U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
CENTRAL RADIO PROPAGATION LABORATORY
WASHINGTON 25, D. C.

Letter
Circular
LC875

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TECHNICAL RADIO BROADCAST SERVICES,

RADIO STATION WWV

The technical radio services broadcast continuously by the National Bureau of Standards, Central Radio Propagation Laboratory, include a total of eight radio frequencies, 2.5, 5, 10, 15, 20, 25, 30 and 35 Mc. Seven or more transmitters are on the air at all times, day and night. This insures reliable coverage of the United States and extensive coverage of other parts of the world.

The services are: (1) standard radio frequencies, (2) time announcements, (3) standard time intervals, (4) standard audio frequencies, (5) standard musical pitch, 440 cycles per second, corresponding to A above middle C, (6) radio propagation disturbance warning notices. All of the frequencies are useful for field intensity recording by persons interested in studies of radio propagation. The three highest frequencies are broadcast particularly for this purpose. The radio frequencies and other data are given on the front and inside cover of this announcement. Vertical non-directional antennas are used.

For information on quality of reception as influenced by distance, carrier frequency, time of day, etc., see part 7 of this announcement.

The Bureau welcomes reports on reception, methods of use, or special applications of the service, particularly with reference to the higher frequencies which have been recently added. Correspondence should be addressed Central Radio Propagation Laboratory, National Bureau of Standards, Washington 25, D. C.

1. Standard Radio Frequency

The national standard of frequency is of value in radio, electronic, acoustic, and other measurements requiring an accurate frequency. Any desired radio frequency, including microwave frequencies, may be accurately measured in terms of the standard frequencies. This may be done by the aid of one or more auxiliary oscillators, harmonic generators, and radio receivers. The accuracy of each of the radio carrier frequencies, as transmitted, is better than a part in 50,000,000. However, if received accuracies of this order are required it is necessary to make measurements over a long interval or apply corrections for errors introduced by transmission effects in the medium (Doppler effect, etc.).

2. Time Announcements

The audio frequencies are interrupted precisely on the hour and each five minutes thereafter; following an interval of precisely one minute they are resumed.

The beginnings of the periods, when the audio frequencies are interrupted, are in agreement with the basic time service of the U. S. Naval Observatory so that they mark accurately the hour and the successive 5-minute periods.

Eastern standard time is announced in telegraphic code each five minutes. This provides a quick reference to correct time where a timepiece may be in error by a few minutes. The zero- to twenty-four-hour system is used starting with 0000 at midnight. The first two figures give the hour and the last two figures give the number of minutes past the hour. For example, at 4:55 PM, or 1655 EST, four figures (1, 6, 5, and 5) are broadcast in code. The code used (International Morse) is given on the inside cover of this announcement. The time announcement refers to the start of an announcement interval, i.e., when the audio frequencies are interrupted. It occurs immediately after the beginning of each five-minute interval. At the hour and half-hour it is followed by the station announcement in voice.

3. Standard Time Intervals

There is on each carrier frequency a pulse of 0.005-second duration which occurs at intervals of precisely one second. The pulse consists of five cycles, each of 0.001-second duration, and is heard as a faint tick when listening to the broadcast; it provides a useful standard time interval, for purposes of physical measurements, and for quick and accurate measurement or calibration of timing devices or very low frequency oscillators. It may be used as an accurate time signal. On the 59th second of every minute the pulse is omitted. The 1-minute, 4-minute, and 5-minute intervals, synchronized with the seconds pulses, are marked by the beginning or ending of the periods when the audio frequencies are off.

A time interval of one second marked by the pulse is accurate, as transmitted, to one microsecond (= 0.000 001 second). A one-minute or longer interval is accurate to a part in 50,000,000.

The one-minute interval without tone modulation is provided in order to give time and station announcements and to afford an interval for the checking of radio-frequency measurements free from the presence of the audio frequencies.

4. Standard Audio Frequencies

Two standard audio frequencies, 440 cycles per second and 4000 cycles per second, are broadcast on radio carrier frequencies as given on the front page.

The two standard audio frequencies are useful for accurate measurement or calibration of instruments operating in the audio or supersonic regions of the frequency spectrum. They may also be used for accurate measurement of short time intervals.

The accuracy of the audio frequencies, as transmitted, is better than a part in 50,000,000. Transmission effects in the medium (Doppler effect, etc.) may result at times in slight fluctuations in the audio frequencies as received; the average frequency received is, however, of the same order of accuracy as that transmitted.

5. Standard Musical Pitch

The 440 cycles per second is the standard musical pitch, A above middle C. It is broadcast for four minutes and interrupted for one minute. This sequence is repeated continuously on each of the radio carrier frequencies. This service is useful to musicians and those concerned with the manufacture or maintenance of musical instruments. For the past 22 years the standard in the music industry of the U. S. has been 440 c/s.

6. Radio Propagation Disturbance Warning Notice

A warning of radio propagation conditions is broadcast in code on each of the standard radio carrier frequencies at twenty and fifty minutes past the hour. If a warning is in effect, a series of "W's" (in the telegraphic code) follow the time announcement; if no warning is in effect, a series of "N's" (in telegraphic code) follow the time announcement.

A warning (W) means that radio propagation disturbance of the ionospheric storm type is anticipated within 12 hours, or is in progress, with its most severe effects on radio transmission paths crossing the North Atlantic; i.e., those paths for which the control points of transmission lie in or near the northern auroral zone. This type of radio propagation disturbance is characterized by low intensities, accompanied by flutter or rapid fading on the normal frequencies used at the different times of the day, or by complete blackout of signals. By shifting to lower than normal frequencies for that time of day it may be possible to get signals through, although with lower than normal intensity. Owing to increased auroral-zone absorption during the disturbance, however, it may be impossible to have usable transmission on any high frequency. Also, during a period of radio propagation disturbance, direction-finder observations may be unreliable. Sudden ionospheric disturbances (SID) characterized by simultaneous fadeouts in the entire high frequency spectrum, on paths in the daylight side of the world, are not covered by this warning.

If no warning (N) is in effect, satisfactory transmission should be possible on the normal frequencies for the different times of day.

The usual daily time for changing the announced warning is 2100 GMT (4 PM, EST). The warning is, however, issued at any hour when disturbance becomes noticeable or anticipated. The announcement is returned to normal whenever conditions seem quiet. Thus any time a radio operator questions

reception on North Atlantic paths, it would be advisable to check with the WWV announcement to see whether conditions are considered by the Bureau sufficiently disturbed to make a warning desirable.

Some one of the frequencies of WWV should be receivable at every location in the United States. Only during very severe storms would reception of WWV within the continental United States be difficult. For some Canadian or other users for whom the transmission path from WWV enter into or near the northern auroral zone, it may be impossible to receive any of the WWV frequencies at usable intensities during even moderate storms. It is probable, if no WWV frequency can be heard at hours when normally audible, that a warning is in effect.

The use of WWV for issuing the Bureau's North Atlantic radio disturbance warning makes the service available to all users of high-frequency receivers. The service should be of use in explaining or anticipating radio propagation conditions existing over North Atlantic paths in particular, and even on paths within the continental United States during severe radio propagation disturbances.

The radio disturbance warning does not apply to sudden ionosphere disturbances, which are unpredictable. These occur only at times when at least part of the transmission path is in sunlight. This type of disturbance is characterized by the received intensity dropping to zero, very rapidly, usually within a minute or so, and remaining out from a few minutes to two hours. The effect is greater on the lower high frequencies, and on paths close to the equator or whose control points are close to noon. Usually the only transmission possible during a sudden ionosphere disturbance is by VLF or by ground waves over short paths. The use of the highest frequency available, as long as it is below the maximum usable frequency for the path in question, may shorten the duration of the fadeout. During the present years of great solar activity these sudden ionosphere disturbances will occur more frequently than in the past few years. They are caused by eruptions on the sun, more of which are observed during the years around sunspot maximum.

7. Distance Range of Reception

Of the radio frequencies on the air at a given time, the lowest provides service to short distances, and the highest to great distances. Reliable reception is in general possible at all times throughout the United States and the North Atlantic Ocean, and reception at times throughout the world. One should select the frequency that gives best reception at any particular place and time. This can be done by two methods:

a. By tuning to the different frequencies and selecting the one most suitable at that time. For night-time conditions over the propagation path, lower frequencies than those used during the day are usually necessary because of skip, but received intensities on those frequencies are much greater than for daytime conditions.

b. By making use of techniques of prediction of usable frequencies.

Although there are a great number of variables affecting radio wave propagation and distance range, techniques exist for the prediction of usable frequencies over any specific path during any future month. By means of such techniques and the Central Radio Propagation Laboratory's forecast service, it is possible for a user to prepare for his locality a graph or table showing the best frequency for any period of the day in any month, three months in advance. Monthly publications giving these techniques and forecasts may be obtained by writing to Central Radio Propagation Laboratory, National Bureau of Standards, Washington 25, D. C. The most useful for this purpose are the reports of the CRPL-D series, "Basic Radio Propagation Predictions," which are issued monthly, three months in advance of the month of prediction, and Circular 465 of the National Bureau of Standards, "Instructions for the Use of Basic Radio Propagation Predictions." These two publications may be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

For continuous 24-hour reception without a break, the use of more than one receiver and antenna is necessary. With skilled operators to anticipate times for frequency shifting and with schedules prepared as under (b) above as a guide, it may in some cases be possible to operate continuously with two receivers. For maximum certainty of reception it is necessary to employ as many receivers as there are satisfactorily receivable WWV frequencies at the location, leaving them all in operation continuously and combining their outputs. A separate and directive antenna for each radio receiver is desirable.

The world map on the cover sheet is a modified reproduction of a larger map supplied by the Navy Department, Hydrographic Office. It gives directly azimuths and great circle distances from station WWV to all points on the earth's surface.