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ELECTRICAL AND MECHANICAL ENGINEERING REGULATIONS
(By Command of the Army Council)

TELECOMMUNICATIONS
A 345

STANDARD FREQUENCY TRANSMISSIONS

Note: This issue, Pages 1 and 2, 1001 to 1004 supersedes Page 1 of Issue 1, dated 1 Oct.1951. It has been revised throughout.

INTRODUCTION

1. Standard frequency transmissions having an accuracy of 2 in 10^8 are broadcast from America and have now commenced on 26th May, 1953 from Great Britain. This is part of an international programme designed to give reliable world coverage on one or other of the frequencies that have been allocated to standard frequency services.

2. These transmissions should be used as the ultimate check of the frequency calibration of wavemeters and wireless sets.

3. The MSF service of transmissions is still experimental and reports on reception onditions should be submitted through the normal channels.

DETAILS OF TRANSMISSIONS

4. Full details of the new standard frequency transmissions from the United Kingdom are given in Page 1001 to 1004. These are re-published by courtesy of the Director, National Physical Laboratory.

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5. Although the American WWV transmissions are not received in all parts of the world at all times, they are still being continued. Continuous transmissions on 2.5, 5, 10, 20 and 25Mc/s with a carrier power of 10kW are broadcast from Station WWV (Washington).

6. Transmissions on 5, 10 and 15Mc/s with a carrier power of 0.4kW are broadcast from Station WWVH (Hawaii) for 22 hours per day.

7. The transmissions from WWV and WWVH are modulated alternately with 600 and 400c/s tones for each five-minute period following the hour. During the last minute of the hour morse and speech announcements are given.

NATIONAL PHYSICAL LABORATORY

STANDARD FREQUENCY TRANSMISSIONS FROM THE UNITED KINGDOM

INTRODUCTION

Standards of frequency and time differ from the other standards of measurement in that they can be made available continuously over wide areas by means of radio transmissions. The frequencies of 2.5, 5, 10, 15, 20, 25Mc/s have, by international agreement, been allocated to this purpose and a continuous service on all of these frequencies is in operation from station WWV of the National Bureau of Standards situated near Washington D.C.

Such transmissions enable the user to standardize his equipment without having to install and maintain costly and elaborate equipment, but to be fully effective they must be received in all parts of the world at all times. The WWV transmissions do not meet this requirement, and experiments on an international scale are therefore being conducted under the general direction of the International Radio Consultative Committee in order to discover the best means of securing world-wide coverage.

TRANSMISSIONS FROM THE UNITED KINGDOM

As the United Kingdom's contribution to this programme, transmissions, each of 31 minutes duration, on 5 and 10Mc/s have been made daily since February, 1950, from the Post Office station at Rugby, under the call sign MSF. Numerous reception reports have been received and have helped in the planning of the second stage of this experiment which will be inaugurated on the 26th May, 1953. The transmission period will then be extended to 24 hours per day and the power will be reduced from 10kW to 0.5kW. The transmissions will be interrupted during the interval between 15 and 20 minutes past each hour to enable one station alone to be measured under those conditions in which two stations such as MSF and WWV are being received at nearly equal strengths. The break in transmission will also permit radio noise measurements to be made if no other transmission is present.

Transmissions will be made initially on 2.5, 5 and 10Mc/s: later, 15 and 20Mc/s may be used but only three frequencies will be broadcast simultaneously. The carriers will be modulated in accordance with the following 60 minute schedule:

Minute past each hour				Modulation
0 - 5		30 - 35	45 - 50	1000 c/s
5 - 10	20 - 25	35 - 40	50 - 55	1 c/s pulses, the 59th pulse in each minute being omitted
10 - 14	25 - 29	40 - 44	55 - 59	unmodulated
14 - 15	29 - 30	44 - 45	59 - 60	speech announcement

The schedule is given in diagrammatic form in Fig 1001

ACCURACY OF THE TRANSMISSIONS

The carrier and modulation frequencies are all derived from the same 100kc/s standard and are maintained with $\pm$ 2 parts in 10^8 of their nominal values. The frequency of the received signal may vary throughout the day, however, if there are ionospheric reflexions in the transmission path. This frequency error is due to the movement of the reflecting layers; it seldom exceeds $\pm$ 2 parts in 10^7 and for a large part of the day is not more than a few parts in 10^8. The transmitted

frequencies do not, in general, vary from day to day by more than ± 2 parts in 10^9.

UNIFORM TIME - A NEW TIME SCALE

The frequencies and therefore the time intervals marked by the seconds pulses are measured on what may be called an estimated uniform time scale.

There is evidence that the length of the day varies by about 1 millisecond in a periodic manner in the course of the year, partly due to a variation in the position of the earth's poles and partly due to a variation in the rate of rotation of the earth on its axis. For precise physical measurements such as the checking of the long term stability of a quartz standard it is desirable to remove this fluctuation. The extent of the fluctuation is estimated at the Royal Greenwich Observatory and is applied as a correction in setting the frequency of the standard controlling the transmissions.

Frequencies measured on the uniform and the astronomical time scales do not differ by more than 1.5 parts in 10^8, and the maximum difference in time on the two scales is about 60 milliseconds. The difference is therefore of significance only for the most precise measurements.

SPECIAL EXPERIMENTAL TRANSMISSION ON 60 KC/S

The frequencies allocated to standard transmissions are not the most suitable for use within the United Kingdom. A lower frequency has some advantages because the ground wave is then received and errors due to the Doppler changes at the reflecting layers are avoided. A special transmission at a frequency of 60kc/s and a power of 10kW is therefore made for use in the United Kingdom. The transmitter used for this purpose is a standby transmitter for a communication channel and is not always available for standard frequency transmissions. Experience has shown that a reliable service can be maintained if the transmissions are restricted to one hour per day. This transmission period will be 1429 - 1530 G.M.T. and the modulation programme will be the same as for the short waves.

FREQUENCY AND TIME ADJUSTMENTS

Some adjustments to the frequency of the standard are necessary in order to keep within the stated tolerance of ± 2 parts in 10^8. The standard, which is an Essenring oscillator made by the Radio Branch of the General Post Office, has increased in frequency fairly steadily at the rate of about 2 parts in 10^9 per month since its installation in February 1950. It is therefore set to be 1×10^{-8} less than its nominal value and is reset when it has drifted to 1×10^{-8} above nominal. Nine adjustments were made in the period between February 1950 and February 1953.

The seconds pulses are derived from the standard by division and consist of five cycles of 1000c/s tone. The precision of the pulses is ± 1μs and the time interval between two pulses is therefore accurate to ± 2 parts in 10^8 ± 2μs. For example, if the frequency is 1×10^{-8} high then the time interval between corresponding pulses on consecutive days is 1×10^{-8} (approximately 1 millisecond) less than 1 day. The time error is integrated and in general no attempt is made to alter the phase of the pulses so as to make them coincident with uniform time. If, however, they are in error by more than 50 milliseconds an adjustment of 50 or 100 milliseconds is made. Such adjustments are made on the first day of the month and the extent of the adjustment is announced.

PUBLICATION OF FREQUENCY VALUES

The values of the transmitted frequencies are published monthly in the Wireless Engineer.

Although the absolute frequency cannot be determined with certainty to better than one part in 10^8, relative values are known to 1 part in 10^9, and, as the day-to-day stability is of interest to some users, the results are published to this accuracy. Owing to the Doppler effect on the higher frequencies, already mentioned, the full precision of the published figures is only significant for reception of the 60kc/s transmission.

RECEPTION REPORTS

The MSF service of transmissions is still experimental and reports concerning reception will be welcomed.

They should be addressed to The Director, National Physical Laboratory, Teddington, Middlesex, England. (In the case of the Army, this will be done through the normal official channels).

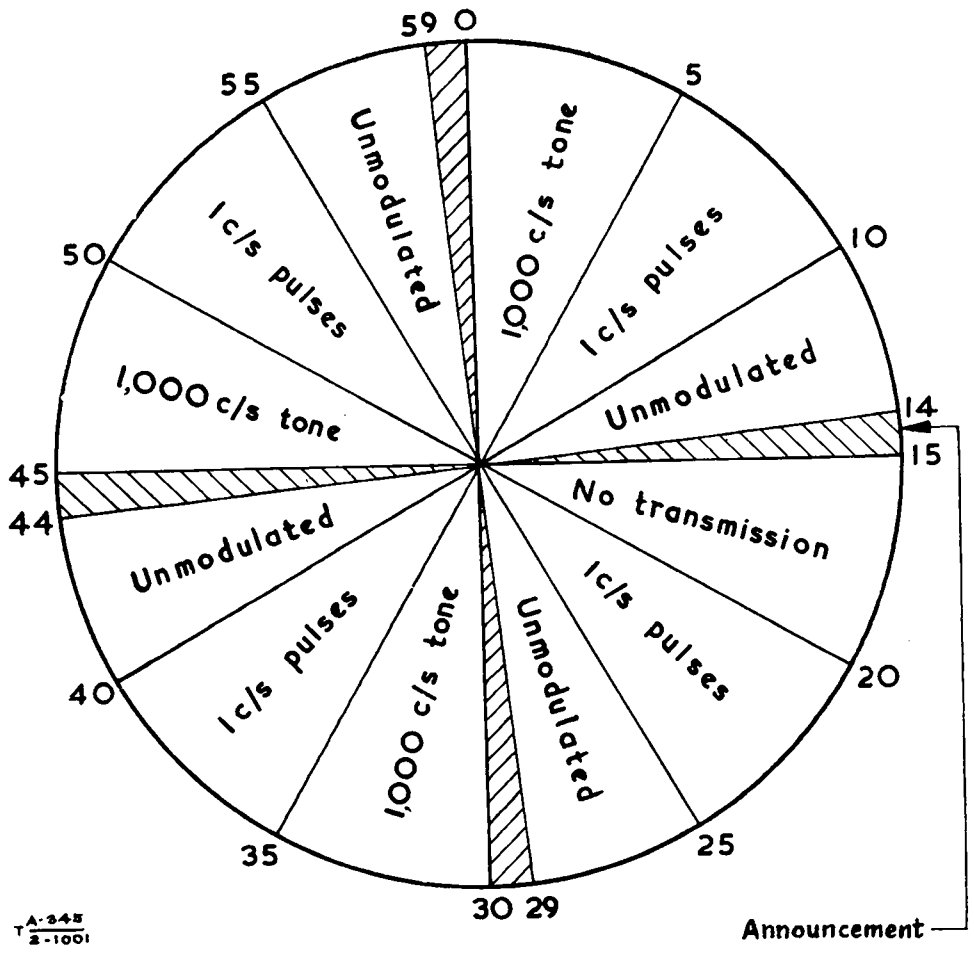

Fig 1001 - MSF Continuous transmission of standard frequencies

Hourly schedule

Carrier frequencies	2.5, 5, 10, 15 and 20Mc/s. Three frequencies only are broadcast simultaneously: initially these will be 2.5, 5 and 10Mc/s.
Power	0.5kW.
Modulation frequencies	1000c/s tone 1c/s pulses, the 59th pulse in each minute being omitted.

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