RECOMMENDATION 460-4

STANDARD-FREQUENCY AND TIME-SIGNAL EMISSIONS

(Question 1/7)

(1970-1974-1978-1982-1986)

The CCIR,

CONSIDERING

(a) that the World Administrative Radio Conference, Geneva, 1979, allocated the frequencies 20 kHz ± 0.05 kHz, 2.5 MHz ± 5 kHz (2.5 MHz ± 2 kHz in Region 1), 5 MHz ± 5 kHz, 10 MHz ± 5 kHz, 15 MHz ± 10 kHz, 20 MHz ± 10 kHz and 25 MHz ± 10 kHz to the standard-frequency and time-signal service;

(b) that additional standard frequencies and time signals are emitted in other frequency bands;

(c) the provisions of Article 33 of the Radio Regulations;

(d) the continuing need for close cooperation between Study Group 7 and the International Maritime Organization (IMO), the International Civil Aviation Organization (ICAO), the General Conference of Weights and Measures (CGPM), the Bureau international des poids et mesures (BIPM), the International Earth Rotation Service (IERS) and the concerned Unions of the International Council of Scientific Unions (ICSU);

(e) the desirability of maintaining world-wide coordination of standard-frequency and time-signal emissions;

(f) the need to disseminate standard frequencies and time signals in conformity with the second as defined by the 13th General Conference of Weights and Measures (1967);

(g) the continuing need to make Universal Time (UT) inmmediately available to an accuracy of one-tenth of a second,

UNANIMOUSLY RECOMMENDS

1. that all standard-frequency and time-signal emissions conform as closely as possible to Coordinated Universal Time (UTC) (see Annex I); that the time signals should not deviate from UTC by more than one millisecond; that the standard frequencies should not deviate by more than 1 part in 10^{10}, and that the time signals emitted from each transmitting station should bear a known relation to the phase of the carrier;

2. that standard-frequency and time-signal emissions, and other time-signal emissions intended for scientific applications (with the possible exception of those dedicated to special systems) should contain information on the difference between UT1 and UTC (see Annexes I and II);

3. that this document be transmitted by the Director, CCIR, to all administrations Members of the ITU, to IMO, ICAO, the CGPM, the BIPM, the IERS, the International Union of Geodesy and Geophysics (IUGG), the International Union of Radio Science (URSI) and the International Astronomical Union (IAU);

4. that the standard-frequency and time-signal emissions should conform to RECOMMENDS 1 and 2 above as from 1 January 1975.

ANNEX I

TIME SCALES

A. Universal Time (UT)

Universal Time (UT) is the general designation of time scales based on the rotation of the Earth.

In applications in which an imprecision of a few hundredths of a second cannot be tolerated, it is necessary to specify the form of UT which should be used:

UT0 is the mean solar time of the prime meridian obtained from direct astronomical observation;

UT1 is UT0 corrected for the effects of small movements of the Earth relative to the axis of rotation (polar variation);

UT2 is UT1 corrected for the effects of a small seasonal fluctuation in the rate of rotation of the Earth;

UT1 is used in this document, since it corresponds directly with the angular position of the Earth around its axis of diurnal rotation. (GMT may be regarded as the general equivalent of UT.)

Concise definitions of the above terms and the concepts involved are available in the glossary of the annual publication, *The Astronomical Almanac* (US Government Printing Office, Washington DC and H.M. Stationery Office, London).

B. International Atomic Time (TAI)

The international reference scale of atomic time (TAI), based on the second (SI), as realized at sea level, is formed by the Bureau international des poids et mesures (BIPM) on the basis of clock data supplied by cooperating establishments. It is in the form of a continuous scale, e.g. in days, hours, minutes and seconds from the origin 1 January 1958 (adopted by the CGPM 1971).

C. Coordinated Universal Time (UTC)

UTC is the time-scale maintained by the BIPM, with assistance from the International Earth Rotation Service (IERS), which forms the basis of a coordinated dissemination of standard frequencies and time signals. It corresponds exactly in rate with TAI but differs from it by an integral number of seconds.

The UTC scale is adjusted by the insertion or deletion of seconds (positive or negative leap-seconds) to unsure approximate agreement with UT1.

D. DUT1

The value of the predicted difference UT1 – UTC, as disseminated with the time signals is denoted DUT1; thus DUT1 ≈ UT1 – UTC. DUT1 may be regarded as a correction to be added to UTC to obtain a better approximation to UT1.

The values of DUT1 are given by the IERS in integral multiples of 0.1 s.

The following operational rules apply:

1. Tolerances

1.1 The magnitude of DUT1 should not exceed 0.8 s.

1.2 The departure of UTC from UT1 should not exceed ± 0.9 s (see Note).

1.3 The deviation of (UTC plus DUT1) should not exceed ± 0.1 s.

Note – The difference between the maximum value of DUT1 and the maximum departure of UTC from UT1 represents the allowable deviation of (UTC + DUT1) from UT1 and is a safeguard for the IERS against unpredictable changes in the rate of rotation of the Earth.

2. Leap-seconds

2.1 A positive or negative leap-second should be the last second of a UTC month, but first preference should be given to the end of December and June, and second preference to the end of March and September.

2.2 A positive leap-second begins at 23h 59m 60s and ends at 0h 0m 0s of the first day of the following month. In the case of a negative leap-second, 23h 59m 58s will be followed one second later by 0h 0m 0s of the first day of the following month (see Annex III).

2.3 The IERS should decide upon and announce the introduction of a leap-second, such an announcement to be made at least eight weeks in advance.

3. Value of DUT1

3.1 The BIH is requested to decide upon the value of DUT1 and its date of introduction and to circulate this information one month in advance. In exceptional cases of sudden change in the rate of rotation of the Earth, the IERS may issue a correction not later than two weeks in advance of the date of its introduction.

3.2 Administrations and organizations should use the IERS value of DUT1 for standard-frequency and time-signal emissions, and are requested to circulate the information as widely as possible in periodicals, bulletins, etc.

3.3 Where DUT1 is disseminated by code, the code should be in accordance with the following principles (except § 3.5 below):

– the magnitude of DUT1 is specified by the number of emphasized second markers and the sign of DUT1 is specified by the position of the emphasized second markers with respect to the minute marker. The absence of emphasized markers indicates DUT1 = 0;

– the coded information should be emitted after each identified minute if this is compatible with the format of the emission. Alternatively the coded information should be emitted, as an absolute minimum, after each of the first five identified minutes in each hour.

Full details of the code are given in Annex II.

3.4 Alternatively, DUT1 may be given by voice or in Morse code.

3.5 DUT1 information primarily designed for, and used with, automatic decoding equipment may follow a different code but should be emitted after each identified minute if this is compatible with the format of the emission. Alternatively, the coded information should be emitted, as an absolute minimum, after each of the first five identified minutes in each hour.

3.6 Other information which may be emitted in that part of the time-signal emission designated in § 3.3 and 3.5 for coded information on DUT1 should be of a sufficiently different format that it will not be confused with DUT1.

3.7 In addition, UT1 – UTC may be given to the same or higher precision by other means, for example, in Morse code or voice, by messages associated with maritime bulletins, weather forecasts, etc.; announcements of forthcoming leap-seconds may also be made by these methods.

3.8 The IERS is requested to continue to publish, in arrears, definitive values of the differences UT1 – UTC and UT2 – UTC.

ANNEX II

CODE FOR THE TRANSMISSION OF DUT1

A positive value of DUT1 will be indicated by emphasizing a number (n) of consecutive second markers following the minute marker from second marker one to second marker (n) inclusive; (n) being an integer from 1 to 8 inclusive.

$$DUT1 = (n \times 0.1)\ s$$

A negative value of DUT1 will be indicated by emphasizing a number (m) of consecutive second markers following the minute marker from second marker nine to second marker ($8 + m$) inclusive, (m) being an integer from 1 to 8 inclusive.

$$DUT1 = -(m \times 0.1)\ s$$

A zero value of DUT1 will be indicated by the absence of emphasized second markers.

The appropriate second markers may be emphasized, for example, by lengthening, doubling, splitting or tone modulation of the normal second markers.

Examples:

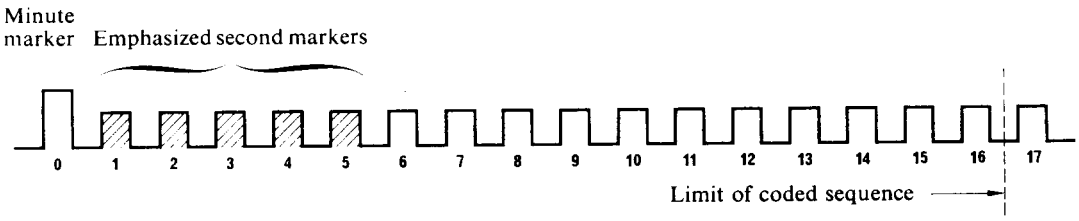

FIGURE 1

DUT1 = +0·5 *s*

D01-sc

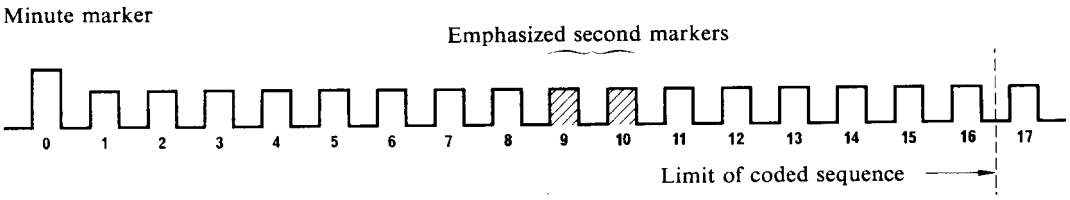

FIGURE 2

DUT1 = −0·2 *s*

D02-sc

ANNEX III

DATING OF EVENTS IN THE VICINITY OF A LEAP-SECOND

The dating of events in the vicinity of a leap-second shall be effected in the manner indicated in the following figures:

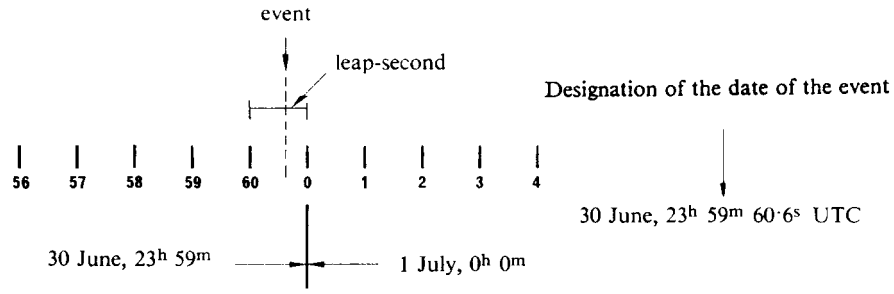

FIGURE 3 – *Positive leap-second*

D03-sc

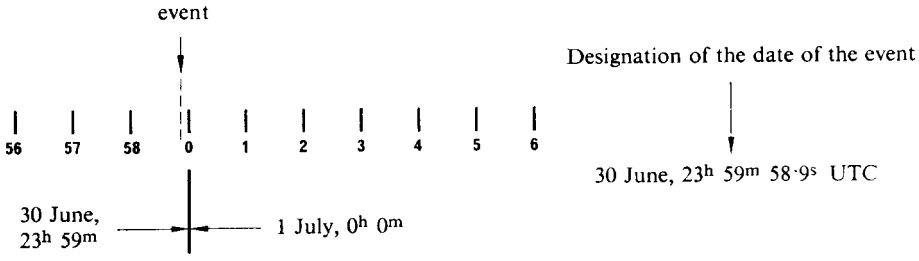

FIGURE 4 – *Negative leap-second*

D04-sc