DEPARTMENT OF COMMERCE

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WASHINGTON, D. C.

RADIO MARKETS

A GUIDE TO RECEPTION OF SHORT WAVE BROADCASTING STATIONS

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DEPARTMENT OF COMMERCE
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WASHINGTON

A GUIDE TO RECEPTION OF SHORT WAVE BROADCASTING STATIONS

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This booklet provides a simple exposition of the basic phenomena involved in the transmission of short wave radio signals as used for broadcasting. It will assist the users of short wave radio receivers to receive such programs as are available with minimum effort and greatest satisfaction and to avoid the futile searching for programs not available to him because of his location or other factors. Since there are generally available throughout the nation competent radio service experts, it makes no attempt to instruct the user of short wave radio receivers in the intricacies of the servicing of receivers. And since the design and production of the modern short wave receivers require the highest type of scientific and engineering skill, it attempts to provide no constructional detail whatsoever except such suggestions as will assist the user in providing himself with a suitable receiving antenna. By studying this booklet and following its brief instructions the user of the short wave receiver will assure himself of getting the most out of his receiver and enjoying to the utmost his choice of the world's broadcasting.

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Installation of the Radio Set

While, for the most part, the modern radio receiver will be installed by a skilled radio man, for the benefit of those who will wish to make their own installation it is to be noted that the choice of the antenna size and location and the connection of the radio receiver to the ground is of major importance. Thus, the efficiency of any antenna varies greatly with the frequency of incoming radio waves, a given length being excellent at certain frequencies and comparatively poor at certain others. Thus, for best possible results throughout a wide tuning range such as found in the modern short wave receiver an antenna of adjustable length would be necessary. From a practical standpoint, however, very good results will be obtained by using a single antenna of length approximately 100 feet overall, the lead-in being considered a part of the total length. Such an antenna, in addition to providing excellent results in the standard broadcast band, will also favor reception in the short-wave broadcast bands located at 49, 31, 25 and 19 meters.

Better performance of radio receivers on the shorter wavelengths can be insured by installation of the noise suppression type of specially constructed receiving antennas. Such antennas consist of one or more highly elevated aerial conductors which are connected, usually through an especial coupling device, to two insulated conductors, closely twisted together throughout their length. These latter serve to carry the signal energy picked up by the elevated signal collecting conductors to the radio receiver and are by the nature of their construction, protected against the picking up of any locally generated electrical disturbances which would otherwise interfere with good radio reception. Such noice suppression type of antennas serve best if their design is matched to the radio receiver and, in general, it will be found that properly matched types are readily available for all types of radio receivers. The advantages of this system are two-fold, its use providing: (1) A great improvement in efficiency, as evidenced by increased signal strength - often several times that obtainable with the conventional single-wire type, and (2) a considerable decrease in local electrical interference (man-made static) which is apt to be objectionably severe at the shorter waves, i.e., the higher frequencies. For densely populated districts, this type of antenna system is virtually a necessity.

Good reception in many installations will be obtained without connecting the instrument to an external ground, since the power lines to which the receiver is connected often serve to supply this ground connection. Best results, however, can be insured only by grounding the radio set in the conventional manner to a water-pipe or radiator or to a metallic pipe or stake driven from five to eight feet into the soil. The ground lead when used should be short, preferably not more than 15 feet in length, and metallically connected to the pipe or stake surface by means of a suitable ground clamp.

Other considerations than those concerned with providing maximum effectiveness for the reception of signals are of importance in the installation of the antenna-ground system of the receiver. Of major importance amongst these are those of protection against such hazards as may develop in radio antennas. These are more specifically referred to in the excerpts from the National Electrical Code which are quoted below:

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"Each lead-in conductor from an outdoor antenna shall be provided with an approved protective device (lightning arrester) which will operate at a voltage of 500 volts or less, properly connected and located either inside the building at some point between the entrance and the set which is convenient to a ground, or outside the building as near as practicable to the point of entrance. The protector shall not be placed in the immediate vicinity of easily ignitable stuff, or where exposed to inflammable gases or dust or flying of combustible materials.

"The grounding conductor from the protective device may be bare and shall be of copper, bronze or approved copper-clad steel, and if entirely outdoors shall not be smaller than No. 14 if of copper nor smaller than No. 17 if of bronze or copper-clad steel. If wholly indoors or with not more than ten feet outdoors it need not be larger than No. 18. The protective grounding conductor shall be run in as straight a line as possible from the protective device to a good permanent ground. The ground connections shall be made to a cold-water pipe where such pipe is available and is in service and connected to the street mains. An outlet pipe from a water tank fed from a street main or a well may be used, provided such outlet pipe is adequately bonded to the inlet pipe connected to the street water main or well. If water pipes are not available, ground connections may be made to a grounded steel frame of a building or to a grounding electrode, such as a galvanized iron pipe or a rod driven into permanently damp earth or to a metal plate or other body of metal buried similarly. Gas piping shall not be used for the ground.

"The protective grounding conductor shall be guarded where exposed to mechanical injury. An approved ground clamp shall be used where the protective grounding conductor is connected to pipes or piping.

"The protective grounding conductor may be run either inside or outside the building. The protective grounding conductor and ground, installed as prescribed in the preceding paragraphs may be used as the operating ground.

"It is recommended that in the case the operating grounding conductor be connected to the ground terminal of the protective device.

Characteristics of Short Wave Radio Transmission

While the design of the modern radio receiver is such that no previous experience or special skill is required for its proper operation, its full possibilities can be realized only by those familiar with the general characteristics of transmission on the shorter wavelengths.

It is, therefore, of interest to note first the general types of signals that can be heard on short wave receivers. These are given in the table below with the approximate frequency bands on which they are carried:

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Signals		Frequency	Wave Length
Foreign Programs	-	5.5 to 6.8 mcs.	49 Meter Band
		9.3 to 10.8 mcs.	31 " "
		11.5 to 12 mcs.	25 " "
		14.5 to 15.6 mcs.	19 " "
		17.5 to 18.1 mcs.	16 " "
		21 to 22 mcs.	13 " "
Police Calls	-	1.60 to 1.72 mcs.	
		2.3 to 2.5 mcs.	
		30 to 41 mcs.	
Aircraft Calls	-	2.7 to 3.5 mcs.	
		5.4 to 5.9 mcs.	
Amateur	-	17.15 to 2.0 mcs.	
		3.5 to 4.0 mcs.	
		7.0 to 7.3 mcs.	
		14.0 to 14.4 mcs.	
		28 to 30 mcs.	

While the short wave channels listed above are much used in all parts of the world, the programs which are carried on them are available to the short wave listener for only a portion of the day and that depending on the distance from the transmitting station, and many other factors including the time of the year. A brief discussion of the characteristics of the short waves will, it is believed, therefore be of marked assistance in the operation of short wave radio receivers.

Transmitted signals of any wavelength are known to divide into two components - the "Ground" wave and the "Sky" wave. The former remains close to the earth's surface, providing reliable service only over short distances from the broadcasting station.

The sky wave, however, travels into the higher layers of the atmosphere and is reflected back to the earth's surface only at a considerable distance from the station. With short-wave signals, the sky wave usually does not return within the radius covered by the ground wave, resulting in a so-called deadspot region within which reception is impossible or extremely unsatisfactory. The radial length of the region wherein such conditions are effective is known as the skip distance, varying greatly from day to night and from summer to winter approximately as shown in the table below:

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TABLE I

EFFECT OF TIME OF DAY AND SEASON OF YEAR ON SHORT-WAVE TRANSMISSION *

Wave-length (Meters)	Ground-Wave Range Miles	Sky Wave (Mid-Summer) Approximate Range Noon Miles	Sky Wave (Mid-Summer) Approximate Range Midnight Miles	Sky Wave (Mid-Winter) Approximate Range Noon Miles	Sky Wave (Mid-Winter) Approximate Range Midnight Miles
100	90	More than 90	90-600	90-100	90-2500
49	75	100-200	250-5000	200-600	400 or more
31	60	200-700	1000 or more	500-2000	1500 or more
25	50	300-1000	1500 or more	600-3000	2000 or more
19	35	400-2000	2500 or more	900-4000	X
16	15	700-4000	X	1500 or more	X

X - Ordinarily cannot be heard.

* Time and season apply to transmitting station. Distances specified are based on relatively high-power transmission and favorable conditions of reception.

For the convenience of the user of the short wave receivers in the interpretation of the above mileage data there is given on the next page the Azimuthal Chart as prepared by the Hydrographic Office of the Navy Department from which can be gotten the distances and directions to the many short wave broadcasting stations of the world.

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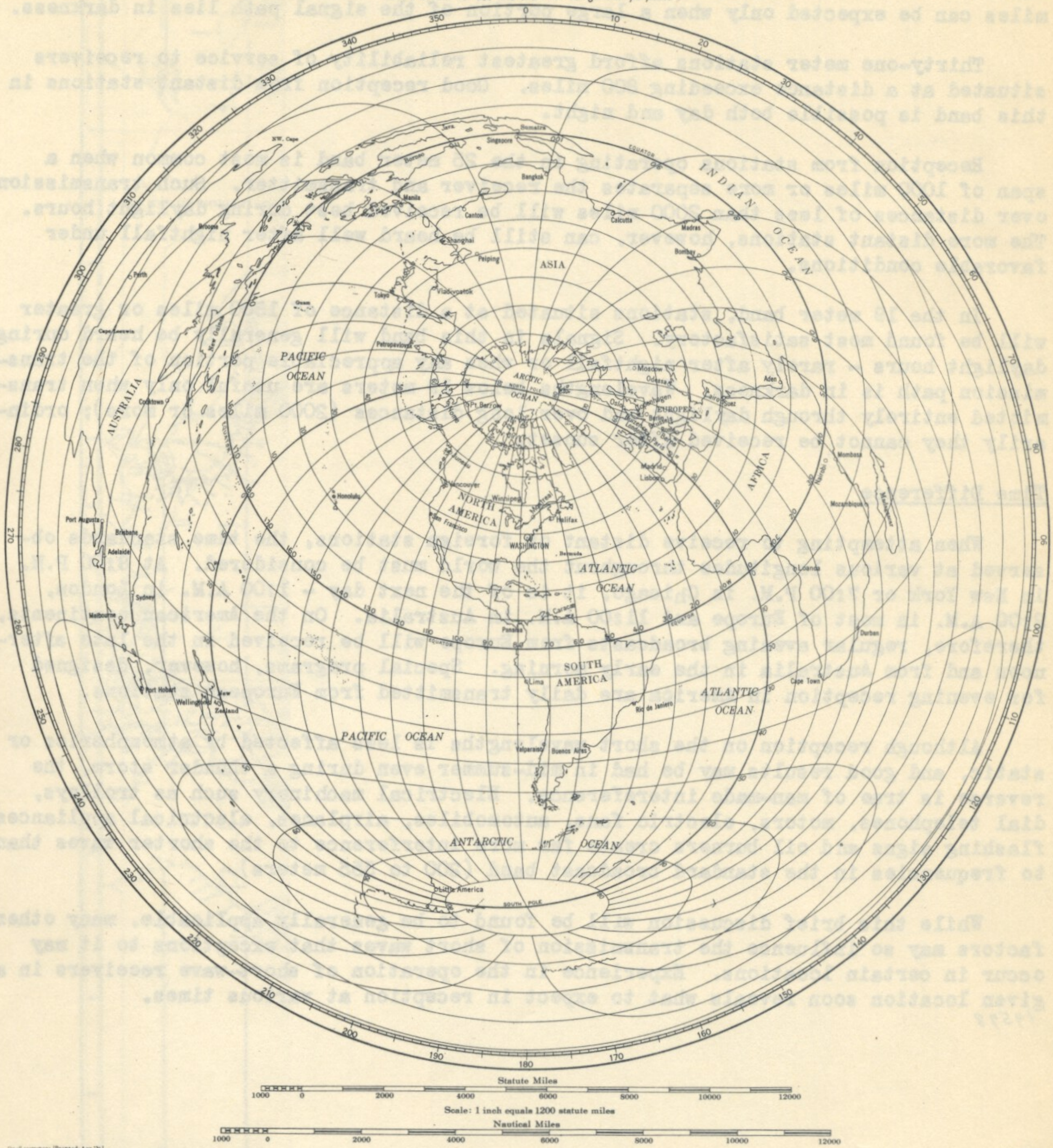
No. 5199
Price 30 cents

CHART OF THE WORLD

Showing Great Circle Distances and Azimuths
from Washington, D.C. to all Points on the Earth's Surface

Vessels should not use this chart for navigational purposes



Small corrections | Printed Apr '34 | from Notices to Mariners | and other sources | IV '34

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1st. EDITION: May 1928

The following notes are a summary of extensive data compiled mainly by experimentation and should be found both interesting and helpful, especially to beginners in the field of short-wave reception.

Broadcast transmission at 49 meters is most reliable when received from a distance of 300 miles or more, although good reception at distances greater than 1500 miles can be expected only when a large portion of the signal path lies in darkness.

Thirty-one meter stations afford greatest reliability of service to receivers situated at a distance exceeding 800 miles. Good reception from distant stations in this band is possible both day and night.

Reception from stations operating in the 25 meter band is most common when a span of 1000 miles or more separates the receiver and transmitter. Such transmission over distances of less than 2000 miles will be received best during daylight hours. The more distant stations, however, can still be heard well after nightfall under favorable conditions.

In the 19 meter band, stations situated at a distance of 1500 miles or greater will be found most satisfactory. Signals in this band will generally be heard during daylight hours - rarely after nightfall or when any appreciable portion of the transmission path is in darkness. Wavelengths below 19 meters are useful only when transmitted entirely through daylight and over long distances (2000 miles or more); ordinarily they cannot be received after sunset.

<u>Time Difference</u>

When attempting to receive distant or foreign stations, the time standards observed at various longitudes throughout the world must be considered. At 8:00 P.M. in New York or 7:00 P.M. in Chicago, it is of the next day - 1:00 A.M. in London, 2:00 A.M. in most of Europe and 11:00 A.M. in Australia. On the American continents, therefore, regular evening broadcasts from Europe will be received in the late afternoon and from Australia in the early morning. Special programs, however, designed for evening reception in America are daily transmitted from European stations.

Although reception on the short wavelengths is less affected by atmospherics or static, and good results may be had in mid-summer even during a thunder storm, the reverse is true of man-made intereference. Electrical machinery such as trolleys, dial telephones, motors, electric fans, automobiles, airplanes, electrical appliances, flashing signs and oil burners create far more interference to the shorter waves than to frequencies in the standard broadcast band (200 to 555 meters).

While this brief discussion will be found to be generally applicable, many other factors may so influence the transmission of short waves that exceptions to it may occur in certain locations. Experience in the operation of short-wave receivers in a given location soon reveals what to expect in reception at various times.

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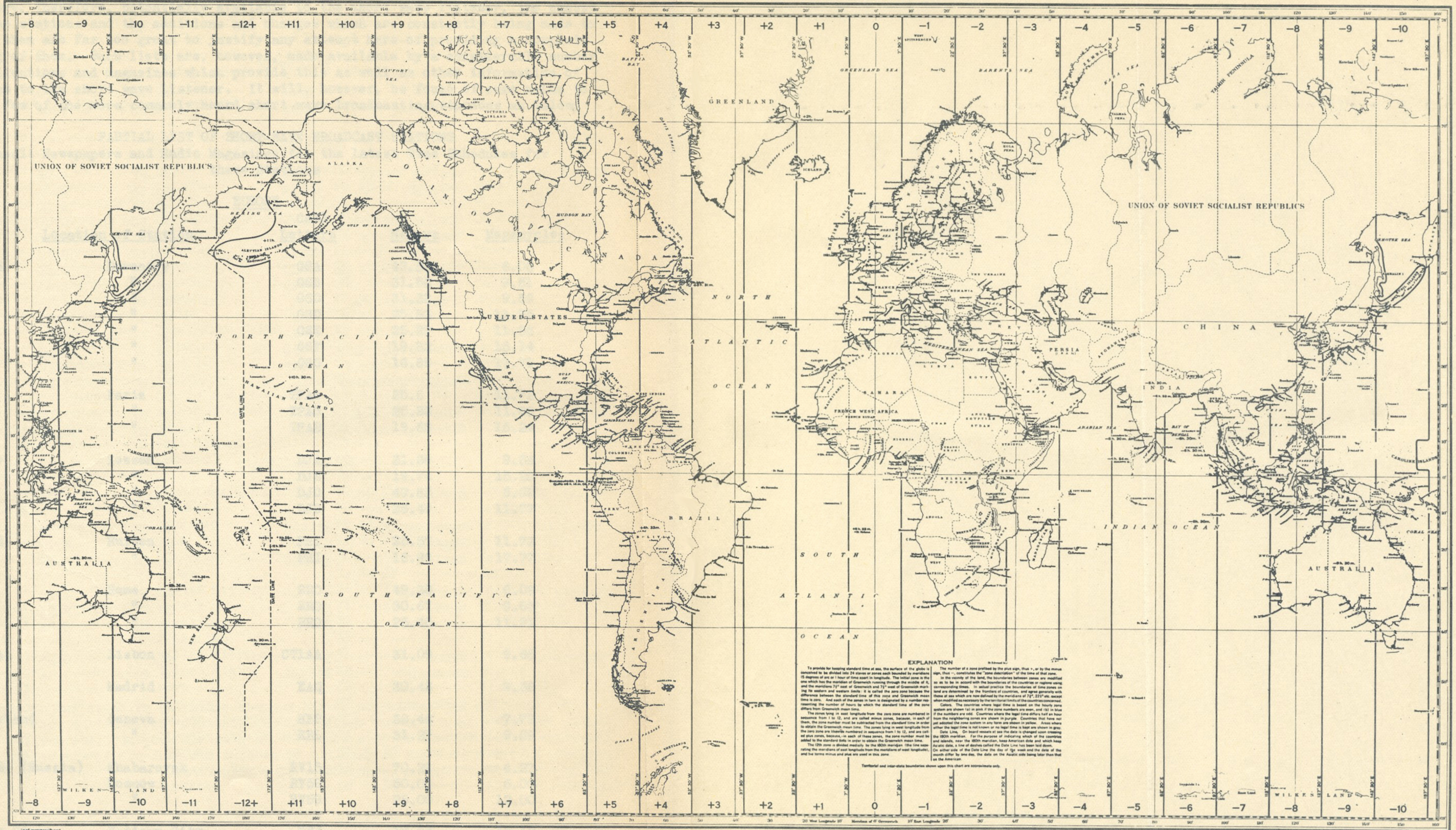
TIME ZONE CHART OF THE WORLD



No.5192

Short Wave Broadcasting Stations

As for the specific radio stations which operate on the short wave bands and which are, therefore, potentially available to the short wave listener, the number of these stations and the additions and changes which are constantly being made to and in them are far too great to justify any attempt here of providing a complete listing of them. Such lists are, however, made available by a considerable number of publications and magazines which provide this as well as other information of interest to the short wave listener. It will, however, be found of some value to list a few of the more commonly heard short wave broadcasting stations as below:

PARTIAL LIST OF SHORT-WAVE BROADCAST STATIONS
Consult Newspapers and Radio Magazines for the latest Time Schedules for these Stations

EUROPE

Location of Station		Call Letters	Meters	Megacycles
England	Daventry	GSA	49.59	6.05
	"	GSB	31.55	9.51
	"	GSC	31.32	9.58
	"	GSD	25.53	11.75
	"	GSE	25.29	11.86
	"	GSF	19.82	15.14
	"	GSG	16.86	17.79
France	Paris	TPA4	25.6	11.72
	"	TPA3	25.23	11.88
	"	TPA2	19.68	15.24
Germany	Zeesen	DJA	31.38	9.56
	"	DJB	19.74	15.20
	"	DJC	49.83	6.02
	"	DJD	25.49	11.77
Holland	Huizen	PHI	25.57	11.73
	"	PHI	16.88	17.77
Italy	Rome	2RO	49.30	6.08
	"	2RO	30.67	9.63
	"	2RO	25.40	11.81
Portugal	Lisbon	CT1AA	31.09	9.65
Spain	Madrid	EAQ	30.43	9.86
Switzerland	Geneva	HBP	38.48	7.79
	"	HBL	31.27	9.59
U.S.S.R. (Russia)	Khabarovsk	RV15	70.21	4.27
	Moscow	RV59	50.00	6.00
	"	RV59	25.00	12.00
Vatican State	Vatican City	HVJ	19.84	15.12

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Location of Station		Call Letters	Meters	Megacycles
		AFRICA		
Morocco	Rabat	CNR	37.33	8.03
		AUSTRALIA		
Australia	Sydney	VK2ME	31.28	9.59
	Melbourne	VK3ME	31.55	9.51
		NORTH AMERICA		
United States	Boston, Mass.	W1XAL	49.67	6.04
	Chicago, Ill.	W9XAA	49.34	6.08
	" "	W9XF	49.18	6.10
	Cincinnati, Ohio	W8XAL	49.50	6.06
	New York City	W3XAL	16.87	17.78
	" " "	W3XAL	49.18	6.10
	Philadelphia, Pa.	W3XAU	31.28	9.59
	" "	W3XAU	49.50	6.06
	Pittsburgh, Pa.	W8XK	48.86	6.14
	" "	W8XK	25.27	11.87
	" "	W8XK	19.72	15.21
	Schenectady, N.Y.	W2XAD	19.57	15.33
	" "	W2XAF	31.48	9.53
	Springfield, Mass.	W1XK	31.36	9.57
Canada	Saint John, N.B.	VE9BJ	49.26	6.09
	Winnipeg, Man.	CJRX	25.58	11.73
		SOUTH AMERICA		
Brazil	Rio de Janeiro	PSK	36.65	8.18
Colombia	Barranquilla	HJ1ABB	46.53	6.44
	Bogota	HJ3ABF	48.62	6.17
	Cali	HJ5ABD	46.22	6.49
Ecuador	Guayaquil	HC2RL	45.00	6.66
	Quito	HCJB	36.5	8.21
	Riobamba	PRADO	45.33	6.62
Venezuela	Caracas	YV3RC	48.78	6.15
	Maracaibo	YV5RMO	51.28	5.85

For specific information as to the program schedules of these and other stations, the short wave listener should consult his daily newspaper or such other publications as are devoted to this subject. Data on the program plans and the actual programs of these stations is gathered by several national and international agencies and is available through a large number of publications.

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International Call Letters

The identification of radio stations by means of a uniform type of signal was first provided for by an international conference in 1912, and though amended from time to time is still in effect fundamentally as originated. The signals adopted consist of from three to six letters, or of one or more letters and one or more numbers, the initial letters of which designate the nationality of the station.

Current assignments are as follows:

CA to CE	Chile	PK to PO	Netherland India
CF to CK	Canada	PP to PY	Brazil
CL to CM	Cuba	PZ	Surinam
CN	Morocco	RA to RQ	Russia
CP	Bolivia	RV	Persia
CR	Portuguese colonies	RX	Panama
CS to CU	Portugal	RY	Lithuania
CV	Rumania	SA to SM	Sweden
CW to CX	Uruguay	SP to SR	Poland
CZ	Morocco	SU	Egypt
D	Germany	SV to SZ	Greece
EA to EH	Spain	TA to TC	Turkey
EI	Irish Free State	TF	Iceland
EL	Liberia	TG	Guatemala
ES	Estonia	TI	Costa Rica
ET	Ethiopia	TS	Saar Basin
F	France and colonies	UH	Hedjaz
G	United Kingdom	UI to UK	Netherland India
HA	Hungary	UL	Luxemburg
HB	Switzerland	UN	Yugoslavia
HC	Ecuador	UO	Austria
HH	Haiti	VA to VG	Canada
HI	Dominican Republic	VH to VM	Australia
HJ to HK	Colombia	VO	Newfoundland
HR	Honduras	VP to VS	British colonies
HS	Siam	VT to VW	British India
I	Italy and colonies	W	United States
J	Japan	XA to XF	Mexico
K	United States	XG to XU	China
LA to LN	Norway	YA	Afghanistan
LO to LV	Argentina	YH	New Hebrides
LZ	Bulgaria	YI	Iraq
M	United Kingdom	YL	Latvia
N	United States	YM	Danzig
OA to OB	Peru	YN	Nicaragua
OH	Finland	YS	Salvador
OK	Czechoslovakia	YV	Venezuela
ON to OT	Belgium and colonies	ZA	Albania
OU to OZ	Denmark	ZK to ZM	New Zealand
PA to PI	Netherlands	ZP	Paraguay
PJ	Curacao	ZS to ZU	Union of South Africa

Tuning to the Short Waves

While in general it will be found that all types of short wave receivers differ markedly from one another, the essential controls which are provided and which must be adjusted to bring in the desired one of the available programs are identical in function and must, therefore, in general be similarly adjusted regardless of the type of receiver. Thus, each short wave receiver will be found to include the following four controls which are provided with knobs or other means for their adjustment:

1. Band Switch. This control provides for the choosing of the band of frequencies to which the receiver is sensitive so as to include the frequency at which the desired program is being transmitted. Short wave receivers differ somewhat as to the actual frequencies included in each of its several frequency bands but markings will be found either on the band switch itself or on the main indicator scale of the receiver showing what frequency bands are receivable at any setting of the band switch.

2. Station Selector. This control is that one which causes the main indicator dial or pointer to move so as to indicate on the scale of the receiver the specific frequency to which it is tuned. It is usually provided with the means for moving the dial or pointer quickly or slowly at the operator's will and, in tuning stations, the rapid motion is employed only for arriving at the approximate adjustment of the indicator while the slow or vernier motion is employed to provide the precise adjustment absolutely requisite for good program reception.

3. Volume Control. This control is that one which allows the operator of the receiver to increase or decrease the sound volume with which the program is being received. It should, however, be noted that all modern short wave receivers are equipped with an unseen and automatically operating volume control that tends to bring in all programs at the same volume and that the manually operated Volume Control has for its major function merely the accommodation of the volume of all programs to the general level at which it is desired to receive them. But, additionally, it provides also, for adjustment of the volume of the extraneous sounds which sometimes accompany the operation of the tuning of short wave receivers.

4. Tone Controls. These controls are those which provide for the control of the general tone color of the program being received. They provide either for emphasizing the lower tones of the music and speech to give the mellowness which is preferred by many, or for emphasizing the high tones and thus give music greater brilliance, and speech the greater clarity required for most faithful reproduction. They serve, secondarily, for reducing the troublesome effect of extraneous and disturbing signals and noises which may accompany the operation of the short wave radio receiver.

Having identified these several controls and having put the short wave receiver in operation by whatever control is provided therefor, and as is usually indicated by the illumination of the indicating scale or dial, several operations follow:

First, the Band Switch is so set that the frequency range in which the receiver is operating includes the frequency of the desired program. Then the Station Selector is rotated until it is approximately set at the frequency of the desired program. During this process, it will usually be found desirable to have the Volume Control so adjusted that such undesired signals as are heard are not so loud as to annoy the operator or others who may be listening, incidentally, or otherwise. When the desired program is heard the Station Selector should then be slowly adjusted back and forth

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through the desired program and finally set as precisely as possible at the mid-position. Where a tuning indicator is provided in the receiver, the special tuning instructions accompanying the receiver should be followed in detail. After this the Volume Control is readjusted to give the desired volume of sound and, if any specific and different tone color in the program is desired, the tone controls may then be adjusted to suit.

This, in brief, is the process of adjusting the short wave receiver to the desired program. A few words of caution, however, should be added.

It will be found that every control with which the radio receiver is provided will serve to change the apparent volume of the program; that is, not only will the Volume Control make the program louder or weaker but so will the adjustment of the adjustment of the Station Selector, the Tone Control and such other controls as may be included in the receiver. Unless, however, only the Volume Control is employed for securing the desired volume and the other controls adjusted to perform their own particular functions, the best of program reception cannot be obtained.

More specifically, on this point it will be found, for instance, that as the Station Selector is adjusted, minor departures in either direction from the position in which the signal is loudest will give markedly lower volume and there is thus always a tendency to adjust this control to that volume which is most suitable. Such a procedure, however, does much to make impossible the best program reception. Not only does the misadjustment of the Station Selector result in the possibility of interference from other and undesired signals and stations but it results in the introduction of the extraneous sounds such as radio noises and the like and, additionally, seriously modifies the tone quality of the station being received. In fact, this tone distortion may be employed as a convenient indicator of the proper setting of the Station Selector. Thus, as the Station Selector is moved back and forth in the tuning region of the desired program, it will be noted that at its mid-position and at the position at which it is properly set, the low tones and the general mellowness of the program is greatest, while at either side-position the high tones are heard to be emphasized along with the introduction of a gentle hiss and a high pitch character is given to any noises that may be present. And so, to arrive at the proper adjustment of the Station Selector it will often be found convenient to rotate it back and forth in the tuning region of the desired program noting the two positions for the hiss or noise or high-toned reception and then to set it finally between these two symmetrical positions of mistuning.

Once this position has been arrived at, the adjustment of Tone Controls and Volume Control can then and only then be made if best possible program reception is to be obtained.

Several of the characteristic phenomena commonly occurring in the reception of short wave signals should be noted. In the first place, all very long-distance signals come to the listener not directly over the surface of the earth but by reflection from the upper atmosphere, as was pointed out previously. The intensity of these signals is, therefore, largely influenced by any changes which may take place in the position and other characteristics of the upper atmosphere. And, indeed, the changes of this medium occur so continuously as to result in continually changing signals. The modern short wave receiver by the details of its design and construc-

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tion provides for correcting this constantly changing condition in a very large degree. However, on occasions, even the wide range of effectiveness of the modern radio receiver is insufficient to accommodate the tremendous change of transmission effectiveness of the medium and the signal slowly "fades" in audibility. There is little that the listener can do to minimize this condition that has not already been done in the design of the radio receiver. It is best merely to await the restoration of the signal to its previous level.

It will further be noted that characteristic squeals or humming or singing tones will occasionally be heard to accompany the desired program. In general, these are the result of the fact that stations all over the world employ the short waves for their long distance broadcasting and general communications with the resultant great difficulty in so coordinating them as to avoid the interferences which result in the squeals, howls, etc. No preventive for the difficulties of this situation can ever be provided in a radio receiver and the listener can do little other than to reduce the degree of interference by the adjustment of the Tone Control, if the squeal or howl is of extremely high pitch, or to await the completion of the fading period in which the interference may be making itself heard.

Both of these undesirable phenomena will be found to associate themselves in widely varying degrees with different stations and experience will soon indicate those which are freest from them and indicate those which will thus give the best program reception.

While it has, in this booklet, been necessary to emphasize the difficulties and limitations in short wave broadcasting in the interest of conciseness, the user of the properly installed and properly operated short wave receiver will soon learn how great is the reward for his patience and his skill and how unusually interesting, instructive and entertaining is the vista of the world's speech and music that is disclosed to him through his short wave receiver.

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PUBLICATIONS OF THE ELECTRICAL DIVISION

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Department of Commerce

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