Summer-to-Winter Changes in AM Coverage

By Paul F. Godley, Jr.

Your AM service area is often smaller in summer than in winter. This article summarizes several years' measurements which indicate the scope of the problem. It also explains how to live with the phenomenon —since you can't change it.

MOST MANAGERS AND operators concerned with AM station performance are familiar with the problem of winter skywave-signal interference in the fringe area. Similarly in summer, electrical storms and other atmospheric disturbances can seriously affect AM coverage. Those with technical backgrounds may also be aware of seasonal changes in their station signal intensity. Operators responsible for directional antenna systems, particularly those who must make monitor-point measurements to satisfy FCC license requirements, are well aware that such monitor-point levels do not always remain constant. Long term noncyclic changes in signal intensity probably can be traced to transmission-plant problems. However, certain other cyclic variations may be caused by changes in effective conductivity, rather than by changes or misadjustments of the transmission system.

Over the years at this company, we have encountered seasonal variations in signal intensity and made positive observations thereof. Starting in 1962 with the cooperation of the engineering department of a clear-channel station, we began to accumulate data that demonstrate the magnitude of the seasonal variations which can be encountered even within a few miles of the antenna. From 1967 to 1969 we made regular measurements on six stations situated in different compass directions and at various distances from our office in Little Falls, N.J.

All the information thus obtained indicates that there can be 200% to 300% variations in AM signal levels at a given location. With the possibility of such large changes due to causes beyond a licensee's control, it is important to have some understanding of the effects.

Amount of Signal Variation

Figure 1 shows the measured variations in field intensity at our office, of the signal from WMTR Morristown, N.J., a 5-kW station which operates daytime on 1250 kHz with a directional array. Measurements were made almost daily from February 1967 to August 1969. As you can see, in winter the maximum signal level was as much as 50% above average, while in summer the minimum level was approximately 45% below average.

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The actual field intensity at our office, which is 13.7 miles from the WMTR antennas, varied from a low of 3.5 mV/m in June to a high of 9.7 mV/m in January.

To investigate the possible effects of different path lengths and compass headings, we measured other station signals at our office. The results are shown in the field-intensity measurements table.

The signal variations illustrated by Fig. 1 and listed in the table are typical of the cyclic variations we have encountered in the field. The clear-channel station study, which covered nearly a four-year period from 1962 to 1965, showed that stable antenna systems exhibit annual field-intensity variations. All stations which were checked during our study showed this evidence of seasonal variation.

The Cause: Temperature

Cyclic variations for a given path are more closely related to air-temperature changes than to soil-conductivity factors, such as soil moisture, freezing, snow and vegetation. The variations were found to occur from hour to hour. In fact, hourly measurements were made of WMTR one day in October when the temperature rose from 36°F at 8:30 a.m. to 65°F at 3 p.m. The 1250-kHz signal level decreased from 5.9 mV/m in the morning to 5.1 mV/m in the afternoon—a change of 14% in about six hours.

Although the signal level changes with air temperature (increasing with decreasing temperature and vice-versa), the amount of variation is not the same for different paths. To date, it has not been possible to determine why there are varying degrees of signal-level change along different paths—even after considering effective conduc-

Table: Field-Intensity Measurements

Station	Freq. in kHz	Distance in miles	Direction	Measured field in mV/m (min)	(max)	Ratio
WNBC	660	22.2	91°	23.0	31.0	1.35
WABC	770	7.3	85°	130.0	180.0	1.38
WCBS	880	22.2	91°	7.4	10.5	1.42
WMTR	1250	13.7	261°	3.5	9.7	2.77
WNJR	1430	11.9	189°	1.31	2.22	1.7
WKER	1500	8.5	332°	0.67	1.82	3.2
WRVA*	1140	1.7	30°	132.0	202.0	1.53

*Not a local station; included to show possible variations within two miles.

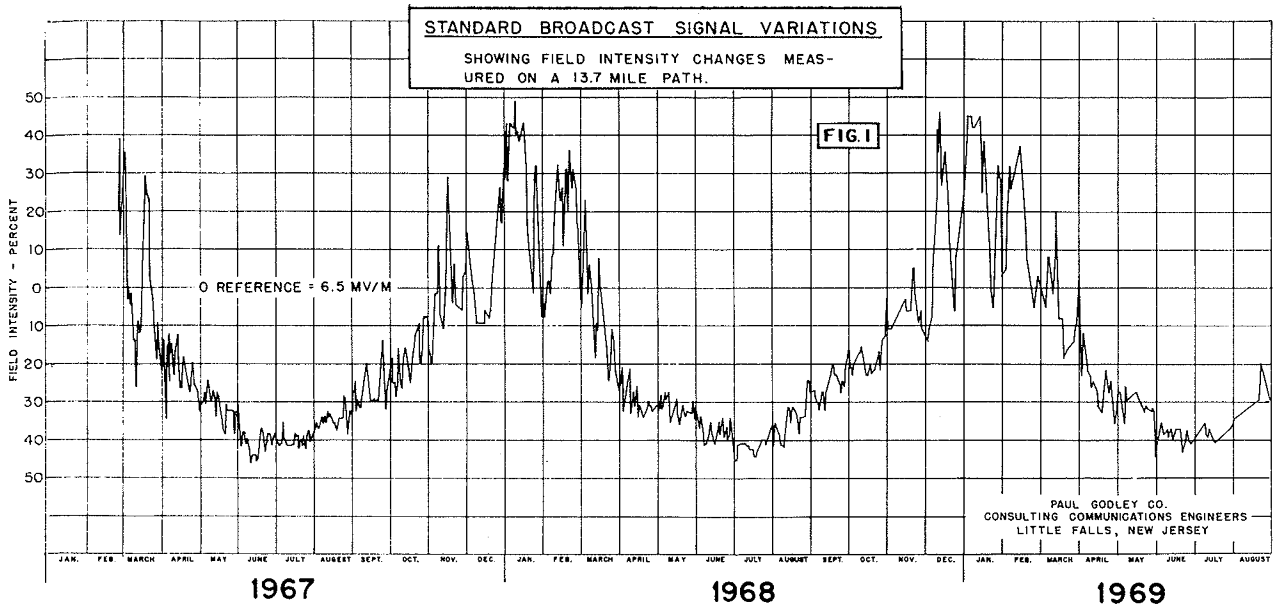

Fig. 1. Summer signal levels are low but stable, while winter levels are strong but variable.

tivities, type of terrain, compass direction, operating frequency, and degree of urbanization. Until all factors which contribute to the signal-variation phenomenon have been identified, it will not be possible to compute the degree of variation which might be anticipated for a given path.

An Example of Coverage Change

Signal-level variations have a direct bearing not only on the apparent adjustment of a directional antenna, but also upon coverage contour locations for both directional and nondirectional operations. To illustrate coverage fluctuations which might occur, we have created hypothetical station WSC (Winter Summer Change). Fig. 2 shows the WSC 0.5 mV/m contour, using a composite of the variations listed in the table. WSC, with its antenna in the business district of Sometown, USA, operates daytime with 250 watts on 1490 kHz, using a nondirectional antenna.

Terrain in the vicinity of Sometown, USA, is assumed to be hilly in some directions and marshy in other directions. To the north and east a greater variable factor has been arbitarily applied and to the southwest it has been assumed that there would be no difference between summer and winter signal levels.

The coverage map shows that Wintertown probably falls within the 0.5 mV/m contour only during the months of November, December, January and February. Halfway Corners is served only during extremely cold days in December, January and February. Zeroville happens to lie in a direction where the summer-winter variation is very small or nonexistent, and therefore is *never* included within the 0.5 mV/m contour—even on the very coldest days. Note that the coverage radius toward Wintertown is 12 miles in the summer and 19 miles in the winter. While the illustration is hypothetical, the contour changes shown have actually been measured.

Most of the measurements referred to in Fig. 1 and the table were made between 8:30 and 9:00 a.m., when the sun has not had much time to increase temperatures above early morning values. In the summer, as shown by Fig. 1, the day-to-day variation in signal strength was minimal. Summer morning air temperatures normally remain in a narrow range between 60° and 80°F. Winter air temperatures in our area generally vary from 10° or 15°F to 50° or even 60°F—sometimes covering the entire range almost overnight. The large changes, which can occur in signal strength because of large winter air temperature variations, are illustrated in Fig. 1.

Included with the technical data we recorded were such parameters as rainfall, air temperature, snow depth and general weather conditions. Additionally, for most of one year a record was kept of the temperature of the upper one inch of soil at the measuring site. Detailed study of all of this information has indicated that factors such as precipitation, snow, frozen ground and soil moisture content appear to have very little effect on signal levels. Measurements made after a one-inch rainfall following two or three sunny summer or winter weeks without significant precipitation indicated a field-intensity increase of less than 2%. In the winter, hourly changes in the signal have been observed even when the ground has been covered with more than a foot of snow.

We feel that the snow cover protected and insulated the soil from hourly temperature changes. This reinforces our earlier observations that air temperature appears to affect signal levels more directly than any other single known factor.

Distance as a Factor

It appears that distance is not necessarily a criterion which affects the amount of signal-level change. Referring back to the table we see that the WKER signal changed 320% (ratio of 3.2 to 1)

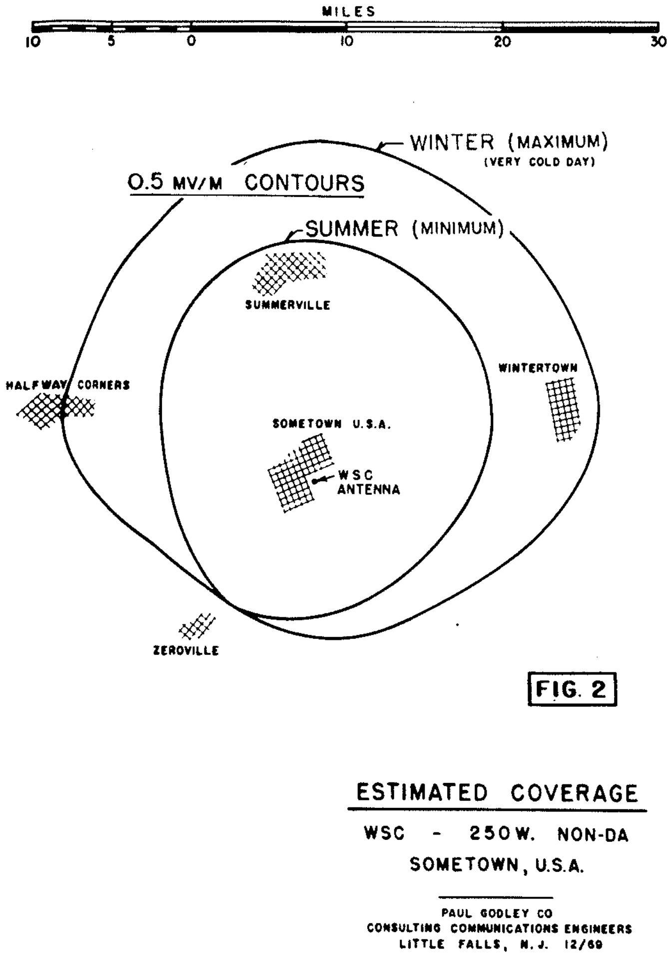

FIG. 2

Fig. 2. Winter/summer coverage of a hypothetical station.

over an 8.5-mile path, while WNBC's signal changed only 135% over a 22.2-mile path. WNBC, WABC and WCBS are all east of our office; in fact, WNBC and WCBS multiplex into the same tower. It is interesting to note that the WABC signal-level change over a 7.3-mile path is essentially the same as the WNBC and WCBS changes for 22.3-mile paths. In Richmond, Virginia, WRVA signal level changes recorded for a 1.7-mile path were 153%.

Less frequent observations (usually twice a week) were made for two-year period on stations ranging in distance from 23 to 132 miles. No trend or clue with respect to frequency or distance was particularly evident. The greatest variation in the group was for WFIL, (560 kHz Philadelphia) which showed a signal-level change of 390% for a 76-mile path. A considerably smaller change of 150%, was found for WCAU, (1210 kHz Philadelphia) at a distance of 73 miles. While there is more than a two-to-one difference in frequency, the reason for the difference in seasonal signal-level ranges might be attributed to terrain.

(Ed. Note: Factors which might contribute to the difference: WCAU operates 50 kW nondirectional, while WFIL operates 5 kW with a different directional pattern day and night. WCAU's smaller variation might be due to the fact that the absolute field intensity measured was greater than the absolute value measured from WFIL. Furthermore, the measuring location might be on the highly variable edge of a steep null in either the day or night pattern of WFIL.)

WCAU's signal starts out up the Delaware River Valley and WFIL's signal must travel some 25 miles over hilly terrain before crossing the river. On the other hand, WTIC's 1080-kHz signal, which traverses a 96-mile path from Hartford over rugged and hilly terrain, was found to change only 210% from winter to summer.

If station coverage over a particular community or area is important, or if DA monitor point fields exceed licensed limits on cold days, management should determine whether or not seasonal factors beyond the station's control are involved. Discussions with the station's consulting engineer may be in order as a step toward identification and isolation of the problem. If the chief engineer does not have the equipment to make field checks, the consultant can plan such a program. Seasonal variations in signal strength can at times be at the root of listener complaints. This is particularly true if the listener is at an electrically noisy urban location, or a distant point which undergoes 200% or 300% changes in signal level.

It appears that any one station might encounter a broad range of possible summer-winter variations in different directions. According to measured data for the northeast part of the country, cyclical changes can go from practically nothing up to 300% or more. Furthermore, the only way of knowing for sure is to make actual field measurements in pertinent directions.

The apparent accuracy of weekly monitor-point measurements made on directional antennas can be greatly affected by summer-winter signal-level variations. Maximum monitor-point fields are usually based upon the level measured in the last full proof, plus a 5% to 10% tolerance. If the proof was done in summer, there is a good chance that monitor-point fields measured in winter could exceed license maximums.

What to Do

Where summer-winter changes affect directional monitor-point values, particularly in instances where license maximums are exceeded, a station should promptly inform the FCC. Information sent to the FCC should include sufficient data to demonstrate the summer-winter effect, which can be identified in several different ways. The first and perhaps most positive procedure is to redo nondirectional and directional measurements at the same sites in the problem direction. This is very easily done where the station normally operates with a nondirectional pattern daytime and directional night (or vice-versa in a limited number of instances).

A second method is to make complete radial measurements in the problem direction and reanalyze the data to show that the field has remained constant and that the conductivities differ from the original or reference data. A third method of demonstrating summer-winter effect is with data which cover a 12-month cycle of field variations. The cycle should, of course, repeat itself in the manner indicated in Fig. 1. If the problem is encountered before data for a 12-month period are available, partial information might be filed as an interim measure with complete data following as soon as a full cycle is made.

The magnitude of signal-level variation which can be caused by seasonal changes in effective conductivity dictates that this phenomenon be taken into account at any time proof, skeleton-proof or other field-intensity measurements are made. If at all possible, skeleton proofs and other pattern checks should be made in the same season that the last full proof was accomplished. In addition to the date and time of each measurement (a recent FCC requirement), the daily temperature or temperature range should be logged as an important aid in data analysis and comparison. Air temperature values should be recorded with weekly monitor-point measurements, to identify and separate antenna-system problems and seasonal variations in signal level.

Section 73.152 of the FCC Rules and Regulations indicates that actual field-intensity measurements will take precedence over computed projections. While the Rules and Regulations do not provide for summer-winter changes, the FCC realizes that such changes in effective conductivity can occur. Measurements taken in the summer often differ considerably with those taken in the winter, and many a competitive argument has ensued on this account. When differing data are presented and seasonal variation is the probable cause, the FCC is likely to accept a mean or average value of conductivity or contour location. In accordance with Section 73.152, properly made measurements—whether taken in summer, winter, spring or fall—are usually accepted in preference to theoretical projections.

I wish to acknowledge the contribution of J. Sherman, who made most of the measurements discussed herein, and C. Kauffman, who helped analyze the data. **BM/E**

A rare example of AM multiplexing, this 525-foot tower is shared by WCBS and WNBC, both 50-kW New York stations. Site is tiny High Island in Pelham Bay off the Bronx. Tower guys extend to edges of the small island, and the ground radials trail off into the surrounding salt water. BM/E Photo