BASIC INFORMATION PAMPHLET

BIP 4

BASIC SHORTWAVE ANTENNAS

by Don Johnson

The least understood and most often neglected phase of the shortwave listening hobby is probably the antenna. It is the purpose of this pamphlet to help the novice SWL, by showing the basic & most popular antennas.

The job of the antenna is to pull in signals so your receiver can amplify them. A good antenna can pull in weak stations, as well as give you more reliable reception of stronger stations. Your antenna should receive just as much attention, if not more, as your selection of receivers. Wether you own a '$20 bargain special' or a high priced 'super duper DX scooper', reception will be greatly improved by adding an outdoor antenna, and the cost if often just a few dollars and a little of your time.

The space you have available will effect your choice of type, lenght, and direction, but the idea is to erect the best antenna you can manage, and, experiment. Try different types, change the lenght, change directions, and find what works best for you. The work involved will pay off with better reception and more enjoyment of the SWL hobby.

SPEEDX
PO BOX E
ELSINORE, CA 92330 USA

Drawings on opposite page show typical installations of common short-wave antennas. These are just a few of the types that are available for a SWL to erect. More information about SW antennas may be obtained from many international broadcasters for just the asking or, several concerns offer excellent material for reasonable costs. Try these:

HCJB, Box 691, Quito, Ecuador
Radio Nederland, PO Box 222, Hilversum, Holland
BBC, Bush House, London, England
NHK, Tokyo, Japan
RSA, PO Box 4559, Johannesburg, South Africa
American Radio Relay League, Newington, CT 06111 USA

SEND A SASE TO ONE OR MORE OF THESE SOURCES.

ASK FOR ANTENNA INFORMATION

WIRE The wire may be solid or stranded, insulated or bare. Lead-in should be insulated. Either coax cable or TV lead-in is a good choice to run from antenna to receiver for dipoles.

HEIGHT Generally, the higher the better. If possible erect your antenna in a clear area away from houses & trees. Do not cross power lines!

LENGTH Lengths are given on last page of this pamphlet. Note that you may choose a length that will be suitable for several meter bands.

INSULATION Insulators should be used at both ends of your antenna and, at all points where lead-in may come in contact with metal.

GROUND A good earth ground is a must! A cold water pipe(metal) or a rod driven into the ground will work well. Make it as close to your receiver as possible and use heavy wire from ground to receiver. Be sure to install a lightning arrester in your lead-in.

ANTENNA HOOKUP To hook an outdoor antenna to a receiver that has no conection on it, such as a portable, wrap several turns of insulated wire on the telescopic mast and attach lead-in to this. In the case of a dipole the second lead goes to ground.

If your receiver has three terminals(A1, A2, & G)a short jumper wire should be hooked between A2 & G when using a single wire feed, such as for an inverted "L" type of antenna. For a dipole feed(2 wire lead-in)one wire is attached to each "A" terminal with no jumper between A2 & G.

DIRECTION A dipole will receive signals best broadside to its erection. A long wire or vertical will receive signals from all directions. Keep this in mind when choosing where you put your antenna up. Look at a world globe or circle chart to see what direction you prefer to receive the best signals from. For example, from the USA, India is due north, Australia is due West, etc.

INDOOR ANTENNA Several of these antennas can be installed indoors if you have no space available outdoors. The folded dipole is popular and will fit nicely in an attic. For apartment dwellers a vertical fastened to the sill of a window or perhaps an 'active' antenna with plans available from Radio Nederland.

ANTENNA TUNER This is a device to match your antenna to the frequency you are tuned to. Very helpful when using a random length of wire for an antenna, as many SWLs must. Plans for its construction may be obtained from any of the above sources or from SPEEDX HQs.

DON'T KEEP A SECRET When you log some good catches on your new antenna, send the information in to your favorite SW Club or Radio DX Club Program. Or perhaps write a letter to a DX friend and let him know what can be heard.

BASIC INFORMATION PAMPHLET BIP-5

BASIC PROPAGATION

by

Doug Snyder and Mark Lucas

INTRODUCTION

This Basic Information Pamphlet (BIP) on shortwave propagation has been written for SPEEDX members, as well as for other shortwave listeners(SWL's), who desire to increase their knowledge of another aspect of the fasinating hobby of DXing. It presents the basics of the propagation phenomena as it affects the travel of the shortwave signal from transmitting antenna to reciving antenna. It covers only the SW spectrum, that is, frequencies from around 2 MegaHertz to 30 mHz.

In this brief presentation, we will be dealing with four elements: the Sun, the Earth's Ionosphere, the Earth's Magnetic Field, and the Shortwave signal. Also included are sections on Abnormal Conditions, WWV Broadcasts, and Future conditions.

ADDITIONAL REFERENCES

Following are three publications that have proven invaluable in preparing this BIP. 1)"Shortwave Propagation" by Stanley Leinwoll, Rider publication #231; Rider Publishers, Inc., 116 W 14th ST., N.Y., NY 2)"Ionospheric Radio Propagation" by Kenneth Davies, Dover Publications, Inc., 180 Varick St., N.Y.. NY 3)"Sun. Earth & Radio" by J. A. Ratcliffe:McGraw-Hill Publishers

#1 is basic & thorough, hardly any math; #2 is technical, very thorough; #3 is intermediate, with not too much math.

SPEEDX
PO BOX E
ELSINORE, CA 92330 USA

THE ELEMENTS

THE SUN. As complex as this big ball of hydrogen is, the basic fact that is common to life on earth and the travel of shortwaves is solar radiation. In addition to visible light waves, the sun radiates its own radio waves, ultraviolet light, X-rays, protons, electrons and other assorted phenomena. Although the amount of visible light seems to be relatively constant day-to-day, the sun is constantly changing and the amount of other types of radiation emitted varies considerably from day-to-day and from year-to-year. The eleven year sunspot cycle is a good example. During the low activity period, such as we are in now (1975), very few sunspots are present on the surface of the sun. This means that there is less ultraviolet radiation leaving the sun, and ultraviolet radiation is the major contributor to the production of ions in the earth's ionosphere. When the next peak is reached, sometime in the 1980's, the sunspot count will be far greater and the ultraviolet radiation far stronger, therefore causing the ionosphere to be much denser than it is today.

THE EARTH'S IONOSPHERE. Existing at an average height of from 50 kilometers to well over 500 kilometers (1 mile equals 1.609 kilometers), the ionosphere is made up of 'layers' of gases which constitute the earth's atmosphere. Although classified as layers, there are no distinct boundaries or areas void of atoms in the ionosphere. The reason these layers exist is due to the fact that gases which make up the upper atmosphere (mainly nitrogen, hydrogen, oxygen and helium) are bombarded by solar radiation, and thus, due to the different properties of each gas, react differently to the radiation. (i.e. the atoms ionize at different heights). The radiation causes ionization, which can be defined as a once-neutral atom which has lost an orbiting electron and has now become a positive ion (because it has lost a negative electron). The electron itself is a called a 'free electron' and it is due to this process that certain radio signals are 'conducted' through the ionosphere and returned to earth.

THE 'D'LAYER'. Closest to the earth's surface (roughly 50-90 km) is the most dense of the layers. This layer exists only during daylight hours and is responsible for nearly all the absorption that occurs with radio waves. (The higher the frequency the less the absorption.)

THE 'E' LAYER. (Roughly 90-130 km) reflects some SW signals back to earth during the daylight hours, but it's affect at night is greatly diminished except on certain sporadic occasions. It also contributes to absorption of the signal.

THE 'F1' LAYER. Is present during daylight hours at a height of approxiately 250 km during winter day and approximately 300 km during a summer day. At night, this layer rises and merges with the F2 layer. The F1 layer, like the D and E layers, is not overly significant in the propagation of SW signals (they do reflect some signals back to earth), however they do have their effects as the signal must pass through these layers going to and returning from the F2 layer, the highest and most significant layer.

THE 'F2' LAYER. (At night refered to as just the F layer) is found at about 400 km during a summer day, 300 km during a winter day, and at night the F layer height for both summer and winter is about 320 km. The heights given do vary however and these figures are approximate. It can safely be said that almost every condition of the ionosphere can be attributed to the position of the sun relative to the local ionosphere and the level of activity of the sun. At night, the sun is on the other side of the earth (I hope) and therefore, no solar radiation is present to further the ionization process. During a summer day, the sun is at a high angle, the days are long, and more ionization occurs. During a winter day, the sun is not so high in the sky, and less ionization takes place. So there are daily, seasonal and long term variations. (11 year cycle).

THE EARTH'S MAGNETIC FIELD. The huge magnetic field surrounding the earth is also affected by solar radiation and this in turn affects the travels of the shortwave signal. During 'normal' solar activity (no solar storms, eruptions or flares), the magnetic field is relatively quite and not much effect on SW signals can be detected. On certain occasions however, particles emitted from the sun reach the earth and wreak havoc with the magnetic field. These effects are felt worldwide and can cancel almost all SW communication if severe enough. The most common effect felt here in North America is called 'PCA', or Polar Cap Absorption. This is because, like a bar of magnet, the earth has its two magnetic poles (not located at geographical poles) and like a bar magnet, the strongest concentration of magnetic lines of force occur at the poles. Therefore, when a disturbance occurs, the severest effects occur at the poles. This can absorb all communications in proximity to the polar regions. Signals originating from Asia, the USSR, India and other countries in that area must cross the polar regions to be

heard in North America. So when a PCA occurs, it's a good time to DX for stations that lie to the south.
The magnetic field itself does not contribute to the propagation of the signal, but it can certainly prevent you from hearing it!

THE SHORTWAVE SIGNAL

How the SW signal interreacts with the ions and the free electrons in the ionosphere is beyond the scope of this BIP. However, suffice to say that as the transmitted wave enters the ionosphere, the oscillating wave (an alternating current) sets in motion the ions and free electrons, which can result in not only refraction of the signal, but also in a certain amount of loss of energy of the signal. Thus, three things can happen to the signal in the ionosphere: 1) it can be refracted back to earth, 2) it can be absorbed, or 3) it can penetrate through the ionosphere into space. When the signal leaves the transmitting antenna, it can be beamed not only in direction, but also in height. If the signal leaves at a low angle, it enters the ionosphere at the same angle and therefore remains there for a longer travel time before being refracted back to earth.

Depending on the desity of the ionosphere and the frequency of the signal, the signal can be returned or absorbed. But being at such a low angle, the wave travels over a greater portion of the earth on one 'hop'. (A hop being the distance between where the wave leaves the surface of the earth and the next return point). The greatest possible distance (approximately) that can be covered in one hop is 4000 km (2400 miles). Obviously, under the right conditions, many hops are possible and common. For the first hop, and only the first hop, there is what is known as the 'skip distance'; this is the distance traveled in the first hop and reception of the signal within that zone is usually impossible because the signal is 'skipping' over that portion of the earth (there are occasions when the signal is scattered back into the skip zone and can be heard weakly); after the first refraction of the signal, the wave is scattered back to earth and therefore reception is possible at all points beyond where the signal first returns to earth. A signal leaving the antenna at a high angle has a short skip distance, but after several hops between earth and the ionosphere, it still has not traveled very far and the signal has been weakened by the absorption.

Another danger of a high angle wave is that while traveling through the ionosphere, it might not strike enough free electrons to be refracted and therefore, will pass through into space. This occurance is also related to the frequency of the signal; during the day, the ionosphere is dense and therefore, low frequency signals which have a long wavelength (5mHz = 60 meters) are absorbed more than high frequency signals which have short wavelengths (15mHz = 20 meters). This is due to the interaction between an actual wavelength and the ionosphere. At night, the ionization is less, therefore the low frequencies are not absorbed as much, but the high frequencies do not interact with the ionosphere as much either, and therefore do not get returned to earth.

This brings up the term 'Critical Frequency'; it simply means that frequency which is the highest one that the ionosphere will refract back to earth. This is also known as the MUF, or Maximum Usuable Frequency. The term 'critical angle' is defined as the angle of the signal in which the signal stays parallel to the ionosphere, neither passing on through to space, nor being returned to earth. All these conditions are constantly changing which is why propagation is so unpredictable in the short term.

ABNORMAL CONDITIONS.

SOLAR FLARES. Solar flares are the most disturbing factor in SW radio propagation. These bright bursts of light emit many different forms of energy in amounts that would solve our energy crisis for ever! The most immediate effect from a solar flare is created from the emission of electromagnetic radiation. X-rays, ultraviolet and visible light, and of course radio waves from microwaves to 10 meters are radiated from the sun. These events will occur within ten minutes of the onset of a severe flare activity. It is electromagnetic radiation that causes Sudden Ionispheric Disturbances (SID), and Short Wave Fadeouts (SWF) due to increase of ionization in the D layer of the ionosphere.

The next in line in terms of time events is caused by Cosmic Ray particles. These deadly particles cause Polar Cap Absorption events that will in turn cause signals passing over the polar regions on earth to have great flutter fading, and if one were to turn to a station that has signals passing over these regions, one would find it difficult to comprehend and understand any intelligence! If one were to observe an Aurora Borealis or Australis, one could well bet that PCA events were happening. Tune in your radio to see if this is not true!

The final effects of a flare is the magnetic storm particles. This set of particles do the most damage to radio reception. As compared to the other particles which begin within ten minutes to several hours, these particles take the longest period of time to reach the ionosphere, within 20 to 40 hours after the flare has occured. These highly charged particles, mainly protons and electrons, cause PCA's as well as geomagnetin and ionospheric storms which can last up to several days. These storms weaken the ionosphere to a low level of usage and under some circumstances, can make the ionosphere useless as a communications medium. It should be noted though that not all of these effects occur with every flare. A lot depends on the type of flare and the location on the solar disc where the flare occurs.

27 DAY SOLAR CYCLE. Many a DXer does not realize that the sun does complete a 'cycle' of movement that takes place once every 27 days or so. Since the sun is not a solid object, different portions retate at slightly different speedx, but on the average, 27 days pass between each rotation. Scientists have theorized that during this cycle, sunspot and flare activity increases to a certain degree and under low sunspot activity these stormy periods can last up to seven days or longer. Sometimes the geomagnetic storms that occur along with these monthly increases in solar activity seemingly linger throughout the month, although they may recede gradually at certain periods in the month.

FADING. Although not considered abnormal conditions, the following explainations on several types of fading may be useful. There are three basic types of fading: interference fading, selective fading, and flutter fading (also known as polar flutter). Interference fading occurs when refracted rays of the same signal arrive at the antenna at very slightly different times, sometimes in phase and sometimes out of phase. When in phase, the signal is stronger and when out of phase, the signal becomes weaker. This is the most common type of fading. Selective fading is when the ionosphere disturbs one component of a radio wave more than another component of the same wave. For example, the carrier frequency, say six megaHertz, may be disturbed more at any one moment than the modulated audio (the announcers voice). The result will be a distorted signal. Polar flutter is present on some or most signals passing over the polar regions and usually places a fast (from about 100 to 2000 Hertz/sec.) fluttering sound on the signal.

WWV BROADCASTS.

Any study of radio propagation is not complete without mentioning the free propagation information obtainable by tuning to either WWV or WWVH. With the cooperation of the NOAA Space Environment Laboratory at Boulder, Colorado, at 18 minutes after the hour on WWV, and at 45 minutes on WWVH, one can obtain information on the SOLAR FLUX levels (level of RF energy radiated from the sun on 2800 mHz), A-INDEX (daily deviation of the strength and activity of the geomagnetic field, from quiet to active), and several other important announcements when valid regarding the start of geomagnetic storms, Proton and normal event flares, PCA levels and events as recorded by satellites. All this information is updated at 0400 UTC (Coordinated Universal Time). If all of this seems too much to swallow, take heart! At 14 minutes after the hour on WWV only, a capsule summary of propagation conditions is given.

Information on geomagnetic field levels and activity, Solar activity levels, K-Index levels (average of geomagnetic Field levels over a six hour period), 2800 mHz Solar Flux levels (from 60 to 400); then a prediction of what conditions will be like the next six hours. Given also is a coded forecast. 'N' stands for Normal conditions, 'U' for Unsettled conditions, and 'W' for disturbed conditions. On a scale of 1 to 9, these numbers give a clue to propagation usefullness; with W-1 as Useless and N-9 as Excellent conditions. All of this compacted information is updated every six hours commencing at 0114 UTC. Note that the forecasts are primarily intended for circuits in the North Atlantic area and for other high latitude paths.

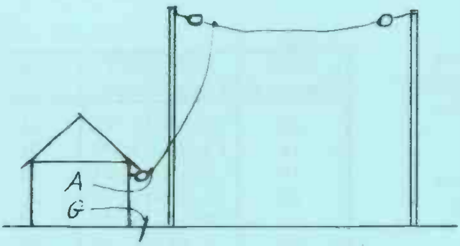
FUTURE CONDITIONS.

Before previewing the future, let's review the past. The last maximum in the 11 year cycle occured at the end of 1968, but stayed relatively constant for several years. The sunspot level started dropping in 1970 and as of now (mid 1975), the minimum is being approached and will probably remain low until at least 1977 or 1978. The next peak might occur as early as mid 1981 or as late as 1983. What all this means is that during this low period, SW stations will be utilizing the low frequency bands because of low MUF's. This is why there is so much crowding on the 6, 7, 9, and 11 mHz bands at present. When the cycle starts picking up, more broadcasters will start returning to the 15, 17, 21, and 25 mHz bands.

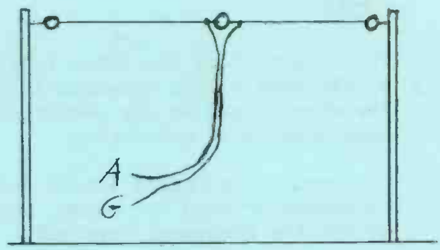
First Printing October 1975 JAN 1977

DOUG SNYDER/MARK LUCAS

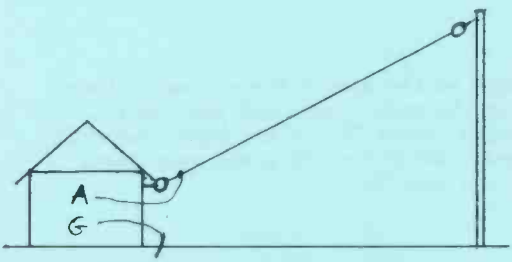
INVERTED "L" ANTENNA.



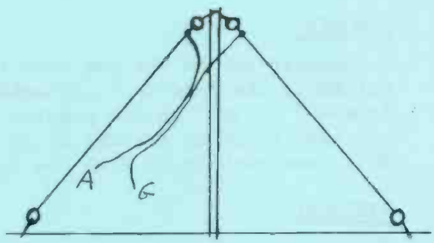
DIPOLE ANTENNA



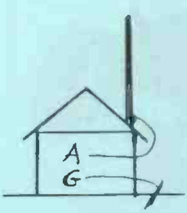
INVERTED "L" W/ONE HIGH MAST.



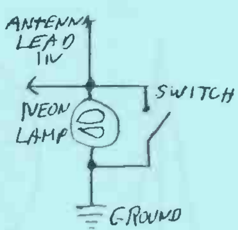
INVERTED "V" DIPOLE ANTENNA



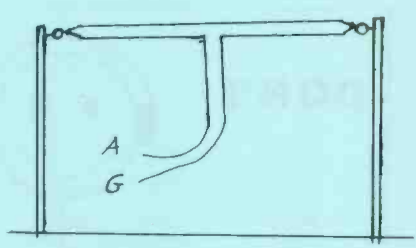
VERTICAL



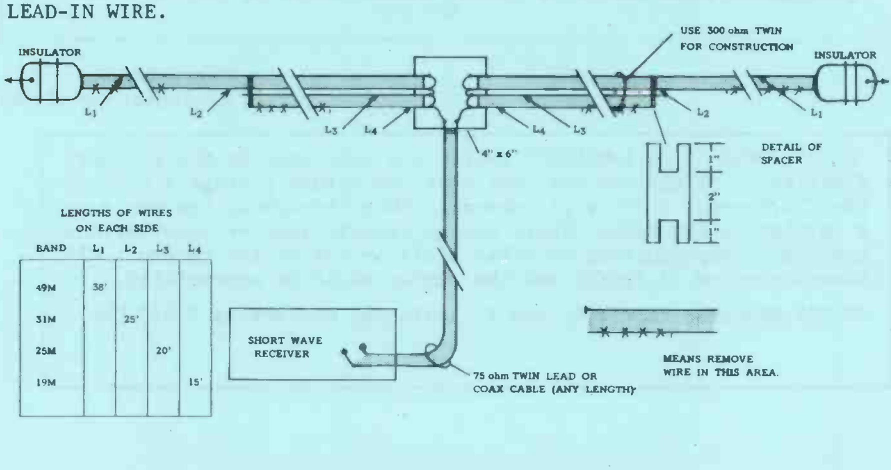
LIGHTNING ARRESTER



FOLDED DIPOLE ANTENNA



MULTI-BAND DIPOLE. TAKEN FROM THE HCJB ANTENNA BOOKLET, THIS IS A VERY EASY AND CHEAP WAY TO COVER SEVERAL BANDS. IT's MADE FROM COMMON TV LEAD-IN WIRE.



LENGTHS OF WIRES
ON EACH SIDE

BAND	L_1	L_2	L_3	L_4
49M	38'			
31M		25'		
25M			20'	
19M				15'

ANTENNA LENGTHS

DIPOLE

This chart shows the total length of a half-wave dipole antenna. In practice the wire is cut in the center, where your lead-in is attached.

To compute the needed length for any frequency or band not shown, merely divide the frequency into 468.

$$\frac{468}{\text{frequency(mc)}} = \text{length in feet.}$$

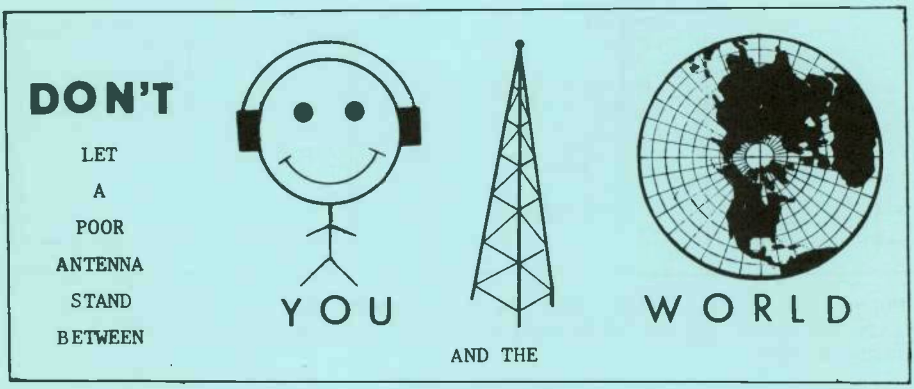
BAND (Meters)	FREQUENCY (Megahertz)	LENGTH (Feet)
13	21.45-21.75	21
16	17.70-17.90	26
19	15.10-15.45	31
25	11.70-11.97	40
31	9.50- 9.77	49
49	5.95- 6.20	78
60	4.75- 5.06	95

LONGWIRE

A longwire can be cut the same length as the dipole for any meter band. Natcherly the lead-in is attached to the end, instead of the center. From 40' to 100' is the popular length. About 78' is the most common if you want to cover several meter bands. Where you can place your masts will have much to do with how long you make it.

VERTICAL

The length is figured the same as above, except that a vertical is often made 1/4 wave length due to construction difficulties.



Don Johnson
Elsinore, California

BASIC INFORMATION PAMPHLETS (BIPs) are published by the projects division of SPEEDX and are available for return postage(A SASE in the USA/Canada, 2 IRC's elsewhere)to SWLs throughout the world as a service to the hobby. There are no restrictions or reservations concerning reproduction or other similiar use of the contents although mention of SPEEDX and the author would be appreciated.

SPEEDX HEADQUARTERS: P.O. Box E, Elsinore, California 92330 USA

A comprehensive "I" report might include such additional notations as: "QRM from BBC on 11925", "Interference from unidentified station in Spanish on 9560", "Strong heterodyne from unknown station on same frequency", "Radioteletype interference from about 5 kHz above your frequency", etc, etc. From such supplemental remarks the broadcaster can piece together a fairly accurate picture of the competition, and if need be, make some adjustments aimed at improving the situation.

N NOISE: This refers to the natural atmospheric electrostatic noise (hence the often used term of "static"). and it is graded in a negative manner much the same as its man-made counterpart interference.

Only a few major broadcasters consider "noise" as being of significant importance since the difficulty (if it exists) may often be confined to relatively small audience areas, and vary widely from day to day with local weather conditions. Certainly it is beyond their capabilities to correct prolonged adverse effects other than by shifting the transmission to an entirely different frequency band.

If the reporter wishes to contribute supplemental information of some value, a reference to the normal conditions for the particular frequency band, season, and time of day can be included....provided that the listener is actually familiar with current reception conditions for the band, season, and time. In this event, one of the following comments is all that is needed:

"Noise level normal"
"Noise level greater than normal"
"Noise level less than normal"

From the "N" SINPO grade which relates to the degree the broadcast may have suffered from atmospherics, and one of these three additional comments, the broadcaster will have no difficulty in determining a course of action should it be indicated.

P PROPAGATION: Here we have perhaps the most confusing and misinterpreted element to the SINPO code. In recent years, several broadcasters have substituted "F" for "P" in an effort to clarify the situation ("F" stands for "fading").

Over long distances the fact that the program is heard at all certainly suggests that at least moderately favorable propagation conditions exist and confirms the technician's calculations. Therefore, the reporter should consider only the degrading characteristics of the signal itself. The fact that the signal may be "strong" or "weak" is adequately covered in the "Signal Strength" portion of the code, so the only factor remaining that is exclusively a signal characteristic is fading.

When using the SINPO code, the reporter needs only to describe the negative effects of cyclical variations to signal strength in one of the five general terms provided. If the signal fading impairs complete comprehension of program content, then it can easily be classified as "moderate", "severe", or "extreme" depending upon the degree to which it degraded reception.

Some broadcasters define fading in specific terms of "cycles per minute" in SINPO report forms prepared for their regular listening audience. In this case, they are requesting more exact information and have predetermined the reference. The reporter should always make every effort to note his observations within such guidelines when asked to do so; but if he is preparing an unsolicited report, the five general options offered will be found to be more than ample.

O OVERALL MERIT: As the name implies, this is a summation of the general "readability" of the transmission. The first four parts of SINPO are used to describe certain specific observations, and "O" is the combined net result.

It follows that the overall grade will normally fall somewhere between the most and least favorable observation. For example, an "O" value of 4 ("good") could hardly be expected to follow a series of all 3's ("fair"), nor would a rate of 2 ("poor") properly sum up reception quality all individually rated from 3 to 5.

However, it might be that a broadcast scoring 2's or 3's throughout could easily be classified as 1 on the overall if the combined degrading effects were sufficient to consider the signal as being unusable. At any rate, when evaluating overall merit, the reporter should consider that he has only a single choice from the five options offered with which to describe the transmission's value to him. After all, the broadcaster is interested in just how well the program is being heard by his regular audience, and "O" just about says it all.

As mentioned earlier, many broadcasters supply their regular listeners with printed reception report forms with spaces provided for indicating the SINPO evaluations. Similiar forms are also available from several SWL clubs or commercial outlets specializing in SWL-ing supplies, which may be used to report to any broadcaster. In using such forms, usually a check in the appropriate box or writing the SINPO numerical values in a space provided is all that is required. The reporter preparing his own letter (considered best by a great many successful DXers) will of course have to incorporate SINPO somewhere in the body of his report.

In preparing a report to a large international broadcaster, it is usually sufficient to present a simplified notation such as:

"SINPO 34323"

The major broadcasters have large audiences and quite often receive hundreds or thousands of reports each year. They are thoroughly familiar with SINPO and its numerical gradients. However, smaller regional broadcasters are engaged in reaching more localized audiences, and may receive only a very few reports from any great distance. In this case, it is entirely possible that SINPO may be unknown, or at best only vaguely understood; so the reporter should expand the above notation something like this:

"Signal Strength:	Fair
Interference:	Slight
Noise:	Moderate
Fading:	Severe
Overall Merit:	Understandable, but with some difficulty"

Rather than employing the numerical grades, the corresponding definition is used in order to prevent a possible misunderstanding.

That's about it. When used properly, SINPO can tell the broadcaster a great deal about the quality of his signal. The main points to keep in mind are:

1. Don't attempt to turn SINPO into a technical dissertation. Add only those supplemental remarks that state whether or not a degrading condition is considered normal. or some comment that might assist in identifying an interfering transmission.

2. ALWAYS consider the reception quality as it might effect those listeners who are attempting to concentrate exclusively upon the actual programming.

3. Report observations fairly and honestly. This is the only way the report will be of any value to the broadcaster receiving it.

Jack White
Gresham, Oregon USA

Basic Information Pamphlets (BIPs) are published by the Projects Division of SPEEDX and are available without charge (other than postage) to SWLs throughout the world as a service to the hobby. There are no restrictions or reservations concerning reproduction or other similiar use of the contents, although mention of SPEEDX and the author would be appreciated in such an event.

SPEEDX International Headquarters: P.O. Box E, Elsinore, CA 92330 USA