,554	2.15	21	52,647	2.54	21	53,239	2.57
29	Brazil	51,976	21,278	20	44,554	2.09	21	52,647	2.47	21	53,239	2.50
30	France and Algeria	52,000	21,288	20	44,554	2.09	21	52,647	2.47	21	53,239	2.50
31	Germany	69,000	28,616	21	46,782	1.63	24	60,168	2.10	24	60,845	2.13
32	Japan	83,200	34,061	23	51,237	1.50	26	65,182	1.91	26	65,915	1.94
33	U.S.A.	163,000	45,000	30	66,831	1.49	30	75,210	1.67	30	76,056	1.69
34	U.S.S.R.	202,000	45,000	30	66,831	1.49	30	75,210	1.67	30	76,056	1.69
35	India	370,000	45,000	30	66,831	1.49	30	75,210	1.67	30	76,056	1.69
			400,853	404	899,991	2.25	359	900,013	2.25	355	899,996	2.25

1 contributive part = 2.227.7 gold francs  
 C.I.P.M. Proposal  
 Proposal No. 1  
 1 contributive part = 2.507.0 gold francs  
 Proposal No. 2  
 1 contributive part = 2.535.2 gold francs

Royal Embassy of Norway

Paris 2 July 1960

.....

In conformity with instructions received from the competent Norwegian authorities, I have the honor to inform you that they do not consider it necessary to increase the number of members of the International Committee on Weights and Measures from 18 to 20.

As regards the election of members of a scientific committee of this kind, the Norwegian authorities consider that it should be done on the basis of the professional aptitudes and knowledge of the candidates, and not on that of an equitable geographic distribution.

(Signed) The Counsellor of the Embassy

Embassy of the Federal Republic of Germany

Paris 19 July 1960

.....

The Federal Government has not yet been informed of the text of a convention designed to modify the International Convention of the Meter of 20 May 1875 per the text of the Convention of 6 October 1921, and of the Annexed Regulation to this Convention in the amended text of October 1907 and of 6 October 1921, which should be adopted when the Eleventh General Conference on Weights and Measures meets.

The Federal Government, therefore, does not give its opinion on the first proposal of the International Committee containing a modification of the different articles of the Convention and of the Regulation, and takes the opportunity to submit the following proposals.

A. The text of paragraph 2 of Article 5 of the Convention cannot be accepted for internal reasons of a constitutional nature. In order to confer on the agencies of the Convention the great flexibility that is desired, the Federal Government proposes to insert in the Regulation a clause reading as follows:

Article... "1. Each contracting party shall be able to propose modifications of the present Regulation. The text of each proposed modification shall be transmitted to the French Government, which will communicate its contents to all the governments of the contracting parties.

"2. Within a term of six months after the French Government will have communicated the proposed modification, each contracting party may make it known,

"a) that it wishes to oppose the proposed modification;

"b) or that, even though it has the intention of accepting the proposal, the conditions necessary for its acceptance have not yet been fulfilled in its country.

"If the contracting party makes the communication provided under b, it shall have the right to oppose the proposal later, so long as it has not informed the French Government of its acceptance.

"3. If it opposes the proposed modification in conformity with paragraph 2a, the modification is considered as not accepted and without effect.

"4. The modification is considered as accepted:

"If none of the contracting parties communicates with the French Government in conformity with paragraph 2b before the expiration of the six months provided for in paragraph 2;

"If at least one contracting party has communicated with the French Government in conformity with paragraph 2b by the date on which all the contracting parties who have made such a communication have notified the French Government that they accept the proposal or, if this date is previous to the date of expiration of the term of six months provided for in paragraph 2, by the expiration of this term.

"It becomes effective six months after this date.

"5. The French Government transmits as rapidly as possible to the contracting parties a notification informing them if there has been opposition to the proposed modification, according to paragraph 2a of the present article, and if one or more contracting parties have communicated with it in conformity with paragraph 2b. In the latter case, the French Government notifies later all the contracting parties if one or more of the contracting parties who have made such a communication opposes or accepts the proposed modification."

B. In order to specify that the Convention cannot be modified except by unanimous decision, Article 12 of the Convention should not be eliminated or replaced.

C. The clause concerning the granting of privileges and immunities in favor of the International Bureau of Weights and Measures should be written in the form of a new article of the Convention and should define more precisely the extent of these privileges. The following text is suggested for this purpose:

"Article... The International Bureau of Weights and Measures enjoys in the territories of the high contracting parties, according to the dispositions of an additional protocol that is an integral part of the present Convention, the privileges and immunities necessary to the accomplishment of its tasks."

It would then be possible to insert in the additional protocol the regulations foreseen for the specialized sections of the United Nations in Articles III, paragraphs 4-9, VI, paragraphs 19-23, and VII of the Convention of 21 November 1947 regarding the privileges and immunities of the specialized sections of the United Nations.

D. Article 5 of the Regulation could be completed by the second phrase as follows:

"The expenses for the construction of the enlargements of the buildings and for their necessary initial fitting should not exceed the sum of 1,800,000 gold francs."

E. In replacing the second phrase of paragraph 3 of Article 7 of the Regulation, the following dispositions regarding the quorum of the General Conference should be inserted:

"The decisions of the General Conference can become effective only if the number of member nations represented is at least two-thirds of the total number of member nations, and if the decisions are ratified by at least four-fifths of the votes cast. The number of votes cast should be at least four-fifths of the number of member nations represented. Abstentions as well as blank or invalid ballots are not counted as votes cast. For cases foreseen in paragraphs 2 and 4 of Article 6 of the Regulation, the majority of three-quarters of the votes cast is sufficient if the minimum number of members represented and votes cast are in conformity with the dispositions of the present paragraph."

As a result of this regulation, the dispositions on the right to vote contained in paragraphs 2 and 4 of Article 6 could be eliminated.

(Signed) (illegible)

COMMENTARIES OF THE UNITED STATES OF AMERICA  
(transmitted by the American Embassy  
at Paris, 5 August 1960)

GENERAL CONSIDERATIONS

Formal Presentation and Language of the Proposed Convention

Having regard to the various changes desired, a revised convention that would replace the present conventions instead of only amending them would be a simpler and more useful document and, it seems to us, a more desirable one. The portions of the present conventions that it is desired to conserve without important changes could be incorporated in the revised convention. A suitable title and a clause of replacement of the preceding conventions, as was done for the 1958 revision and for the previous revisions of the Convention on Industrial Property, would serve at the same time to confirm that the new convention has its origin in the Convention of 1875, that it is a revised form of it, and that it replaces it. We suggest a title and a preamble analogous to text A, and a separate article (text B) that would be added to the final part of the convention.

CONVENTION OF THE METER  
SIGNED AT PARIS ON 20 MAY 1875  
REVISED AT SEVRES ON 6 OCTOBER 1921  
AND AT PARIS ON ...

A {

The high contracting parties, desiring to modify the Convention of the Meter signed at Paris on 20 May 1875 and modified at Sevres on 6 October 1921, have agreed as follows:

B {

The present Convention, insofar as it concerns the relations between the high contracting parties to which it applies, replaces the Convention of the Meter signed at Paris on 20 May 1875, and the modification signed at Sevres on 6 October 1921.

We propose that the convention be signed in the English as well as in the French languages.

Apart from what is indicated in the enclosed comments and apart from the changes of form suggested in A and B, the proposals of the International Committee are generally acceptable by the United States.

## COMMENTS

## Convention

Article 5 (1960). In the form proposed by the Committee, paragraph 1, which unites Articles 5 and 22 of the present Regulation, would cause no objections on the part of the United States.

The United States cannot, however, accept the procedure proposed in paragraph 2 to modify the Regulation. By this procedure, a modification could be imposed on a member nation without its consent and even in spite of its opposition. The Annexed Regulation and the proposed amendments to this Regulation provide a certain flexibility that makes unnecessary any special clause permitting the amendment of the Annexed Regulation.

Article 7 (1960). We suggest that the beginning of this article be modified and rewritten as follows: "When it shall have been so authorized by resolutions of the General Conference, the International Bureau shall be charged with the following tasks:"

Article 11 (1875). This article establishes the conditions for accession to the Convention and provides that the right of accession to the Convention is "reserved for every nation." The United States proposes that the Convention be open to present member nations and in addition to the nations that are members of the United Nations or of its specialized agencies, and also to every other sovereign nation of which the candidacy is approved by two-thirds of the members of the Convention. This clause would take into account both the political relations existing between members of international organizations as well as the independent character of the present Convention.

Article 12 (1960). The proposed text imposes on the high contracting parties the obligation to accord to the International Bureau the same privileges and immunities they concede to the most favored of similar organizations.

It would be extremely difficult to determine which of the organizations are "similar." The United States believes that the privileges and immunities enjoyed by an international organization within the territory of a member nation depend on the activities of this organization within this nation.

The United States would prefer, therefore, that this article be modified to stipulate that the International Bureau enjoys on the territory of each of the high contracting parties the privileges and immunities that are necessary to the accomplishment of the tasks assigned to it.

Article 13 (1960). With a view to the eventual replacement of the new convention by an ulterior revised convention, we propose to add to this article the following paragraph:

"The present Convention will cease to be in effect for all the high contracting parties when at least three-quarters of the members of the present Convention have become members of a convention that replaces the present Convention."

#### Annexed Regulation

Article 6 (1960), paragraph 6. It would be desirable in the first sentence to make clearer the expression "each year" by stipulating "each calendar year" in order to avoid all difficulties of interpretation, for it is probable that for certain members the fiscal year is not the year from 1 January to 31 December. Regarding the continuation of this paragraph, it does not seem to be a very honest procedure to penalize the members who pay their contributions by requiring that they pay part of the contributions not paid by others.

Consequently, the United States would be in favor of eliminating this clause.

Paragraph 8. We consider that it is necessary to specify the procedure of exclusion of a nation in arrears in its payments. One convenient procedure would be its exclusion by a vote of the General Conference of a majority of three-quarters.

Paragraph 10. Even though the general terms of this clause are satisfactory, the United States believes that the ceiling approved by the General Conference should be maintained. The contributions paid by the new members could serve to reduce the contributions of the other members, or could be held in reserve at the disposition of the succeeding Conference.

Article 9 (1960), paragraph 3. We consider that an advance notice of three months should be given in the case of all vacancies that may occur. We consider, in addition, that it would be well to add the clauses of this paragraph to a portion of Article 14 (1875) in order to make up a new Article 10, Article 14 as it now stands being eliminated.

Article 13 (1875). Taking into account the elimination of Article 14 as proposed above, we suggest specifying in Article 13 that elections to fill vacancies on the Committee be held by correspondence.

Article 19 (1960). The United States considers that the reports and publications of the International Bureau (paragraph 4) should be published

in English as well as in French, since English is now the predominant language of scientific publications. We consider, moreover, that paragraph 5 should be eliminated.

Committee on Norms, Measures, and Instruments of Measure  
attached to the Council of Ministers of the USSR

Moscow 11 August 1960

1. The present text of the Convention does not stipulate the procedure for adhesion of nations to the Convention of the Meter, and it is not mentioned except in Article III of the International Convention of 1921 modifying the Convention of 1875. We find that it would be necessary that the procedure for adhesion of nations to the Convention of the Meter be in the text of the Convention in a special article, or as a complement to an existing article.

2. We find it should be necessary to eliminate from the Annexed Regulation Article 5, which is entirely out of date.

3. The distribution of the amount of the contribution of a nation in arrears as a supplementary payment among the other nations creates a condition favoring delays in payments. We propose, therefore, to exclude paragraph 6 in Article 6 of the proposed Regulation, except for the first sentence concerning payment of contributions at the beginning of each year.

4. The International Organization of Weights and Measures that the International Committee on Weights and Measures directs is inter-governmental, and it is normal, therefore, for the members of this Committee to be the representatives of their countries, and not scientists elected as individuals. Under present conditions, the International Committee is called upon to resolve not only scientific problems, but also numerous questions of an administrative character whose resolution requires the members of the International Committee to be representatives of their government, the more so because many similar questions arise in the interval between General Conferences. The representative character of the Committee would make it possible for all its members to take part in its work since their presence would be assured by their governments.

For this reason, and also to increase the authority of the International Organization and guarantee effective representation of the nations in the organization that directs it, we propose the following text for paragraph 1 of Article 8 of the proposed Regulation:



"The International Committee mentioned in Article 3 of the Convention is composed of 20 representatives of nations elected by the General Conference, taking into account their equitable geographic distribution. The nation elected appoints its representative to work on the Committee, who should be a specialist in the field of scientific metrology. Each nation designates a single representative. The nations elected for the International Committee continue their functions until the election of new members of the Committee by the General Conference."

5. Concerning the text proposed above, we believe it would be convenient to replace the present text of Article 14 with the following:

"If a vacancy occurs in the International Committee in the interval between General Conferences, the President of the Committee organizes, by correspondence between the participants in the Convention, elections by secret ballot to fill the vacancy of the member nation of the Committee."

6. In order to facilitate the communications of the International Committee on Weights and Measures with the member nations of the Convention of the Meter, we propose the following text for Article 16 of the proposed Regulation:

"All communications of the International Committee with the governments of the high contracting parties shall be directly or through diplomatic channels."

Embassy of the Netherlands

Paris 13 September 1960

.....

1. Regarding the proposed revision on the whole, it is recommended emphatically not to conclude a convention including modification of a large number of articles, but to conclude a modified convention and a modified regulation containing integral texts. As a matter of fact, it is already difficult at present to consult the text of 1875, itself replaced in part by that of 1921.

2. In the texts of 1875 and 1921, as well as in the proposed modification of 1960, the parties are designated in turn by the terms "high contracting parties," "governments of the high contracting parties," "contracting governments," "governments," "contracting nations," "participating nations," "member nations," "nations," and "powers." A revision of the complete text would permit giving this terminology a greater uniformity.

### 3. Convention

Article 5 (1960), paragraph 2. It would be possible to add that a modification of the Regulation must never be contrary to one of the dispositions of the Convention.

When adopting this paragraph, it would be convenient to take into consideration that a decision involving a modification of the Regulation shall be equally mandatory on those who voted against it and on those who are not represented at the Conference. Account should be taken, for example, of the obligations devolved on France (Article 3 of the Regulation, text of 1875) which should not be extended if France votes against it.

The second sentence of paragraph 2 stipulates that only modifications of which the text has been submitted one year in advance can be introduced. This disposition seems too rigid; the Conference could no longer introduce an editorial improvement to the proposed modification. It would be convenient no doubt to improve the wording of this disposition as follows:

"In any case, these modifications shall affect only those provisions on the subject of which proposals have been communicated by the International Committee to the contracting parties at least one year before the opening of the General Conference."

The means of adhering to the Convention of 1875 have not been settled; the possibility of adhesion is mentioned only incidentally in Article 11 of the Convention. It seems desirable to remedy this. It might be possible to use as a model the present usage by which the possibility of adhesion is provided for by means of a notification to the government of the depositary nation, for all the member nations of the United Nations or of one of its specialized organizations. This disposition must stipulate also the date on which the Convention shall become effective for the nation adhering to it.

Article 11 (1875). This article makes the Committee responsible for the determination of the amount of the contribution due from the adhering nations. The maintenance of this disposition does not seem to be justified in view of Article 6, paragraph 10 of the Regulation (text of 1960)<sup>1</sup>.

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<sup>1</sup>Note of the International Bureau: This comment is the result of a misunderstanding. The contribution in question in this article is an "entrance fee" independent of the normal annual contribution of the nations.

Article 12 (1875). The Government of the Netherlands can give its approval to the elimination of this article, since it does not give the contracting parties any rights they do not possess already, even without dispositions on this subject, in view of international customs in matters concerning the conclusion of treaties. In any case, if Canada's request to maintain this article (see p. 124) gives as its reason for existing the opportunity to provide a more precise definition of the consequences of a modification of the Convention for the nations who have not yet ratified such modification, my Government is willing to accede to the wishes of Canada. The new paragraph of Article 13 proposed by the Government of the United States of America (see p. 134) already provides in great measure for the solution of this difficulty. Apropos of this, I take the liberty to return to the last part of point 5 above.

Article 12 (1860). This article contains a clause comparable to the one stating "of the most favored nation." Such a clause in matters of immunities and privileges is highly unusual. The Government of the United States points out--justly--that it is not easy to determine which are the organizations to be considered as "similar organizations." It would seem probable that in practice this clause will be a source of confusion and will give rise to many disputes in its interpretation.

If it is proposed to insert a clause regarding privileges and immunities aimed at creating for the International Bureau and its functionaries an identical juridical stature in each of the contracting nations, it falls short in its present form, since the attribution of privileges and immunities differs in many respects from country to country.

In view of the preceding, the proposed text of Article 12 does not appear to be acceptable. I take the liberty of proposing in the name of my Government that the extents of the privileges and immunities really necessary for the International Bureau, the functionaries and the Conference be determined, and then to proceed to a definition of the privileges and immunities to be accorded in an annex to the Convention, or, as proposed by the Government of the Federal Republic of Germany (see p. 131), in a separate protocol.

If, on the other hand, the proposed insertion of this clause aims to regulate only the juridical stature in France, this fact should be mentioned in the disposition by rewriting it, for example, in the following terms: "The Government of the French Republic accords to the International Bureau.....etc."

#### 4. Regulation

Article 6 (1960). This article, which contains ten paragraphs, could be divided for greater clarity into several articles. In any case, it would be desirable to number the paragraphs.

Paragraph 7. This paragraph picks up the term "adhesion" used in the 1921 text. Since this article is without any doubt applicable also to the nations that have not become parties by adhesion but by signature and ratification, it would be desirable to correct its wording as follows: "The advantages and prerogatives resulting from the Convention of the Meter are suspended as regards any nation, party to the Convention, that has not....etc."

Paragraph 8. This paragraph says: "The nation in arrears can be excluded..." By whom is this decision taken? When the 1921 text was applicable ("the nation....is excluded"), the exclusion was the automatic consequence of the delay in payment of the contribution.

Article 9, paragraph 3 (1960 text taken without modification from that of 1921). In employing the expression "new elections or nominations," the impression is created that the rule established for this is valid not only for the "nominations" stipulated in paragraph 1, but also for the "nomination" of the director and subdirectors (Article 17, paragraph 2 of the Regulation), as well as for the "election" of the temporary members (Article 14 of the Regulation). If this wide interpretation is not intentional, which is my opinion, it would be convenient to eliminate the words "elections or" and to add after "the vacancy" the words "to the Bureau."

Article 16. Since the Committee does not maintain diplomatic relations, the formula "diplomatic channels" does not seem to be well chosen. The intention was undoubtedly to say "by the intermediary of diplomatic representatives of the contracting parties accredited to the French Government."

5. The proposed modification of the Convention of the Meter does not include a proposed article on its ratification and placement into effect. The dispositions that were provided for in Article IV by the Convention of 1921 are not satisfactory and should not be included inasmuch as they provide for a date of placement into effect only for each nation separately. It would be convenient to take into consideration whether, for the placement into effect of the proposals being studied (carrying modifications so radical as the simplification of the procedure of modification for the Regulation and a modification of the calculation of the contributive parts), the condition of their ratification by all the parties to the Convention of 1875 should not be imposed. If it is not desired to impose such a condition, it would be well to examine what will be the position of the parties to the Convention of 1875 who, at the time the modifications come into effect, have not yet ratified them.

(Signed) For the Plenipotentiary Minister

MEMORANDUM FROM THE BELGIAN DELEGATION  
(transmitted by the Belgian Embassy  
in Paris, 15 September 1960)

.....

Convention

Article 5 (1960). According to the proposal, the Regulation annexed to the Convention "has the same force and value" as the Convention itself, but it could be modified hereafter on any predetermined point whatsoever by a decision, even not a unanimous one, of the General Conference.

In this text it would seem as though this assembly might be an ordinary conference, which is to say one in which the delegates of the governments have not received diplomatic powers (full powers or special powers), whereas just as in the case of the Convention, the Regulation was established by a diplomatic conference and must have been ratified according to Article 14 of the Convention combined with the present Article 5 or the first paragraph of the proposed Article 5.

If it is agreed that any clause of the Regulation may be modified henceforth by an ordinary conference (a hypothesis on which the Belgian Government reserves opinion, it should then be said in the Convention that the Conference establishes the Regulation, even if it means fixing the conditions for a quorum and advance notice.

If the ordinary conference does not have the right to establish, it is difficult to recognize its right to modify (and, furthermore, to modify by a vote that is not unanimous).

Many have actually thought up to now that the expression "same force and value" implied the same character of deliberative assembly and the same need for ratification. (However, Belgium has felt up to now that the ratification, as regards Parliament, could be made by voting on the budgetary law, provided the Regulation was modified only as to the amount of the endowment.)

Article 12 (1875). The International Committee seems to be proposing the elimination purely and simply of this article. It has been felt in Belgium that its effect was to simplify, not the powers of the delegates, but the formalities of ratification of the Convention and the Regulation.

In this respect, the Parliament of 1875 trusted the Government as to the modifications of the Convention decided upon unanimously (by common consent), except for those affecting the national budget (see above apropos of Article 5 and subject to reserve on other exceptions that are not thus far normally subject to question herein).

Is it desired to eliminate Article 12, and would any modification of the Convention entail henceforth the same requirements as a new Convention; particularly, the delivery of the ratifications to the French Government?

The Belgian Government would like to have immediately, if possible, clarifications on these points concerning the two articles. It assumes that so far as the present revision is concerned, it will be made in conformity with Article 12 of 1875 (see Note 1).

Article 12 (1960). The Belgian Government considers there is reason to accord not only to the International Bureau and its personnel, but also to the members of the General Conference, the Committee and the Consultative Committees, including the experts and other collaborators who accompany them, the privileges and facilities necessary for the accomplishment of their mission; and this not only in the country where the headquarters of the International Bureau is situated, but also in all the member nations they must traverse or visit in the execution of their mission. It is necessary also to arrange for passing through customs in the different countries the standards and other scientific instruments when they are transported for purposes within the framework of the activities provided for in the Convention.

Articles 6 and 7 (1960). Would it not be well to consider as "international prototypes" the bases of electric, photometric, and similar units conserved by the International Bureau? The text should be more extensive.

Are these bases "fundamental standards" in the sense of the proposed Article 7, paragraph 1? Is the coordination provided for in paragraph 2 limited to the case in which the International Bureau conserves the fundamental standards in the sense of paragraph 1?

#### Regulation

Article 8 (1960). The following is not stated explicitly:

1) that the members of the International Committee are elected by the Conference (subject to provisional cooptations by the Committee itself in the interval between sessions of the Conference);

2) that the members of the Committee should be citizens of member nations of the Convention, and that they cease to be members of the Committee if the nation of which they are citizens becomes the object of a suspension, exclusion, or expulsion;

3) that no person may be coopted, elected, or maintained as a member of the Committee if he does not enjoy, or if he no longer enjoys, the confidence of the government of the nation of which he is a citizen; that this condition is presumed to be complied with for the delegates of the governments at the General Conference in session, if it is a question of an election by this Conference;

4) that the Committee may be assisted for specific questions by consultative committees, which it appoints but to which it can give no delegation of authority.

The Belgian Government insists particularly on point 3 above, on which it made a proposal to the 1954 General Conference (Transactions, p. 83); although this proposal raised no objections, it would be well to make it more explicit.

The International Committee is not only charged in fact with a high scientific mission (for which it disposes moreover of Consultative Committees), but in powers, and also in fact, with an exclusive mission of direction and supervision over the International Bureau (Article 3 of the Convention).

It is thus responsible for the expenditure of increasing large sums of money furnished exclusively by the governments of member nations, as well as having full powers to determine the framework and choose the personnel of the International Bureau.

The decisions of the Committee have repercussions on the legislation, the regulation, and even the organization of interested services of the member nations; all the more so when these decisions are taken by delegation of the General Conference, as is more and more frequently the case.

It is impossible, therefore, to admit in an intergovernmental organization that the members of the Committee ignore or even oppose the government of the nation of which they are citizens.

In the opinion of the Belgian Government, the desirable increase in the right to supervision, or at least some kind of veto by the large and small nations, of the composition of the Committee as regards their own citizens should not in any case be pushed to the point of introducing political considerations or a bureaucratic cast into the Committee.

Concerning the distribution of powers among the nationals of the member nations, the Belgian Government proposes the introduction of the following clause:

"No founding nation of the Convention of the Meter of 1875 may remain more than 12 years without having one of its nationals on the International Committee, save in case the nation desists from this right."

This proposal has the following justification:

Actually, the great nations always have one of their nationals on the Committee, whereas a certain routine of change exists regarding the smaller nations, although without any precise rules.

At the same time, certain of the small nations have provided and are still providing serious contributions to the progress of international metrology, and it would not be wise to deprive them for too long of a place on the Committee.

On the other hand, it must be expected that a goodly number of the nations that have just recently gained their independence will adhere to the Convention. In spite of the generally rudimentary state of metrology in these nations, they should be able to ask to have their turn at appointments just the same as the other small nations.

It would be wise to be very cautious and not to confer seats impulsively, and even less so for purely political reasons, in an organization that possesses, as has been pointed out above, extremely important powers in metrological matters.

This is why the above-mentioned proposed guarantees in favor of the small nations are limited for the moment to nations that have given conclusive proof of their competence ever since the foundation of the Convention of the Meter. This does not exclude the possibility of the de facto existence of one or the other mandate that might be attributed to a new nation of which one of the nationals may have already been remarked because of interesting articles in the scientific or technological international press.

Further, the Belgian Government would like to stipulate the following:

"Every member of the Committee who shall have been absent from two consecutive sessions without having himself represented by another shall be considered as having resigned as from the second of the sessions."

This clause is inspired by Article 13, sixth paragraph of the Convention establishing an International Organization of Legal Metrology,



in which it was desired to avoid the regrettable situations that were produced previously within the International Committee on Weights and Measures.

Finally, the Belgian Government believes it convenient to specify that,

"The members of the Committee may not receive any remuneration or indemnification whatever paid for by the International Bureau, not even reimbursement for traveling and living expenses, without a specific decision by the Conference."

Note 1. It seems permissible to ask if the absence of the old Article 12 in the new text may not be the cause of the following consequences, in case it were desired later to make new modifications to the Convention:

Should not these modifications be the object, then, of a new Convention rather than of a simple modification?

If all the contracting parties are present at the time of the new Convention and give their approval, there are no difficulties, even if there are new contracting parties. On the other hand, if contracting parties are absent or do not give their approval, they cannot be considered for the future as having simply resigned. Consequently, since they do not lose their rights as co-owners of the property of the International Bureau, there is need to liquidate the old property, at the risk that most of this property be turned over immediately to the new Bureau.

Note 2. The Metrological Service feels that it would be a delicate matter to bring forward the definition of what will be understood henceforth by "government," since up to now Article 20 of the Regulation regulated the status of the "colonies" and required the agreement of the mother country for the admission of a "colony recognized as autonomous" as a contracting party itself, nor did it permit the independent participation of other colonies.

Nevertheless, the proposed elimination without replacement of the two last paragraphs of Article 20 of the Regulation would seem of such a nature as to complicate further the situation in the case of certain territories.

COMMENTS OF THE UNITED KINGDOM  
(transmitted by the British Embassy  
in Paris, 28 September 1960)

Form of the proposed revision. The United Kingdom gives its approval to the views of the United States of America according to which a modified convention replacing the existing Convention is preferable to a convention of modification. The new convention would then include in a single document the articles remaining unchanged in the existing Convention and the new articles approved by the General Conference. In accordance with modern usage, the members of the new convention should be nations or governments, and not chiefs of state.

Languages. We propose that the Convention be signed in the French and the English languages, and that each of these texts have the same authority.

Convention

Article 5 (1960), paragraph 2. The Annexed Regulation should not be modified by the General Conference except by unanimous vote.

Article 12. The United Kingdom recognizes the uselessness of the present Article 12 (1875).

It is not convinced of the need for the new proposed Article 12 conferring privileges and immunities on the International Bureau. An article in the proposed terms is not satisfactory for the reasons indicated by the United States, and it would be susceptible of becoming an obstacle to the ratification of the new convention. However, if the Conference were in favor of the inclusion of a clause on this subject, the United Kingdom would propose the following text:

"The International Bureau of Weights and Measures shall enjoy on the territory of each contracting party, in conformity with the agreements concluded between the International Bureau and each contracting party, the immunities and privileges that they will have recognized mutually to be necessary for the accomplishment of the tasks of the International Bureau."

Article 13. In order to facilitate the preparation of a modified convention along the lines indicated in the proposed modification, the United Kingdom proposes, as annexed to this present note, a group of articles relating to signature, ratification, accession, placement into effect, and cessation. Certain proposals presented by other governments are included in these articles.

## Regulation

Article 6 (1960). The United Kingdom would prefer that the endowment for six years should not be subject to change without unanimous approval of the General Conference.

We consider that the best way to establish the contributions would be to refer to the scale of the United Nations, which takes into account both the population and the resources of each nation.

We agree with the United States and the USSR that the contributions that are not paid should not be distributed for payment by all the other member nations.

The maximum endowment approved by the General Conference should be maintained.

Article 7 (1960). We feel that a quorum should be specified for the General Conference.

Article 8 (1960). We are in favor of the proposal that the members of the International Committee should be the official representative of their nation.

Article 9 (1960). We support the suggestion that an advance notice of three months should be given in the case of all vacancies that may occur.

Article 13 (1875). We approve that voting by correspondence should be specified when it is a question of filling vacancies within the Committee.

Article 16 (1960). We approve that communications between the International Committee and the member nations should be through diplomatic channels or directly.

ANNEX. Proposals for Articles 13 to 17 of the Convention

Article 13. 1. The present Convention shall remain open for signature in Paris until.....by all the nations that are members of the United Nations or of one of its specialized agencies.

2. The present Convention shall be submitted for ratification by the signatory nations.

3. The ratified texts shall be deposited in the archives of the French Government.

Article 14. 1. After the present Convention goes into effect, it shall remain open for the accession of any nation that is a member of the United Nations or of one of its specialized agencies, or for any other nation the accession of which is approved by two-thirds of the member nations of the General Conference.

2. The texts of accession shall be deposited in the archives of the French Government.

Article 15. 1. The present Convention shall go into effect on the thirtieth day after the date of deposit of the [sixth] text of ratification with the French Government.

2. For each nation ratifying the Convention or acceding to it after the deposit of the [sixth] text of ratification, the Convention shall take effect on the thirtieth day after the deposit by this nation of its texts of ratification or accession.

3. As regards the relations between the contracting parties to which it applies, the present Convention shall replace the Convention of the Meter signed at Paris on 20 May 1875 and the modified Convention signed at Sevres on 6 October 1921.

Article 16. 1. Any of the contracting parties may withdraw from the present Convention by means of written notice to the French Government one year in advance. Any nation making use of this facility shall renounce thereby all rights to co-ownership of the property of the International Committee.

2. The present Convention shall terminate for all contracting parties when three-quarters at least of the contracting parties to the present Convention shall have become members of a Convention replacing the present Convention.

Article 17. 1. The French Government shall inform all nations that have signed the present Convention or acceded to it

- a) of all the signatories to the present Convention;
- b) of the deposit of all texts of ratification or accession;
- c) of the date the Convention takes effect in conformity with Article 15, paragraph 1;
- d) of all notifications of withdrawal presented, according to Article 16, paragraph 1;
- e) of the cessation of the Convention according to Article 16, paragraph 2.

In evidence of which, the undersigned, duly provided with the necessary powers, have signed the present Convention.

Executed in Paris the.....1960 in a single copy in the.....language [each of the texts having the same authority], which shall be deposited in the archives of the French Government which shall transmit certified copies to all signatory nations or nations acceding to the present Convention.

Embassy of Japan

Paris 4 October 1960

1. Taking into account the need for relations between the International Atomic Energy Agency as regards normalization of the standards of measure of ionizing radiations, the Japanese Government proposes adding to Article 7 (first sentence) of the proposed new Convention after "the Committee," the following words: "in close collaboration with all other competent intergovernmental organizations."

2. Considering the need for the new Convention to remain open for the signature of all countries, the Japanese Government suggests, as was the case for the 1921 Convention, adding to the new Convention a clause specifying that it shall remain open for signature until the.....

3. In order to assure the presence of the members of the International Committee, the Japanese Government proposes to add to Article 11 of the Regulation annexed to the principal Convention a second paragraph specifying that the traveling expenses of the members of the Committee shall be paid from the budget of the International Committee.

COMMENTARIES OF ROUMANIA  
(presented during the Conference)

Regulation

Article 6 (1960). Article 20 of the Regulation annexed to the Convention of the Meter establishes the method of calculating the contributions which cannot be less than 0.5 percent or greater than 15 percent of the total allocation, whatever the population.

For 1960, the payment of contributions was made according to this criterion. Since the budget of the International Bureau was 300,000 gold francs, the minimum contribution paid was 1500 gold francs (0.5 percent) and the maximum was 45,000 gold francs (15 percent).

The International Committee now proposes a modification of Article 6 specifying the contributions as well as the elimination of Article 20 establishing their distribution. It proposes to change the method of calculation, each nation being required to pay a given number of contributive parts established according to population in conformity with the table on page 122.

As concerns this proposal, we must agree that in general we find the system of contributive parts equitable, but we do not agree on the basis used for establishing the table: for nations with a population of 5 to 12 million inhabitants, one part represents one million inhabitants; between 12 and 20 million inhabitants, one part represents 2 million; between 20 and 50 million inhabitants, each part represents 5 million; and above 50 million inhabitants, each contributive part represents 16 million.

The result of this method of calculation is that nations having a small or medium-sized population (for which one contributive part is equal to 1 or 2 million inhabitants) will be penalized, the contributive part of these nations increasing by almost twice their present contribution. At the same time, nations having a large population will be favored, their contribution being reduced. Thus, for nations with a population of more than 150 million inhabitants, the contribution passes from 45,000 to 29,580 gold francs; that is, almost a one-third reduction.

In order to remedy these disparities, the delegation of the Roumanian People's Republic makes the following proposals:

1. That in the system of contributive parts, each million or fraction thereof of inhabitants represent one contributive part. The nations having a population of less than 3 millions would be obliged to pay 3 contributive parts; whereas, those having a population in excess of 100 millions would pay 100 contributive parts (Proposal 1).

2. In view of the unequal industrial and technological development of the member nations of the Convention of the Meter, Proposal 1 would be further improved by dividing the nations into three classes, namely: developed nations (coefficient 1.2); middle nations (coefficient 1.0); and underdeveloped nations (coefficient 0.8) (Proposal 2).

The number of contributive parts calculated according to the population and multiplied by the established coefficient according to the national income gives the contribution to be paid.

The following table shows the contributions of the member nations, calculated according to the proposal of the International Committee and according to Proposals 1 and 2 of the Roumanian People's Republic, as well as a comparison with the 1960 contributions calculated according to the present scale on the basis of the 1960 budget.

Article 10 (1921). This article gives the International Committee latitude to establish a collaboration of specialists in metrological problems and to coordinate the results of their work.

Such collaborations have been numerous and of different kinds. For matters of special importance, consultative committees are generally created, their activities extending at times over very long periods. In order to be precise about this special manner of collaboration and to give it a regulated organization, we propose that the right of the International Committee to establish consultative committees according to requirements be specified explicitly.

We propose to this end that a paragraph composed as follows be added to Article 10:

"The International Committee may establish consultative committees to study new metrological problems of particular importance and request them to make concrete recommendations.

"The consultative committees shall be composed of specialists from different nations chosen by the International Committee. The activity of the consultative committees shall be coordinated by the International Committee."

Article 19 (1960). The Roumanian People's Republic proposes, in order to direct the scientific activity of the International Bureau aimed at solving problems essential to metrology posed by science and the development of technology, that the Director of the International Bureau present a plan of the proposed work to be carried out between the sessions of the International Committee. The adoption of this plan does not, of course, imply a limitation on the other important problems to be taken up and resolved.

For this purpose, we propose that paragraph 1c be composed as follows: "A general report on the work accomplished since the preceding session and a proposed plan for the activity of the International Bureau during the succeeding two years."

Comparative Table of Contributions of the Member Nations Calculated According to the Proposal of the  
Intl. Committee and Proposals No. 1 and No. 2 of the Roumanian People's Republic

No.	Nations	Population (thousands)	1960 Contribution According to Present Scale (gold francs)	Contribution Proposed by Intl. Committee		Contribution per Proposal No. 1		Contribution per Proposal No. 2		
				Number of Shares	Gold Francs	Number of Shares	Gold Francs	Calculation of Number of Shares	Number of Shares	Gold Francs
1	Germany { East West	69,900	21,083	21	20,706	70	30,059	$70 \times 1.2$	84	33,177
2	U.S.	163,000	45,000	30	29,580	100	42,942	$100 \times 1.2$	120	47,396
3	Argentina	16,318	6,680	12	11,832	17	7,300	$17 \times 1$	17	6,714
4	Austria	6,954	2,847	4	3,944	7	3,006	$7 \times 1.2$	8	3,160
5	Belgium	8,798	3,602	6	5,916	9	3,865	$9 \times 1.2$	11	4,345
6	Bulgaria	7,022	2,875	5	4,930	8	3,435	$8 \times 1$	8	3,160
7	Canada	15,235	6,237	11	10,846	16	6,871	$16 \times 1.2$	19	7,504
8	Chile	5,931	2,426	3	2,958	6	2,577	$6 \times 0.8$	5	1,975
9	Denmark	4,300	1,760	2	1,972	5	2,147	$5 \times 1.2$	6	2,370
10	Spain	27,977	11,453	15	14,790	28	12,024	$28 \times 0.8$	22	8,689
11	Finland	4,030	1,650	2	1,972	5	2,147	$5 \times 1$	5	1,975
12	France and Algeria	52,000	21,288	20	19,720	52	22,330	$52 \times 1.2$	62	24,488
13	Hungary	9,632	3,943	7	6,902	8	3,435	$8 \times 1$	8	3,160
14	Italy	46,738	19,134	19	18,734	47	20,103	$47 \times 1.2$	56	22,118
15	Japan	83,200	34,061	23	22,678	84	36,063	$84 \times 1.2$	101	39,892
16	Mexico	25,781	10,554	15	14,790	26	11,165	$26 \times 0.8$	21	8,294
17	Norway	3,400	1,500	2	1,972	4	1,710	$4 \times 1$	4	1,580
18	Portugal	9,098	3,725	7	6,902	10	4,294	$10 \times 0.8$	8	3,160
19	Roumania	15,900	6,509	12	11,832	16	6,871	$16 \times 1$	16	6,320
20	United Kingdom	50,674	20,745	20	19,720	51	21,900	$51 \times 1.2$	61	24,093



Comparative Table of Contributions of the Member Nations Calculated According to the Proposal of the  
Intl. Committee and Proposals No. 1 and No. 2 of the Roumanian People's Republic (Continued)

No.	Nations	Population (thousands)	1960 Contribution According to Present Scale (gold francs)	Contribution Proposed by Intl. Committee		Contribution per Proposal No. 1		Contribution per Proposal No. 2		
				Number of Shares	Gold Francs	Number of Shares	Gold Francs	Calculation of Number of Shares	Number of Shares	Gold Francs
21	Sweden	7,192	2,944	5	4,930	8	3,435	$8 \times 1$	8	3,160
22	Switzerland	4,715	1,930	2	1,972	5	2,147	$5 \times 1$	5	1,975
23	Thailand	17,317	7,089	12	11,832	18	7,730	$18 \times 0.8$	14	5,530
24	U.S.S.R.	202,000	45,000	30	29,580	100	42,942	$100 \times 1.2$	120	47,396
25	Uruguay	3,000	1,500	2	1,792	3	1,288	$3 \times 0.8$	3	1,185
26	Yugoslavia	16,927	6,930	12	11,832	17	7,300	$17 \times 1$	17	6,714
27	Australia	8,962	3,669	6	5,916	9	3,865	$9 \times 1$	9	3,555
28	Brazil	51,976	21,278	20	19,720	52	22,330	$52 \times 1$	52	20,538
29	Korea	29,000	12,281	15	14,790	29	12,453	$29 \times 0.8$	23	9,084
30	Dominican Republic	2,136	1,500	2	1,972	3	1,288	$3 \times 0.8$	3	1,185
31	India	370,000	45,000	30	29,580	100	42,942	$100 \times 0.8$	80	31,600
32	Ireland	2,961	1,500	2	1,972	3	1,288	$3 \times 1$	3	1,185
33	Netherlands	9,756	3,994	7	6,902	10	4,294	$10 \times 1.2$	12	4,740
34	Poland	24,977	10,225	14	13,804	25	10,736	$25 \times 1$	25	9,874
35	Czechoslovakia	12,500	5,117	10	9,860	13	5,582	$13 \times 1$	13	5,135
36	Turkey	20,935	8,570	14	13,804	21	9,018	$21 \times 0.8$	17	6,714

0.8 Underdeveloped nations

Coefficients 1.0 Nations with medium development

1.2 Developed nations

PROPOSAL OF SPAIN  
(presented during the Conference)

Article 6 (1960) of the Regulation. Our delegation feels that the distribution of the contributive parts destined to the support of the International Bureau is not appropriate.

The system is based on the establishment of a contribution proportional to the population of each of the member nations, with the stipulation that the General Conference may grant member nations that request it reductions up to 50 percent of their quota, taking into account their national income. These reductions should be granted by a majority vote of three-quarters of the votes cast at the General Conference.

It should be noted that even with this reduction of 50 percent, the method of distributing the contributions according to population results in, or may result in, an obvious inequity in treatment, taking into account the economic potential of the respective member nations.

Our delegation considers that a system more representative of the respective conditions of each nation would be to establish the contributions in proportion to the national income of each nation according to the system adopted by the United Nations, with the restriction that no nation would have a contribution of less than 0.5 percent or more than 15 percent of the endowment of the International Bureau.

OBSERVATIONS OF BRAZIL  
(presented during the Conference)

Convention

Article 5 (1960), paragraph 2. We propose the following text:

"The Annexed Regulation may be modified by the General Conference by a majority vote of three-quarters of the votes cast at the General Conference, provided three-quarters of the member nations of the Convention are represented at the Conference. The modifications....".

Brazil finds that this text makes possible the modification of the Annexed Regulation to the Convention with the guarantee that the modifications will not be made without the approval of the majority or of a great number of the member nations at the Convention.

Article 7 (1960). The first sentence could be replaced by the following:

"In conformity with the resolutions of the General Conference, the International Bureau is responsible for:"

Article 3 of the Convention of the Meter specifies the hierarchy of the organizations responsible for its execution. It is not necessary to mention it again in Article 7. The proposed text would seem to have the advantage of indicating clearly that the resolutions of the General Conference have an immediate value.

Article 11 (1875). We propose that the beginning of this article be written as follows:

"The governments making use of the opportunity to accede to the present Convention by means of approval by three-quarters of the member nations shall be required to pay.....Bureau."

Article 12 (1960). We propose the following text:

"The International Bureau of Weights and Measures enjoys on the territory of each of the high contracting parties privileges and immunities that are necessary for the accomplishment of the tasks for which it is responsible. These privileges and immunities shall not be less than those afforded in similar cases."

Article 13 (1960). To add to this article a second paragraph as follows:

"The present Convention shall cease to be in effect for all the high contracting parties when at least three-quarters of the members shall have become members of a convention replacing it."

## Regulation

Article 6 (1960). We propose the following modifications:

Paragraph 6. "The annual contributions are due at the beginning of the month of January of each year."

Paragraph 8. "After three more years, the nation in arrears may be excluded from the Convention by three-quarters of the votes cast at the General Conference, and it shall not be able to adhere anew to the Convention without first paying its overdue contributions."

Paragraph 10. "..... The amount of these new contributions shall serve to reimburse the nations that will have made payments to cover the contributions of nations that are in arrears, the eventual balance being added to the total endowment of the International Bureau."

Article 9 (1960). We propose to add a fourth paragraph containing the complete text of Article 14 (1875) of the Regulation.

Article 14 (1875). Incorporated in Article 9.

Article 19 (1960), paragraph 4. We propose that the reports and publications of the International Committee and the International Bureau be published in English also.

Paragraph 5. "The Committee decides which resolutions should be translated and published in other languages. In case of dispute, the French and English texts prevail."

Articles 20, 21, and 22. Eliminated.

COMMENTS OF THE YUGOSLAV DELEGATION  
(presented during the Conference)

Convention

Article 5. The proposal is based on the assumption that the Convention and the Regulation have the same importance. Moreover, paragraph 2 of this article mentions the possibility of changing the Regulation by a decision of a majority of three-quarters of the votes cast at the General Conference.

In such a case, we consider that a quorum of the General Conference should be required in the first place. We believe, furthermore, that the changes in the Regulation are valid only in the measure that they conform to the Convention. The Government of the Netherlands has taken the same position. In other words, it should not be possible to make a change in the constitutional decisions contained in general in the Convention by a change in the Regulation. The dispositions of paragraph 2, moreover, should find their place in the Regulation. Finally, there should be a special provision in the Regulation by which changes and additions to the Regulation would be obligatory only if they concern the organization's functioning and internal work, and do not result in new obligations for the member nations.

Article 12. The proposal regarding the privileges and immunities of the International Bureau is not sufficiently explicit. In order to avoid eventual future disputes on this subject, it would be necessary to either enumerate the fundamental privileges and immunities, or to name a similar organization with which the International Bureau intends to identify itself. We would like to recommend that the dispositions concerning the privileges and immunities of the specialized agencies of the United Nations be applied in an analogous fashion to the International Bureau and its staff.

We are, finally, in agreement with the proposal of the Canadian Government in that the new convention should specify means of resolving the eventual disputes that may result from its application and interpretation, the possibility of its revision, and should also include a special provision concerning reservations, in conformity with practice in international law.

In view of contemporary international practice concerning the use of an official language, we consider that the Yugoslav delegation should accept the proposal of the Government of the United States of America that the Convention be published also in English.

#### Regulation

Article 6, paragraph 6. We do not consider that the disposition should be accepted providing for the member nations to pay provisionally the contribution of a nation that has not paid in its quota during the year in question.

This is why this paragraph should be completed by specifying that this payment would be made only in case the interested nations would have given their consent for each particular case, or if in each of these cases the General Conference makes a decision by a majority of two-thirds.

Article 8, paragraph 1. This paragraph, which provides that the International Committee be composed of 18 members of different nations, should be completed by stipulating that at the time of the elections it is indispensable to take into account also an equitable geographic distribution, in addition to the specialty of the members. The Soviet proposal is similar, but it takes into account only the geographic criterion.

## ANNEX 3

REPORTS OF THE WORK GROUP IN CHARGE OF THE STUDY OF THE  
REVISION OF THE CONVENTION OF THE METER

## First Report

For the time being, the group has not prepared articles on procedures (ratification, placement into effect, adhesion, resignation, etc. of the Convention), since their preparation is tied in with a decision on the character of the revision to be undertaken. This could take the form of a "convention containing modification" of a large number of articles, or of a "modified convention" and a "modified regulation" containing integral texts.

For the same reason, the group has not yet studied the title and the preamble, as well as certain articles on which it received only remarks on wording.

The group proposes that the General Conference adopt the text proposed by the International Committee (Annex 1), modified as follows:

## Convention

## Article 5.

Paragraph 1: No change.

Paragraph 2, first sentence: Replace the words "a majority of three-quarters" by "unanimously."

Remark 1. A number of governments have remarked that the Regulation contains certain dispositions of such importance that their modification by the General Conference, even by unanimous vote, does not seem admissible. It is necessary, therefore, to ascertain which of the articles of the Regulation should be incorporated in the Convention.

Paragraph 2, last sentence: To be replaced by: "In any case, these modifications shall affect only those provisions on the subject of which proposals have been communicated to the contracting parties at least one year before the opening of the General Conference."

Article 6: No change.

Article 7: No change.

Article 9: Replace the words "contracting nations" by "contracting parties."

Remark 2. In case the procedure proposed in Remark 1 would be followed insofar as Article 6 of the Regulation is concerned (regarding financial matters), the words "established in the Regulation annexed to the present Convention" should be replaced by "established in Article... of the present Convention."

Article 11: The wording of this disposition, which does not regulate the adhesion procedure, but only the entrance fee to be paid by a nation adhering to the Convention, has been postponed pending preparation of an article relating to adhesions.

Article 12: The group can give its approval to the elimination of the present wording (1875) of this article, since this article does not give the contracting parties any authority they do not already possess.

Proposed new wording:

"1. The French Government shall conclude with the International Bureau of Weights and Measures a headquarters agreement on a nondiscriminatory basis in relation to agreements of this kind already concluded with other international institutions.

"2. The other contracting parties shall accord to the International Bureau of Weights and Measures the privileges and immunities that shall be considered necessary for the accomplishment of the tasks with which it is charged."

Article 13: Preparation postponed (see introduction of this report).

#### Annexed Regulation

Article 5: The observations made by some governments have not yet been studied while awaiting a decision on the character of the revision (see introduction to this report).

Article 6.

Paragraph 1: No change.

Paragraph 2: The Eleventh General Conference must decide if a majority of three-quarters or unanimity should be required for a vote on the amount of the annual endowment.

Paragraph 3: Eliminate "high" before "contracting parties."

Paragraph 4: Replace "member nations" by "contracting parties." The first sentence should be modified if the distribution of the contributions were not to be based on population anymore.

Paragraph 5: Replace the words "nation" and "member nations" by "contracting party (or parties)."

Paragraph 6, first sentence: Eliminate this disposition which exists already in Article 10 of the Convention. Following sentences to be eliminated.

Article 7: To read: "The advantages and prerogatives resulting from the Convention of the Meter are suspended in the case of any nation party to the Convention that has not.....consecutive...."

Article 8: To be replaced by: "After three further years, the General Conference may by a majority of three-quarters of the votes cast within the General Conference decide that the nation in arrears is no longer party to the Convention."

Article 9: No change.

Article 10: Replace the words "for each year or fraction of a year" by "for the year or fraction of the year of adhesion and the following year."

The last sentence should read: "During this period, the corresponding sums shall be added to the total endowment."

Article 7: No change.

Remark 3. The stipulation of a quorum in paragraph 3 of Article 7 asked by certain governments is not judged necessary.

Article 8: The preparation of this article has been postponed while awaiting for the International Committee to decide on this subject.

Article 9.

Paragraph 1: Eliminate "high" before "contracting parties."

Paragraph 2: No change.



Paragraph 3: Eliminate the words "elections or;" add after "the vacancy" the words "to the International Bureau."

Article 11: The proposals of Canada (Annex 2, p. 125, last paragraph) and of Japan (Annex 2, p. 150, item 3) concerning traveling expenses of Committee members could be submitted to the International Committee for their opinion.

Article 12: No change.

Article 14: The wording of this article depends on a decision on the contents of Article 8.

Article 15.

Paragraph 1: Replace "a regulation" by "directives."

Paragraph 2: No change.

Article 16: Eliminate "high" before "contracting parties" and add the words "directly or" before "through."

Article 19.

Paragraph 1: No change.

Paragraph 2: Replace the words "the governments of the high contracting parties" by "the governments of the contracting parties;" replace the words "contracting nations" by "contracting parties."

Paragraph 3: No change.

Paragraphs 4 and 5: The proposal to introduce the English language could be submitted to the International Committee for its opinion.

Remark 4. Items of each article of the Convention and the Regulation of more than one paragraph should be numbered<sup>1</sup>.

## Second Report

In execution of the decision taken by the General Conference at its third session (14 October 1960), the work group continued its studies,

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<sup>1</sup>Note to be added to the proofs: Account was taken of this remark for the publication of Annex 1.

taking into account the texts proposed and the comments offered by the International Committee (Annex 1) and by the governments of the different contracting parties (Annex 2). The group attempted to find a mean among the divergent opinions that could be accepted by all the delegations.

The group has felt that the preparation of a revised Convention of the Meter with a revised Regulation containing integral texts would be preferable, from the point of view of uniform terminology and greater facility of orientation, to the preparation of a second convention containing modification of a great number of articles. In order to avoid any misunderstanding on this subject, it seems advisable to point out that the choice is no more than a choice between the more or less coherent forms in which the modifications can be presented; this choice does not affect the number of modifications to be included.

As has already been indicated in the first report above, several governments have remarked that the Regulation contains certain dispositions of such importance that their modification by the General Conference, even by unanimous vote, seems inadmissible. For this reason, Article 6 in part, and Articles 7, 10, 11, and 14 of the Regulation containing attributions essential to the General Conference and to the International Committee have been transferred to the Convention (Articles 9a, 3a, 4b, 4a, and 4c, respectively, of the proposed convention given below).

Much as the group has wished to maintain them, the recommended amendments in the first report have been inserted completely in this second report. The amendments made after the distribution of the first report are marked with an asterisk (\*).

#### \*Convention

To ensure the international unification and the improvement of the Metric System,

signed at Paris on 20 May 1875,  
revised at Sevres on 6 October 1921  
and at Paris on ..... October 1960

\*The parties to the present Convention,

desirous of revising the Convention of the Meter signed at Paris on 20 May 1875 and revised at Sèvres on 6 October 1921,

are agreed on the following:

\*Article 1 (1875 text): Eliminate the word "high" before "contracting parties."

Article 2 (1875 text): No change.

\*Article 3 (1875 text): Replace the words "all the contracting governments" by "all the contracting parties."

\*Article 3a (Article 7 of the Regulation, text proposed in Annex 1).

Paragraph 1: Eliminate the words "mentioned in Article 3 of the Convention."

Paragraph 2: Eliminate the last lines: "and proceed by secret ballot.....Regulation."

Insert a new paragraph (paragraph 2a):

"It elects by secret ballot the members of the International Committee, in conformity with the dispositions of Article 8 of the Regulation annexed to the present Convention."

Paragraph 3: The first sentence has been modified as follows: "each contracting party represented at the General Conference has the right to one vote. The majority.....Regulation."

Paragraph 4: No change.

Article 4 (1875 text): No change.

\*Article 4a (old Article 11 of the Regulation, 1921 text): introduce the word "international" before "Committee."

\*Article 4b (old Article 10 of the Regulation, 1921 text): No change, except the elimination in the first paragraph of the word "high" before "contracting parties."

\*Article 4c (old Article 14 of the Regulation, 1875 text): Proposed modification:

"The International Committee fills provisionally the vacancies that may occur among its members in the interval between sessions of the General Conference. The members shall be informed of these vacancies at least three months before the elections. Each of the members shall be called upon to take part in them by secret ballot. These elections may be carried out by correspondence."

Article 5 (proposed text)

Paragraph 1: No change.

Paragraph 2, first sentence: Replace the words "three-quarters majority" by "unanimously."

last sentence: To be replaced by: "In any case, these modifications shall affect only those provisions on the subject of which proposals have been communicated to the contracting parties at least one year before the opening of the General Conference."

Article 6 (proposed text): No change.

Article 7 (proposed text): No change.

Article 8 (proposed text): No change.

Article 9 (1875 text): Replace the words "contracting nations" by "contracting parties."

\*Eliminate the words "established according to a scale based on their present population."

Article 9a: A new article is introduced giving certain dispositions contained heretofore in Article 6 (proposed text) of the Regulation.

"1. Each General Conference establishes the annual endowment destined to cover the expenses of the International Bureau and of the International Committee.

"2. A three-quarters majority of the votes cast at the General Conference is required for the vote on the amount of this endowment.

"3. The General Conference establishes the contributive part of each of the contracting parties according to a scale approved unanimously by votes cast at the General Conference. Under exceptional circumstances, it may decide also by a three-quarters majority of the votes cast within the Conference to grant temporary reductions of up to 50 percent at the request of any contracting party.

"4. The advantages and prerogatives resulting from the Convention of the Meter are suspended in the case of any contracting party that has not paid its contributions during three consecutive years.

"5. After three further years, the nation in arrears is excluded from the Convention."

\*Article 10 (1875 text): Eliminate the words "through the intermediary of the Ministry of Foreign Affairs.....of the Director of the International Bureau."

\*Article 11 (1875 text): Eliminate the words "reserved to every nation." Replace "a contribution" by "an entrance fee;" replace "governments" by "nations."

Article 12 (1875 text): The group agrees to the elimination of this article, since this article does not grant any authority to the contracting parties that they do not already possess.

Proposed new wording:

"1. The French Government shall conclude with the International Bureau of Weights and Measures a headquarters agreement on a nondiscriminatory basis in relation to agreements of this kind already concluded with other international institutions.

"2. The other contracting parties shall accord to the International Bureau of Weights and Measures the privileges and immunities that shall be considered necessary for the accomplishment of the tasks with which it is charged."

\*Article 13: "1. The present Convention is open during a period of six months to its signature by all nations that are parties to the Convention of the Meter, signed at Paris on 20 May 1875 and revised at Sèvres on 6 October 1921.

"2. The present Convention shall be ratified. The instruments of ratification shall be deposited with the French Government as soon as possible."

\*Article 14: "The present Convention shall go into effect on the date on which twenty of the signatory nations shall have deposited their instruments of ratification, on the condition that the total amount of their financial contributions, calculated according to the scale adopted by the Eleventh General Conference on Weights and Measures, shall represent at least 50 percent of the annual endowment of the International Bureau."

\*Article 15 (The group has prepared two proposed texts for this article, since it could not determine which text would be the most acceptable.)

Proposal A: "All nations may adhere to the present Convention by notifying the French Government of their adhesion."

Proposal B: "The present Convention is open to the adhesion of all nations that are parties to the Convention of the Meter, signed at Paris on 20 May 1875 and revised at Sèvres on 6 October 1921, or that are members of the United Nations or of one of its specialized institutions,

as well as of all nations of which the request for adhesion has been approved by at least two-thirds of the parties to the present Convention."

\*Article 16: "The present Convention shall go into effect for each nation that shall have ratified it, or that shall have adhered to it after the entrance into effect of the Convention, on the same day of the deposit of its instrument of ratification or adhesion."

\*Article 17 (Article 13, proposed text in Annex 1): Eliminate the word "high" before "contracting parties."

\*Article 18: "The French Government shall notify all parties to the Convention of the Meter signed at Paris on 20 May 1875 and revised at Sèvres on 6 October 1921, and all nations adhering to the present Convention,

- a) of the signatures, ratifications, and adhesions;
- b) of the date on which the present Convention shall take effect;
- c) of the resignations received."

\*AS EVIDENCE OF WHICH, the undersigned Plenipotentiaries, whose powers have been recognized to be in due form, have signed the present Convention.

Executed at Paris on.....October 1960 in a single copy (in the French, English, and Russian languages, each of which texts is authoritative), which (or which copy) shall remain deposited in the archives of the French Government, and of which a certified copy shall be remitted to each of the signatory or adhering nations.

#### Annexed Regulation

Articles 1, 2, 3, and 4 (1875 text): No change.

\*Article 5: Eliminated.

\*Article 6.

\*Paragraph 1: Eliminated (see Article 9a above of the Convention).

\*Paragraph 2: Eliminated (see Article 9a above of the Convention).

Paragraph 3: Eliminate the word "high" before "contracting parties."

\*Paragraph 4: Eliminated (see Article 9a above of the Convention).

\*Paragraph 5: Eliminated.

Paragraph 6, first sentence: Eliminate this disposition, which already exists in Article 10 of the Convention.

following sentence: Eliminate.

\*Paragraph 7: Eliminated (see Article 9a above of the Convention).

\*Paragraph 8: Eliminated (see Article 9a above of the Convention).

Paragraph 9: No change.

\*Paragraph 10: Proposed improved text:

"For a nation adhering to the Convention in the interval between two sessions of the General Conference, the contribution for each year or fraction of a year shall be equal to that.....total endowment."

Article 7: Eliminated (see Article 3a above of the Convention).

\*Article 8.

Paragraph 1: The International Committee proposes the following text:

"The International Committee, mentioned in Article 3 of the Convention, is composed of eighteen members, all belonging to different nations. Each candidacy should have the previous approval of the government of the nation to which the candidate belongs."

Paragraph 2: No change.

Article 9.

Paragraph 1: Eliminate "high" before "contracting parties."

Paragraph 2: No change.

Paragraph 3: Eliminate the words "elections or;" and after "the vacancy" add the words "at the International Bureau."

\*Article 10: Eliminate (see Article 4b above of the Convention).

\*Article 11: No change.

Article 12: No change.

Article 13: No change.

\*Article 14: Eliminate (see Article 4c above of the Convention).

Article 15.

Paragraph 1: Replace "a regulation" by "directives."

Paragraph 2: No change.

Article 16: Eliminate "high" before "contracting parties;" add the words "directly or" before "through."

Articles 17 and 18: No change.

Article 19.

Paragraph 1: No change.

Paragraph 2: Replace the words "the governments of the high contracting parties" by "the governments of the contracting parties;" replace the words "contracting nations" by "contracting parties."

Paragraph 3: No change.

\*Paragraphs 4 and 5: No change.

Articles 20, 21, and 22: Eliminated.



## ANNEX 4

PROPOSALS FOR THE DISTRIBUTION OF THE ANNUAL ENDOWMENT  
(900,000 GOLD FRANCS) OF THE INTERNATIONAL  
BUREAU OF WEIGHTS AND MEASURES

- A - Contributions in gold francs calculated according to the proposal of the International Committee on Weights and Measures.
- B - Contributions in gold francs calculated according to the coefficients of the scale of the United Nations (or, in default, of UNESCO) with a maximum of 15 percent and a minimum of 0.5 percent.
- C - Same calculation as B, but with a maximum of 10 percent and a minimum of 0.5 percent.
- D - Same calculation as C, but taking into account the distribution of Uruguay's contribution.

	Population (thousands)	Number of Shares	A	Coefficient U.N. (or U.N.E.S.C.O.)	B	C	D
Germany <sup>1</sup> { East West	72,900	22	45,102		102,060 <sup>2</sup>	90,000 <sup>2</sup>	90,000*
U.S.A.	177,702	30	61,503	32.51	135,000	90,000	90,000*
Argentina (Republic)	20,614	14	28,701	1.11	13,680	17,820	17,640
Australia	9,846	7	14,351	1.79	22,050	28,710	28,440
Austria	7,021	5	10,251	0.43	5,310	6,930	6,840
Belgium	9,053	7	14,351	1.30	16,020	20,880	20,610
Brazil	64,216	21	43,052	1.02	12,690	16,380	16,200
Bulgaria	7,793	5	10,251	0.16	4,500	4,500	4,500*
Canada	17,442	12	24,601	3.11	38,430	49,950	49,410
Chile	7,465	5	10,251	0.27	4,500	4,500	4,500*
Korea (Republic of)	33,000	16	32,802	0.21	4,500	4,500	4,500*
Denmark	4,515	2	4,100	0.60	7,380	9,630	9,540
Dominican Republic	2,894	2	4,100	0.05	4,500	4,500	4,500*
Spain	29,894	15	30,751	0.93	11,430	14,940	14,760
Finland	4,376	2	4,100	0.36	4,500	5,760	5,760
France and Algeria	55,300	20	41,002	6.40	78,840	90,000	90,000*
Hungary	9,917	7	14,351	0.42	5,130	6,750	6,660

	Population (thousands)	Number of Shares	A	Coefficient U.N. (or U.N.E.S.C.O.)	B	C	D
India	402,750	30	61,503	2.46	30,330	39,510	39,060
Ireland	2,846	2	4,100	0.16	4,500	4,500	4,500*
Italy	49,055	19	38,950	2.25	27,720	36,090	35,730
Japan	92,740	24	49,202	2.19	27,000	35,190	34,830
Mexico	33,304	16	32,802	0.71	8,730	11,430	11,250
Norway	3,557	2	4,100	0.49	6,030	7,830	7,740
Netherlands	11,186	9	18,451	1.01	12,420	16,200	16,020
Poland	28,783	15	30,751	1.37	16,830	21,960	21,780
Portugal	9,052	7	14,351	0.20	4,500	4,500	4,500*
Roumania	18,059	13	26,651	0.34	4,500	5,490	5,400
United Kingdom	51,870	20	41,002	7.78	95,850	90,000	90,000*
Sweden	7,415	5	10,251	1.39	17,100	22,320	22,140
Switzerland	5,235	3	6,150	0.97	11,970	15,570	15,390
Czechoslovakia	13,564	10	20,501	0.87	10,710	13,950	13,860
Thailand	21,881	14	28,701	0.16	4,500	4,500	4,500*
Turkey	26,881	15	30,751	0.59	7,290	9,630	9,360
U.S.S.R.	208,827	30	61,503	13.62	135,000	90,000	90,000*
Uruguay				0.12			4,500*
Yugoslavia	18,421	13	26,651	0.35	4,500	5,580	5,580

<sup>1</sup>The two parts of Germany (East and West) will establish by mutual agreement the distribution of their contribution.

<sup>2</sup>Contribution calculated on the basis of provisional coefficients of 2.95 for East Germany and 5.33 for West Germany.

\*Maximum or minimum contribution.

## ANNEX 5

## PRACTICAL INTERNATIONAL TEMPERATURE SCALE OF 1948

Amended Edition of 1960

## I. Introduction

The thermodynamic Kelvin scale on which temperatures are designated by  $^{\circ}\text{K}$  and represented by the symbol  $T$  is recognized as the fundamental scale to which every temperature measurement should be finally referred. The form of the Kelvin degree has been defined by the decision fixing it at exactly  $273.16^{\circ}\text{K}$  thermodynamic temperature of the triple point of water (Tenth General Conference on Weights and Measures, 1954, Resolution 3).

The inherent experimental difficulties in measuring temperatures on a thermodynamic scale led to the adoption in 1927 by the Seventh General Conference on Weights and Measures of a practical scale easily and exactly reproducible that was named the "International Temperature Scale." This scale should correspond as exactly as possible to the thermodynamic scale.

The International Temperature Scale was revised in 1948 and made to conform to the state of knowledge of that period.

The scale presented in this document under the new title adopted by The International Committee on Weights and Measures in May 1960, "Practical International Temperature Scale," is not a revision of the 1948 scale, but merely an amended edition of the same scale, the numerical values of the temperatures remaining the same as in 1948.

## II. Definition of the Practical International Temperature Scale of 1948

The temperatures of the Practical International Temperature Scale of 1948 are expressed in degrees Celsius, designated by  $^{\circ}\text{C}$  or  $^{\circ}\text{C}$  (Int. 1948), and represented here by the symbols  $t$  or  $t_{\text{int}}$ .

The Practical International Temperature Scale is based on six reproducible temperatures (fixed points of definition) to which are assigned numerical values, and on formulas establishing the relation between the

temperature and the indications of the graduated instruments by means of values assigned to the six fixed points of definition. The fixed points are defined by the specified states of equilibrium; except for the triple point of water, these states of equilibrium are considered as being under a pressure of 101,325 newtons per square meter (1 normal atmosphere).

The fixed points on the scale and the exact numerical values assigned to them are given in Table I.

Table I. Fixed Points of Definition

Exact assigned values. The pressure is 1 normal atmosphere, except for the triple point of water.

	Temperature °C (Int. 1948)
Temperature of equilibrium between liquid oxygen and its vapor (boiling point of oxygen)	-182.97
Temperature of equilibrium between ice, liquid water, and water vapor (triple point of water)	+0.01
Temperature of equilibrium between liquid water and its vapor (boiling point of water)	100
Temperature of equilibrium between liquid sulfur and its vapor (boiling point of sulfur)	444.6*
Temperature of equilibrium between solid silver and liquid silver (solidification point of silver)	960.8
Temperature of equilibrium between solid gold and liquid gold (solidification point of gold)	1063

\*Instead of the boiling point of sulfur, it is preferable to use the temperature of equilibrium between solid zinc and liquid zinc (solidification point of zinc), giving it a value of 419.505°C (Int. 1948). This point is more easily reproducible than that of sulfur, and the value assigned to it has been chosen so as to give the same result in the determination of the temperatures of the Practical International Scale.

This process of interpolation results in the division of the scale into four areas:

a. From  $0^{\circ}\text{C}$  to  $630.5^{\circ}\text{C}$  (point of solidification of antimony), the temperature  $t$  is defined by the formula

$$R_t = R_0(1 + At + Bt^2),$$

in which  $R_t$  is the resistance at temperature  $t$  of the platinum wire of a standard resistance thermometer, and  $R_0$  is the resistance at  $0^{\circ}\text{C}$ . The constants  $R_0$ ,  $A$ , and  $B$  should be determined starting from the values of  $R_t$  at the triple point of water, at the boiling point of water, and at the boiling point of sulfur (or at the solidification point of zinc). The platinum wire of a standard resistance thermometer should be annealed and its purity should be such that  $R_{100}/R_0$  is not less than 1.3920.

b. From the boiling point of oxygen to  $0^{\circ}\text{C}$ , the temperature  $t$  is defined by the formula

$$R_t = R_0[1 + At + Bt^2 + C(t - t_{100})t^3],$$

in which  $R_0$ ,  $A$ , and  $B$  are determined in the same way as in a above; the constant  $C$  should be determined by starting from the value of  $R_t$  at the boiling point of oxygen and  $t_{100} = 100^{\circ}\text{C}$ .

c. From  $630.5^{\circ}\text{C}$  to the solidification point of gold, the temperature  $t$  is defined by the formula

$$E = a + bt + ct^2,$$

in which  $E$  is the electromotive force of a standard platinum and rhodium-platinum thermocouple when one of its joints is at  $0^{\circ}\text{C}$  and the other at temperature  $t$ . The constants  $a$ ,  $b$ , and  $c$  should be determined starting with the values of  $E$  at  $630.5^{\circ}\text{C}$  and at the solidification points of silver and gold. The value of the electromotive force at  $630.5^{\circ}\text{C}$  should be determined by measuring this temperature with a standard resistance thermometer.

The wires of the thermocouple should be annealed. The purity of the platinum wire should be such that the ratio  $R_{100}/R_0$  is not less than

1.3920. The rhodium-platinum wire should contain nominally 90 percent platinum and 10 percent rhodium by weight. When one of the joints of the thermocouple is at  $0^\circ\text{C}$  and the other either at  $630.5^\circ\text{C}$  or at the solidification point of silver or the solidification point of gold, the resulting thermocouple should give electromotive forces such that

$$\begin{aligned} E_{\text{Au}} &= 10,300 \mu\text{V} \pm 50 \mu\text{V}, \\ E_{\text{Au}} - E_{\text{Ag}} &= 1,183 \mu\text{V} + 0,158 (E_{\text{Au}} - 10,300 \mu\text{V}) \pm 4 \mu\text{V}, \\ E_{\text{Au}} - E_{630.5} &= 4,766 \mu\text{V} + 0,631 (E_{\text{Au}} - 10,300 \mu\text{V}) \pm 8 \mu\text{V}. \end{aligned}$$

d. Above the solidification point of gold, the temperature  $t$  is defined by the formula

$$\frac{J_t}{J_{\text{Au}}} = \frac{\exp\left[\frac{c_2}{\lambda(t_{\text{Au}} + T_0)}\right] - 1}{\exp\left[\frac{c_2}{\lambda(t + T_0)}\right] - 1},$$

in which

$J_t$  and  $J_{\text{Au}}$  are the spectral densities, at temperature  $t$  and at the solidification point of gold  $t_{\text{Au}}$ , of the energetic luminance of a black body of wavelength  $\lambda$ ;

$c_2$  is the second constant of radiation; in using the value  $c_2 = 0.01438$  meter·degree, the wavelength  $\lambda$  should be expressed in meters.

$$T_0 = 273.15 \text{ degrees.}$$

### III. Recommendations

The following recommendations are suggestions rather than prescriptions. The apparatus, methods, and operating methods recommended represent good practice at the present time, but it is not intended to delay the development and utilization of improvements. Experience has shown that these recommendations are favorable to the obtaining of uniformity and reproducibility in the realization of the Practical International Temperature Scale as defined in Chapter II.

## 1. Standard Resistance Thermometer

A standard resistance thermometer should be conceived and constructed so that the platinum resistance wire is as free as possible from constraint and remains in this state during its use. The platinum wire should be drawn from a melted ingot and not from a hammered sponge.

Standard resistance thermometers have been made with a wire between 0.05 and 0.5 mm diameter, a short length at least of each conductor joined to the resistance being also of platinum. Once the resistance coil of the thermometer has been formed, it should be annealed in the air at a temperature greater than the highest temperature for which the thermometer will be used; this annealing temperature should not in any case, however, be less than 450°C. There are also some reasons for believing that better stability is obtained when the tube protecting the coil is filled with a gas containing a small amount of oxygen.

A useful criterion that serves to protect against a fault in construction of the completed thermometer, and against errors in the marking of the graduations at the fixed points of definition, is that the value of the constant B should be  $(-0.5857 \pm 0.0010) \cdot 10^{-6}/\text{deg}^2$ , and that of C,  $(-4.35 \pm 0.05) \cdot 10^{-12}/\text{deg}^4$ . Another useful criterion to judge the effectiveness of the annealing and the exactness of the thermometer is the constancy of the resistance at a given temperature. For example, the resistance of a thermometer at the triple point of water should not change by an amount greater than that corresponding to 0.001 degrees when the thermometer is submitted to a cycle of temperature variations such as that necessary for its calibration.

## 2. Standard Thermocouple

Standard thermocouples have been made with wire diameters between 0.35 and 0.65 mm. Before calibration, the wires of the thermocouple should be carefully annealed in order to ensure the permanence of their thermoelectric forces during use. To do this, the platinum wire should be heated to a temperature of at least 1100°C, and the rhodium-platinum wire to 1450°C. If the annealing is done before the wires are mounted in their insulators, the thermocouple should be heated again after this is done to a temperature of at least 1100°C until the thermoelectric force is stabilized and any local homogeneity defects caused by constraint disappear. When this treatment has been carried out satisfactorily, the readings on the thermocouple should not vary when there is a change in the temperature gradient along the length of the wire; they should not vary, for example, with the depth of immersion within a uniform temperature ambience.

The electromotive force of the thermocouple at  $630.5^{\circ}\text{C}$  should be determined by measures taken at a uniform and constant temperature between  $630.3$  and  $630.7^{\circ}\text{C}$ .

### 3. Pressure

In practice, pressures are determined by means of a mercury column. It can be assumed that the volumetric mass of pure mercury at  $20^{\circ}\text{C}$  is

$13,545.87 \text{ kg/m}^3$  on the average in a column of mercury supporting one atmosphere. For the practical determination of a normal atmosphere, the International Committee on Weights and Measures recommends that the value of the local gravity be expressed in the Potsdam system until such time as the employment of another system is authorized.

In the following paragraphs concerning the boiling points of oxygen, of water, and of sulfur, the formulas giving the equilibrium temperatures  $t_p$  are given in the form of polynomials in function of

$\left(\frac{p}{p_0} - 1\right)$ , in which  $p$  is the pressure of the boiling point and  $p_0$  the pressure of 1 normal atmosphere. The limit of exactitude of the formulas is indicated for a given interval of pressure. In practice, errors due to the use of these formulas are less than those resulting from the instability of systems open to the atmosphere. Greater stability and increased exactitude may be obtained in enclosed systems maintained at a constant pressure within a few thousandths of 1 atmosphere;

in this case, only the first term in  $\left(\frac{p}{p_0} - 1\right)$  of the polynomials is necessary.

### 4. Zero Point on the Scale and Triple Point of Water

a. Zero Point on the Scale. The zero point on the Practical International Temperature Scale is defined as being the temperature less by exactly  $0.01$  degrees than that of the triple point of water. Calculations show that the old "point of fusion of ice" defined as being the temperature of equilibrium between ice and air-saturated water at a pressure  $p_0$  of 1 normal atmosphere is  $0^{\circ}\text{C}$  within a limit of  $0.0001$  degrees.

It is difficult, however, to obtain the point of fusion of ice directly with an exactitude of better than  $\pm 0.001$  degrees; however, when this exactitude is sufficient, the  $0^{\circ}\text{C}$  temperature may be obtained by using a mixture of finely crushed ice and air-saturated water at  $0^{\circ}\text{C}$  in a well-insulated container such as a Dewar vessel. The temperature



of equilibrium  $t$  corresponding to an ambient atmospheric pressure  $p$  and to a depth  $h$  beneath the surface of the water can be calculated by the formula

$$t = 0.01 \left( 1 - \frac{p}{p_0} \right) ^\circ\text{C} - (0.7 \times 10^{-6} \text{ deg/mm}) h.$$

b. Triple Point of Water. The temperature of the triple point of water was obtained in sealed glass vessels containing only water of great purity; these vessels contain an axial thermometer well. In such vessels, the triple point is obtained wherever the ice is in equilibrium with a liquid-vapor surface. At a depth  $h$  beneath the liquid-vapor surface, the temperature of equilibrium  $t$  between ice and liquid water is given by the formula

$$t = 0.01^\circ\text{C} - (0.7 \times 10^{-6} \text{ deg/mm}) h.$$

The recommended method for preparing a triple-point vessel is to form around the well a thick layer of ice by cooling the interior of the well, and then to cause enough of this layer of ice to melt--by using the interior of the well also--to form a new surface of water-ice contact around the well. During the first several hours following the preparation of the vessel, the temperature measured in the well is not yet constant; it increases by 0.0001 to 0.0005 degrees; then it becomes stable after one to three days. This initial change in temperature is explained no doubt by the increase in the dimensions of the ice crystals or by the slow disappearance of tensions in the crystals. A vessel thus prepared and kept in an ice bath is capable of maintaining a constant temperature within a limit of 0.0001 degrees for several months. When vessels from various sources were compared under these conditions, no difference greater than 0.0002 degrees was found.

Water from most natural sources (normal water) contains about 0.0148 mole percent of deuterium, 0.20 mole percent of  $^{18}_8\text{O}$ , and 0.04 mole percent of  $^{17}_8\text{O}$ . Variations from these percentages amounting to 0.0015 mole percent for the deuterium contained in natural water have been observed. An increase of 0.001 mole percent of deuterium contained in the water corresponds to an increase of 0.00004 degrees in the temperature of the triple point. River waters having their sources on the windward side of mountain ranges or at the base of permanent glaciers may contain an amount of deuterium less than normal; whereas, waters from the surface of large lakes may contain an amount greater than normal.

The isotopic composition of the water-ice contact surface in the vessels at the triple point depends also on the natural differences in the proportion of the isotopes of oxygen, the distillation process used for the water, and the freezing technique. The influence of these various isotopic compositions on the temperature obtained in the vessels at the triple point is probably sufficiently small to be neglected.

## 5. Boiling Point of Oxygen

The temperature of equilibrium between liquid oxygen and its vapor is usually obtained by the static method. The platinum coil in the standard thermometer and the liquid oxygen in its recipient are brought to the same temperature in a metallic block placed in a suitable cryostat. The metallic block is usually immersed in a well-agitated bath of liquid oxygen open to the atmosphere, but greater stability can be obtained by enclosing the metallic block in a vessel free of air and maintained at a uniform temperature close to that of the boiling point of oxygen. The vapor pressure of the oxygen is transmitted by an external tube attached to a manometer; this tube should be at a temperature greater along its entire length than the saturation temperature of oxygen.

The obtaining of the temperature of equilibrium may be controlled by the following criteria: the observed temperature, referred back to a constant pressure corresponding to that of the free surface of oxygen, should be independent of small variations of depth of immersion of the thermometer in the metallic block, of the relation of the volume of liquid oxygen to the volume of oxygen vapor, and of the small variations of the vessel's temperature.

The temperature of equilibrium  $t_p$  corresponding to a pressure  $p$  at the surface of the liquid oxygen can be calculated with an accuracy of within a few thousandths of a degree in the area between  $p = 660$  and  $p = 860$  mm Hg by the formula

$$t_p = \left[ -182.97 + 9.530 \left( \frac{p}{p_0} - 1 \right) - 3.72 \left( \frac{p}{p_0} - 1 \right)^2 + 2.2 \left( \frac{p}{p_0} - 1 \right)^3 \right] ^\circ\text{C}.$$

## 6. Boiling Point of Water

The temperature of equilibrium between liquid water and its vapor is usually obtained by the dynamic method, the thermometer being placed in the saturated steam. Open systems were formerly used for obtaining the boiling point of water, but for precise graduating it is preferable to use closed systems in which the boiler and the manometer are attached to a manostat filled with air or, better, with helium.

The boiler should be made in such a way as to avoid all contamination with the steam. The thermometer should be protected from the radiation emitted by bodies that may be at different temperatures from that of saturation.

The obtaining of the temperature of equilibrium can be verified by the following criteria: the observed temperature, brought back to a constant pressure, should be independent of the water used, of the time interval, of variations in the output of heat supplied to the liquid, and of the depth of immersion of the thermometer.

The temperature of equilibrium  $t_p$  corresponding to a pressure  $p$  can be calculated with an accuracy of within 0.001 degrees in the area between  $p = 660$  and  $p = 860$  mm Hg by means of the formula

$$t_p = \left[ 100 + 28.012 \left( \frac{p}{p_0} - 1 \right) - 11.64 \left( \frac{p}{p_0} - 1 \right)^2 + 7.1 \left( \frac{p}{p_0} - 1 \right)^3 \right] ^\circ\text{C}.$$

A modification in the proportion of deuterium in the water produces a variation in the boiling point of water as for the triple point, but about one-third as great.

## 7. Boiling Point of Sulfur

The temperature of equilibrium between liquid sulfur and its vapor is usually obtained by the dynamic method in an aluminum boiler analogous in form to that used for the boiling point of water; however, a supplementary protection against the effects of radiation, and greater volumes for the free circulation of the vapor are necessary.

It has been pointed out that the addition to the sulfur of 0.1 percent arsenic, then 0.1 percent selenium, increases the normal boiling point by 0.02 degrees, and then by 0.07 degrees; these elements are normally found in sulfur of volcanic origin. Commercial sulfur contains organic impurities that decompose slowly and give off carbon during boiling of the sulfur; this carbon is probably without influence on the boiling point, but it is still preferable to eliminate the carbon and organic materials.

The criteria for verifying that the boiling point of sulfur has been achieved correctly are similar to those for the boiling point of water, except that it may be necessary to wait several hours to obtain a constant temperature.

The temperature of equilibrium  $t_p$  corresponding to a pressure  $p$  can

be calculated with an accuracy of within 0.001 degrees in the area between  $p = 660$  and  $p = 800$  mm Hg by the formula

$$t_p = \left[ 444,6 + 69,010 \left( \frac{p}{p_0} - 1 \right) - 27,48 \left( \frac{p}{p_0} - 1 \right)^2 + 19,14 \left( \frac{p}{p_0} - 1 \right)^3 \right] ^\circ\text{C}.$$

## 8. Solidification Point of Zinc

Easily reproducible temperatures closely allied to those given by the point of liquifaction of an alloy have been obtained by means of the gradation observed on the temperature curves during the course of the slow solidification of a zinc of great purity (99.999 percent by weight).

The fusion and solidification of zinc were produced in artificial graphite crucibles of high purity (99.999 percent by weight) containing an axial thermometer well. These crucibles, with a diameter of about 5 cm and a sufficient depth to eliminate the influence of thermal conduction along the thermometer wire, were heated in a simple metallic block oven.

At the end of the cooling, when solidification began to form on the wall of the crucible, the thermometer was taken out, cooled to the ambient temperature, then replaced in its well in order to produce a thin sleeve of solid zinc around the well. Another technique that has also been used consists in taking out the thermometer when the temperature it shows is 0.01 degrees less than the solidification point, and introducing in its place a silica rod for about 30 seconds; the thermometer is then replaced in the well. The temperature corresponding to the gradation was that of the equilibrium between the liquid zinc and the solid sleeve while solidification was continuing slowly from the outside of the crucible toward the center. It is preferable to operate in an inert atmosphere to prevent oxidation of the graphite and the zinc; on the other hand, it has been impossible to observe an influence on the temperatures of the gradation from the presence of zinc oxide in the fusion metal, even after prolonged heating in air. It was found that the gradation temperature rose by 0.0043 degrees per atmosphere.

A criterion for verifying that the purity of the zinc sample is satisfactory is that its fusion interval should not be greater than about 0.001 degrees. Samples of zinc of this purity from different countries have given almost identical temperature gradients (within a limit of about 0.0002 degrees). Samples with fusion intervals of about 0.01 degrees have given temperature gradients lower by 0.0004 to 0.0016 degrees.

## 9. Solidification Point of Silver and Gold

The equilibrium temperature between solid and liquid silver, or between solid and liquid gold, has been obtained in covered crucibles of either artificial graphite of high purity, ceramic, or vitreous silica. Account should be taken in choosing the crucible's size of the great increase in volume of the metals during fusion. Their depth should be sufficient to eliminate the influence of thermal conduction along the length of the thermocouple wire. The silver should be protected from oxygen while it is fusing.

The crucible and its contents should be brought to a uniform temperature greater by a few degrees than the fusion point of the metal, then cooled slowly. A thermocouple mounted in a protecting tube of porcelain or any other suitable refractory material, and furnished with insulators to separate the two wires, is immersed in the molten metal which is then allowed to solidify.

The obtaining of the temperature of equilibrium can be verified by the following criteria: the electromotive force of the thermocouple should be independent of small variations in the depth of immersion during successive solidifications, and it should remain practically constant during at least five minutes in the course of a single solidification.

Within the area of the scale above 1063°C, where Planck's formula is used, the crucible used for solidification of gold should be modified so that it becomes a black body at the solidification point of gold.

## IV. Supplementary Information

### 1. Resistance-Temperature Formulas

The formula for interpolation of the temperature interval between 0°C and 630.5°C as given in the definition of the Scale (paragraph IIa)

$$R_t = R_0(1 + At + Bt^2),$$

can be written in the form of Callendar

$$t = \frac{1}{\alpha} \left( \frac{R_t}{R_0} - 1 \right) + \delta \left( \frac{t}{t_{100}} - 1 \right) \frac{t}{t_{100}},$$

in which  $\alpha = \frac{I}{t_{100}} \left( \frac{R_{100}}{R_0} - 1 \right)$  and  $t_{100} = 100^\circ\text{C}$ .

The relations between the coefficients are:

$$\begin{aligned} A &= \alpha \left( 1 + \frac{\delta}{t_{100}} \right), & \alpha &= A + B t_{100}, \\ B &= -\frac{\alpha \delta}{t_{100}^2}, & \delta &= -\frac{B t_{100}^2}{A + B t_{100}}. \end{aligned}$$

The interpolation formula for the interval between  $0^\circ\text{C}$  and the boiling point of oxygen as given in the definition of the Scale (paragraph IIb)

$$R_t = R_0 [1 + A t + B t^2 + C (t - t_{100}) t^3],$$

can be written under the form of Callendar-Van Dusen

$$t = \left[ \frac{1}{\alpha} \left( \frac{R_t}{R_0} - 1 \right) + \delta \left( \frac{t}{t_{100}} - 1 \right) \frac{t}{t_{100}} + \beta \left( \frac{t}{t_{100}} - 1 \right) \left( \frac{t}{t_{100}} \right)^3 \right]^\circ\text{C}.$$

The relations between  $A$ ,  $B$ , and  $\alpha$ ,  $\delta$  are the same as above; the other relations are

$$C = -\frac{\alpha \beta}{t_{100}^4}, \quad \beta = -\frac{C t_{100}^4}{A + B t_{100}}.$$

## 2. Secondary Points

In addition to the fixed point of definition of the Scale given in Table I, other reference points may be established. Some of these points as well as their temperature on the Practical International Temperature Scale of 1948 are given in Table II. Except for triple points, each temperature is that of a system in equilibrium under a pressure of 1 normal atmosphere. The formulas giving the variations in temperature according to pressure are destined for use within the area from  $p = 680$  to  $p = 780$  mm Hg.

Table II. Secondary Points at a Pressure of 1 Normal Atmosphere  
(except for triple points)

	Temperature °C (Int. 1948)
Temperature of equilibrium between solid carbon dioxide and its vapor	-78.5
$t_p = \left[ -78.5 + 12.12 \left( \frac{p}{p_0} - 1 \right) - 6.4 \left( \frac{p}{p_0} - 1 \right)^2 \right] ^\circ\text{C}$	
Temperature of equilibrium between solid and liquid mercury	-38.87
Temperature of equilibrium between ice and air-saturated water	0.000
Temperature of the triple point of phenoxybenzene (diphenyl oxide)	26.88
Transition temperature of decahydrated sodium sulfate	32.38
Temperature of the triple point of benzoic acid	122.36
Temperature of equilibrium between solid and liquid indium	156.61
Temperature of equilibrium between solid naphthalene and its vapor	218.0
$t_p = \left[ 218.0 + 44.4 \left( \frac{p}{p_0} - 1 \right) - 19 \left( \frac{p}{p_0} - 1 \right)^2 \right] ^\circ\text{C}$	
Temperature of equilibrium between solid and liquid tin	231.91
Temperature of equilibrium between liquid benzophenone and its vapor	305.9

$$t_p = \left[ 305.9 + 48.8 \left( \frac{p}{p_0} - 1 \right) - 21 \left( \frac{p}{p_0} - 1 \right)^2 \right] ^\circ\text{C}$$

(continued)

Table II (continued)

Temperature  
°C (Int. 1948)

Temperature of equilibrium between solid and liquid cadmium	321.03
Temperature of equilibrium between solid and liquid lead	327.3
Temperature of equilibrium between liquid mercury and its vapor	356.58
$t_p = \left[ 356.58 + 55.552 \left( \frac{p}{p_0} - 1 \right) - 23.03 \left( \frac{p}{p_0} - 1 \right)^2 + 14.0 \left( \frac{p}{p_0} - 1 \right)^3 \right] ^\circ\text{C}$	
Temperature of equilibrium between solid and liquid aluminum	660.1
Temperature of equilibrium between solid and liquid copper (in a reducing atmosphere)	1083
Temperature of equilibrium between solid and liquid nickel	1453
Temperature of equilibrium between solid and liquid cobalt	1492
Temperature of equilibrium between solid and liquid palladium	1552
Temperature of equilibrium between solid and liquid platinum	1769
Temperature of equilibrium between solid and liquid rhodium	1960
Temperature of equilibrium between solid and liquid iridium	2443
Fusion temperature of tungsten	3380



### 3. Relation Between the Practical International Temperature Scale and the Thermodynamic Scale

When the International Temperature Scale was adopted in 1927, it was in agreement with the thermodynamic scale as closely as knowledge at that time made it possible. It was recognized, however, that future research should increase knowledge on the existing temperature value differences between the two scales. When it is desired to know the value of a temperature on the thermodynamic scale, the usual process consists in obtaining this temperature on the Practical International Scale and then converting it to the thermodynamic scale, adding the appropriate difference between these two scales. These differences, however, had to be determined experimentally; these experiments are difficult to perform with accuracy because the differences are small with relation to the absolute temperature values. Some of the differences obtained at different areas on the scale are given below to show the present state of our knowledge on the divergencies between the two scales.

Taking into account the uncertainties about these differences, it seems preferable not to modify at present the value of the temperatures on the Practical International Scale and to continue to improve our knowledge on the differences between the scales. It is possible if so desired to improve the means of determination of the temperatures on the Practical International Scale without changing appreciably the value of the temperatures. This method of proceeding will avoid the confusion that would result from too frequent changes in the value of the temperatures.

In the interval between 0°C and the boiling point of sulfur, comparisons between two nitrogen thermometers and standard resistance thermometers were made at M.I.T. (1939). The differences found between the thermodynamic Celsius temperature  $t_{th}$  (definition of 1954) and the temperature  $t_{int}$  (1948 Scale) is expressed by the formula

$$t_{th} - t_{int} = \frac{t}{t_{100}} \left[ -0.0060 + \left( \frac{t}{t_{100}} - 1 \right) (0.04106 - 7.363 \times 10^{-8} t \text{ deg}^{-1}) \right] \text{ degrees}$$

This relation gives 99.994°C (therm.) for the boiling point of water and 444.70°C (therm.) for the boiling point of sulfur; the results obtained with the two gas thermometers differed by 0.005 degrees at the boiling point of water and 0.05 degrees at the boiling point of sulfur. In 1958, the Physikalisch-Technische Bundesanstalt published the value 444.66°C (therm.) for the boiling point of sulfur.

In the area between the boiling point of oxygen and  $0^{\circ}\text{C}$ , research published by the Physikalisch-Technische Reichsanstalt (1932) and by the University of Leyden (1935) gave a group of values indicating that the differences  $t_{\text{th}} - t_{\text{int}}$  show a maximum of approximately  $+0.04$  degrees

around  $-80^{\circ}\text{C}$ . Below  $-100^{\circ}\text{C}$ , some of the published differences have shown contrary signs. These differences are in the range of possible uncertainties in the measurements with gas thermometers. For the boiling point of oxygen, results published by four laboratories since 1927, recalculated on the basis of a value of  $T_0 = 273.15^{\circ}\text{K}$  adopted in 1954

gave the following:  $90.191^{\circ}\text{K}$  at the Physikalisch-Technische Reichsanstalt (1932);  $90.17^{\circ}\text{K}$  at Tôhoku University, Sendai, Japan (1935);  $90.160^{\circ}\text{K}$  at Leyden (1940), and  $90.150^{\circ}\text{K}$  at Pennsylvania State University (1953). Giving the same weight to each laboratory, the average of the four results is  $90.168^{\circ}\text{K}$  or  $-182.982^{\circ}\text{C}$  (therm.).

The Practical International Temperature Scale has not been defined below the boiling point of oxygen.

Around  $1000^{\circ}\text{C}$ , new determinations of thermodynamic temperatures of solidification points of silver and gold have been made in recent years in Germany and Japan:  $962.16^{\circ}\text{C}$  (therm.) was obtained at the Physikalisch-Technische Bundesanstalt (1958) for silver, and  $1064.76^{\circ}\text{C}$  (therm.) for gold; at the Tokyo Institute of Technology (1958)  $961.20^{\circ}\text{C}$  (therm.) and  $1063.73^{\circ}\text{C}$  (therm.) were obtained for these two points, these last two values being very little different from those published by the same laboratory in 1956:  $961.28^{\circ}\text{C}$  (therm.) and  $1063.69^{\circ}\text{C}$  (therm.).

In the area above the solidification point of gold, Planck's formula is used. This formula is based on the thermodynamic scale and should, therefore, give the true value of Kelvin temperatures, provided the correct Kelvin temperature of the solidification point of gold and of the constant  $c_2$  were known.

An analysis of the variances of atomic constants, published by the California Institute of Technology in 1955, gave the value of  $0.0143888$  meter·degree for  $c_2$ . A similar study published by Johns Hopkins University in 1957 gave the value of  $0.0143886$  meter·degree.

If  $T_0 = 273.15$  degrees are added to the practical international Celsius temperatures defined above, the practical international Kelvin temperatures are obtained. Subtracting  $T_0$  from the thermodynamic temperatures, the thermodynamic Celsius temperatures are obtained. Table III gives the recommended designations; the arrows indicate the

direction of passage from the first-defined temperature to the derived temperature through change of origin.

Table III

## PRACTICAL INTERNATIONAL SCALE

Practical International Temperature	→	Practical International Kelvin Temperature
$t_{\text{int}}$		$T_{\text{int}} = t_{\text{int}} + T_0$
Symbol:		Symbol:
$^{\circ}\text{C}$ (Int. 1948)		$^{\circ}\text{K}$ (Int. 1948)
Practical International Celsius degree 1948		Practical International Kelvin degree 1948

## THERMODYNAMIC SCALE

Thermodynamic Celsius Temperature	←	Thermodynamic Temperature
$t = T - T_0$		$T$
Symbol:		Symbol:
$^{\circ}\text{C}$ (therm.)		$^{\circ}\text{K}$
Thermodynamic Celsius degree		degree Kelvin

$$(T_0 = 273.15 \text{ degrees})$$

Note: For the designation of the practical international temperature, the symbol "int" after  $t$  may be omitted if there is no possible confusion that can result.

## ANNEX 6

## INTERNATIONAL SYSTEM OF UNITS

By G.D. Bourdoun,  
President of the System of Units Commission of the  
International Committee on Weights and Measures

The establishment of the international system of units recommended for scientific, technical, practical, and teaching purposes, and the adoption of basic units in 1954 by the Tenth General Conference on Weights and Measures (Resolution 6), ends the preparatory work of several years required to ensure international uniformity in the field of units of measure. The scientific and technical principles involved in the construction of this system and the practical aspects of the problem are discussed herein.

#### Scientific and Technical Principles Involved in the Construction of the International System of Units

The establishment of the units of measure of physical quantities by means of a system of units, using a few fundamental units from which the others are derived as secondary units, is basically the only rational means of defining the units of the various quantities justified by scientific, technical and practical considerations.

The first system of units of measure was the Metric System introduced in France at the end of the XVIIIth century. It consisted of a set of coherent units for the measurement of length, area, volume, capacity, and mass, the base being two fundamental units: the meter and the kilogram.

The notion of a system of units of measure for a wide field of physical quantities was first introduced in 1832 by Gauss, who proposed a system based on three fundamental units (length, mass, and time), which he called "Absolute System of Units." Gauss chose, for the fundamental units of the proposed system the millimeter, the milligram, and the second.

Later on, there appeared several systems of units for physical dimensions (the centimeter-gram-second (C.G.S.) system adopted in 1881 by the International Congress of Electricity; the meter-kilogram-force-second (M.Kf.S.) system, which became widely used in technology after the middle of the XIXth century; the meter-kilogram-second (M.K.S.) system, proposed by Giorgi in 1901; the meter-ton-second (M.T.S.) system, introduced in 1919 by French legislation; etc.).

The use of several systems of units leads in practice to numerous difficulties arising from the problem of conversion of the numerical values of the measured quantities, of constants, etc., from one system to another; as well as from the introduction of a great number of conversion factors. It was therefore becoming necessary to choose the most rational possible single system of units that could be recommended for use on an international level.

The construction of a rational system of units implies the resolution of the following special problems:

- a) Elaboration of a system of independent physical equations relating all the quantities for which it is necessary to establish units of measure;
- b) Analysis of the system of equations and choice of the fundamental units of the system;
- c) Formation of the derived units;
- d) Formation of multiples and submultiples of the units.

The system of physical equations necessary for the formation of a system of units must satisfy the following conditions: the equations of the system must be independent and compatible, each one containing at least two physical quantities; the system of equations must permit the choice of a system of units all of whose coefficients are dimensionless quantities.

The following conditions must be observed in the choice of the fundamental units:

- 1) The certainty of coherence of the system of units, that is to say, a choice of the fundamental units such that all secondary units may be derived by simple multiplication or division, without introduction of numerical coefficients;
- 2) The fundamental units should be those it is possible to reproduce with the greatest precision;

3) The magnitude of both fundamental and secondary units should be convenient for practical use.

In studying the problem of the construction of a system of mechanical units based on a system of physical equations bringing together the mechanical dimensions, it is possible to conclude that it should be possible to choose several systems of units whose base would rest on two or three units having different combinations. For this reason, systems of the LT type (in which the fundamental units are length and time), the LMT type (length, mass, and time), or LFT type (length, force and time) have been suggested.

Taking the above-mentioned conditions into consideration, the analysis of these various systems leads to the conclusion that the LMT system is the more nearly perfect. The system of the LFT type used at present in technology is far less perfect. Reproduction of the unit of force is far less accurate than that of the unit of mass; and in this system the secondary unit of mass is not a very convenient quantity.

For practical purposes, the meter, kilogram, and second are the most convenient fundamental units of the system of the LMT type; this is why international organizations of metrology and standardization have chosen the M.K.S. system.

Three fundamental units are not sufficient for the construction of the system in the field of heat measurements; it is necessary to add a fourth specific fundamental unit. This fourth quantity is temperature, and the calorific unit system is of the LMT $\theta$  type, where  $\theta$  is temperature. The unit of temperature can be defined in several ways, but the meter-kilogram-second-degree Kelvin system is the easiest and most rational so far as the magnitude of the fundamental units is concerned.

In the field of electric and magnetic measurements, it is possible to build a system of units using as a starting point the units of length, mass, and time, plus a unit of some electric or magnetic quantity. For practical purposes, the system with the four fundamental units: meter, kilogram, second, and ampere (M.K.S.A. system) is the most convenient. This system insures the necessary liaison with the mechanical units.

Acoustical measurements do not require additional fundamental units; all quantities in this field can be expressed in the M.K.S. system.

For measurements of light, three fundamental units are sufficient: those of length and of time, and a third specific unit: light intensity. That is why a system of the LTI type can be used for light measurements where I is the light intensity. In practice the system with the three fundamental units: meter, second, and candela is the most convenient.

For measurements in the field of ionizing radiations (X- and  $\gamma$ -rays and radioactivity), additional fundamental units are not necessary (except for one electrical unit), and the M.K.S.A. system can be used. The International Commission on Radiological Units and Measurements (I.C.R.U.) has established the dimensions and special names of the most usual secondary units, namely: radiation dosage, absorbed dosage, and activity (roentgen, rad, and curie). For the measurement of the amount of radiation in the M.K.S.A. system, the secondary unit is the coulomb per kilogram (C/kg); for the absorbed dosage, it is the joule per kilogram; for activity, it is 1/s. The corresponding units adopted by the

I.C.R.U. are the roentgen =  $2.57976 \cdot 10^{-4}$  C/kg; the rad = 0.01 J/kg; the curie =  $3.7 \cdot 10^{10} \text{ s}^{-1}$ .

In order to include the entire field of physical phenomena in a single system of units of measure, the most rational system is the system based on six fundamental units: length, mass, time, thermodynamic temperature, current strength, and light intensity. The most convenient magnitudes for the fundamental units of this system are those of the meter-kilogram-second-degree Kelvin-ampere-candela system of units.

#### Preparation, Establishment and Propagation of the International System of Units

In 1913, Ch.-Ed. Guillaume, Deputy-Director of the International Bureau, presented to the Fifth General Conference on Weights and Measures a report on systems of units, giving particular attention to the M.K.S. system, and emphasizing the fact that it should be preferred to all other systems of units. Guillaume pointed out the fact that in the M.K.S. system, the units of work and power coincide with the same units in the practical absolute system of electrical units. Acting on this report, the General Conference invited the International Committee on Weights and Measures to continue the study of the question of the system of units.

In 1948, the International Union of Pure and Applied Physics submitted the following resolution to the Ninth General Conference:

a) "The International Union of Pure and Applied Physics has decided to request from the International Committee on Weights and Measures that a practical international system of units be adopted for international relations. It does not recommend that the C.G.S. system be abandoned by physicists.

b) "The International Union of Pure and Applied Physics recommends for this purpose the system involving the meter, the kilogram (mass), the

second, and an electrical unit of the practical absolute system (to be decided upon in the near future).

c) "The unit of force of this system (the force that, when applied to a mass of one kilogram, gives it an acceleration of  $1 \text{ m/s}^2$ ) is to be named newton."

Simultaneously, the French Government had presented to the General Conference a project of its own whose aim was the international unification of units of measure. The general considerations of the French proposal, established upon the advice of the National Permanent Scientific Bureau of Weights and Measures, were as follows:

1) "The fundamental units of length, mass, and time must be the meter, the kilogram (mass), and one second of solar mean time.

2) "The absolute units of the practical electrical system as they are defined in the October 1946 resolutions of the International Committee on Weights and Measures, and as they are included at the present time in national legislations, must be preserved.

3) "It is necessary to eliminate any system that includes a fundamental unit of force or of weight. Even if it seems advisable to authorize the use of a unit of weight for practical mechanics, a special name, not resembling the name of a metric unit of mass either by its expression or by its symbol, should be given to it."

The above project included the table of units of the M.K.S.A. system and the drafts of legal documents and regulations concerning units of measure.

After discussion of the propositions presented, the Ninth General Conference (1948) adopted Resolution 6 as follows:

"The General Conference,

"CONSIDERING that the International Committee on Weights and Measures has received a request from the International Physics Union, asking that it adopt a practical international system of units for international relations, and recommending to it the M.K.S. system plus an electrical unit of the practical absolute system and not recommending that the C.G.S. system be abandoned by physicists;

"CONSIDERING that it has received a similar request from the French Government, together with a project destined to be used as a base for discussions of the establishment of complete regulations regarding units of measure;



"INSTRUCTS the International Committee

"to open an official investigation concerning the opinion of the scientific, technical and pedagogical circles of all countries (offering as a base the French document), and to conduct its investigation actively;

"to centralize the replies;

"and to submit recommendations concerning the institution of a single practical system of units of measure susceptible of being adopted by the signatory nations of the Convention of the Meter."

The study of this question in the various countries, and the dispatch of comments to the International Bureau of Weights and Measures, took more time than was expected, and the study of all the documents received was not completed at the time of the Tenth General Conference on Weights and Measures (1954).

After discussing the question of the International System of Units, the Tenth General Conference adopted the following Resolution 6:

"As a result of the wish expressed by the Ninth General Conference in its Resolution 6 concerning the institution of a practical system of units of measure for international relations, the Tenth General Conference on Weights and Measures,

"has decided to adopt as the basic units of this system, which remains to be established, the following units:

Length	meter
Mass	kilogram
Time	second
Electric current intensity	ampere
Thermodynamic temperature	degree Kelvin
Luminous intensity	candela."

This resolution establishes a strong base for international unification of units of measure. At the same time (1954), the International Committee on Weights and Measures had created an internal "system of units commission" made up of seven members of the Committee plus the director of the International Bureau.

From 1954 to 1956, the results of the investigation conducted in the different countries were studied according to the decision of the Ninth General Conference. The replies received from 21 nations indicated that the proposed project for unification of the systems of units

of measure had been very welcome and that the comments concerned only details, especially about the legal part of the project.

In October of 1956, at the time of the International Committee meeting, during a meeting of the System of Units Commission, consideration was given to the results of the official investigation, and a study was made of drafts of an initial list of additional and secondary units established from the resolution on basic units of the Tenth General Conference.

A lengthy discussion was started when the question of a name for the system of units was raised. Of the three proposed variations: "Giorgi system," "M.K.S.A.<sup>o</sup>K.C. system" (initials of the names of the six basic units of the system) and "International System of Units," the last-named was unanimously adopted by the Commission for recommendation to the International Committee.

The Commission also adopted an initial list of units of the International System of Units, including two additional units and twenty-eight secondary units. This list was presented to the International Committee for approval.

On the 6th of October 1956, the International Committee examined the recommendation of the System of Units Commission, and adopted Resolution 3, which follows:

"CONSIDERING the instructions of the Ninth General Conference on Weights and Measures concerning the institution of a practical system of units susceptible of being adopted by all the signatory nations of the Convention of the Meter;

"CONSIDERING all the documents sent by the twenty-one countries that have responded to the inquiry prescribed by the Ninth General Conference on Weights and Measures;

"CONSIDERING Resolution 6 of the Tenth General Conference on Weights and Measures determining the choice of the basic units of the system to be established:

"RECOMMENDS that the system based on the (six) basic units adopted by the Tenth General Conference be taken as the International System of Units...."

Simultaneously the recommended list of additional and secondary units of the International System was adopted without prejudice to other units that could be added in the future.

During its 1958 meeting, the International Committee discussed, and took a decision concerning, the abbreviation to be used to designate the "International System of Units;" the abbreviation SI, formed of the initials of the words "International System," and utilizable in all languages, was adopted. In addition, in order to complete the list of prefixes already adopted for the formation of multiples and submultiples of the units, the International Committee gave its approval to the four prefixes tera and giga, nano and pico.

The designations of the secondary units of the International System of Units are proposed in accordance with international recommendations. As far as the unit of magnetic field is concerned, the adoption of the name "tesla" corresponds to a decision by the International Electrotechnical Commission (1956). At the present time, Technical Committee No. 24 of the C.E.I. is studying a Russian proposal concerning the attribution of the name "lantz" to the unit magnetic field intensity. Considering the fact that no decision has been reached up to now, this unit does not yet have any particular name.

The introduction of the International System of Units based on the six fundamental units adopted by the Tenth General Conference on Weights and Measures is an important step forward by generalizing the experience of the scientific and technical circles of various countries, and of the international organizations of metrology, of standardization, of physics, and of electrotechnics.

In 1956, the International Standardization Organization (I.S.O.) adopted the first international recommendation for standardization of the units of measure (I.S.O., R 31, Part 1). In this recommendation, the system of units based on the six units adopted by the Tenth General Conference on Weights and Measures and temporarily labelled "M.K.S.A. system" is given the first place. The first table of this recommendation is that of the fundamental units of this system: meter, kilogram, second, ampere, degree Kelvin, and candela.

In 1958, the International Committee of Legal Metrology adopted the following resolution concerning the International System of Units:

"The International Committee of Legal Metrology, meeting in plenary session on the 7th of October in Paris, has decided to adhere to the resolution of the International Committee on Weights and Measures concerning the establishment of the International System of Units (SI).

"The basic units of this system are: meter, kilogram, second, ampere, degree Kelvin, and candela.

"The Committee recommends the adoption of this system by Member Nations of the Organization in their legislation on units of measure."

Since 1955, several countries have adopted, in their legislation or in their national standards, the system of units recommended by the International Committee on Weights and Measures under the name of International System of Units.

As a conclusion to the proceedings and recommendations about the establishment of a practical system of units of measure, the final decisions to be taken concern the ratification,

1) Of the name "International System of Units" and of the abbreviation SI for the system based on the six fundamental units adopted by the Tenth General Conference<sup>1</sup>;

2) Of the additional and secondary units of this system as recommended by the International Committee (see records C.I.P.M., 1956, 25, Resolution 3, p. 83);

3) Of the list of prefixes approved by the International Committee for the formation of multiples and submultiples of the units (see records C.I.P.M., 1958, 26-A, p. 89)<sup>2</sup>.

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<sup>1</sup>The definitions of the basic units are those that have been approved by the General Conferences:

- meter and second (Eleventh Conference, 1960, Resolutions 6 and 9, pp. 98 and 99);
- kilogram (Third Conference, 1901, p. 70);
- ampere and candela (records C.I.P.M., 1946, 20, pp. 132 and 121; Ninth Conference, 1948, pp. 49 and 54);
- degree Kelvin (Tenth Conference, 1954, Resolution 3, p. 79).

<sup>2</sup>Note added to the proof: Items 1, 2, and 3 have been re-examined by the System of Units Commission, which met at the "Pavillon de Breteuil" on 6 October 1960 and handed its report to the International Committee (records C.I.P.M., 1960, 28, fifth meeting). After discussion of the propositions submitted by the International Committee (see p. 75), the Eleventh General Conference adopted Resolution 12, p. 101).

<p>NASA TT F-217 National Aeronautics and Space Administration. TRANSACTIONS OF THE MEETINGS OF THE ELEVENTH GENERAL CONFERENCE ON WEIGHTS AND MEASURES. (Comptes Rendus des Seances de la Onzieme Conference Generale des Poids et Mesures.) September 1964. xi, 197p. OTS price, \$3.50. (NASA TECHNICAL TRANSLATION F-217. Translation of Comptes Rendus des Seances de la Onzieme Conference Generale des Poids et Mesures, Paris, 11-20 octobre 1960 (France))</p> <p>A detailed report is given on the commentaries, proposals, and final resolutions adopted at the Eleventh General Conference on Weights and Measures held in Paris, France, in October 1960. Five sessions were held, and agreements were reached concerning international standards for use by the nations represented.</p>	<p>I. NASA TT F-217 Comptes Rendus des Seances de la Onzieme Conference Generale des Poids et Mesures, Paris, 11-20 octobre 1960 (France)</p> <p>NASA</p>	<p>NASA TT F-217 National Aeronautics and Space Administration. TRANSACTIONS OF THE MEETINGS OF THE ELEVENTH GENERAL CONFERENCE ON WEIGHTS AND MEASURES. (Comptes Rendus des Seances de la Onzieme Conference Generale des Poids et Mesures.) September 1964. xi, 197p. OTS price, \$3.50. (NASA TECHNICAL TRANSLATION F-217. Translation of Comptes Rendus des Seances de la Onzieme Conference Generale des Poids et Mesures, Paris, 11-20 octobre 1960 (France))</p> <p>A detailed report is given on the commentaries, proposals, and final resolutions adopted at the Eleventh General Conference on Weights and Measures held in Paris, France, in October 1960. Five sessions were held, and agreements were reached concerning international standards for use by the nations represented.</p>	<p>I. NASA TT F-217 Comptes Rendus des Seances de la Onzieme Conference Generale des Poids et Mesures, Paris, 11-20 octobre 1960 (France)</p> <p>NASA</p>	<p>NASA TT F-217 National Aeronautics and Space Administration. TRANSACTIONS OF THE MEETINGS OF THE ELEVENTH GENERAL CONFERENCE ON WEIGHTS AND MEASURES. (Comptes Rendus des Seances de la Onzieme Conference Generale des Poids et Mesures.) September 1964. xi, 197p. OTS price, \$3.50. (NASA TECHNICAL TRANSLATION F-217. Translation of Comptes Rendus des Seances de la Onzieme Conference Generale des Poids et Mesures, Paris, 11-20 octobre 1960 (France))</p> <p>A detailed report is given on the commentaries, proposals, and final resolutions adopted at the Eleventh General Conference on Weights and Measures held in Paris, France, in October 1960. Five sessions were held, and agreements were reached concerning international standards for use by the nations represented.</p>	<p>I. NASA TT F-217 Comptes Rendus des Seances de la Onzieme Conference Generale des Poids et Mesures, Paris, 11-20 octobre 1960 (France)</p> <p>NASA</p>
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