CHAPTER 2

RADIO TIME SIGNALS

200A. General

The system of Coordinated Universal Time (UTC), described fully in “The American Practical Navigator” (Bowditch) (NVPUB9), came into use on 1 January 1972. Most countries have agreed to use the revised transmission procedures recommended by the the International Telecommunications Union-Radiocommunications Sector (ITU-R). Users are advised that some stations not specifically operating in the Standard Frequency and Time Signal Services may not be able to conform exactly to the current recommendations.

Stations use various systems to broadcast time signals. The more commonly used systems are described below and referred to in the station listings at the end of this chapter. Special systems are described under their respective stations.

ACCURACY OF SIGNALS: The majority of radio time signals are transmitted automatically and are referenced to standards at the various national standards labs such as the National Institute of Standards and Technology (NIST) in the U.S. Absolute reliance may be had in these signals; they should be correct to 0.05 second. Some stations transmit by a combination of manual and automatic signals. Care should be exercised to differentiate between the two at the time of actual comparison to a chronometer.

Other radio stations, however, have no automatic transmission system installed. In this instance, the operator is guided by the standard clock at the station. The clock is checked by either astronomical observations or by reliable time signals. The hand transmission should be correct to 0.25 second.

STATIONS MUST AVOID INTERFERENCE: During the transmission of time signals, stations are prohibited from making any transmissions which might interfere with the reception of these signals.

HIGH PRECISION: For ordinary navigational purposes no special precautions need be observed in receiving the signals other than to avoid those signals which are marked in the station schedule as unsatisfactory for navigational purposes.

200B. The United States System

The transmission of signals begins at 55 minutes, 0 seconds of a given hour and continues for 5 minutes. Signals are transmitted on every second during that time, except that there is no signal on the 29th second of any minute, nor on certain seconds at the ends of the minutes, as shown in the diagram.

The dashes in the diagram indicate seconds on which signals are transmitted. The seconds marked “60” are the zero seconds of the following minutes. The dash on the beginning of the hour (shown as 59 minutes, 60 seconds) is much longer than the others.

In all cases, the beginning of the dash indicates the beginning of the second; the end of the dash is without significance.

Note that the number of dashes sounded in the group at the end of any minute indicates the number of minutes of the signal yet to be sent.

200C. The Old International (ONOGO) System

The time signal is usually preceded by a preparatory signal, described where necessary in the station listings.

The signal itself is described in the following table. In the transmission of the ONOGO signals, each dash (–) =1 second and each dot (•) = 0.25 second.

200D. The New International (Modified ONOGO) System

This is identical to the old system except that six dots are sent at the 55th through 60th seconds of each minute (instead of the old system of three 1 second dashes that commenced at the 55th, 57th, and 59th seconds), which constitute the time signals.

200E. The English System

The time signal on the hour is preceded by 5 minutes of a preparatory signal consisting of a 0.1 second dot at each second, 1 through 59, and a 0.4 second dash at each exact minute. The beginning of each dot or dash is the time reference point.

200F. The BBC System

The time signal on the hour is preceded by five 0.1 second dots sent at seconds 55 through 59. The hour marker is a 0.5 second dash. The beginning of each dot or dash is the time reference point.

The United States System

Minute	Second										
	50	51	52	53	54	55	56	57	58	59	60
55	–		–	–	–	–					–
56	–	–		–	–	–					–
57	–	–	–		–	–					–
58	–	–	–	–		–					–
59	–										—

Old International (ONOGO) System

Signal	Times					Morse Symbols
	m.	s.		m.	s.	
Letter X sent once every 10 seconds	57	00	to	57	49	– • • – – • • – – • • – – • • – – • • –
Letter O	57	55	to	58	00	– – –
Letter N sent once every 10 seconds	58	08	to	58	10	– • – • – • – • – •
Letter O	58	55	to	59	00	– – –
Letter G sent once every 10 seconds	59	06	to	59	10	– – • – – • – – • – – • – – •
Letter O	59	55	to	60	00	– – –

New International (Modified ONOGO) System

Signal	Times					Morse Symbols
	m.	s.		m.	s.	
Letter X sent once every 10 seconds	57	00	to	57	49	– • • – – • • – – • • – – • • – – • • –
Six dots	57	55	to	58	00	• • • • • •
Letter N sent once every 10 seconds	58	08	to	58	10	– • – • – • – • – •
Six dots	58	55	to	59	00	• • • • • •
Letter G sent once every 10 seconds	59	06	to	59	10	– – • – – • – – • – – • – – •
Six dots	59	55	to	60	00	• • • • • •

The English System

M.	Seconds: 1-59	60
55	• •	–
56	• •	–
57	• •	–
58	• •	–
59	• •	–

The BBC System

minute	seconds 1-54	55	56	57	58	59	60
59	(silence)	•	•	•	•	•	–

200G. Codes for the Transmission of UTC Adjustments

Currently the rate of departure between UTC and Greenwich mean time (UT1), used in celestial navigation, is 2.5 milliseconds a day. However, it is planned that UTC will not normally deviate from UT1 by more than 0.9 seconds. Provision has been made to maintain this relativity by means of step adjustments to the time signals of exactly 1 second. These adjustments, known as leap seconds, will normally be effected at 2400 on 30 June or 31 December. (A positive leap second begins at 23 hours, 59 minutes, 60 seconds, ending at 0 hours, 0 minutes, 0 seconds of the first day of the following month. For a negative leap second, 23 hours, 59 minutes, 58 seconds will be followed one second later by 0 hours, 0 minutes, 0 seconds of the first day of the following month.)

However, it is also quite possible that these dates may be varied depending upon any unpredicted variations in the earth's rate of rotation.

The difference between UTC and UT1 is known as D (for delta) UT1, the relationship being DUT1 = UT1 - UTC. By means of a coding system incorporated in the actual emissions, primary time signal sources will promulgate DUT1 in integral multiples of 0.1 second.

In most cases the coding will be in the form of a ITU-R code with emphasized second markers in the first 16 seconds following the minute marker. The emphasis of the second markers can take the form of lengthening, doubling, splitting or tone modulating of the normal second markers. Each emphasized second represents a DUT1 value of 0.1 second, the total value of DUT1 being indicated by the number of emphasized seconds. The sign of DUT1 is determined by the position of the coded signals within the 16 second period, positive values being indicated by emphasis of the first 8 seconds and negative values being indicated by emphasis of seconds 9 to 16.

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

Time signal emissions of Russia follow this system; additionally, they carry a similar coding of seconds 21 to 24 or 31 to 34. The extra coding indicates a further figure (known as dUT1) to be added to the DUT1 value; the total value of the UT1 - UTC corrections being DUT1 + dUT1. Each emphasized second represents a dUT1 value of 0.02 second.

Positive values of dUT1 are indicated by emphasizing a number of consecutive second markers from seconds 21 through 24.

Negative values of dUT1 are indicated by emphasizing a number of consecutive second markers from seconds 31 through 34.

A zero value of dUT1 is indicated by the absence of emphasized second markers.

Time signals originating from Russia will also include a Morse code transmission of DUT1 + dUT1. The information is broadcast by means of a three digit group. The first number indicates the sign of the difference (1 means a positive value and 0 means a negative value). The two numbers following give the absolute value (e.g., 072 = -0.72 second; 128 = +0.28 second). The numbers are transmitted with an interval corresponding to the length of three dashes (approximately 0.9 second).

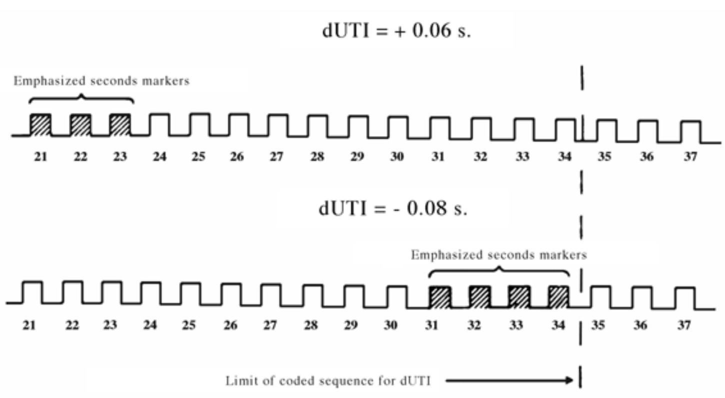
The information is repeated 10 to 15 times during 1 minute, each group of three digits being separated from each other by a separation marker (• – •).

DUT1 may also be given by voice announcement or in Morse code. For example, U.S. Naval Radio Stations use standard Morse code from seconds 56 through 59 each minute (not used for time signals) to indicate the sign and value in tenths of a second of DUT1.

Positive values will be indicated by the letter "A" and the appropriate digit (e.g., • – • • • – – "A3": add 0.3 second).

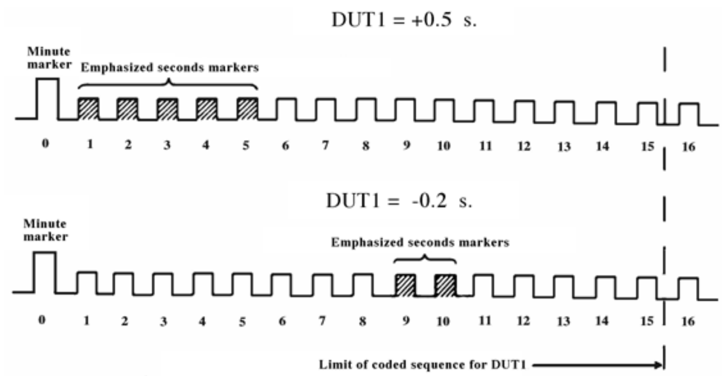
Negative values will be indicated by the letter "S" and the appropriate digit (e.g., • • • – – – – • "S9": subtract 0.9 second).

EXAMPLES:



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

EXAMPLES:



200H. Shortwave Services Provided by the National Institute of Standards and Technology WWV-WWVH Broadcasts

SHORTWAVE SERVICES: NIST broadcasts time signals continuously from the two high-frequency (shortwave) radio stations WWV, near Fort Collins, Colorado, and WWVH, Kekaha, Kauai, Hawaii on frequencies of 2.5, 5, 10, and 15 MHz (also 20 MHz from Fort Collins only). All frequencies provide the same information. Services include time announcements, standard time intervals, standard frequencies, UT1 time corrections, BCD time code, geophysical alerts, marine storm warnings, and GPS navigation system status information. The accompanying diagrams give the hourly broadcast schedules of WWV and WWVH. Station locations, radiated power, and details of antennas and modulation are given in the station listings which follow. The NIST also broadcasts time and frequency signals from its low frequency station, WWVB, also located at Fort Collins, Colorado, and from two geostationary GOES satellites.

The NIST Time and Frequency Division is internet accessible through the World Wide Web at:

http://www.boulder.nist.gov/timefreq/index.html

ACCURACY AND STABILITY: The time and frequency broadcasts are controlled by the NIST Frequency Standard, which realizes the internationally defined cesium resonance frequency with an accuracy of 1 part in 10^{14}. The frequencies as transmitted by WWV and WWVH are accurate to about 1 part in 100 billion (1 x 10^{-11}) for frequency and about 0.01 millisecond (ms) for timing. The day-to-day deviations are normally less than 1 part in 1,000 billion (1 x 10^{-12}). However, the received accuracy is far less due to various propagation effects (Doppler effect, diurnal shifts, etc.) that cause fluctuations in the carrier frequencies. The usable received accuracy is about 1 part in 10 million (1 x 10^{-7}) for frequency and about 1 ms for timing.

TIME ANNOUNCEMENTS: Once per minute, voice announcements are made from WWV and WWVH. The two stations are distinguished by a female voice from WWVH and a male voice from WWV. The WWVH announcement occurs first, at 15 seconds before the minute, while the WWV announcement occurs at 7.5 seconds before the minute. Coordinated Universal Time is used in these announcements.

STANDARD TIME INTERVALS: The most frequent sounds heard on WWV and WWVH are the pulses that mark the seconds of each minute, except for the 29th and 59th second pulses which are omitted completely. The first pulse of every hour is an 800-ms pulse of 1500 Hz. The first pulse of every minute is an 800-ms pulse of 1000 Hz at WWV and 1200 Hz at WWVH. The remaining second pulses are brief audio bursts (5-ms pulses of 1000 Hz at WWV and 1200 Hz at WWVH) that resemble the ticking of a clock. Each pulse commences at the beginning of each second. They are given by means of double-sideband amplitude modulation.

Each second’s pulse is preceded by 10 ms of silence and followed by 25 ms of silence to avoid interference which might make it difficult or impossible to pick out the pulses.

STANDARD AUDIO FREQUENCIES: In alternate minutes during most of each hour, 500 or 600 Hz audio tones are broadcast. A 440 Hz tone, the musical note A above middle C, is broadcast once each hour. In addition to being a musical standard, the 440 Hz tone can be used to provide an hourly marker for chart recorders or other automated devices.

“SILENT” PERIODS: These are periods with no tone modulation. However, the carrier frequency, second pulses, time announcements, and 100 Hz BCD time code continue. The main silent periods extend from 43 to 46 and from 47 to 52 minutes after the hour on WWV and from 8 to 11 and from 14 to 20 minutes after the hour on WWVH. Minutes 29 and 59 on WWV and minutes 00 and 30 on WWVH are also silent.

BCD TIME CODE: A modified IRIG-H time code occurs continuously on a 100 Hz subcarrier. The format is 1 pulse per second with a 1 minute time frame. It gives year (2 digits), day of the year, hours, and minutes in binary coded decimal form. Indicators for daylight saving time and leap seconds are also included in the code.

UT1 TIME CORRECTIONS: The UTC time scale operates on atomic frequency, but by means of resets is made to approximate the astronomical UT1 scale. It may disagree with UT1 by as much as 0.9 second before resets in steps of exactly 1 second are made. For those who need astronomical time more accurate than 0.9 second, a UTC correction is applied through the ITU-R code described earlier, using double ticks as emphasized markers.

GEOPHYSICAL ALERTS: Current geophysical alerts (Geoalerts) are broadcast in voice at 18 minutes after the hour (for WWV) and at 45 minutes after the hour (for WWVH). The messages are less than 45 seconds in length and are updated every three hours, i.e., 0000, 0300, 0600 UTC, etc. Part A of the message gives the solar-terrestrial indices for the day: specifically the 2000 UTC solar flux from Penticton, B.C., Canada at 2800 MHz, the estimated A-index for Boulder, CO and the current Boulder K-index. Part B gives the solar-terrestrial conditions for the previous 24 hours. Part C gives optional information on current conditions that may exist (that is, major flares, proton or polar cap absorption [PCA] events, or stratwarm conditions). Part D gives the expected conditions for the next 24 hours. For example:

A) Solar-terrestrial indices for 26 October follow:
Solar flux 173 and estimated Boulder A-index 20, repeat: Solar flux one-seven-three and estimated Boulder A-index two-zero.
The Boulder K-index at 1800 UTC on 26 October was four, repeat: four.

B) Solar-terrestrial conditions for the last 24 hours follow:
Solar activity was high.
Geomagnetic field was unsettled to active.

C) A major flare occurred at 1648 UTC on 26 October. A satellite proton event and PCA are in progress.

D) The forecast for the next 24 hours follows:
Solar activity will be moderate to high. The geomagnetic field will be active.

Solar activity is defined as transient perturbations of the solar atmosphere as measured by enhanced x-ray emission, typically associated with flares. Five standard terms are used to describe solar activity:

- Very low: x-ray events less than C-class.
- Low: C-class x-ray events.
- Moderate: isolated (one to four) M-class x-ray events.
- High: several (five or more) M-class x-ray events, or isolated (one to four) M5 or greater x-ray events.
- Very High: several M5 or greater x-ray events.

The geomagnetic field experiences natural variations classified quantitatively into six standard categories depending upon the amplitude of the disturbance. The Boulder K and estimated A indices determine the category according to the following table:

Condition	Range of A-index	Typical K-indices
Quiet	$0 \le A < 08$	usually no K indices > 2
Unsettled	$08 \le A < 16$	usually no K indices > 3
Active	$16 \le A < 30$	a few K indices of 4
Minor storm	$30 \le A < 50$	K indices mostly 4 and 5
Major storm	$50 \le A < 100$	some K indices 6 or greater
Severe storm	$100 \le A$	some K indices 7 or greater

Solar Flares are classified by their x-ray emission as:

Peak Flux Range (0.1 - 0.8 nm)

Class	mks system (Wm^{-2})	cgs system (erg $cm^{-2}s^{-1}$)
A	$f < 10^{-7}$	$f < 10^{-4}$
B	$10^{-7} \le f < 10^{-6}$	$10^{-4} \le f < 10^{-3}$
C	$10^{-6} \le f < 10^{-5}$	$10^{-3} \le f < 10^{-2}$
M	$10^{-5} \le f < 10^{-4}$	$10^{-2} \le f < 10^{-1}$
X	$10^{-4} \le f$	$10^{-1} \le f$

The letter designates the order of magnitude of the peak value. Following the letter the measured peak value is given. For descriptive purposes, a number from 1.0 to 9.9 is appended to the letter designation. The number acts as a multiplier. For example, a C3.2 event indicates an x-ray burst with peak flux of 3.2×10^{-6} Wm^{-2}.

Forecasts are usually issued only in terms of the broad C, M, and X categories. Since x-ray bursts are observed as a full-sun value, bursts below the x-ray background level are not discernible. The background drops to class A level during solar minimum; only bursts that exceed B1.0 are classified as x-ray events. During solar maximum the background is often at the class M level, and therefore class A, B, or C x-ray bursts cannot be seen. Data are from the NOAA GOES satellites, monitored in real time by the Space Weather Operations (SWO) branch at the Space Environment Center (SEC). Bursts greater than $1.2 \times 10^{-3} Wm^{-2}$ may saturate the GOES detectors. If saturation occurs, estimated peak flux values are reported.

The remainder of the report is as follows:

– MAJOR SOLAR FLARE: a flare which produces some geophysical effect; usually flares that have x-rays ≥ M5 class.
– PROTON FLARE: protons detected by satellite detectors (or polar cap absorption by riometer) have been observed in time association with H-alpha flare
– SATELLITE LEVEL PROTON EVENT: proton enhancement detected by Earth orbiting satellites with measured particle flux of at least 10 protons $cm^{-2}s^{-1}ster^{-1}$ at ≥ 10 MeV.

– SATELLITE LEVEL PROTON EVENT: proton enhancement detected by Earth orbiting satellites with measured particle flux of at least 10 protons $cm^{-2}s^{-1}ster^{-1}$ at $\geq$ 10 MeV.
– POLAR CAP ABSORPTION: proton-induced absorption ≥2 dB during the daytime, 0.5 dB at night, as measured by a 30 MHz riometer located within the polar ice cap.
– STRATWARM: reports of stratospheric warming in the high latitude regions of the winter hemisphere of the earth associated with gross distortions of the normal circulation associated with the winter season.

The Geophysical Alert messages are also available by dialing: (1) 303-497-3235.

Inquiries regarding these messages should be addressed to:

SPACE WEATHER OPERATIONS
NOAA
325 BROADWAY R/E/SE
BOULDER CO 80303-3328

Telephone: (1) 303-497-5127.
Fax: (1) 303-497-3137.

The Space Environment Center (SEC) provides real-time monitoring and forecasting of solar and geophysical events, conducts research in solar-terrestrial physics, and develops techniques for forecasting solar and geophysical disturbances. Information on SEC products and data is internet accessible through the World Wide Web at:
http://www.sel.noaa.gov

PROPAGATION FORECASTS: Users interested in further reading material on the effect of solar and geophysical activity on radio propagation should consult the latest edition of the Amateur Radio Handbook, published by the American Radio Relay League.

MARINE STORM WARNINGS: Weather information about major storms in the Atlantic and eastern North Pacific are broadcast in voice from WWV at 8 through 10 minutes after each hour. Similar storm warnings covering the eastern and central North Pacific are given from WWVH at 48 through 51 minutes after each hour. An additional segment (at 11 minutes after the hour on WWV and at 52 minutes on WWVH) may be used when there are unusually widespread storm conditions. The brief messages are designed to tell mariners of storm threats in their areas. If there are no warnings in the designated areas, the broadcasts will so indicate. The ocean areas involved are those for which the U.S. has warning responsibility under international agreement. The regular times of issue by the National Weather Service are 0500, 1100, 1700, and 2300 UTC for WWV and 0000, 0600, 1200, and 1800 UTC for WWVH. These broadcasts are updated effective with the next scheduled announcement following the time of issue.

Mariners might expect to receive a broadcast similar to the following:

"North Atlantic weather west of 35 West at 1700 UTC: Hurricane Donna, intensifying, 24 North, 60 West, moving northwest, 20 knots, winds 75 knots; storm, 65 North, 35 West, moving east, 10 knots; winds 50 knots, seas 15 feet."

Information regarding these announcements may be obtained from:

METEOROLOGICAL OPERATIONS DIVISION
MARINE FORECAST BRANCH
NATIONAL METEOROLOGICAL CENTER
5200 AUTH ROAD
CAMP SPRINGS MD 20746

or:

MARINE AND APPLIED SCIENCES BRANCH
NATIONAL WEATHER SERVICE
1325 EAST WEST HIGHWAY
SILVER SPRING MD 20910

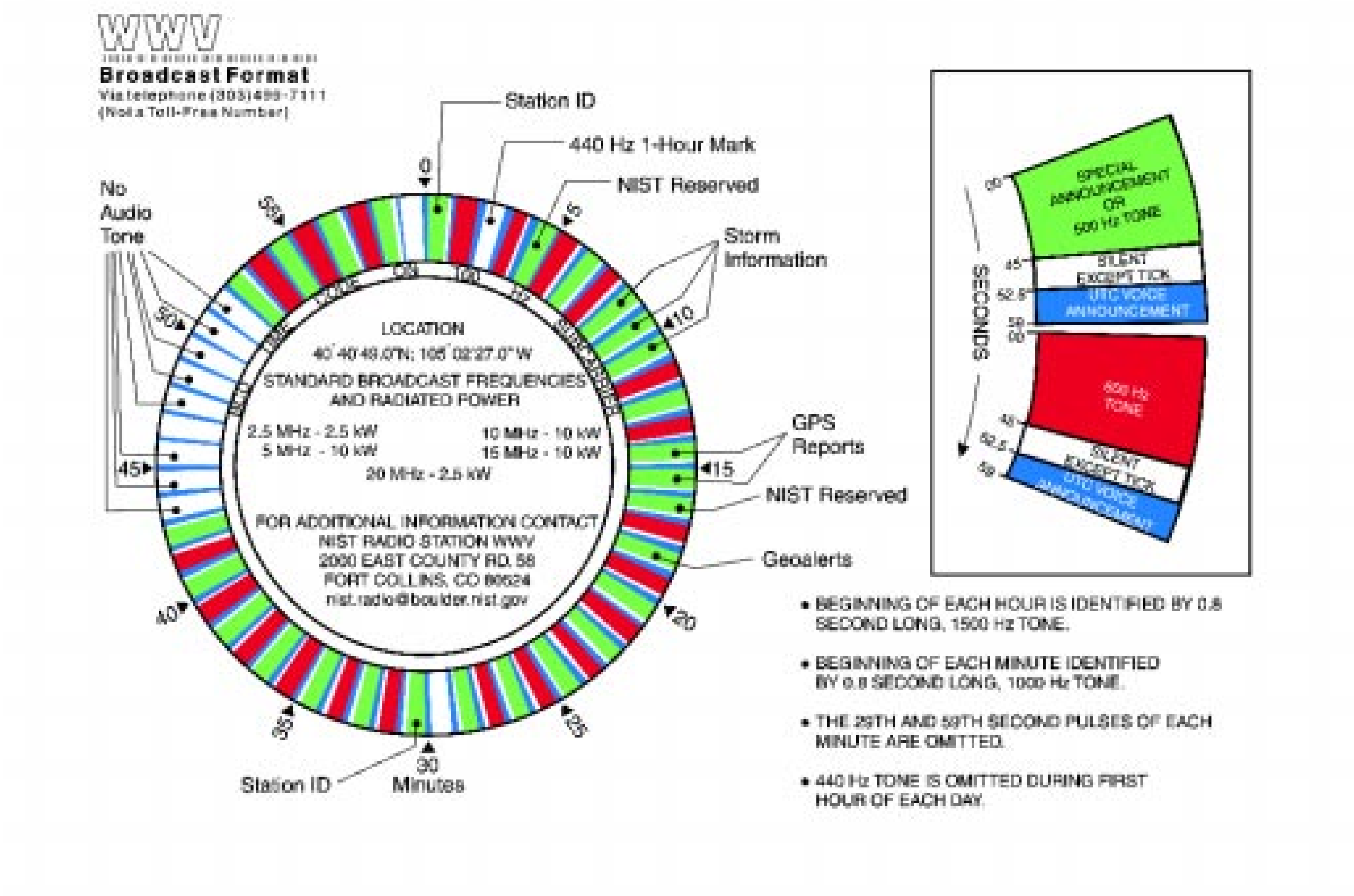
GLOBAL POSITIONING SYSTEM (GPS) STATUS ANNOUNCEMENTS: Since March 1990 the U.S. Coast Guard has sponsored two voice announcements each hour on both WWV and WWVH. These give current information about GPS Satellites and related operations. The announcements are at 14 through 15 minutes after the hour on WWV and at 43 through 44 minutes after the hour on WWVH. For further information contact:

COMMANDING OFFICER
U.S. COAST GUARD NAVIGATION CENTER
7323 TELEGRAPH ROAD
ALEXANDRIA VA 22315-3998

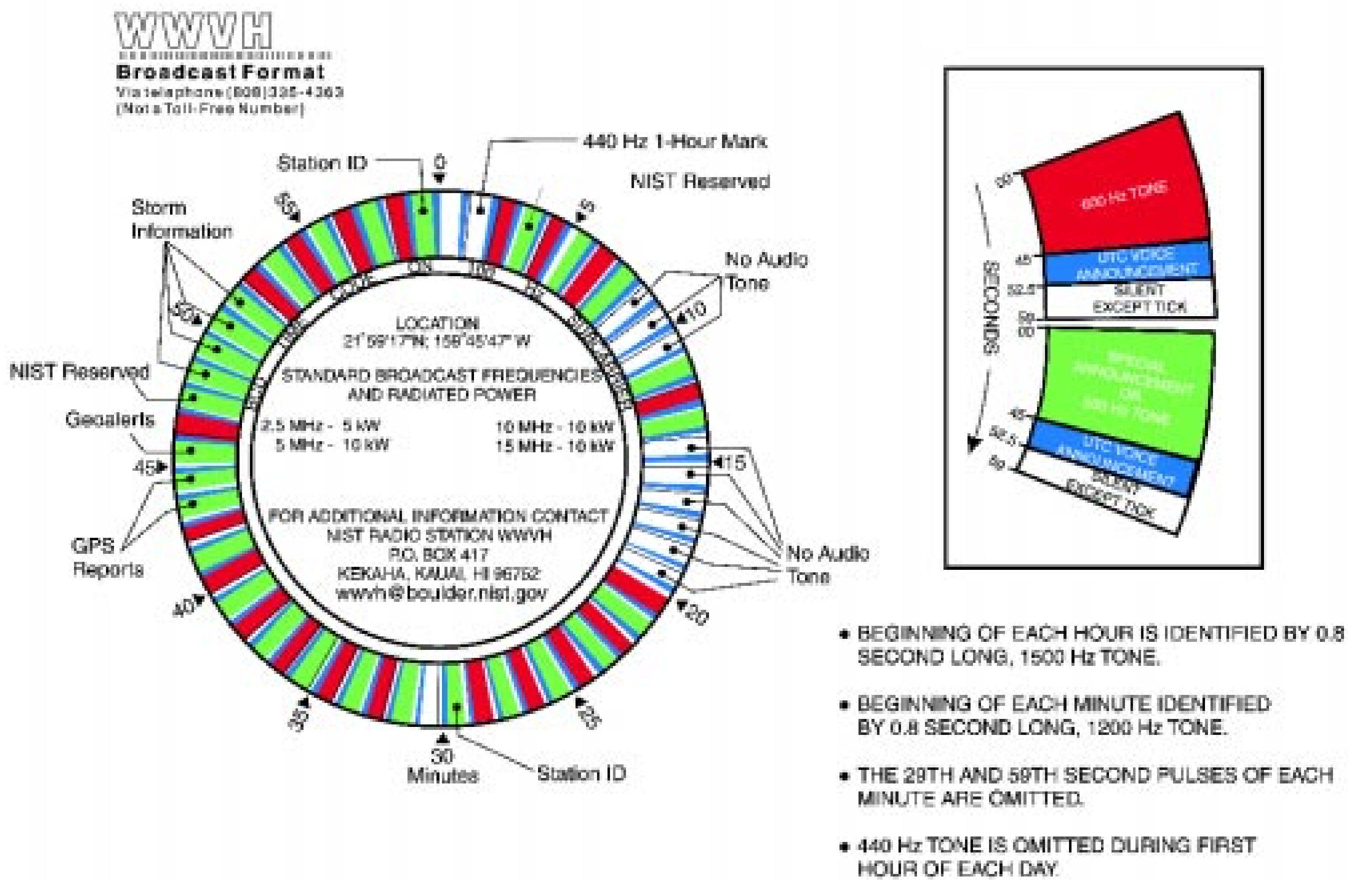
Telephone: (1) 703-313-5900.
Fax: (1) 703-313-5920.

The Navigation Information Service (NIS) is internet accessible through the U.S. Coast Guard Navigation Center Website at:
http://www.navcen.uscg.gov/
http://www.nis-mirror.com (Mirror site)

WWVB: This station (located at 40˚40'28.3"N, 105˚02'39.5"W; radiated power 13 kW) broadcasts on 60 kHz. Its time scale is the same as for WWV and WWVH, and its frequency accuracy and stability as transmitted are the same. Its entire format consists of a 1 pulse per second special binary time code giving minutes, hours, days, the current year (two digits), and the correction between its UTC time scale and UT1 astronomical time. Indicators for daylight saving time, leap seconds, and leap year are also included. Identification of WWVB is made by its unique time code and a 45˚ carrier phase shift which occurs for the period between 10 minutes and 15 minutes after each hour. The useful coverage area of WWVB is within the continental United States. Propagation fluctuations are much less with WWVB than with high frequency reception, permitting frequency comparisons to be made to a few parts in 10^{11}per day.



The hourly broadcast schedules of WWV.



The hourly broadcast schedules of WWVH.

(1) No.	(2) Name	(3) Hours of Transmission	(4) System	(5) Frequency

UNITED STATES

The United States Frequency and Time Standard is maintained by the Time and Frequency Division, National Institute of Standards and Technology, Boulder, CO. Services include time announcements, standard time intervals, standard frequencies, geophysical alerts, marine storm warnings, Global Positioning System (GPS) information, UT1 time corrections and BCD Time Codes.

2000 *2-6735*	**Fort Collins, CO (WWV).**	Continuous.	U.S.	2.5 MHz, A9W, 2.5 kW; 5.0 MHz, A9W, 10.0 kW; 10.0 MHz, A9W, 10.0 kW; 15.0 MHz, A9W, 10.0 kW; 20.0 MHz, A9W, 2.5 kW.
2001 *2-4955*	**Kekaha, Kauai, HI (WWVH).**	Continuous.	U.S.	2.5 MHz, A9W, 5.0 kW; 5.0 MHz, A9W, 10.0 kW; 10.0 MHz, A9W, 10.0 kW; 15.0 MHz, A9W, 10.0 kW.

ANTENNAS MODULATION: At both WWV and WWVH, double sideband amplitude modulation is employed with 50 percent modulation on steady tones, 25 percent for the BCD Time Code, 100 percent for second pulses and 75 percent for voice. The broadcasts on 5, 10 and 15 MHz from WWVH are phased from vertical half-wave dipole arrays. They are designed and oriented to radiate a cardioid pattern directing maximum gain in a westerly direction. The 2.5 MHz antenna at WWVH and all antennas at WWV are half-wave dipoles that radiate omnidirectional patterns.

CANADA

2020 *2-7221*	**Ottawa, Ont. (CHU).**	Continuous.	(See belo	3330 kHz, A2A, H3E, 3 kW; 7335 kHz, A2A, H3E, 10 kW; 14670 kHz, A2A, H3E, 3 kW.

DUT1: Marked seconds indicated by split pulses.
SYSTEM: 00s.: 500ms second marker. From 01s. to 28s.: Second markers of 300ms each. 29s.: Silence. From 30s. to 50s.: Second markers of 300ms each. From 51s. to 59s.: Station identification and time (+5R). At the beginning of the hour the first second marker lasts for 1s. and 500ms markers for seconds 01 to 09 are omitted. A binary time code is included in second markers 31-39.
ANTENNAS: CHU broadcasts from 45-17-47N 75-45-22W using vertical antennas designed to give the best possible coverage for Canadian users.

MEXICO

2040 *2-6720*	**Chapultepec (XDD)(XDP).**	Weekdays: 0155-0200, 1555-1600, 1755-1800; Sun. and holidays: 1755-1800.	U.S.	XDP: 4800 kHz, A1A; XDD: 13043 kHz, A1A.

SYSTEM: From 54m. to 55m.: “VVV DE” station call sign (“XPD” or “XDD”). From 55m. to 60m.: U.S. system, except that the second marker at 28s. is omitted each minute.

2041 *2-6715*	**Tacubaya (XBA).**	Weekdays: 0155-0200, 1555-1600, 1755-1800; Sun. and holidays: 1755-1800.	U.S.	6976.74 kHz, A1A; 13953.6 kHz, A1A.

SYSTEM: From 54m. to 55m.: “VVV DE XBA”. From 55m. to 60m.: U.S. system, except that the second marker at 28s. is omitted each minute.

VENEZUELA

2043 *2-6230*	**Observatorio Naval Caracas (YVTO).**	Continuous.	U.S.	5000 kHz, A9W, 10 kW.

SYSTEM: From 01s. to 29s.: second markers of 100ms each. 30s.: silence. From 31s. to 40s.: second markers of 100ms each. From 40s. to 50s.: station identification, in Spanish. 51s. and 52s.: second markers of 100ms each. From 52s. to 57s.: time announcement, in Spanish. 57s. and 59s.: second markers of 100ms each. 00s.: minute marker of 500ms (800 Hz). Second markers are 1000 Hz tone.

BRAZIL

2050.5 *2-6093*	**Rio de Janeiro (PPEI).**	0025-0030, 1125-1130, 1325-1330, 1925-1930, 2325-2330.	English	8721 kHz, A1A, 2 kW.

DUT1: Marked seconds indicated by double pulse.

ECUADOR

2051 *2-5496*	**Guayaquil (HD210A).**	0000-1200.	(See belo	3810 kHz, A1A, A3E, 1 kW.
		1200-1300.		5000 kHz, A1A, A3E, 1 kW.
		1300-2400.		7600 kHz, A1A, A3E, 1 kW.

SYSTEM: 00s.: minute marker of 300ms. From 01s. to 28s.: second markers of 100ms each. 29s.: silence. From 30s. to 50s.: second markers of 100ms each. From 50s. to 52s.: silence. From 52s. to 58s.: time announcement. 59s.: silence. Call sign transmitted on 3810 kHz, 7600 kHz from 59m.-15s. to 59m.-50s. of each hour. In addition to time signals on 5000 kHz, a 600 Hz tone is transmitted 1200-1215 and a 400 Hz tone is transmitted 1215-1230.

(1) No.	(2) Name	(3) Hours of Transmission	(4) System	(5) Frequency
		ARGENTINA		
2080 *2-5944*	**Buenos Aires (LOL).**	0055-0100, 1255-1300, 2055-2100.	(See belo	4856 kHz, A1A; 8030 kHz, A1A; 17180 kHz, A1A.
		1100-1200, 1400-1500, 1700-1800, 2000-2100, 2300-2400.		5000 kHz, A1A, A2A, A3E, 2 kW; 10000 kHz, A1A, A2A, A3E, 2 kW; 15000 kHz, A1A, A2A, A3E, 2 kW.

A1A-ONLY FREQUENCIES:
DUT1: Marked seconds indicated by double pulse.
SYSTEM: English. The marker at 29s. is omitted each minute.
OTHER FREQUENCIES:
DUT1: Marked seconds indicated by lengthened signal.
SYSTEM: From 01s. to 58s.: second markers of 5ms each. 59s.: silence. 00s.: minute marker of 5ms.
CARRIER MODULATION: From 00m. to 03m., 10m. to 13m., 20m. to 23m., 30m. to 33m., 40m. to 43m., 50m. to 53m.: 1000 Hz tone. From 03m. to 05m., 08m. to 10m., 13m. to 15m., 18m. to 20m., 23m. to 25m., 28m. to 30m., 33m. to 35m., 38m. to 40m., 43m. to 45m., 48m. to 50m., 53m. to 55m., 58m. to 60m.: “LOL” in morse code, station identification and time (+3P) in voice. From 05m. to 08m., 15m. to 18m., 25m. to 28m., 35m. to 38m., 45m. to 48m.: 440 Hz tone.

2081 *2-5945*	**Buenos Aires (LQB)(LQC).**	2200-2205, 2345-2350.	(See belo	LQB9: 8167.5 kHz, A2A, A3E, 10 kW.
		1000-1005, 1145-1150.		LQC20: 17550 kHz, A2A, A3E, 10 kW.

DUT1: Marked seconds indicated by double pulse.
SYSTEM: From 55m. to 00m./40m. to 45m.: “CQCQCQ DE” followed by call sign (“LQB” or “LQC”) repeated three times. From 00m. to 05m./45m. to 50m.: second markers of 300ms each (except omitted on 59s. of each minute); minute markers of 500ms each. After 05m./50m., “OKOKOK” is broadcast if time signals were valid, “NVNVNV” if invalid.

		CZECH REPUBLIC		
2091 *2-1370*	**Liblice (OMA).**	Continuous.	(See belo	50 kHz, A1A, 7 kW.

50 kHz FREQUENCY:
SYSTEM: Carrier interruptions of 100ms each second, 500ms each minute.
TRANSMITTER: Backup transmitter, 0.05kW, used 0600-1200 first Wed. each month.

		BELARUS		
2150 *2-0402*	**Molodechno (RJH69).**	Daylight savings time in effect: 0836-0855, 2136-2155; Daylight savings time not in effect: 0736-0755, 1936-1955.	(See belo	25 kHz, A1A, 300 kW.
		Not transmitted on 2nd, 12th, 22nd of each month.		

SYSTEM: From 36m. to 37m.: call sign. From 37m. to 40m.: carrier. From 40m. to 43m.: sub-second markers of 12.5ms every 25ms. From 43m. to 52m.: sub-second markers of 25ms every 100ms; second markers of 100ms each; 10-second markers of 1s. each; minute markers of 10s. each. From 52m. to 55m.: sub-second markers of 12.5ms every 25ms.

		RUSSIA		
2202 *2-0404*	**Moskva (RWM).**	Continuous.	(See belo	4996 kHz, A1A, 5 kW; 9996 kHz, A1A, 5 kW; 14996 kHz, A1A, 8 kW.

DUT1 AND dUT1: Marked seconds indicated by double pulse with 100ms separation, between 10m.-20m. and 40m.-50m.
SYSTEM: From 00m. to 08m.: carrier. From 08m. to 09m.: silence. From 09m. to 10m.: call sign. From 10m. to 20m.: second markers of 100ms each, minute markers of 500ms each. From 20m. to 30m.: sub-second markers of 20ms every 100ms, second markers of 40ms each, minute markers of 500ms each. From 30m. to 38m.: carrier. From 38m. to 39m.: silence. From 39m. to 40m.: call sign. From 40m. to 50m.: second markers of 100ms each, minute markers of 500ms each. From 50m. to 00m.: sub-second markers of 20ms every 100ms, second markers of 40ms each, minute markers of 500ms each. Markers omitted between 56s. and 59s. at 14m., 19m., 24m., 29m., 44m., 49m., 54m., 59m.
TRANSMITTERS: 4996 kHz off-air 0500-1300 first Wed. each quarter. 9996 kHz off-air 0500-1300 second Wed. each quarter. 14996 kHz off-air 0500-1300 third Wed. every odd month.

2202.5 *2-0406*	**Moskva (RBU).**	January-June: 0252-0313, 0852-0913, 1452-1513, 2052-2113; July-December: 0852-0913, 2052-2113.	(See belo	66.67 kHz, A1A, 10 kW.

DUT1 AND dUT1: Marked seconds indicated by double pulse with 100ms separation, between 00m.-05m.
SYSTEM: From 52m. to 59m.: carrier. From 59m. to 00m.: sub-second markers of 20ms every 100ms, second markers of 40ms, minute markers of 500ms each. From 00m. to 05m.: second markers of 100ms each, minute markers of 500ms each. From 05m. to 06m.: call sign. From 06m. to 13m.: carrier.
TRANSMITTER: Off-air 0500-1300 third Tues. each month.

(1) No.	(2) Name	(3) Hours of Transmission	(4) System	(5) Frequency
2203 *2-0407*	**Gorky (RJH99).**	Daylight savings time in effect: 0736-0755, 1436-1455, 1936-1955; Daylight savings time not in effect: 0536-0555, 1336-1355, 1836-1855.	(See belo	25 kHz, A1A, 300 kW.
		Not transmitted on 8th, 18th, 28th of each month.		

SYSTEM: From 36m. to 37m.: call sign. From 37m. to 40m.: carrier. From 40m. to 43m.: sub-second markers of 12.5ms every 25ms. From 43m. to 52m.: sub-second markers of 25ms every 100ms, second markers of 100ms each, 10-second markers of 1s. each, minute markers of 10s. each. From 52m. to 55m.: sub-second markers of 12.5ms every 25ms.

(1) No.	(2) Name	(3) Hours of Transmission	(4) System	(5) Frequency
2204 *2-0410*	**Novosibirsk (RTA).**	0000-0530, 1400-2400.	(See belo	10000 kHz, A1A, 5 kW.
		0630-1330.		15000 kHz, A1A, 5 kW.
		Transmission times 1 hr. later on both frequencies when daylight savings time in effect.		

DUT1 AND dUT1: Marked seconds indicated by double pulse with 100ms separation, between 00m.-10m. and 30m.-40m.
SYSTEM: From 00m. to 10m.: second markers of 100ms each, minute markers of 500ms each. From 10m. to 20m.: sub-second markers of 20ms every 100ms, second markers of 40ms each, minute markers of 500ms each. From 20m. to 28m.: carrier. From 28m. to 29m.: silence. From 29m. to 30m.: call sign. From 30m. to 40m.: second markers of 100ms each, minute markers of 500ms each. From 40m. to 50m.: sub-second markers of 20ms every 100ms, second markers of 40ms each, minute markers of 500ms each. From 50m. to 58m.: carrier. From 58m. to 59m.: silence. From 59m. to 00m.: call sign. Markers omitted between 56s. and 59s. at 04m., 09m., 14m., 19m., 34m., 39m., 44m., 49m.
TRANSMITTERS: Both frequencies off-air 0000-1000 first and third Thurs. each month.

(1) No.	(2) Name	(3) Hours of Transmission	(4) System	(5) Frequency
2205 *2-0412*	**Irkutsk (RID).**	Continuous.	(See belo	5004 kHz, A1A, 1 kW; 10004 kHz, A1A, 1 kW; 15004 kHz, A1A, 1 kW.

DUT1 AND dUT1: Marked seconds indicated by double pulse with 100ms separation, between 20m.-30m. and 50m.-00m.
SYSTEM: From 00m. to 10m.: sub-second markers of 20ms every 100ms, second markers of 40ms each, minute markers of 500ms each. From 10m. to 18m.: carrier. From 18m. to 19m.: silence. From 19m. to 20m.: call sign. From 20m. to 30m.: second markers of 100ms each, minute markers of 500ms each. From 30m. to 40m.: sub-second markers of 20ms every 100ms, second markers of 40ms each, minute markers of 500ms each. From 40m. to 48m.: carrier. From 48m. to 49m.: silence. From 49m. to 50m.: call sign. From 50m. to 00m.: second markers of 100ms each, minute markers of 500ms each. Markers omitted between 56s. and 59s. at 04m., 09m., 24m., 29m., 34m., 39m., 54m., 59m.
TRANSMITTERS: 5004, 15004 kHz off-air 0000-0800 second Tues. and third Sun. each month. 10004 kHz off-air 0000-0800 third Tues. and third Sun. each month.

(1) No.	(2) Name	(3) Hours of Transmission	(4) System	(5) Frequency
2205.5 *2-0414*	**Irkutsk (RTZ).**	0000-2100, 2200-2400.	(See belo	50 kHz, A1A, 10 kW.

DUT1 AND dUT1: Marked seconds indicated by double pulse with 100ms separation, between 00m.-05m.
SYSTEM: From 00m. to 05m.: second markers of 100ms each, minute markers of 500ms each. From 05m. to 06m.: call sign. From 06m. to 59m.: carrier. From 59m. to 00m.: sub-second markers of 20ms every 100ms, second markers of 40ms each, minute markers of 500ms each.
TRANSMITTER: Transmitter off-air 0000-0800 first, third, fourth Mon. each month.

(1) No.	(2) Name	(3) Hours of Transmission	(4) System	(5) Frequency
2206 *2-3843*	**Khabarovsk (UQC3).**	Daylight savings time in effect: 0236-0255, 0636-0655, 1836-1855; Daylight savings time not in effect: 0036-0055, 0636-0655, 1736-1755.	(See belo	25 kHz, A1A, 300 kW.
		Not transmitted on 10th, 20th, 30th of each month.		

SYSTEM: From 36m. to 37m.: call sign. From 37m. to 40m.: carrier. From 40m. to 43m.: sub-second markers of 12.5ms every 25ms. From 43m. to 52m.: sub-second markers of 25ms every 100ms, second markers of 100ms each, 10-second markers of 1s. each, minute markers of 10s. each. From 52m. to 55m.: sub-second markers of 12.5ms every 25ms.

(1) No.	(2) Name	(3) Hours of Transmission	(4) System	(5) Frequency
2209 *2-3952*	**Arkhangel'sk (RJH77).**	0836-0855, 1136-1155; 1 hr. later when daylight savings time in effect.	(See belo	25 kHz, A1A, 300 kW.
		Not transmitted on 4th, 14th, 24th of each month.		

SYSTEM: From 36m. to 37m.: call sign. From 37m. to 40m.: carrier. From 40m. to 43m.: sub-second markers of 12.5ms every 25ms. From 43m. to 52m.: sub-second markers of 25ms every 100ms, second markers of 100ms each, 10-second markers of 1s. each, minute markers of 10s. each. From 52m. to 55m.: sub-second markers of 12.5ms every 25ms.

KYRGYZSTAN

(1) No.	(2) Name	(3) Hours of Transmission	(4) System	(5) Frequency
2211 *2-0416*	**Frunze (RJH66).**	Daylight savings time in effect: 0536-0555, 1136-1155, 2336-2355; Daylight savings time not in effect: 0436-0455, 0936-0955, 2136-2155.	(See belo	25 kHz, A1A, 300 kW.
		Not transmitted on 6th, 16th, 26th of each month.		

SYSTEM: From 36m. to 37m.: call sign. From 37m. to 40m.: carrier. From 40m. to 43m.: sub-second markers of 12.5ms every 25ms. From 43m. to 52m.: sub-second markers of 25ms every 100ms, second markers of 100ms each, 10-second markers of 1s. each, minute markers of 10s. each. From 52m. to 55m.: sub-second markers of 12.5ms every 25ms.

(1) No.	(2) Name	(3) Hours of Transmission	(4) System	(5) Frequency
		UZBEKISTAN		
2212 *2-0408*	**Tashkent (ULW4).**	0000-0400, 0500-2400.	(See belo	2500 kHz, A1A, 1 kW.
		0000-0400, 1400-2400.		5000 kHz, A1A, 1 kW.
		0500-1330.		10000 kHz, A1A, 1 kW.
		1 hr. later when daylight savings time in effect.		

DUT1 AND dUT1: Marked seconds indicated by double pulses with 100ms separation, between 00m.-10m. and 30m.-40m.
SYSTEM: From 00m. to 10m.: second markers of 100ms each, minute markers of 500ms each. From 10m. to 20m.: sub-second markers of 20ms every 100ms, second markers of 40ms each, minute markers of 500ms each. From 20m. to 28m.: carrier. From 28m. to 29m.: silence. From 29m. to 30m.: call sign. From 30m. to 40m.: second markers of 100ms each, minute markers of 500ms each. From 40m. to 50m.: sub-second markers of 20ms every 100ms, second markers of 40ms each, minute markers of 500ms each. From 50m. to 58m.: carrier. From 58m. to 59m.: silence. From 59m. to 00m.: call sign. Markers between 56s. and 59s. omitted at 04m., 09m., 14m., 19m., 34m., 39m., 44m., 49m.
TRANSMITTERS: All off-air 0100-1100 third Mon. each month.

(1) No.	(2) Name	(3) Hours of Transmission	(4) System	(5) Frequency
		GERMANY		
2320 *2-0250*	**Mainflingen (DCF77).**	Continuous.	(See belo	77.5 kHz, A1A, A3E, 38 kW.

SYSTEM: Carrier interruptions act as second markers. From 00s. to 19s.: second markers of 100ms each. 20s.: second marker of 200ms. From 21s. to 27s.: second markers of 100ms or 200ms each; these markers are used to send binary time code information. 100ms marker—binary 0, 200ms marker—binary 1. 28s.: second marker of 100ms. From 29s. to 34s.: binary second markers of 100ms or 200ms each. 35s.: second marker of 100ms. From 36s. to 57s.: binary second markers of 100ms or 200ms each. 58s.: second marker of 100ms. 59s.: uninterrupted carrier. Station call sign transmitted twice using audio modulation of the carrier at 19m., 39m., 59m.; second markers are not interrupted.
ANTENNAS: When backup antenna is used, marker at 15s. is lengthened.

(1) No.	(2) Name	(3) Hours of Transmission	(4) System	(5) Frequency
		UNITED KINGDOM		
2351 *2-0010*	**Rugby (MSF).**	Continuous.	(See belo	60 kHz, A1A, 27 kW.

SYSTEM: National Physical Laboratory (NPL) Computer Time Service via Modem (NPL Truetime). NPL offers a service which allows a computer to set its clock to within 1/50th of a second by direct telephone connection to the National Time Scale at the NPL in Teddington, Middlesex. A call to the service, at any time of the day or night, allows a computer equipped with a suitable modem and software to correct its clock. The service uses a premium-rate telephone number. For further information contact the Time and Frequency Services, NPL at:
Inquiries telephone.....(011) 44-01819436880
NPL Truetime Telephone.....0891 516333 (UK only)
Fax.....(011) 44-01819436458
E-mail.....time@npl.co.uk
Internet.....http://www.npl.co.uk/npl/ctm/index.html
TRANSMITTER: Transmitter off-air 1000-1400 (1 hr. earlier when daylight savings time is in effect) first Tues. each month.

(1) No.	(2) Name	(3) Hours of Transmission	(4) System	(5) Frequency
2360 *2-0014*	**BBC-Radio 1.**	Mon.-Fri.: 0700, 0800; Sat.: 1300; Sun.: Nil.	(See belo	1053 kHz, A3E, 1-150 kW; 1089 kHz, A3E, 1-150 kW; 97.6-99.8 MHz, F3E (97.1 MHz for Channel Islands).
		1 hr. earlier when daylight savings time in effect.		

SYSTEM: From 59m.-55s. to 59m.-59s.: second markers of 100ms each. 00m.-00s.: minute marker of 500ms.

(1) No.	(2) Name	(3) Hours of Transmission	(4) System	(5) Frequency
2361 *2-0015*	**BBC-Radio 2.**	Mon.-Fri.: 0000, 0700, 0800, 1300, 1700; Sat.: 0000, 0700, 0800; Sun.: 0000, 0800, 0900, 1900.	(See belo	88-90.2 MHz, F3E (89.6 MHz for Channel Islands).
		1 hr. earlier when daylight savings time in effect.		

SYSTEM: From 59m.-55s. to 59m.-59s.: second markers of 100ms each. 00m.-00s.: minute marker of 500ms.

(1) No.	(2) Name	(3) Hours of Transmission	(4) System	(5) Frequency
2362 *2-0016*	**BBC-Radio 3.**	Mon.-Fri.: 0700, 0800; Sat.: 0600, 0700.	(See belo	90.2-92.4 MHz, F3E (91.1 MHz for Channel Islands).
		1 hr. earlier when daylight savings time in effect.		

SYSTEM: From 59m.-55s. to 59m.-59s.: second markers of 100ms each. 00m.-00s.: minute marker of 500ms.

(1) No.	(2) Name	(3) Hours of Transmission	(4) System	(5) Frequency
2363 *2-0020*	**BBC-Radio 4.**	Mon.-Fri.: 0600, 0700, 0800, 0900, 1000, 1100, 1200, 1300, 1400, 1500, 1600, 1700, 1900, 2200; Sat.: 0700, 0800, 0900, 1000, 1100, 1300, 1400, 1600; Sun.: 0600, 0700, 0800, 0900, 1300, 1700, 2100.	(See Belo	198 kHz, A3E, 50-400 kW; Tyneside: 603 kHz, A3E, 2 kW; London: 720 kHz, A3E, 0.5.kW; N. Ireland: 720 kHz, A3E, 0.25-10 kW; Redruth: 756 kHz, A3E, 2 kW; Plymouth: 774 kHz, A3E, 1 kW; Aberdeen: 1449 kHz, A3E, 2 kW; Carlisle: 1485 kHz, A3E, 1 kW; 92.4-94.6 MHz, F3E (94.8 MHz for Channel Islands).
		1 hr. earlier when daylight savings time in effect.		

SYSTEM: From 59m.-55s. to 59m.-59s.: second markers of 100ms each. 00m.-00s.: minute marker of 500ms.

(1) No.	(2) Name	(3) Hours of Transmission	(4) System	(5) Frequency
2370 *2-0022*	**BBC-World Service.**	0000, 0200, 0300, 0400, 0500.	(See belo	198 kHz.
		0000, 0200, 0300, 0600, 0700, 0800, 0900, 1100, 1200, 1300, 1500, 1600, 1700, 1900, 2000, 2200, 2300.		648 kHz.
		0200, 0300, 0600, 2200, 2300.		1296 kHz.
		0400, 0500, 0600.		3955 kHz.
		0200, 0300, 0400, 0500, 0600, 0700, 1500, 1600, 1700, 1800, 1900, 2000, 2200.		6195 kHz.
		0600, 0700, 0800.		7150 kHz.
		0300, 0400.		7230 kHz.
		0000, 0200, 0300, 0700, 0800, 0900, 2000, 2200, 2300.		7325 kHz.
		0200, 0300, 0400, 0500, 0600, 0700, 0800, 0900, 1100, 1200, 1300, 1500, 1600, 1700, 1800, 1900, 2000, 2200, 2300.		9410 kHz.
		0900, 1100, 1200, 1300, 1500.		9750 kHz.
		0700, 0800, 0900, 1100, 1200, 1300, 1500, 1600.		9760 kHz.
		0000, 0200, 0300, 2200, 2300.		9915 kHz.
		0000, 0200, 0300, 0400, 0500, 0600, 0700, 0800, 0900, 1100, 1200, 1300, 1500, 1600, 1700, 1800, 1900, 2000, 2200, 2300.		12095 kHz.
		0000, 0500, 0600, 0700, 0800, 0900, 1100, 1200, 1300, 1500, 1600, 1700, 1800, 1900, 2000, 2200, 2300.		15070 kHz.
		2200, 2300.		15340 kHz.
		0700, 0800, 0900, 1100, 1200, 1300, 1500.		17640 kHz.
		0800, 0900, 1100, 1200, 1300, 1500, 1600.		17705 kHz.

SYSTEM: From 59m.-55s. to 59m.-59s.: second markers of 100ms each. 00m.-00s.: minute marker of 500ms.
NOTE: Not intended for precise use. Direct transmissions from United Kingdom will normally be received within 0.1s. of UTC, but signals from overseas relay stations may have additional errors of up to 0.25s.

FRANCE

(1) No.	(2) Name	(3) Hours of Transmission	(4) System	(5) Frequency
2380 *2-0795*	**France Inter (Allouis) (TDF).**	Continuous, except 0100-0500 each Tues.	(See belo	162 kHz, A3E.

SYSTEM: From 00s. to 20s.: second markers of 100ms each. From 21s. to 58s.: time and date announcement. 59s.: emphasized second marker of 100ms. Other second markers are emphasized to indicate the following: 13s. - the day preceding a holiday; 14s. - holiday; 17s. - local time is -2B; 18s. - local time is -1A.

SWITZERLAND

(1) No.	(2) Name	(3) Hours of Transmission	(4) System	(5) Frequency
2400 *2-1155*	**Prangins (HBG).**	Continuous in the absence of telegraph traffic.	(See belo	75 kHz, A1A, 20 kW.

SYSTEM: Carrier interruptions act as markers. From 01s. to 59s.: second markers of 100ms each. 00s.: minute marker of double pulse, 100ms each. 00m.-00s.: hour marker of triple pulse, 100ms each. 12h./24h.-00m.-00s.: 12-hour marker of quadruple pulse, 100ms each.

(1) No.	(2) Name	(3) Hours of Transmission	(4) System	(5) Frequency
		ITALY		
2410 *2-1256*	**Roma (IAM).**	Mon.-Sat.: 0730-0830, 1030-1130.	(See belo	5000 kHz, A2A, A3E, 1 kW.
		1 hr. earlier when daylight savings time in effect.		

DUT1: Marked seconds indicated by double pulse.
SYSTEM: From 01s. to 59s.: second markers of 5ms each. 00s.: minute marker of 20ms. At 00m., 15m., 30m., 45m.: station identification in morse code and Italian. At 05m., 20m., 35m., 50m.: “IAM IAM IAM”, time in morse code.

2411 *2-1335*	**Torino (IBF).**	0545-0600, 0645-0700, 0845-0900, 0945-1000, 1045-1100, 1145-1200, 1245-1300, 1345-1400, 1445-1500, 1545-1600, 1645-1700.	(See belo	5000 kHz, A2A, A3E, 5 kW.
		1 hr. earlier when daylight savings time in effect.		

DUT1: Marked second indicated by double pulse.
SYSTEM: 45m.: station identification. From 45m. to 00m.: second markers of 5ms each, minute markers of septuple pulses of 5ms each. 50m.: “IBF IBF IBF”, time (-1A) in morse code. 00m.: “IBF IBF IBF”, time (-1A) in morse code, station identification.

		CHILE		
2445 *2-5610*	**Valparaiso Playa Ancha Radiomaritima (CBV).**	0855-0900, 1255-1300, 1655-1700, 2155-2200.	U.S.	4228 kHz, A2A; 8677 kHz, A2A.
		PERU		
2461 *2-5539*	**Peru National Radio.**	0300, 1300, 1700, 2300.	U.S.	609.5 kHz, A3E; 850 kHz, A3E; 103.9 MHz, F3E.

SYSTEM: The hour marker of 1s. commences at 59m.-59s.

2462 *2-5550*	**Radio Victoria.**	0300, 1300, 1700, 2300.	U.S.	780 kHz, J3E.

SYSTEM: The hour marker of 1s. commences at 59m.-59s.

		INDIA		
2475 *2-3070*	**Calcutta (VWC).**	0825-0830, 1625-1630.	ONOGO	434 kHz, A1A, 0.35 kW.
		1625-1630.		4286 kHz, A1A, 2.5 kW.
		0825-0830.		12745.5 kHz, A1A, 2.5 kW.

SYSTEM: From 25m. to 27m.: “CT CQ CQ CQ DE VWC VWC VWC AT”. From 27m. to 30m.: ONOGO time signals. Incorrectly sent signals are followed by the error signal (“E E E E E E E E”) and the message “signals failed”.

2476 *2-3077*	**New Delhi (ATA).**	1230-0330.	(See belo	5000 kHz, A1A, 8 kW.
		Continuous.		10000 kHz, A1A, A3E, 8 kW.
		0330-1230.		15000 kHz, A1A, 8 kW.

SYSTEM: 00m.: call sign and time in morse code. From 00m. to 04m.: second markers of 5ms 1000 Hz modulation each, minute markers of 100ms 1000 Hz modulation each. From 04m. to 15m.: second markers of 5ms each, minute markers of 100ms each. 15m.: call sign and time in morse code. From 15m. to 19m.: second markers of 5ms 1000 Hz each, minute markers of 100ms 1000 Hz each. From 19m. to 30m.: second markers of 5ms each, minute markers of 100ms each. 30m.: call sign and time in morse code. From 30m. to 34m.: second markers of 5ms 1000 Hz each, minute markers of 100ms 1000 Hz each. From 34m. to 45m.: second markers of 5ms each, minute markers of 100ms each. 45m.: call sign and time in morse code. From 45m. to 49m.: second pulses of 5ms 1000 Hz each, minute markers of 100ms 1000 Hz each. From 49m. to 00m.: second markers of 5ms each, minute markers of 100ms each. All time signals are sent 50ms in advance of UTC.

		SRI LANKA		
2480 *2-3110*	**Colombo (4PB).**	0555-0600, 1325-1330.	English	482 kHz, A2A, 1 kW; 8473 kHz, A1A, 2.5 kW.

SYSTEM: From 53m./23m. to 55m./25m.: “CQ DE 4PB TIME SIGNALS AS”. From 55m./25m. to 00m./30m.: second markers of 100ms each, minute markers of 400ms each.

(1) No.	(2) Name	(3) Hours of Transmission	(4) System	(5) Frequency
		CHINA		
2485.1 *2-3395*	**Shanghai (XSG).**	0256-0856.	(See belo	458 kHz, A1A, A2A; 4290 kHz, A1A; 6414.5 kHz, A1A; 6454 kHz, A1A; 8487 kHz, A1A; 8502 kHz, A1A; 12871.5 kHz, A1A; 12954 kHz, A1A; 17002.4 kHZ, A1A.
	SYSTEM: From 59m.-55s. to 59m.-59s.: second markers of 100ms each. 00m.-00s.: minute marker of 100ms.			
2490 *2-3355*	**Xian (BPM).**	0730-0100.	(See belo	2500 kHz, A1A, A3E.
		Continuous.		5000 kHz, A1A, A3E.
		Continuous.		10000 kHz, A1A, A3E.
		0100-0900.		15000 kHz, A1A, A3E.
	SYSTEM: From 00m. to 10m.: UTC second markers of 10ms each, UTC minute markers of 300ms each. From 10m. to 15m.: carrier. From 15m. to 25m.: UTC second markers of 10ms each, UTC minute markers of 300ms each. From 25m. to 29m.: UT1 second markers of 100ms each, UT1 minute markers of 300ms each. From 29m.-00s. to 29m.-40s.: “BPM” in morse code. From 29m.-40s. to 30m.-00s.: “BPM” and other station identification in Chinese. From 30m. to 40m.: UTC second markers of 10ms each, UTC minute markers of 300ms each. From 40m. to 45m.: carrier. From 45m. to 55m.: UTC second markers of 10ms each, UTC minute markers of 300ms each. From 55m. to 59m.: UT1 second markers of 100ms each, UT1 minute markers of 300ms each. From 59m.-00s. to 59m.-40s.: “BPM” in morse code. From 59m.-40s. to 00m.-00s.: “BPM” and other station identification in Chinese. All UTC signals are broadcast 20ms in advance of UTC.			
		JAPAN		
2500 *2-3788*	**Sanwa (JG2AS).**	Continuous in the absence of telegraph traffic.	(See belo	40 kHz, A1A, 10 kW.
	SYSTEM: From 00m.-01s. to 00m.-58s.: second markers of 500ms each. 00m.-59s.: second marker of 200ms. 01m.-00s.: minute marker of 500ms. At 15m. and 45m.: “JG2AS JG2AS JG2AS” in morse code.			
2501 *2-3787*	**Sanwa (JJY).**	Continuous.	(See belo	2500 kHz, A9W, 2 kW; 5000 kHz, A9W, 2 kW; 8000 kHz, A9W, 2 kW; 10000 kHz, A9W, 2 kW; 15000 kHz, A9W, 2 kW.
	DUT1: Marked seconds indicated by 45ms pulses. SYSTEM: Second markers of 5ms 1600 Hz tone each are used. The second marker indicating the minute is preceded by an annunciatory marker: from 59.000s. to 59.005s. a second marker of 5ms 1600 Hz tone; from 59.005s. to 59.045s. silence; from 59.045s. to 59.700s. annunciatory marker of 655ms 600 Hz; from 59.700s. to 00.000s. silence; from 00.000s. to 00.005s. a second marker of 5ms 1600 Hz. The carrier is modulated by a 1000 Hz tone as well as the second markers during alternating 5m. periods. From 00m. to 05m.: second markers and 1000 Hz tone. From 05m. to 09m.: second markers only. From 09m. to 10m.: second markers; “JJY JJY” and time (-9I) in morse code and then in voice; radio propagation warnings in morse code: “N” - normal, “U” - unstable, “W” - disturbed. This 10m. cycle is repeated throughout each hour except for 35m. to 39m., which is a silent period.			
		REPUBLIC OF KOREA		
2505 *2-3507*	**Taedok (HLA).**	Mon.-Fri.: 0100-0800.	(See belo	5000 kHz.
	DUT1: Marked seconds indicated by double pulse. SYSTEM: 00s.: minute marker of 500ms 1800 Hz tone. From 01s. to 28s.: second markers of 5ms 1800 Hz tone each. 29s.: silence. From 30s. to 52s.: second markers of 5ms 1800 Hz tone each. From 53s. to 58s.: time announcement by voice. 59s.: silence. 00m.: hour marker of 500ms 1500 Hz tone. A binary time code is transmitted continuously on a 100 kHz subcarrier.			
		PHILIPPINES		
2530 *2-4020*	**Manila (DUW21).**	Every even hour +55m. to +60m.	U.S.	3650 kHz, A1A, 0.5 kW.

(1) No.	(2) Name	(3) Hours of Transmission	(4) System	(5) Frequency
		AUSTRALIA		
2600	**Radio Australia.** *2-4497*	0700, 0800, 0900, 1000, 1100, 1200.	(See belo	6020 kHz.
		1500, 1700, 1800, 1900, 2000.		6060 kHz.
		0700, 0800, 0900, 1000, 1100, 1200, 1500, 1700, 1800, 1900, 2000.		6080 kHz.
		0900, 1000, 1100, 1200, 1300, 1400, 1500, 1600, 1700, 1800, 1900, 2000.		7240 kHz.
		1500, 1600, 1700, 1800, 1900, 2000.		7260 kHz.
		0900, 1000, 1100.		9510 kHz.
		0900, 1000, 1100, 1200, 1300, 1400, 1500, 1600, 1700, 1800, 1900, 2000.		9580 kHz.
		2100, 2200.		9645 kHz.
		0700, 0800, 0900, 1000, 1100, 1200.		9710 kHz.
		1500, 1600.		9770 kHz.
		1500, 1600, 1700, 1800, 1900, 2000.		11660 kHz.
		1500, 1600, 1700, 1800, 1900, 2000.		11695 kHz.
		0000, 0100, 0200, 0300, 0700, 0800, 0900, 1000, 1100, 1900, 2000, 2100, 2200, 2300.		11720 kHz.
		1300, 1400, 1500.		11800 kHz.
		2100, 2200.		11855 kHz.
		0000, 0100, 0200, 0300, 0700, 0800, 1700, 1800, 1900, 2000, 2200, 2300.		11880 kHz.
		0700, 0800.		11910 kHz.
		0000, 0900, 1000, 1100.		13605 kHz.
		1300, 1400.		13755 kHz.
		0900, 1000, 1100.		15170 kHz.
		0000, 0100, 0200, 0300, 2300.		15240 kHz.
		0000, 0100, 0200, 0300, 2100, 2200, 2300.		15320 kHz.
		0000, 0700, 0800, 2100, 2200, 2300.		15365 kHz.
		0100, 0200, 0300.		15510 kHz.
		1200.		15530 kHz.
		1200.		15565 kHz.
		0700, 0800.		17695 kHz.
		0100, 0200, 0300.		17715 kHz.
		0000, 0100, 0200, 0300, 0700, 0800.		17750 kHz.
		0000, 2200, 2300.		17795 kHz.
		0000, 0100, 0200, 0300.		17880 kHz.
		0700, 0800.		21525 kHz.
		0100, 0200, 0300, 0700, 0800.		21595 kHz.
		0900, 1000, 1100.		21725 kHz.
		0000, 0400, 0500, 0600, 2200, 2300.		21740 kHz.

SYSTEM: From 59m.-55s. to 59m.-59s.: second markers of 100ms each. 00m.-00s.: minute marker of 500ms. In addition a warning signal consisting of a single dot is transmitted 5s. before the first series of six dots (at ten seconds before the hour).

(1) No.	(2) Name	(3) Hours of Transmission	(4) System	(5) Frequency
2601 *2-4553*	**Llandilo, Penrith (VNG).**	Continuous.	(See belo	2500 kHz, H9W, 1 kW; 5000 kHz, B9W, 10 kW; 8638 kHz, A1A, 10 kW; 12984 kHz, A1A, 10 kW.
		2200-1000.		16000 kHz, B9W, 5 kW.

DUT1: Marked seconds indicated by a double pulse.
SYSTEM: 00s.: minute marker of 500ms. From 01s. to 16s.: second markers of 50ms each, lengthened (as necessary) by 50ms of 900 Hz tone to indicate the current value of DUT1. From 17s. to 19s.: second markers of 50ms each. 20s.: second marker of 200ms. From 21s. to 46s.: second markers of 100ms or 200ms each, indicating the time of day and the day of the year in machine readable CCIR code. From 47s. to 49s.: second markers of 50ms each. From 50s. to 54s.: second markers of 5ms each. From 55s. to 58s.: second markers of 50ms each. 59s.: silent. Every 5th minute from 50s. to 58s.: second markers of 5ms each. Second markers of 1000 Hz tone are used. On frequencies 2500, 5000 and 16000 kHz from 01s. to 03s. of each minute a female voice announces the time of day of the preceding minute marker. On frequencies 2500, 5000 and 16000 kHz from 21s. to 49s. on every 15th minute a male voice announces the details of the service. On frequencies 8638 and 12984 kHz for one minute following 14m.-00s., 29m.-00s., 44m.-00s. and 59m.-00s. the call sign VNG (which may be distorted) is transmitted in slow morse at an audio tone of about 400 Hz.

INDONESIA

(1) No.	(2) Name	(3) Hours of Transmission	(4) System	(5) Frequency
2633 *2-4260*	**Jakarta (PKI)(PLC).**	0055-0100.	Modified	PKI: 8542 kHz, A1A, 1-3 kW; PLC: 11440 kHz, A1A.

TAIWAN

(1) No.	(2) Name	(3) Hours of Transmission	(4) System	(5) Frequency
2635 *2-3348*	**Chung-Li (BSF).**	Continuous.	(See belo	5000 kHz, A1A, A2A; 15000 kHz, A1A, A2A.

DUT1: Marked seconds indicated by lengthened pulse.
SYSTEM: Second markers of 5ms each and minute markers of 300ms each are used. A 1000 Hz tone is transmitted constantly except from 40ms before to 40ms after each marker during alternating 5m. periods. From 00m. to 05m.: markers with 1000 Hz tone. From 05m. to 10m.: markers without the 1000 Hz tone. This 10m. cycle is repeated throughout the hour except for 35m. to 40m., which is a silent period.