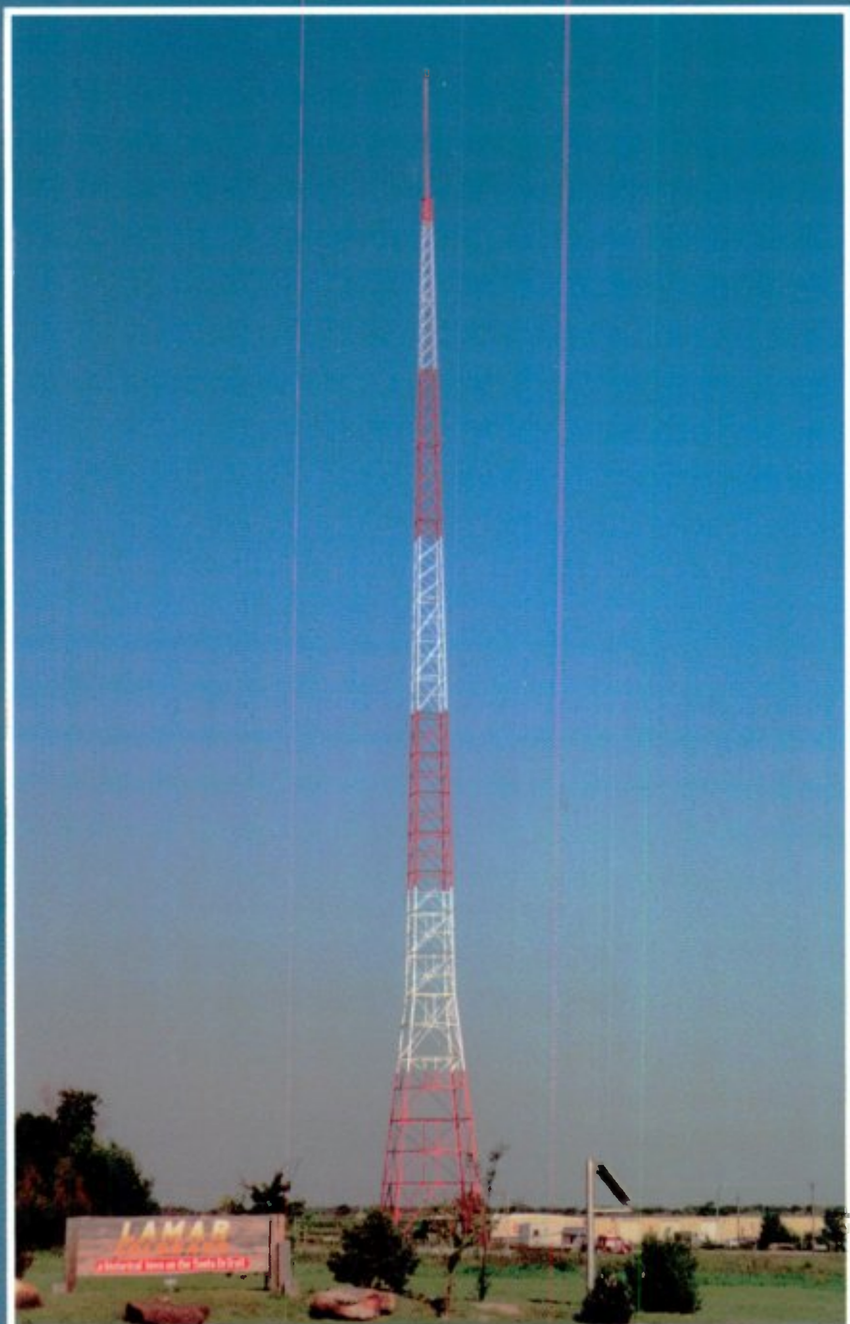
AM BROADCAST STATION ANTENNA SYSTEMS

A BASIC GUIDE



PATRICK M. GRIFFITH

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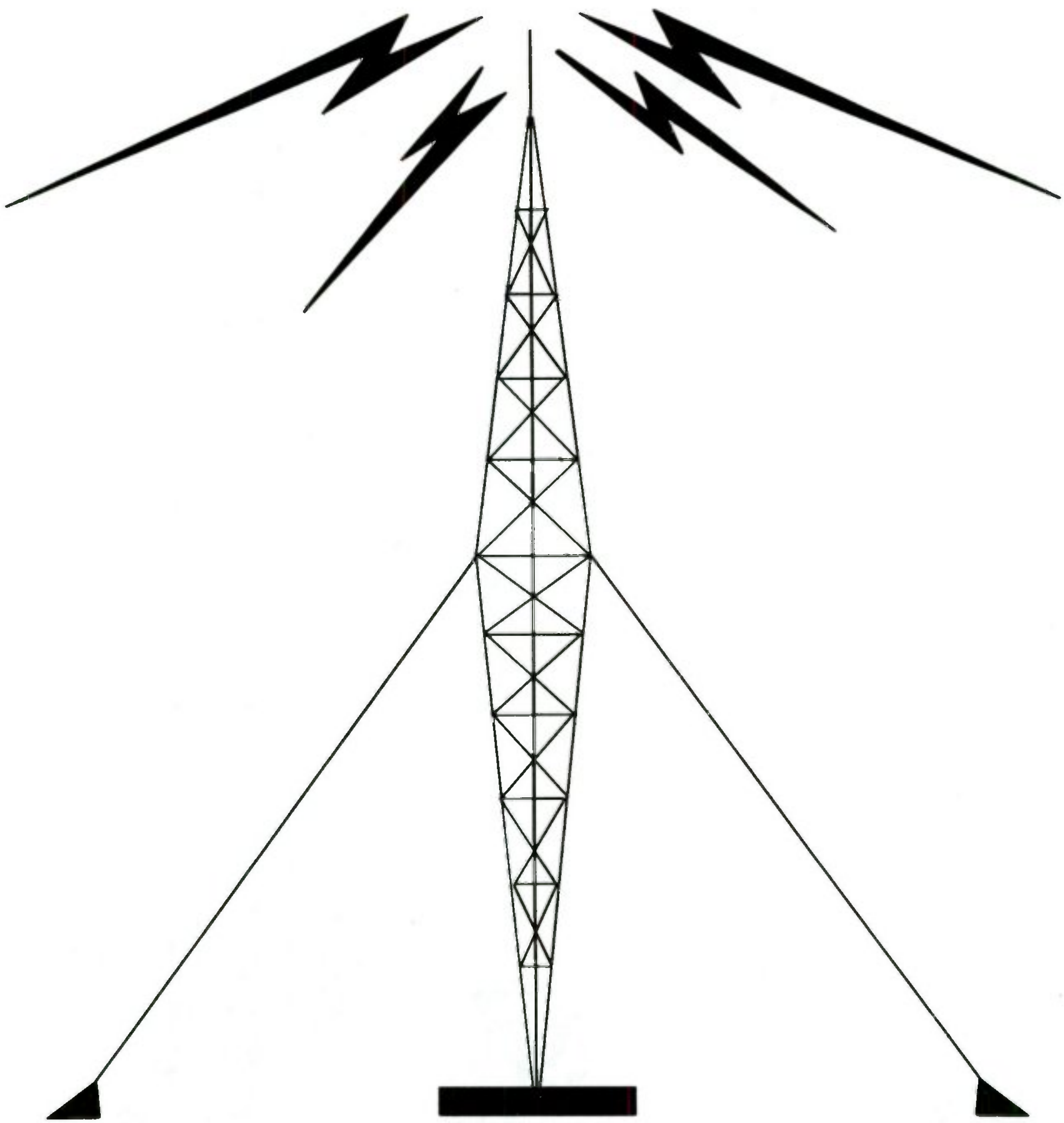

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Printed in the United States of America.

Library of Congress Catalog Card Number: 98-93568
ISBN: 0-7392-0085-2

Printed in the USA by

MORRIS PUBLISHING

3212 East Highway 30 • Kearney, NE 68847 • 1-800-650-7888

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by

Patrick M. Griffith

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FOREWORD

Humans were created to be social beings. The need to communicate with one another was evident from day one. As social structures developed mankind's insatiable appetite for the exchange of thoughts, ideas and opinions could not be fulfilled with personal one-on-one face-to-face communication. The ancients employed the services of runners to carry information between persons and groups. Later came the messengers on horseback. In the sixteenth century the printing press stepped in with the written word to satisfy part of this need. Native Americans used fire in the form of smoke signals. The early American stagecoach drivers used a horn to signal the way station of their imminent arrival. The Pony Express was the forerunner to today's Federal Express. Samuel Morse's telegraph was the miracle of communication in the nineteenth century. Shortly after the turn of the century the telegraph became the wireless radiotelegraph.

In 1912 Dr. Frank Conrad, an employee of the Westinghouse Electric Company, began experimenting with methods of sending the human voice through the air by amplitude modulating (AM) the carrier wave. Within a few years Conrad, and others, were on the air on an intermittent basis, with music and voice announcements. A giant step forward in the art of communication was taken on November 2, 1920 when KDKA signed on the air as the first commercially licensed broadcast station. It was now possible to reliably communicate with the masses not only via the written word but the spoken word as well! By today's standards the miniscule amount of power and the antenna system used on that November evening seems indeed crude. A one hundred-watt transmitter and a wire antenna on the roof of the Westinghouse Electric Company's building in East Pittsburgh, Pennsylvania served as the electronic gateway to the world.

Broadcasting was an instant success. Before the end of 1924 KDKA had increased power to fifty thousand watts. By then there were hundreds of licensed broadcast stations in the United States providing information, ideas and entertainment to any and all who cared to listen.

Both the equipment and the antenna systems used by AM radio stations became much more sophisticated. Plate modulated transmitters were replaced by Dougherty amplifiers and later by transmitters that utilized pulse duration and digital modulation. The days of water and forced air-cooled transmitters that literally had buildings built around them faded into the sunset. Tubes fell out of favor. Solid state devices made for transmitters that could be unloaded and put in place by two people. The vertical radiator replaced the horizontal wire antenna. The single vertical radiator opened the door to multi-element directional antenna systems. This technology paved the way for the almost 5000 AM radio stations that occupy the medium wave broadcast band in the U.S. today.

The following paragraphs and pages introduce the non-technical reader to the very basic concepts of what is an integral part of the AM broadcast system. The antenna system is the final hardware link between the broadcast system and the listener's radio. Without this link broadcasting would not be possible!

Enjoy! May you come away after reading the last page of this book with a bit more knowledge of the AM antenna system than you had when you began reading this foreword!

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INTRODUCTION

The term *AM radio station* is somewhat misleading from a technical standpoint. The name was applied in the early beginnings of broadcasting because of the modulation method employed for encoding the audio signals onto the carrier frequency, Amplitude Modulation. So in technical terms AM describes a modulation type rather than a frequency range. AM modulation can actually be used on any frequency as can FM, SSB, PM and any of the other types of modulation. However, since the early application of the term, *AM radio* has been the common reference name given to the band of frequencies that now lie between 535 and 1705 kHz (kilohertz).

These stations are also commonly referred to as *medium wave* (MW) stations, a reference to their general frequency range, or as *standard broadcast* stations, a reference to their being the first type of radio station designed to broadcast with the intent of being received by the general public.

Commercial AM broadcasting in the U.S. generally began about 1920. By November of that year there were approximately 18 stations on the air. The first real control of these broadcasters came about with the establishment of the Federal Radio Commission (precursor of the Federal Communications Commission) by the Radio Act of 1927.

As of December 31, 1997, Federal Communications Commission records listed a total of 4,762 AM broadcast licenses in its database. The present U.S. AM band is comprised of 117 channels, each 10 kHz wide, with carrier (center) frequencies starting at 540 kHz and ending at 1700 kHz. The section of the band that is located between 1605 and 1705 kHz is commonly referred to as the *X-band* (not to be confused with the microwave region X-band) or the *AM expanded band*.

The purpose of this publication is to provide a basic understanding of the facilities and operations associated with an AM broadcast station transmitting plant, with particular emphasis on the antenna system. It has been written at the layman level and many of the more technical aspects of these facilities have been intentionally excluded.

This publication will be of interest to non-engineering members of the AM broadcast station staff as well as to broadcast band 'DXers' (those whose hobby is to listen to distant AM stations) and others with a general interest in such facilities.

Those needing additional or more detailed information on this subject will find many of the listings in the RESOURCES section of this publication to be an excellent source of material.

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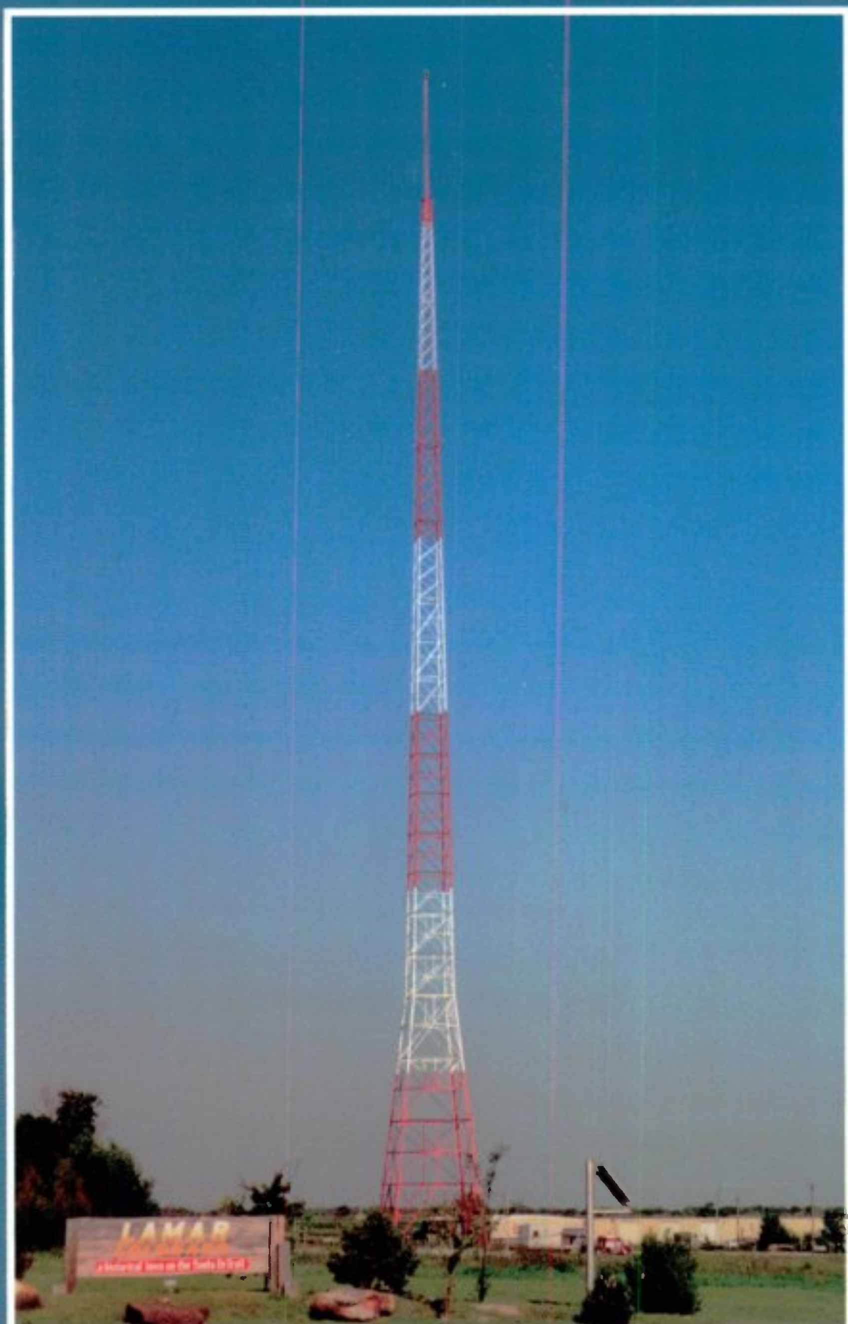

PATRICK M. GRIFFITH

CHAPTER 1

PROPAGATION

The signals radiating from an antenna generally tend to travel away from the antenna in all directions unless they are electrically or physically altered in some manner.

Some of the signals travel along and parallel to the ground for a distance. These signals may be effected by absorption into buildings and foliage, by moisture in the atmosphere, and by many other objects in their path (see figure 1.1). They may also be scattered by RF reflective objects. These are called *ground wave* signals and are the main source of signals in the station's primary coverage area.

Other signals radiate upward at various vertical angles. These are called *sky wave* signals (see figure 1.2) and are the main source of signals in, and sometimes beyond, the station's secondary coverage area.

Many AM broadcast stations are required to either reduce power, switch from a non-directional antenna to a directional antenna, change from one directional pattern to another, or cease operations completely each day at local sunset. This is because of the changes that occur in the ionosphere during local nighttime hours and the effect that these changes have on the propagation of the sky wave signals (see figure 1.3).

The ionosphere is the area of the atmosphere that extends from about 50 km (31 miles) to about 600 km (370 miles) above the earth's surface. The various types of energy that radiate from the sun and strike its molecules heavily effect it. One example of the effects of the sun's energy on this region of the atmosphere is what is known as the aurora borealis or northern lights. These effects vary greatly with time of day, season, and the intensity and nature of the solar activity.

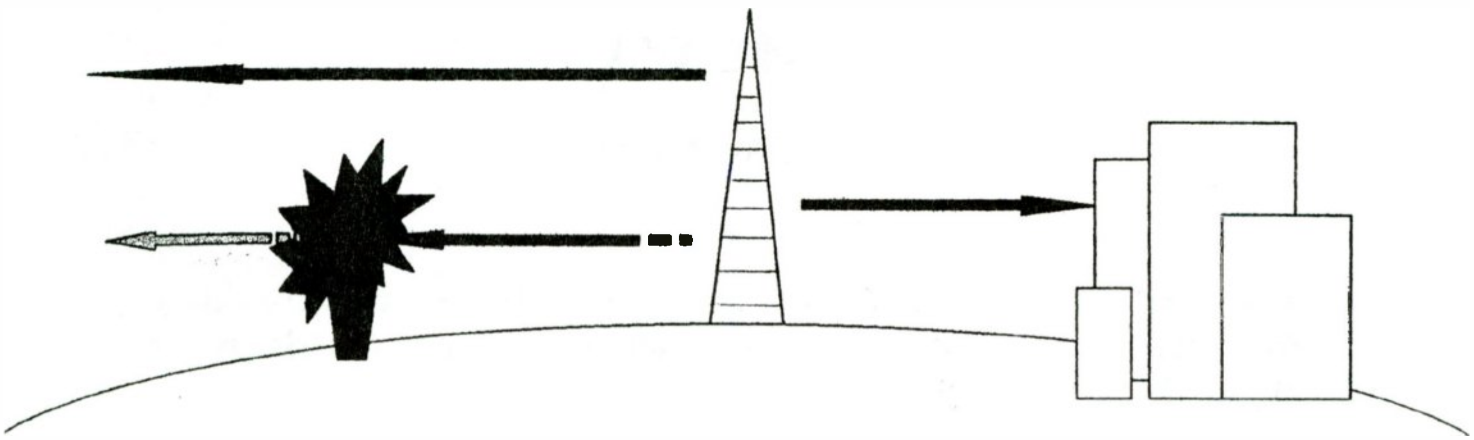

Figure 1.1 – ground wave signals

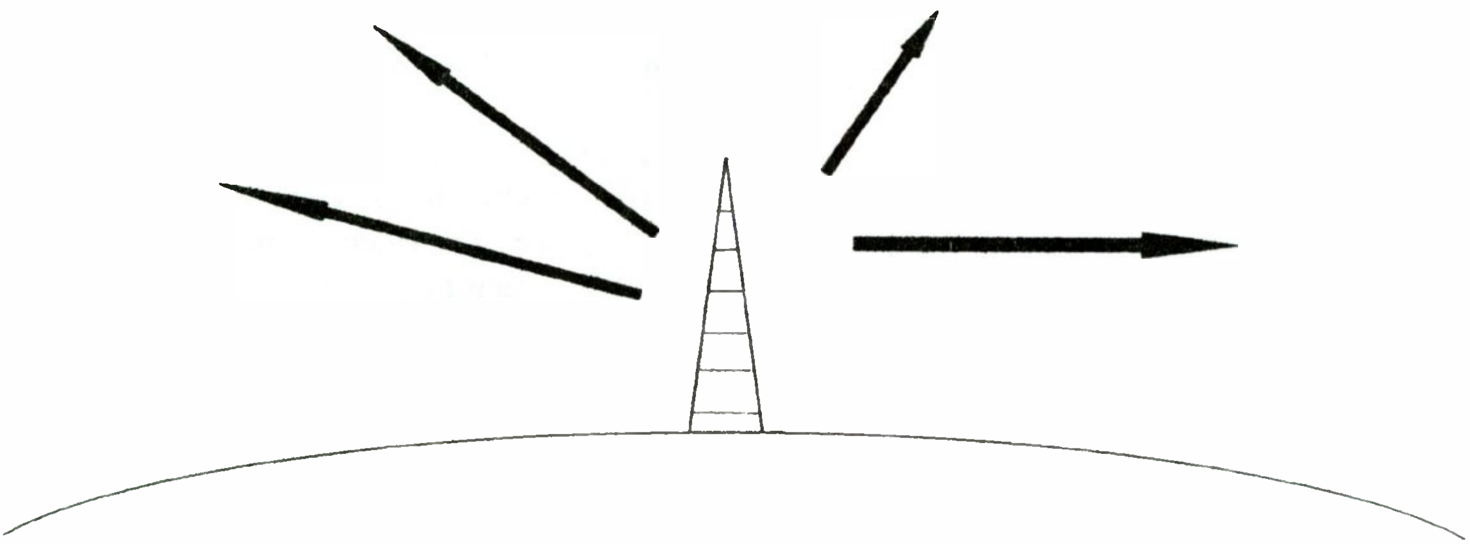

Figure 1.2 – sky wave signals

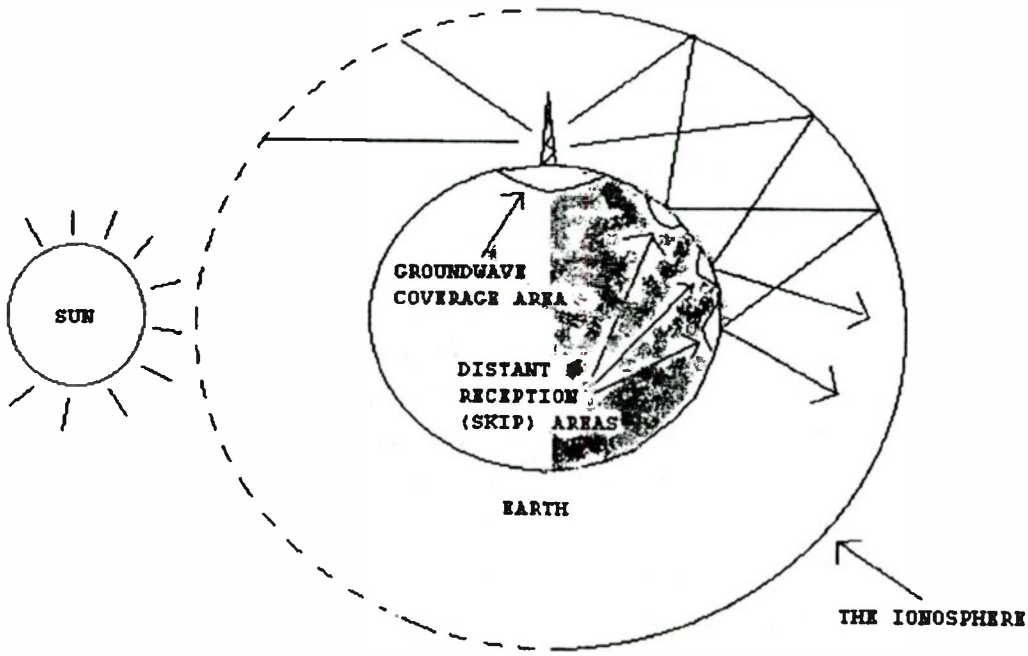

Figure 1.3 – effect of day and night ionosphere on transmitted signal

During daylight hours, with the ionosphere effected by direct radiation from the sun, the D layer of the ionosphere absorbs AM broadcast band energy. No AM band signals can pass through this layer. During this period an AM station must depend entirely upon its ground wave signal for coverage. The distance of this coverage is a product of many variables including transmitter power, antenna characteristics, ground conductivity between the transmitter and receiver locations, weather, physical location of the transmitter and the receiver, and so on. Even the most powerful AM station has a reliable daytime ground wave coverage of only about 100 miles.

As the sun sets, the D layer quickly disappears and AM signals are refracted back to the earth by the F2 layer of the ionosphere. Under these conditions the sky wave signals tend to bounce back to the earth at a distant location that is determined by the angle at which the signals strike and bounce off the ionosphere. Given sufficient energy these signals can bounce again off of the earth's surface and back to the ionosphere where the cycle is repeated. At each point where the signals return to the earth they might be of sufficient strength to be heard on a receiver.

This is a common method employed by short wave broadcasters to reach international audiences. Some may refer to this as *skip* because the signals skip off the ionosphere and the earth much as a flat rock thrown at the proper angle skips along the surface of a pond.

The ionosphere is very *fluid* and varies continuously much like the surface of the ocean. The signals striking and reflecting off it also vary continuously in their arrival and reflected launch angles. This causes much of the fading that is commonly heard on distant AM stations at night. The analogy is much like that of a very bright flashlight being shone on the earth's surface from the altitude of the ionosphere. As the light is moved around at various angles, it illuminates various areas of the surface to different degrees. The *illuminated* areas are the areas where the signal can be heard at that moment in time.

So at night an AM station has coverage from both its ground wave and it's sky wave signals. The problem that arises from the bouncing sky wave signals is that the signals might return to earth in an area where another station is operating on the same frequency thus causing an interference problem in that station's primary coverage area. It is for this reason that the FCC places certain restrictions on the various classes of AM stations based on many variables including the *grandfather* principal or 'who was there first.' Protection of other stations on the operating frequency is the prime reason that many stations must alter their operations at night.

Frequently there will be an area between the primary and secondary coverage areas where the signals are poor or non-existent. This can be due to the fact that the area is beyond the coverage of the primary service ground wave signal but not far enough away from the transmitter to receive the first secondary service sky wave signals. Or it might be that the receive site is so located that signals are received from both the sky wave and the ground wave and they are slightly out of phase causing cancellation of one another. This area is known as the *intermittent coverage* area.

CHAPTER 2

CLASSES OF AM STATIONS

There are several classes of AM stations in the United States. These are:

A. Clear channels
   1. Class A
   2. Class B
   3. Class D
B. Regional channels
   1. Class B
   2. Class D
C. Local Channels
   1. Class C

Clear channels are designated for stations that serve very large geographical areas.

A class A clear channel station is one that renders primary service (the area covered by the ground wave signal) and secondary service (the area covered by the sky wave signal) over an extended area of the country. These stations are protected from objectionable interference by stations on the same or adjacent channels in the primary coverage area and by stations on the same channel in the secondary coverage area. Although these stations can be licensed for anywhere from 10,000 to 50,000 watts of power, a typical class A clear channel station operates with 50,000 watts, a non-directional antenna, and an unlimited (7 days a week, 24 hours a day) schedule. These stations are referred to as the *dominant station* on that channel. In some cases there are two dominant stations on a clear channel separated by vast distances and utilizing directional antennas at night to protect each other's signals.

A class B clear channel station renders service only in it's primary coverage area. Class B stations operate with power of anywhere from 250 watts to 50,000 watts (limited to 10,000 watts in the expanded band). They are also required to have unlimited hours of operation and must provide protection to all class A stations on the frequency.

A class D clear channel station operates with between 250 watts and 50,000 watts. It receives no protection from other stations but must render protection to all class A and B stations on the channel. It's hours can be daytime only, limited time, or unlimited. Class D stations operating at night are not required to provide specific amounts of coverage during those hours. It is not unusual to see these stations operating with very low power settings, sometimes as low as 1 watt, during this period.

Regional channels are those on which class B and D stations may operate for the purpose of serving a specific geographic region or a specific center of population such as a city or town and the suburban areas around it.

Local channels are those on which class C stations operate to serve a primary community and the suburban areas around it. Their hours of operation must be unlimited.

The size of a class C station's service area may be reduced because of interference from adjacent stations. They operate with a minimum of 250 watts and as much as 1,000 watts. In a few cases, an older station whose license was issued prior to the establishment of the current rules may have been grandfathered in at power levels as low as 100 watts.

AM CHANNEL ASSIGNMENTS BY CLASS

540 / A	930 / B	1320 / B
550 / B	940 / A	1330 / B
560 / B	950 / B	1340 / C
570 / B	960 / B	1350 / B
580 / B	970 / B	1360 / B
590 / B	980 / B	1370 / B
600 / B	990 / A	1380 / B
610 / B	1000 / A	1390 / B
620 / B	1010 / A	1400 / C
630 / B	1020 / A(1)	1410 / B
640 / A(1)	1030 / A(1)	1420 / B
650 / A(1)	1040 / A(1)	1430 / B
660 / A(1)	1050 / A	1440 / B
670 / A(1)	1060 / A	1450 / C
680 / A	1070 / A	1460 / B
690 / A	1080 / A	1470 / B
700 / A(1)	1090 / A	1480 / B
710 / A	1100 / A(1)	1490 / C
720 / A(1)	1110 / A	1500 / A
730 / A	1120 / A(1)	1510 / A
740 / A	1130 / A	1520 / A
750 / A(1)	1140 / A	1530 / A
760 / A(1)	1150 / B	1540 / A*
770 / A(1)	1160 / A(1)	1550 / A
780 / A(1)	1170 / A	1560 / A
790 / B	1180 / A(1)	1570 / A
800 / A	1190 / A	1580 / A
810 / A	1200 / A(1)	1590 / B
820 / A(1)	1210 / A(1)	1600 / B
830 / A(1)	1220 / A	1610 / B
840 / A(1)	1230 / C	1620 / B
850 / A	1240 / C	1630 / B
860 / A	1250 / B	1640 / B
870 / A(1)	1260 / B	1650 / B
880 / A(1)	1270 / B	1660 / B
890 / A(1)	1280 / B	1670 / B
900 / A	1290 / B	1680 / B
910 / B	1300 / B	1690 / B
920 / B	1310 / B	1700 / B

A(1) - ON THESE CHANNELS ONLY 1 CLASS A 50,000 WATT STATION MAY BE ASSIGNED - CLASS B & D STATIONS MAY ALSO BE ASSIGNED - IN ALASKA THESE ARE CLASS A CHANNELS (ON SOME CHANNELS MULTIPLE 50,000 WATT STATIONS MAY BE AUTHORIZED IF SEPARATED BY VAST DISTANCES AND USING DIRECTIONAL ANTENNAS TO PROTECT EACH OTHER'S NIGHT PATTERNS

A - ON THESE CHANNELS CLASS A, B OR D STATIONS MAY BE ASSIGNED

B - ON THESE CHANNELS CLASS B & D STATIONS MAY BE ASSIGNED

C - ON THESE CHANNELS CLASS C STATIONS MAY BE ASSIGNED - IN ALASKA, HAWAII, PUERTO RICO AND THE U.S. VIRGIN ISLANDS THESE CHANNELS ARE CONSIDERED AS CLASS B SINCE THERE ARE NO CLASS C CHANNELS ASSIGNED IN THOSE AREAS

* STATIONS OPERATING ON 1540 MUST PROTECT THE BAHAMA ISLANDS

CHAPTER 3

FEDERAL COMMUNICATIONS COMMISSION REGULATIONS

The Federal Communications Commission regulations pertaining to AM broadcast stations are contained primarily in the Code of Federal Regulations (CFR) Title 47 Part 73.

FCC regulations specify minimum allowable antenna heights for AM broadcast stations as well as minimum allowable specifications for the electrical ground system beneath the antenna. They also specify minimum allowable field strength requirements for the radiated signal. These requirements are designed to ensure that the station radiates sufficient power to effectively provide the coverage required for it's particular class and to meet the specifications of it's license.

The height requirements range from about 45 meters (147.63 feet) for a class C station operating above 1200 kHz to 166 meters (544.62 feet) for a class A station operating at 640 kHz. These of course are minimums and many stations use longer antennas that have a gain factor in order to achieve better coverage. Large antennas that are .5 wavelengths or more in height are often referred to as *anti-fade* antennas because their radiation pattern helps to eliminate fading and interference at distant reception sites.

Of course, as they say, rules are made to be broken and it is always possible for the FCC to approve an exemption. For example, if a station can achieve the necessary field strength with a shorter antenna than the minimum requirements, a waiver might be granted for that station.

The listed antenna height requirements specify the physical height of the antenna structure itself, not the height above ground. Mounting the antenna on a high object, such as a building, does not change the height requirement for the antenna itself.

Mounting AM antennas on buildings (see photo 3.1) was a fairly common practice a few decades ago. However, it is a rather rare sight now and the FCC will no longer authorize new rooftop AM antenna systems. Although this type of installation did have a few advantages such as the elimination or reduction of shadowing effects caused by the presence of a large number of tall buildings in an urban setting, there were many disadvantages including the difficulty in obtaining a sufficient ground system below the antenna. Experience has also shown that installing AM antennas on buildings that are around ¼ wavelength in height for the frequency of operation may actually decrease the efficiency of the antenna.

The electrical ground system is a very important part of the AM antenna array. It serves several purposes including lightning and static dissipation. However, it's primary importance in the AM broadcast setting is to act as an electrical counterpoise for the radiating element, the tower. Electrically speaking the ground system is the second half of the antenna element. Without a good ground counterpoise the AM antenna array performs poorly and unpredictably.

The electrical conductivity of the earth varies widely. Some areas, such as mountainous terrain, are poor electrical conductors. Other areas, such as marshy or wetland areas are good electrical conductors. Salt water is usually the best and the ground in and around large cities is usually the worst.

Because of these variables and the need for a good ground to ensure proper operation, FCC regulations specify that the ground system below a vertical radiator used in the AM broadcast service must consist of a series of at least 90 wires radiating out from the tower base at evenly spaced intervals like the spokes of a wheel (see photo 3.2) and extending at least .25 wavelength at the operating frequency.

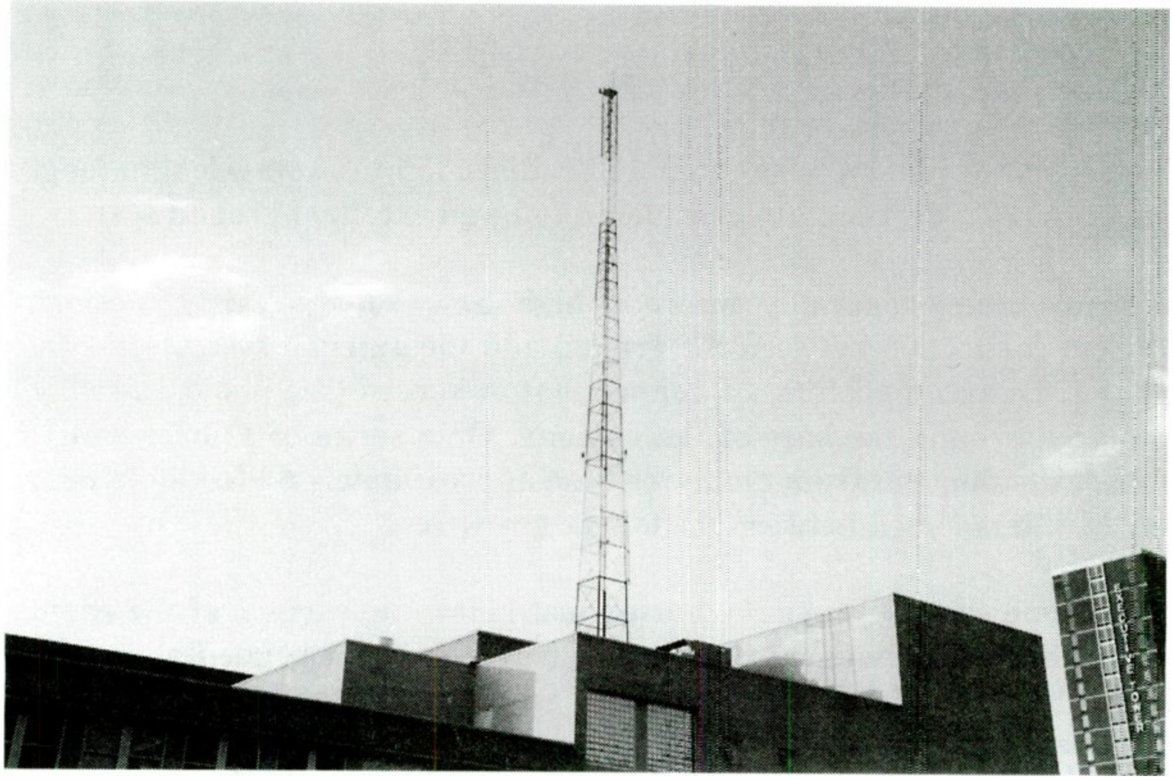

photo 3.1 – Roof mount AM broadcast antennas, common in the past, are rare today.

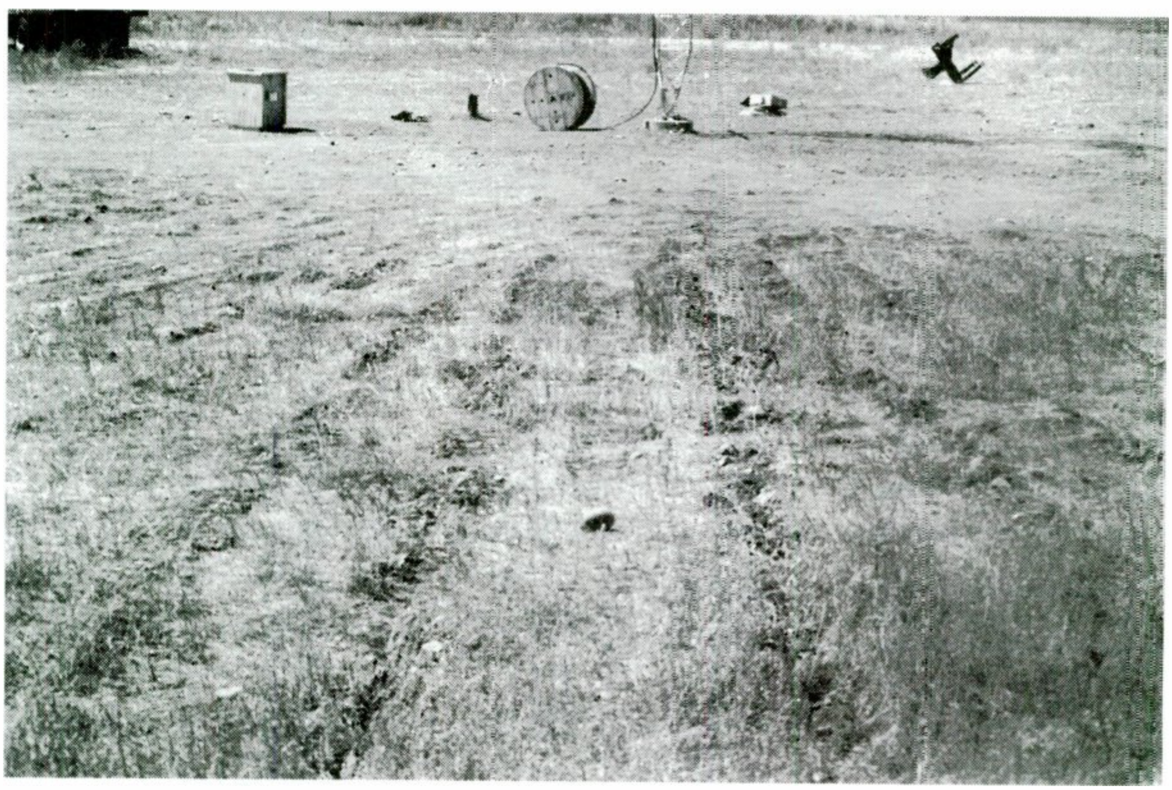

photo 3.2 – The trenches in which the ground radials have been buried for this new AM tower can be seen radiating outward from the tower base.

The regulations go on to say that 120 radials, .35 to .4 wavelength long, spaced every 3 degrees, are considered to be an excellent ground system.

In many cases, especially where a high base voltage exists, a more efficient connection between the ground and the antenna system may be desired. To accomplish this a copper mat or screen (see photo 3.3) may be placed around the base of the antenna. Or a series of shorter radial wires, extending out from the tower base approximately 50 feet in length, may be interspersed between the longer guy wires.

The ground system is usually buried just below the surface of the earth for its physical protection. However, it may also be suspended above the ground or simply laid upon the ground and still maintain its effectiveness.

Again, as in the case of the antenna itself, these requirements may be reduced if it is proven that a lesser system is sufficient. For example, a station whose antenna is immediately adjacent to a saltwater ocean might achieve sufficient coverage with a very minimal ground system.

Another consideration of the ground system is the physical ability to install the system at the site. If the terrain is excessively inclined, filled with rocks, or covered with trees and brush, this may be a difficult or impossible task. These considerations should be weighed during site selection. In some cases it may be necessary to physically clear a large area (see photo 3.4) in order to accomplish the installation.

Because of need for a highly conductive ground system, many AM broadcast antennas are located on low, marshy ground (see photos 3.5 and 3.6) instead of the high ground usually sought for FM stations.

photo 3.3 – Beacon lights, rolls of copper ground mat, and spools of copper wire await installation at a new AM tower construction site.

photo 3.4 – The large circular clearing surrounding the antenna tower near the center of this photo is an example of the need to remove obstructions from the antenna field.

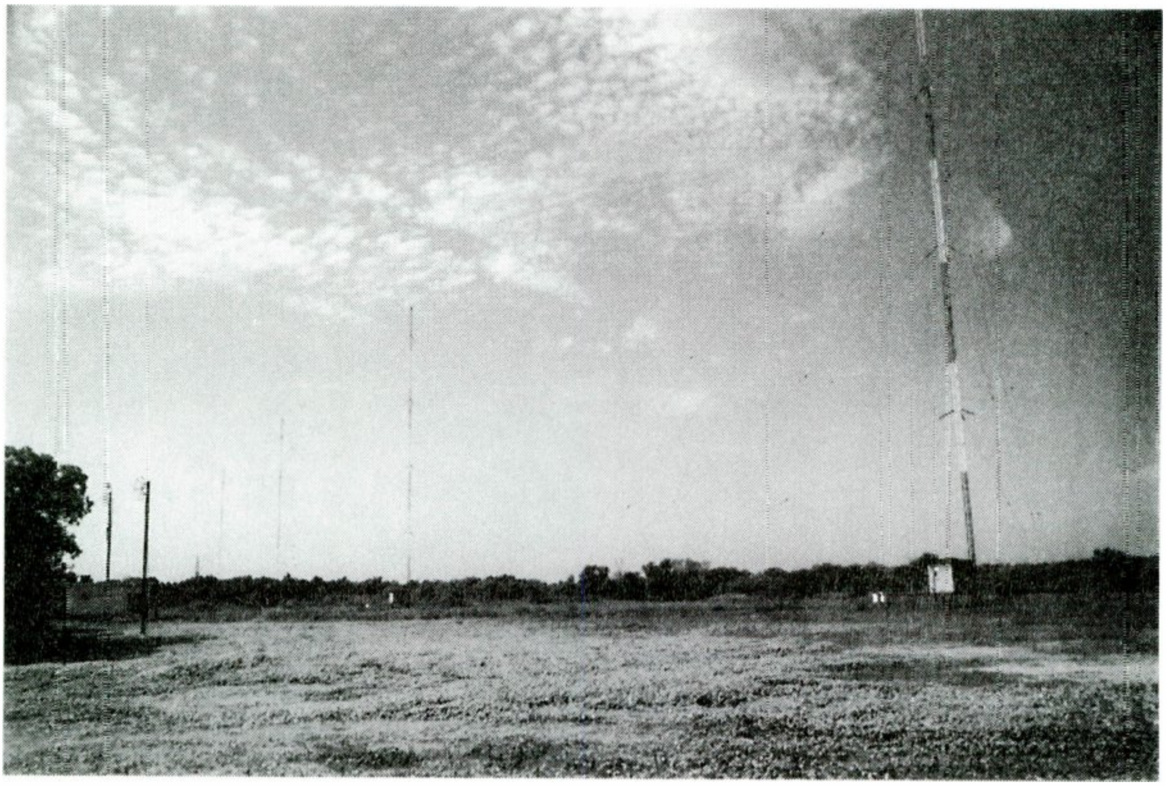

photo 3.5 – The KOOO/1190 daytime transmitter site is located in a marsh adjacent to a landfill in Irving, TX.

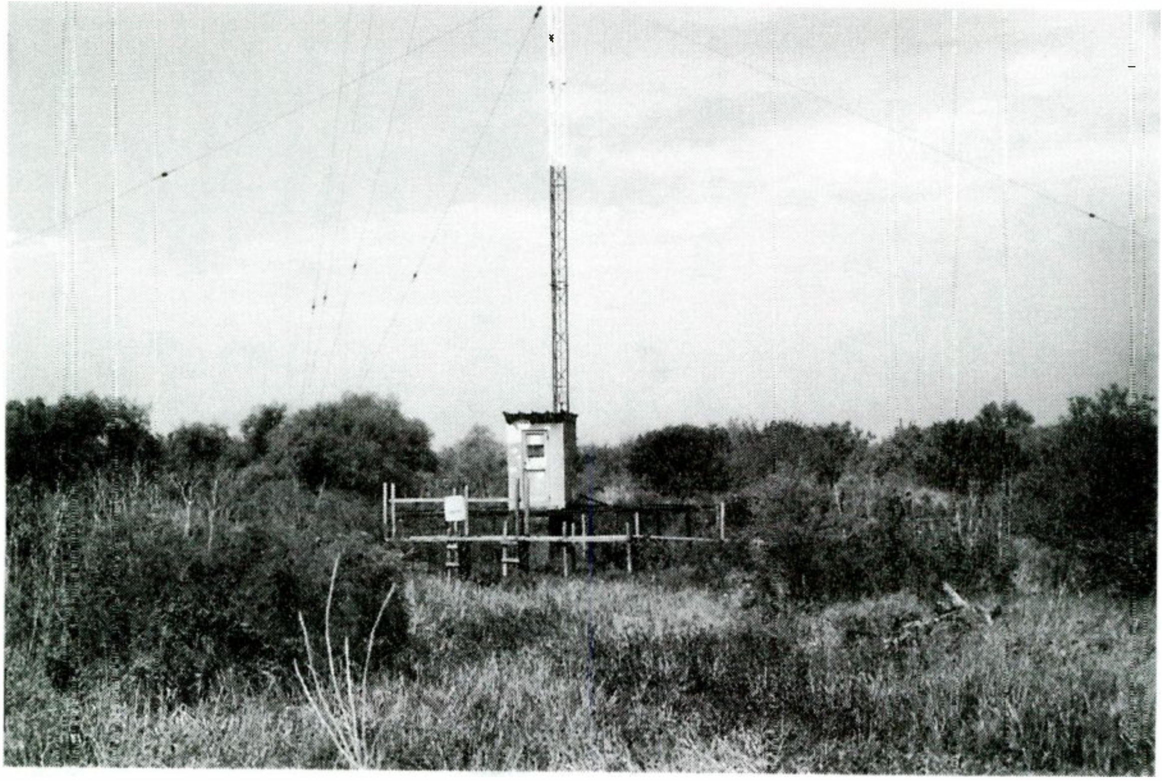

photo 3.6 – A closer view of one of the KOOO/1190 tuning shacks. It is built on supports that actually straddle a creek bed.

CHAPTER 4

THE AM ANTENNA

The average person might be very surprised to learn that the towers used in an AM radio station don't simply support the antenna....they *are* the antenna! In AM stations the entire tower acts as an antenna element and radiates the transmitted signal. This is because of the long physical length of the signals generated at these frequencies.

At 98 megahertz (MHz) in the center of the FM radio band, for example, a ¼ wavelength antenna is about 30 inches long, the reason that most car radio antennas are about that length. But at 1000 kilohertz (kHz), near the center of the AM broadcast band, a ¼ wavelength antenna is around 245 feet long!

In the early days of AM radio, the broadcast antenna was almost universally some form of *flat top* style (see photo 4.1). The antenna most often consisted of one or more horizontal wires with a vertical wire dropping down from either the center, or from one or both ends, to the transmitter. Most used wooden towers or poles for support.

During the 1930s as propagation began to be understood it was realized that flat top antennas produced more sky wave, and less ground wave, than was desirable for the coverage needs of many stations. The need to create directional patterns (see Chapter 5) also came about during this period and vertical antennas began to increase in popularity while horizontal antennas slowly began to be replaced. As late as 1949 some large non-directional stations such as KNBC/680 (now KNBR) were still using flat top style antennas. Other stations are known to have maintained their flat top antennas into the 1980s as a backup antenna.

However, by the middle 1980s virtually all U.S. horizontal AM broadcast antennas had disappeared. Today all U.S. AM stations employ vertical antenna systems comprised of towers.

photo 4.1 – This classic 'flat top' style antenna is a 'T' configuration. It is currently in use as an aircraft navigation beacon operating near 400 kHz.

Vertical tower antennas are generally easy to install and maintain, they provide vertical signal polarization in their ground wave or primary coverage area, and they provide the proper takeoff angles for the sky wave signals needed to create the nighttime secondary coverage pattern required of many stations. Individually they are generally non-directional radiating equally in all directions of the compass. However, they are also well suited to system designs that allow them to work with other vertical elements to produce precise directional patterns.

There are several types of vertical towers commonly used in the AM broadcast service. These are:

1. **self-supporting**
    - a. **grounded**
    - b. **base insulated**
2. **guy-wire supported**
    - a. **grounded**
    - b. **base insulated**

Each type has several distinct advantages and disadvantages. Self-supporting towers (see photo 4.2) are generally of heavier construction than their guyed counterparts since the tower must support it's own weight, the weight of any additional equipment mounted on it, and the forces of wind and ice loading placed upon it. The tower itself is the sole support mechanism for this weight. The primary advantage is the lack of need for guy wires to support them. Disadvantages include typically higher initial acquisition and installation costs. They are also generally limited to lesser heights than guyed towers due to the fact that they must self support all of the weight and stress loading on the tower. The more common base insulated type also requires an expensive insulator at the bottom of each leg which must be strong enough to support the weight and stress forces on the tower.

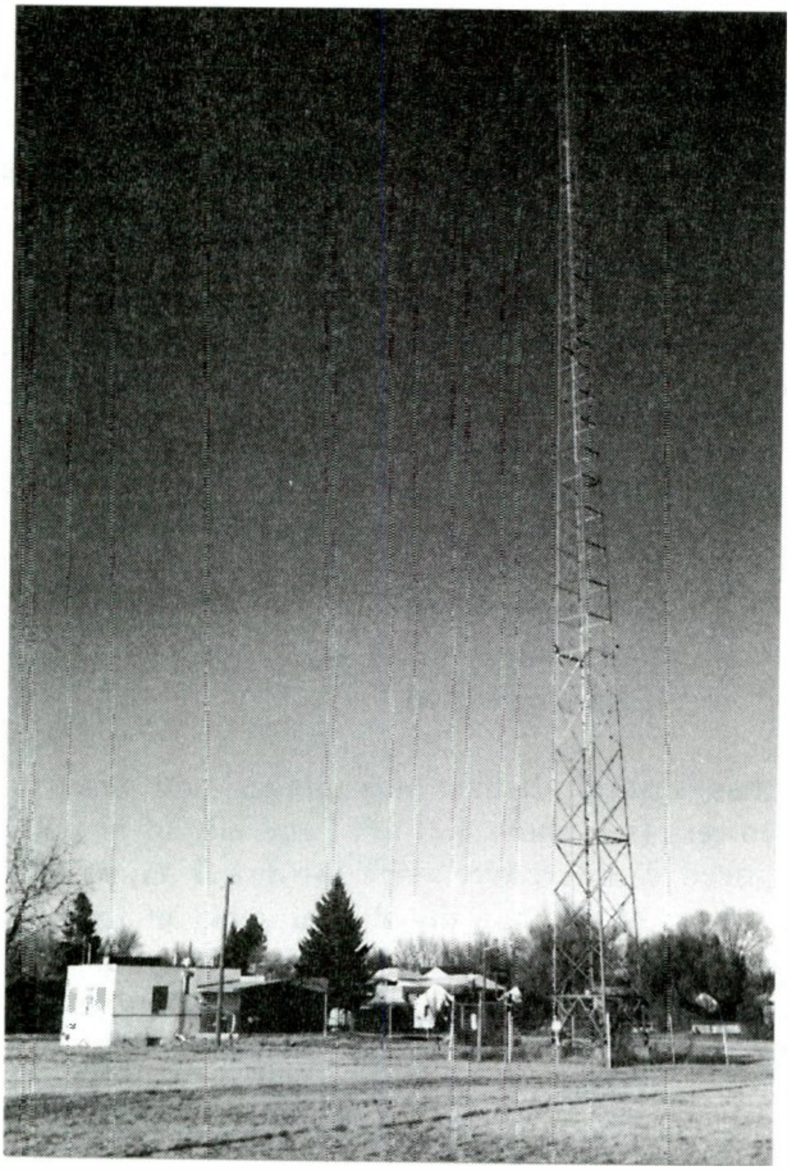

photo 4.2 – The 148 foot self supporting tower of KJJL/1370 in Cheyenne, WY.

Guy-wire supported towers (see photo 4.3) are designed so that the guy-wires absorb a large portion of the stresses placed upon the tower. The tower must support it's own weight and the weight of any equipment mounted on it plus the additional downward force applied to it by the guy-wires and by the weight of any accumulations of ice. The guy-wires absorb a large portion of the wind loading. One of the primary advantages is typically lower cost and easier installation as compared to the self-supporting tower. Disadvantages include the need for a large amount of real estate to accommodate the guy-wires, susceptibility of the wires to damage from aircraft and ground vehicle strikes, and the need to use insulators to break the guy-wires into non-resonant sections (see photo 4.4) to prevent them from interacting with the signals being radiated from the tower.

It has also been suggested that self-supporting towers may be more resistant to earthquake damage than their guyed counterparts. This is because the point on the ground where the base of the antenna is mounted and the point on the ground where the guy-wires are anchored may not move at the same time, the same speed, or in the same direction during an earthquake. The resulting lengthening and/or shortening of the distance between these two points may tend to cause the guy-wires to pull the tower over, induce enough slack in the guy-wires to allow the tower to collapse, or simply break the guy-wires.

As previously stated, both types of towers come in two varieties, the grounded type and the base insulated type. Each of these also has distinct advantages and disadvantages.

Grounded towers, as the name implies, are directly grounded to the earth at their base (see photo 4.5). This has the advantage of giving the tower a direct electrical drainage path to ground in the event of a lightning strike and for dissipation of wind and precipitation static that may build up on the tower. It is also far easier, and less expensive, to mount peripheral equipment such as obstruction warning lights, two way radio antennas, and FM radio antennas on these towers since a complex and expensive isolation network is not required on the feed lines from these units when using a grounded tower.

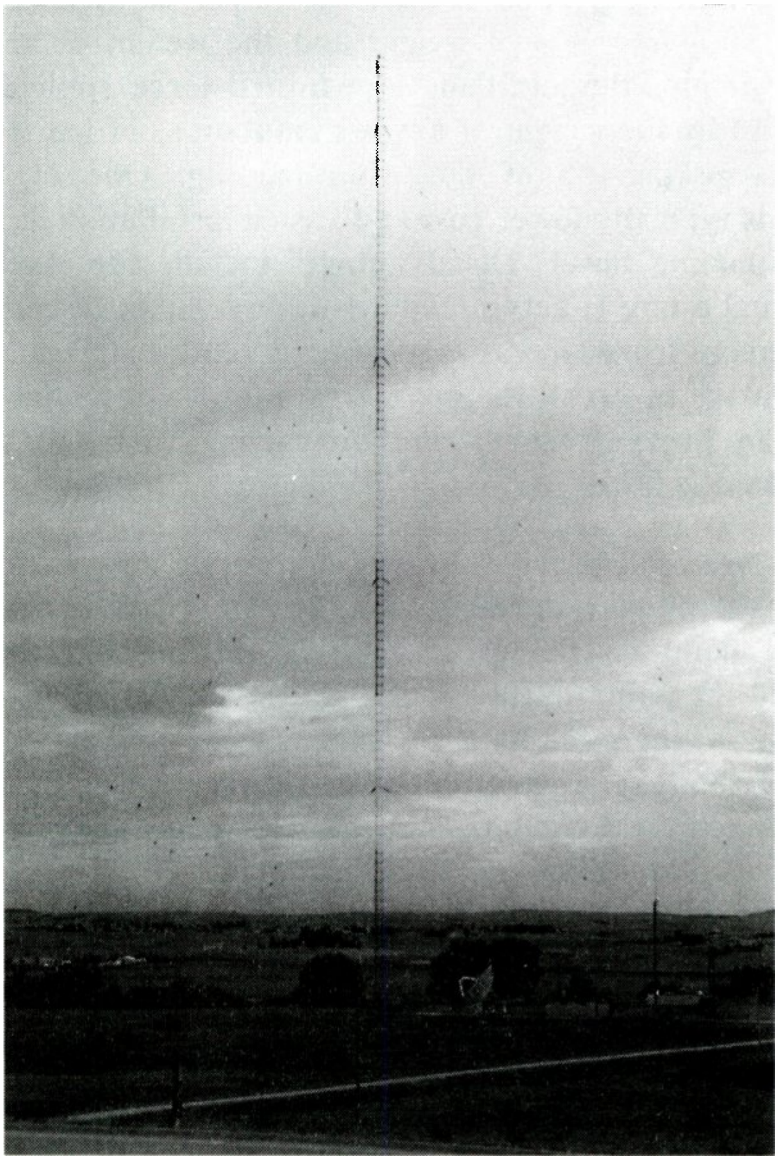

photo 4.3 – The 665 foot guy wire supported tower of KOA/850 in Denver, CO.

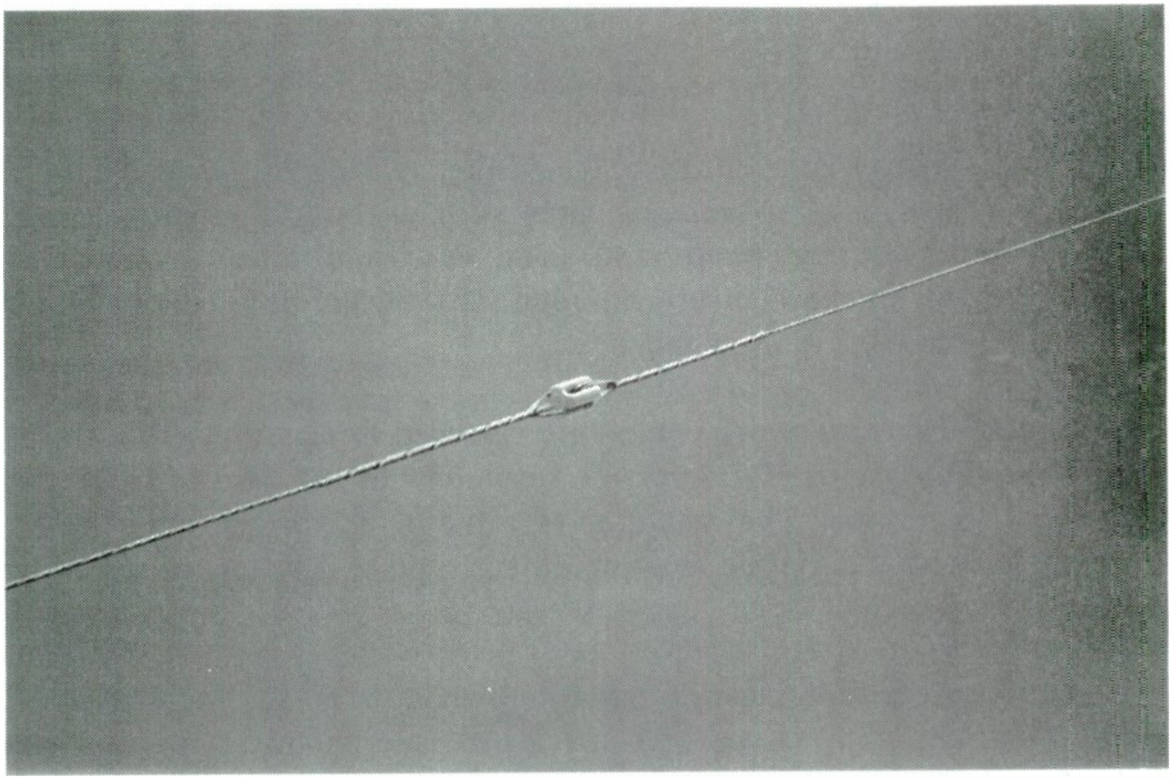

photo 4.4 – Insulators divide the guy wires into non-resonant sections to prevent them from interfering with the signal radiating from the tower.

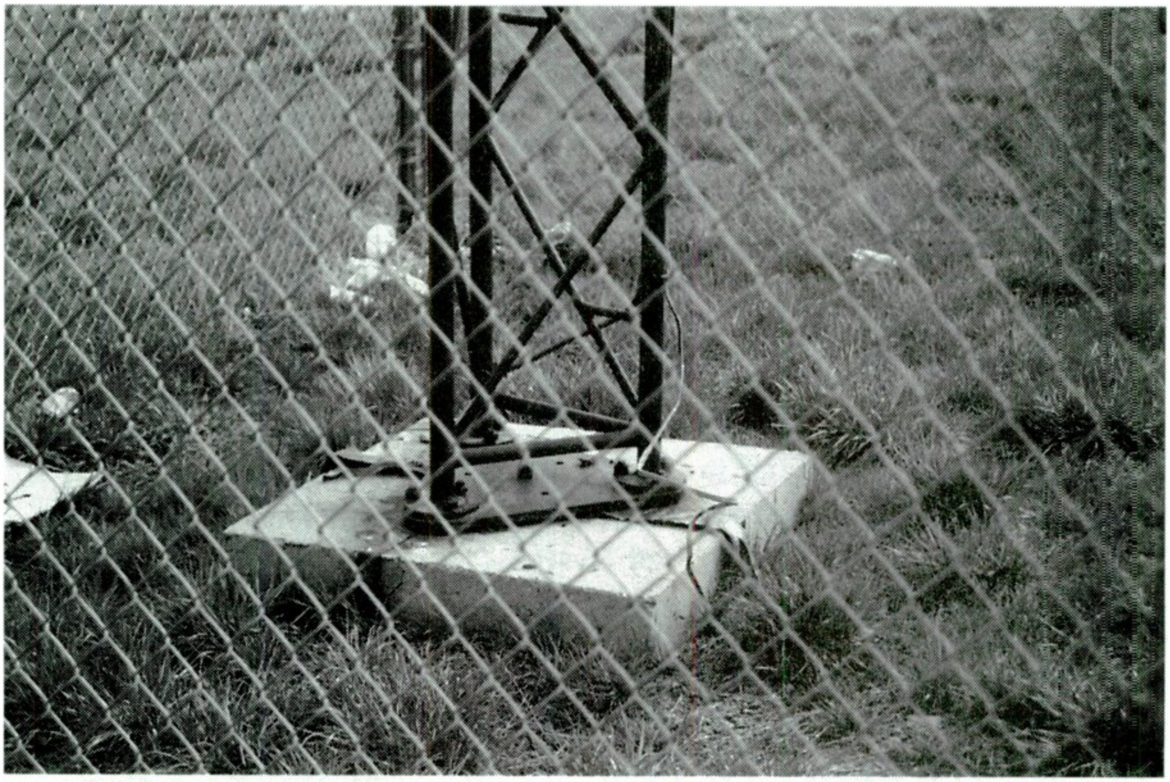

photo 4.5 – This slant wire fed AM tower is grounded through the copper straps across the base pad. The wire leading from the right leg of the tower supplies AC power to the obstruction lights.

Many AM stations gain additional revenue by leasing space on their towers to others needing antenna sites such as mobile telephone and paging companies (see photo 4.6). The ease and lower expense of mounting these antennas on a grounded AM tower may help to make them more attractive to these markets.

Base insulated towers, more commonly referred to as *series fed* towers, are mounted on a large insulator (or insulators in the case of multi leg towers) at their base. The insulator (see photo 4.7) isolates the tower from the ground. This is the most prevalent type of AM tower currently in use.

With these towers care must be taken to provide a means for discharge of lightning and static charges. A spark gap (see photo 4.8) is used for this purpose. It must be carefully adjusted so that lightning strikes and large static buildups will flash across the gap to ground but the radio frequency (RF) energy from the transmitter at peak modulation power will not. As previously stated a means must also be provided to isolate tower lighting circuits, and the downleads from other antennas mounted on the towers, from the tower itself in order to prevent the RF energy from the AM antenna from passing through these devices and into the ground. Austin ring devices, isocouplers, isolation coils and other similar devices are used to accomplish this.

There are several methods of coupling or feeding the RF energy from the transmitter to the antenna.

In the case of the grounded tower, all of the feed methods are basically a variation of the *shunt feed* system. One type of shunt feed is the *delta* or *slant wire* feed. Slant wire feed systems (see photo 4.9) were very common in AM broadcasting in the 1930s and 1940s. Today they are less common. With this system RF energy is fed to an antenna tuning device whose output is connected to a sloping wire. This wire then attaches to the tower at a specific elevation which, combined with the angle of the feed wire and it's physical relationship to the vertical antenna element, gives the proper impedance to the circuit.

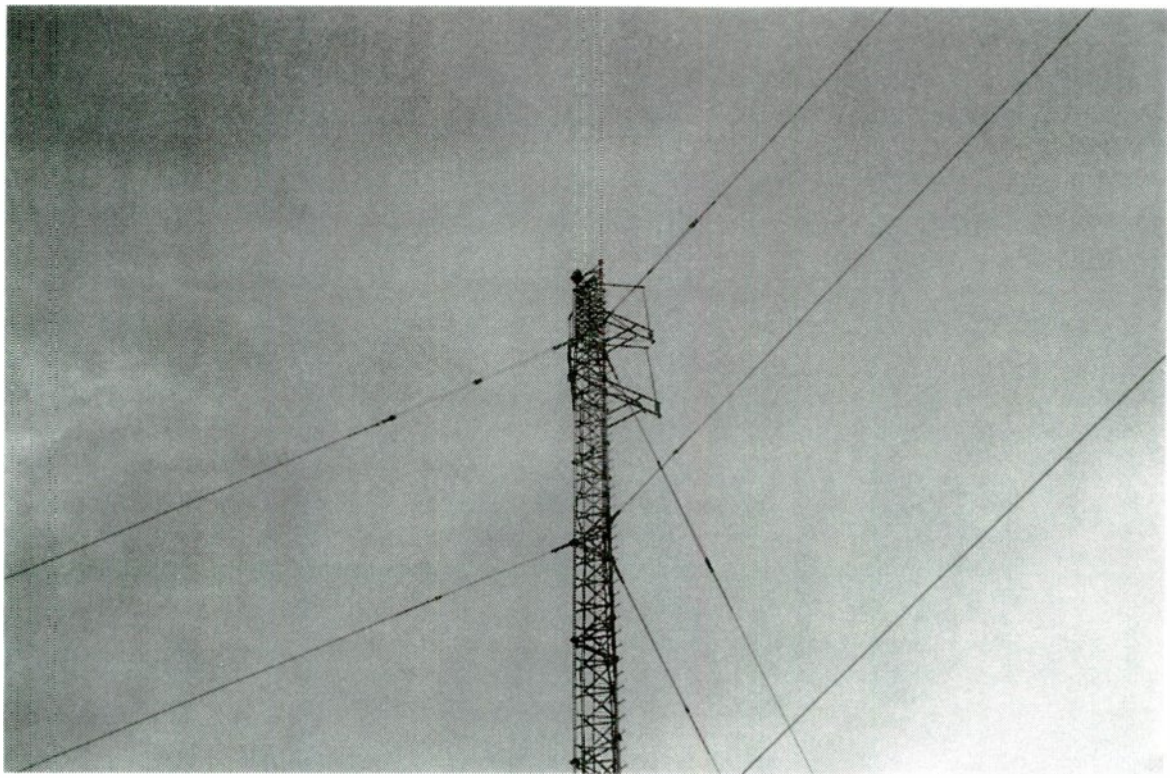

photo 4.6 – This AM tower also supports several commercial two-way and amateur radio repeater antennas.

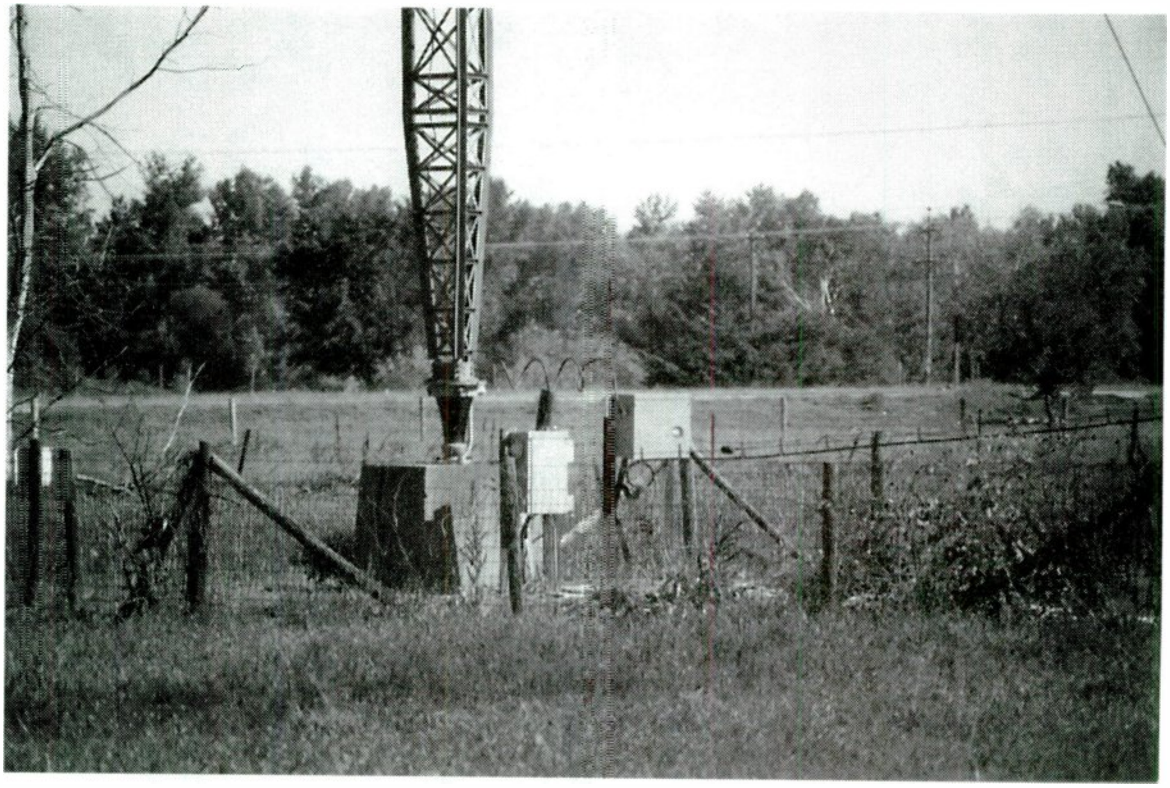

photo 4.7 – The base of this series fed AM tower rests on a large ceramic insulator.

photo 4.8 – The lightning discharge spark gap for this series fed AM tower consists of large metal rods attached the tower and the grounded base. The tips of the rods terminate in round anti-corona balls.

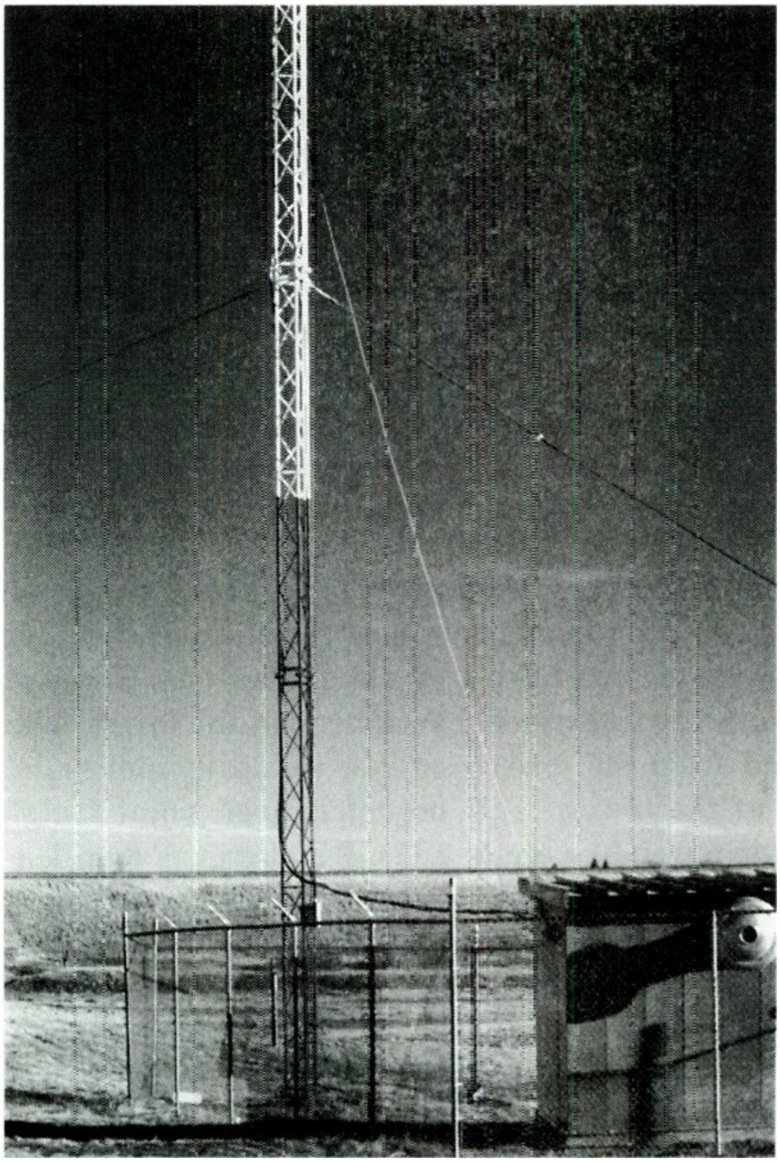

photo 4.9 – This slant wire fed, grounded base tower belongs to KFBC/1240 in Cheyenne, WY. The white wire rising up from the transmitter building is the slant wire feed line. It attaches to the tower just above the lower guy wires. The black wires leading from the tower just above the fence line are coax cables to several two-way radio antennas mounted on the tower.

This is a simple and fairly efficient system. However it has the slight disadvantage of introducing a small amount of directivity and other undesired lobes into the radiation pattern due to the fact that the main feed is angled instead of being purely vertical.

Another feed method is the *gamma* feed. In this method a vertical element is mounted parallel to the antenna tower. The top of this element is attached to the tower. This element is then fed through 2 tuning capacitors, one from the feed line to the shunt and one from the base of the shunt to the ground. A variant of the gamma feed is the *omega* feed. This method is quite similar to the gamma feed except that it adds an additional shunt capacitor to the system.

One method of feeding a grounded vertical tower, and one whose popularity is steadily increasing, is a variation of the gamma or omega feed known as the *skirt* feed. A skirt feed (see photo 4.10) typically employs 3 to 6 vertical wires spaced around the tower. These skirt wires are insulated from the tower and run vertically alongside it to, or near to, the top of the tower. At a predetermined point the skirt wires are shorted to the tower (see photo 4.11). RF energy is then fed to the bottom of the skirt through a tuning network. This type of system is also commonly referred to as a *folded unipole* antenna. This feed method may offer another advantage by providing improved bandwidth over that of a small circumference series fed tower. This is due to the large diameter of the shunt system which has the effect of making the antenna act electrically as if it were larger in diameter than it actually is.

Series fed towers receive RF energy directly across the base of the tower just above the insulator. In most cases the feed line from the transmitter connects to a tuning unit located near the antenna. The output from the tuning unit passes through a piece of copper or aluminum tubing (see photo 4.12) that connects to the tower. This feed tubing frequently has 1 or more loops placed in it between the tuning unit and the tower. These loops act as a *lightning choke* to help protect the transmitter and tuning equipment from damage during a lightning strike.

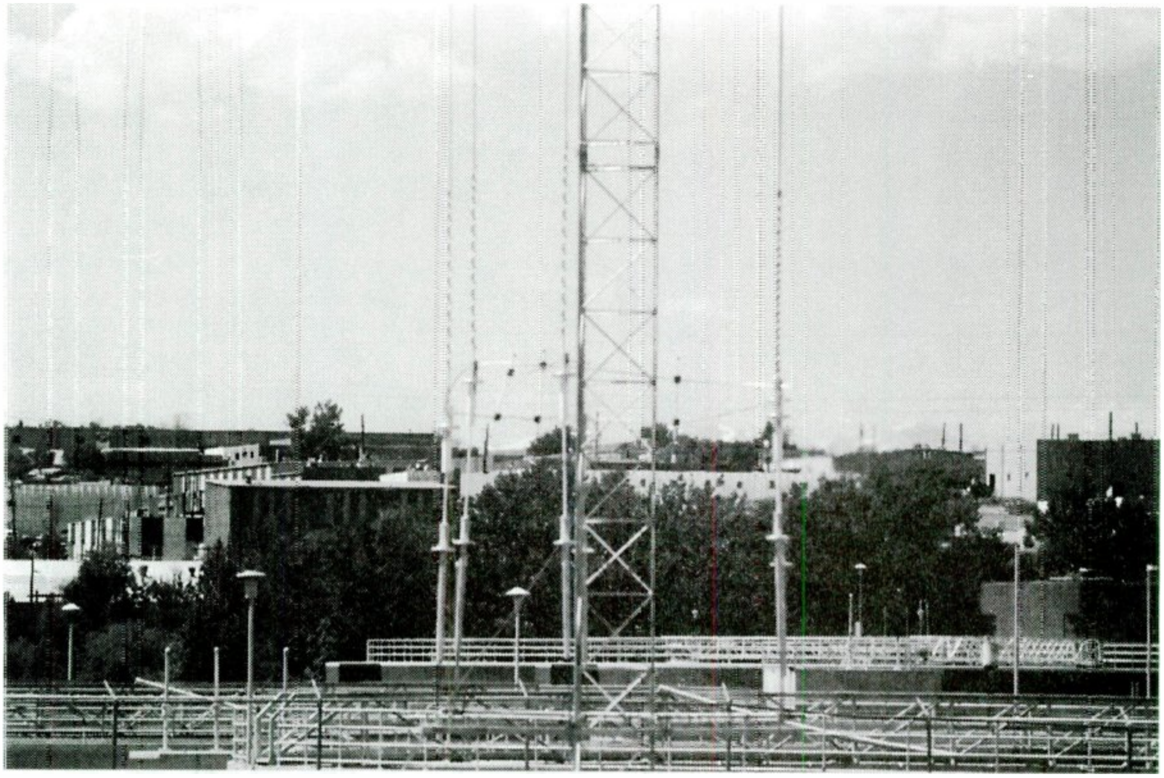

photo 4.10 – The skirt feed for the KQXI/1550 / KAYK/1690 folded unipole in Englewood, CO. Both stations are multiplexed into the same tower.

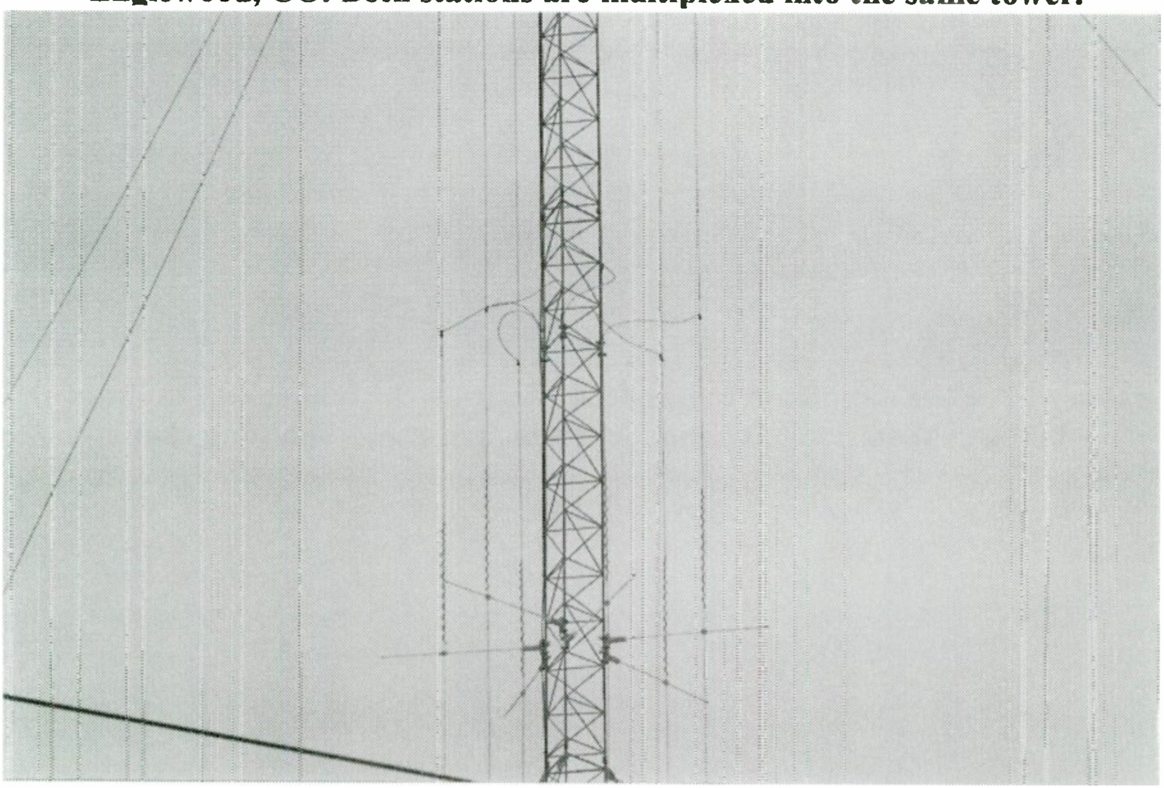

photo 4.11 – The contact wires that connect the skirt to the tower in this folded unipole can be seen near the center of this photo. Just below them is one of the 'spider' assemblies that maintains the spacing of the skirt from the tower.

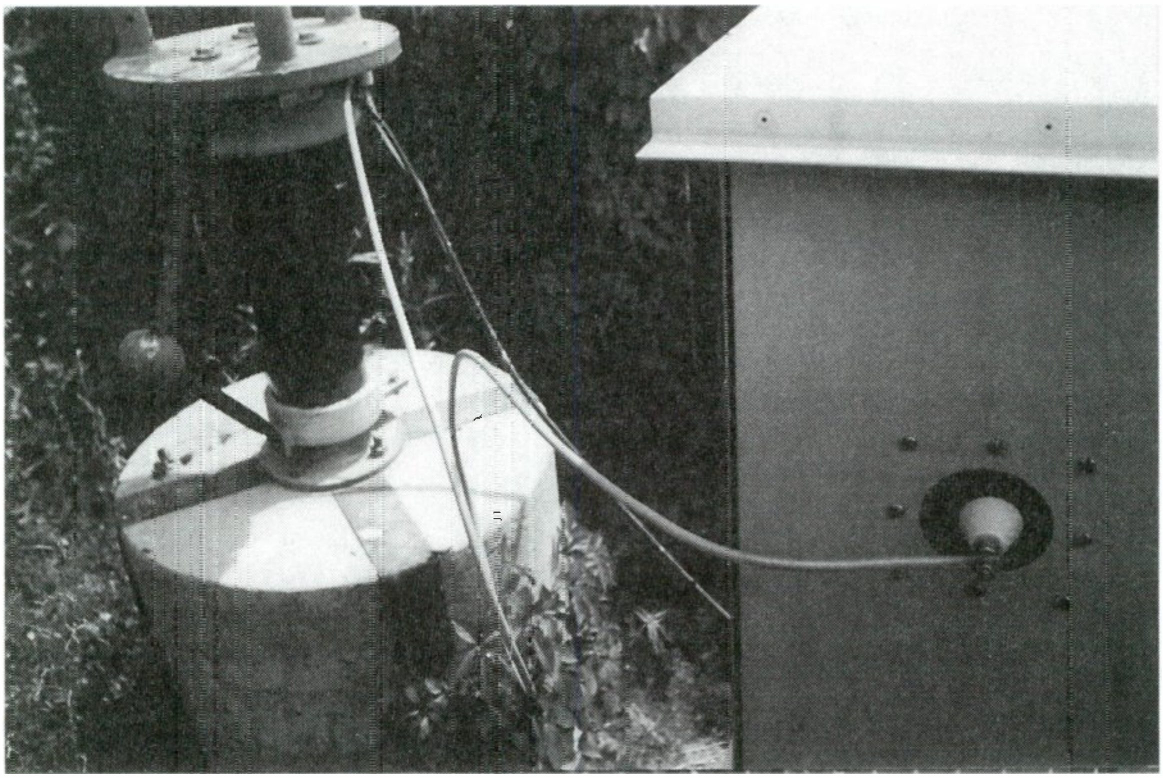

photo 4.12 – The aluminum tubing feed line from the tuning unit to the tower in this AM station has a loop in it which acts as a lightning choke.

*Top loading is a*nother method of improving vertical antenna performance. Top loading a vertical tower adds electrical inductance to it. This helps to counteract the effects of high capacitance created by an antenna that is too short for the operating frequency. Top loading is usually accomplished by attaching several horizontal elements, or a system that resembles a large spoked wheel (see photo 4.13), to the top of the tower. Such top loading devices are also sometimes referred to as *capacitance hats.*

Another method to accomplish top loading is the *umbrella* system. In this method (see photo 4.14) the upper sections of the top guy wires are attached directly to the top of the tower and the first insulators in the guy wires are located several feet down from the tower top. The wires are connected together with a wire loop just above the insulators.

Another type of AM tower is the *sectionalized* or *collinear* type (see photo 4.15) also sometimes known as a Franklin antenna. Insulators separate this type of tower into 2 or more sections one atop the other. The sections are fed either as a vertical dipole or, more commonly, as a collinear network in order to improve the coverage of the station's ground wave signal. This system concentrates more of the radiated energy towards the horizon in order to produce a gain factor in the ground wave zone.

Some stations, especially class A stations, maintain *auxiliary antennas* in addition to their main antennas. Auxiliary antennas are used during times when the main antenna is out of service for repairs, maintenance, replacement, and other situations. An auxiliary antenna may be co-located with the main antenna (see photo 4.16) or it can be located at a completely different site so long as it meets FCC approval.

The chief engineer of one large midwestern class A station told the author that he frequently switches from the main antenna to the auxiliary antenna, and to an auxiliary transmitter, during severe lightning storms in order to protect the main equipment. He then grounds the main antenna which acts as a giant lightning rod helping to protect the nearby auxiliary equipment.

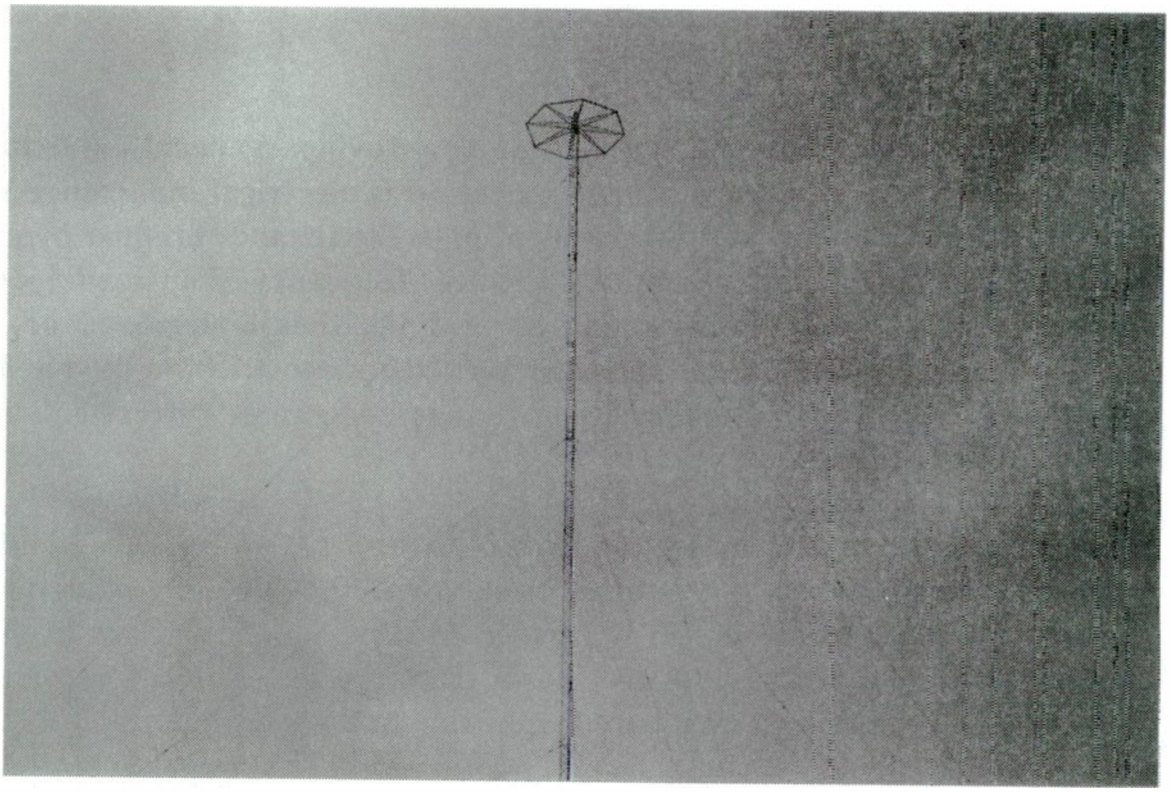

photo 4.13 – The 'capacitance hat' top loading device on the KHTH/1130 tower in Dillon, CO.

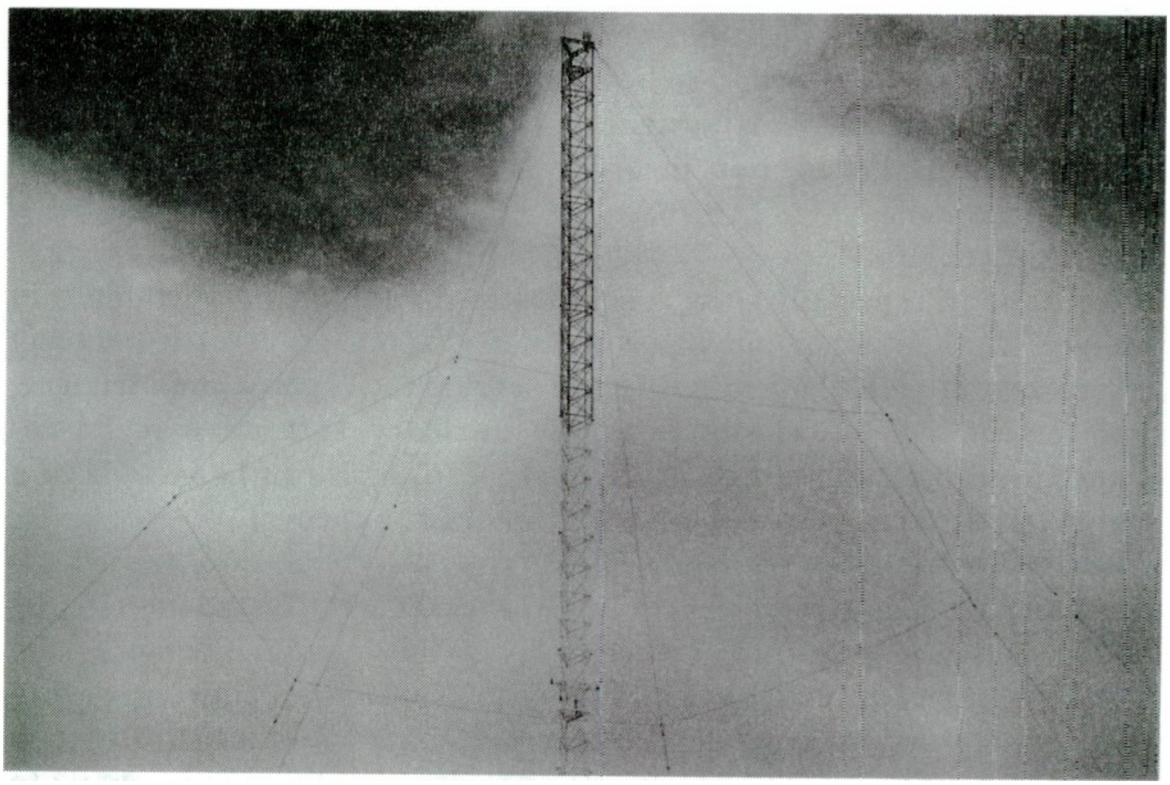

photo 4.14 – The 'umbrella' top loading device on one of the KLIF/570 towers in Dallas, TX.

photo 4.15 – The center tower in this 5 tower in line array is sectionalized by an insulator mounted midway in the structure.

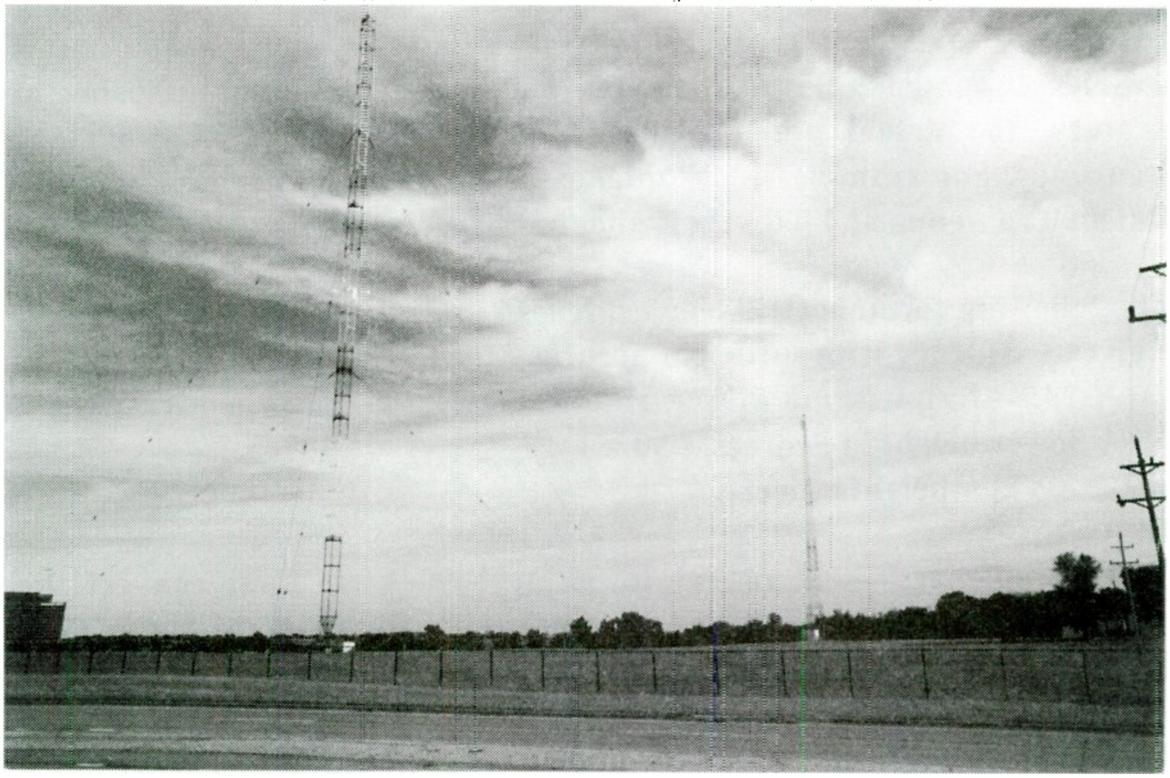

photo 4.16 – The 680 foot guyed main tower (left) and the 250 foot self-supporting auxiliary tower (right) of WBBM/780 in suburban Chicago, IL.

AM stations can also employ an *emergency antenna* when necessary. An emergency antenna is defined by the FCC as 'one which is erected for temporary use in cases where the main antenna is damaged to the point of being unusable and where no auxiliary antenna exists or is usable.' AM emergency antennas can be a vertical or horizontal wire, another tower, or in the case of multi-tower directional arrays, one of the undamaged towers in the directional array. When using an emergency antenna, transmitter output power must be controlled so that the radiated field strength does not exceed the station's normal field strength in any direction. Prior FCC approval is not required but the FCC must be notified of the operations on the emergency antenna within 24 hours. If operations on the emergency antenna are to be continued for a period of time, a Special Temporary Authority (STA) may be issued by the FCC.

Most broadcast professionals and most AM antenna databases refer to antenna length in degrees rather than feet or meters. A full wavelength antenna is equivalent to 360°, a ½ wavelength antenna is 180°, a ¼ wavelength antenna is 90°, and so on. When speaking in terms of degrees, the actual antenna height in feet is dependent upon the frequency. For example, a 90° antenna at 540 kHz is about 454 feet tall. But a 90° antenna at 1700 kHz is about 144 feet tall.

The following formulas will convert length in degrees to length in feet at a given frequency with sufficient accuracy for the hobbyist:

> 245 ÷ frequency in MHz = H (height of a ¼ wavelength antenna in feet)
> tower height in degrees ÷ 90 = F
> F x H = height in feet

For example, let's use a 110° tower at 1090 kHz. First convert the frequency in kHz to MHz by dividing it by 1000. In this case 1090 divided by 1000 yields 1.09. Next use the formula 245 ÷ 1.09 which yields 224.77064 feet. This is the height (H) of a ¼ wavelength antenna at 1090 kHz. Next divide the tower height in degrees (110 in this example) by 90 which gives us 1.222222. This is the height factor (F) of the tower. Now multiply 1.222222 (F) by 224.77064 (H) and you get 274.71966. You have determined that a 110° tower at 1090 kHz is about 274.72 feet tall.

CHAPTER 5

AM DIRECTIONAL ARRAYS

As mentioned previously, many AM stations are required to employee directional antenna (DA) systems during all or part of their broadcast periods.

DA systems can be used to increase power in one or more directions in order to increase coverage into specific areas. They can also be used to reduce power in one or more directions in order to decrease or eliminate the signal level radiated into specific areas in order to protect other stations on the same or adjacent frequencies. In some cases the DA system may be performing both functions in various directions.

According to several sources, the first AM DA system in the U.S., and quite possibly in the world, was likely that of WFLA/620 (now WSUN) in Florida. It is believed that as early as 1932, WFLA was operating with a directional pattern to protect the signals of another station on the same frequency after that station lodged complaints of interference.

To achieve a directional pattern a station must have at least 2 towers. Depending on the complexity of the pattern or patterns required, a station may require as many as 12 or more towers. A station in Michigan reportedly once had plans for a 17 tower array. However, the requirements changed and it was never actually constructed.

KLUV/1190 in Dallas, TX is an example of a very complex DA system. The KLUV daytime pattern is somewhat circular except for slight nulls to the northwest and northeast and a deep null to the south. In order to provide sufficient daytime groundwave coverage into both Dallas and Fort Worth, and the surrounding suburban areas, the daytime transmitter site was located between those two cities (see Chapter 3, photos 3.5 and 3.6) in Irving, TX. This site consists of four 250 foot towers in an 'in line' configuration.

The KLUV nighttime pattern requires a very narrow beam aimed to the southwest in order to protect several stations in virtually all other directions of the compass.

Most stations with different day and night patterns use the same transmitter site with some of the towers pulling double duty in both patterns. However, if KLUV transmitted their night pattern from their daytime site, they would radiate practically no signal at all into Dallas which is northeast of the daytime site.

So KLUV uses a separate nighttime site located northeast of Dallas near Rockwall, TX. From there the southwest facing night pattern is aimed directly into both Dallas and Fort Worth. This site consists of twelve 225 foot towers (see photo 5.1) in a 'parallelogram' configuration with two rows of 6 towers each arranged broadside to the Dallas/Forth Worth metro area. This antenna system provides a gain factor that boosts the 5,000 watt transmitter's effective radiated power (ERP) to about 50,000 watts to the southwest while limiting the power to almost nothing in the other directions.

In effect, KLUV uses 16 towers, and a very large amount of real estate at two separate sites, to achieve its required day and night patterns!

The KLUV 12-tower nighttime site is unique in that it currently has the most towers of any AM transmitter site currently in operation in the United States.

The expenses associated with the antenna system can represent a very large portion of the radio station's initial and annual budgets. In addition to the acquisition and installation of the towers themselves, the cost of either purchasing or leasing the real estate on which to place them must be considered.

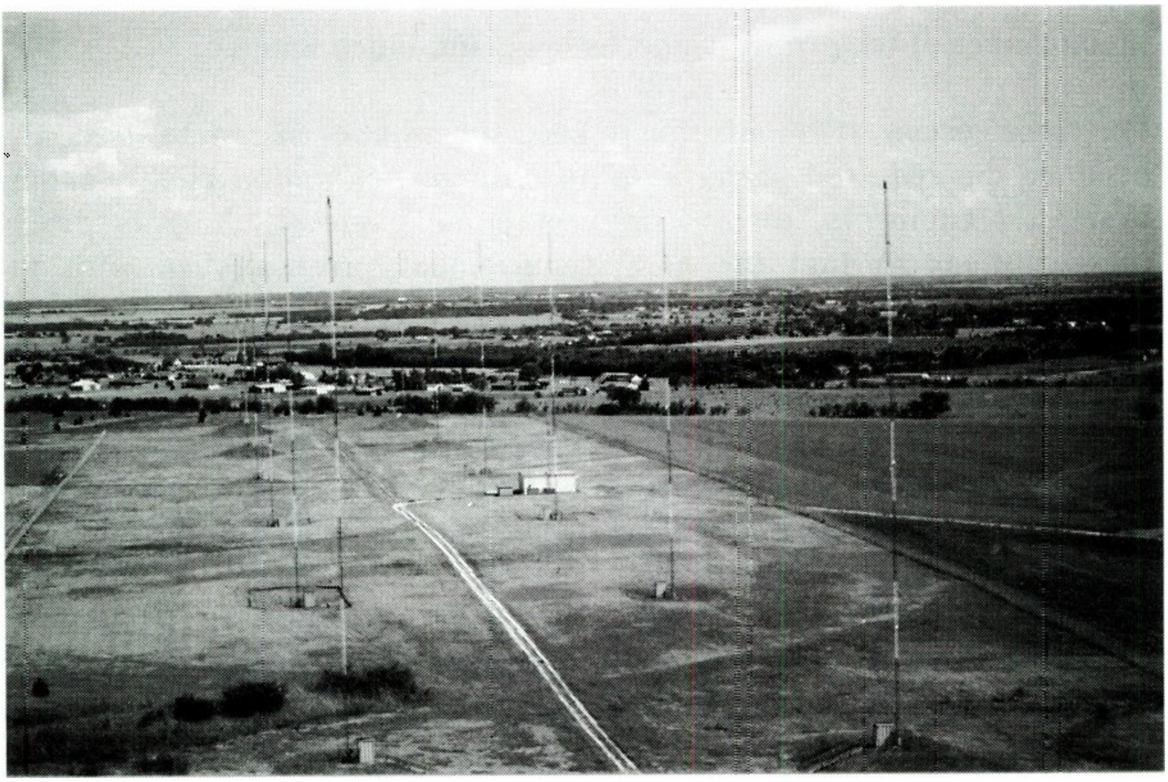

photo 5.1 – The giant KOOO/1190 12 tower night pattern transmitter site, located near Rockwall, TX, currently has the most towers of any AM directional array in the United States.

There is also the cost of constructing a climate controlled building to house the transmitter and associated equipment, the cost of the transmitter itself, installation of electric and telephone lines, a backup power generator, fencing, access roadways, studio-transmitter links, and so on.

Ongoing costs which must be figured into the annual budget include the electricity used, maintenance of paint and lighting on the towers, maintenance of the property and fencing, and much more.

For these reasons it is desirable to keep the number of towers needed to produce the required patterns to an absolute minimum. Highly skilled broadcast engineers, many using computer modeling, help to design these stations so that the FCC requirements are satisfied with the minimum possible expense.

These engineers determine the number of towers needed, their height, their position, their orientation, and their electrical phasing to an exact degree long before ground is ever broken at the transmitter site. All of these factors, and much more, determine what is needed to generate the required DA patterns.

Many DA patterns can be created with the proper spacing and phasing of only 2 or 3 towers. In fact, the majority of directional AM stations use 5 towers or less to generate their DA patterns. There are presently only 15 AM stations in the U.S., and 12 in Canada, who use 8 or more towers in their directional arrays.

As an example of how phasing and spacing can be used to create an antenna pattern, let's look at a simple two-tower system with the towers spaced ½ wavelength apart. By dividing the transmitter power and feeding it equally and in phase to each tower simultaneously, the towers create a 'figure 8' pattern radiating off the sides of the array (see figure 5.1). This is commonly referred to as a *broadside* array.

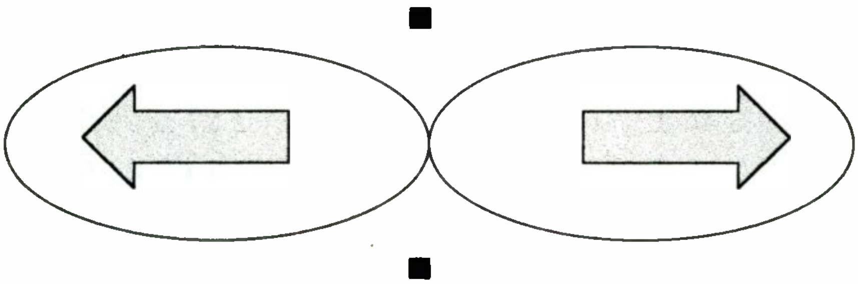

Figure 5.1 – 2 tower figure 8 broadside pattern – ½ wave spacing

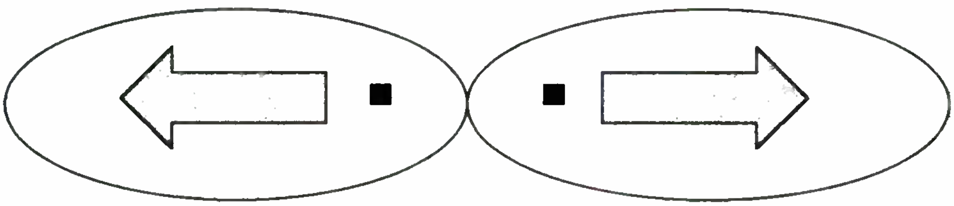

Figure 5.2 – 2 tower figure 8 double end fire pattern – ½ wave spacing

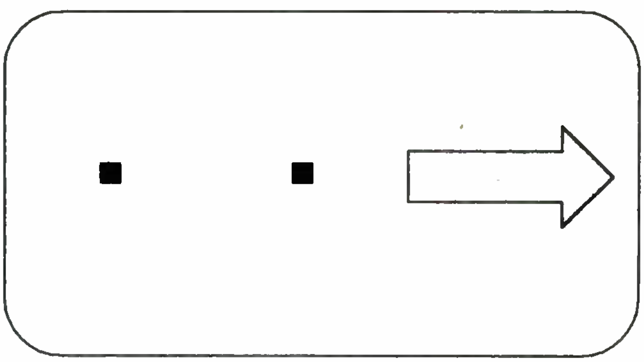

Figure 5.3 – 2 tower end fire array – ¼ wave spacing

By feeding the same 2 towers 180 degrees out of phase with each other, the transmitter power going first to one tower then to the other, a 'figure 8' pattern radiating off the ends of the line of towers is achieved (see figure 5.2).

Thus by simply changing the method in which the power is fed to the two towers, the antenna pattern is rotated by 90 degrees. Technically speaking, this 'figure 8' pattern can be 'rotated' to point in any 2 directions of the compass by simply shifting the phasing between the two towers.

By spacing the same 2 towers ¼ wavelength apart and feeding them 90 degrees out of phase with each other, an *end fire* pattern can be achieved with the signal radiating off of one end of the 2 towers in a single direction (see figure 5.3).

By properly adjusting the spacing, the orientation, and the electrical phasing between the towers, the signal can be caused to radiate in almost any desired direction and in a variety of pattern shapes.

Additional towers are used to suppress the signal as in the case of the KLUV nighttime site. The wider the azimuths over which the signal must be suppressed, the more towers are required in the DA system.

Additional towers can also be used to create high signal strength lobes in the direction of areas with high population in order to increase the signal level in those areas.

So, as you can see, AM transmitter site design and engineering can be a very complicated discipline.

CHAPTER 6

OTHER CONSIDERATIONS

Cellular telephone and other communications towers are popping up across the country in record numbers. So are tall buildings, water towers, bridges, electrical transmission towers, and many other metallic structures.

Because of their electrical conductivity and heights that are near to the resonance of the signals from the AM stations, many of these structures have the potential to cause severe interference to the radiation pattern of nearby AM transmitter sites by what is known as *parasitic re-radiation.*

The FCC has declared (47 CFR 22.371) that any structures that are located within 3 kilometers (1.86 miles) of an AM directional antenna, or within 1 kilometer (.62 miles) of an AM non-directional antenna, must not cause interference with the antenna pattern of the AM station. It is the responsibility of those constructing new structures to bear the costs of testing and of corrective measures to ensure that this ruling is obeyed.

Such structures can be rendered electrically invisible at the AM frequency by a method called detuning. One or more wires supported on insulators (see photos 6.1 and 6.2) are dropped down the face of the offending structure forming a *skirt.* A capacitor, or a coil and capacitor, is connected between the bottom of the skirt and the structure's base which is at ground potential. The skirt is tuned to resonance at the AM frequency. This minimizes current in the structure, thus minimizing re-radiation.

Detuning has actually been used in the AM broadcast industry itself for many years. In multiple tower systems during periods when some of the towers aren't being used to generate the pattern required, those towers are detuned to prevent interference to the remainder of the antenna system. This is commonly referred to as 'floating' a tower.

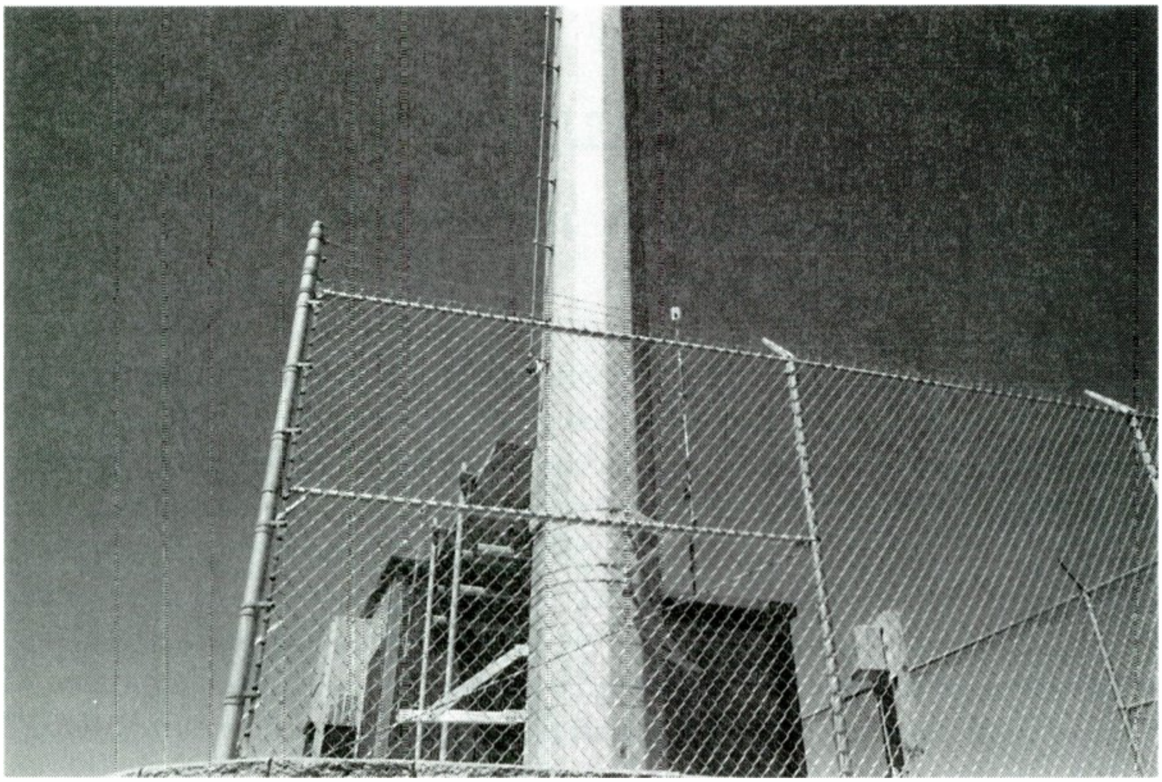

photo 6.1 – The detuning wires for this cellular telephone tower in Rockford, IL protect the directional pattern of nearby WROK/1440. The detuning unit is mounted on the wooden post to the right of the tower.

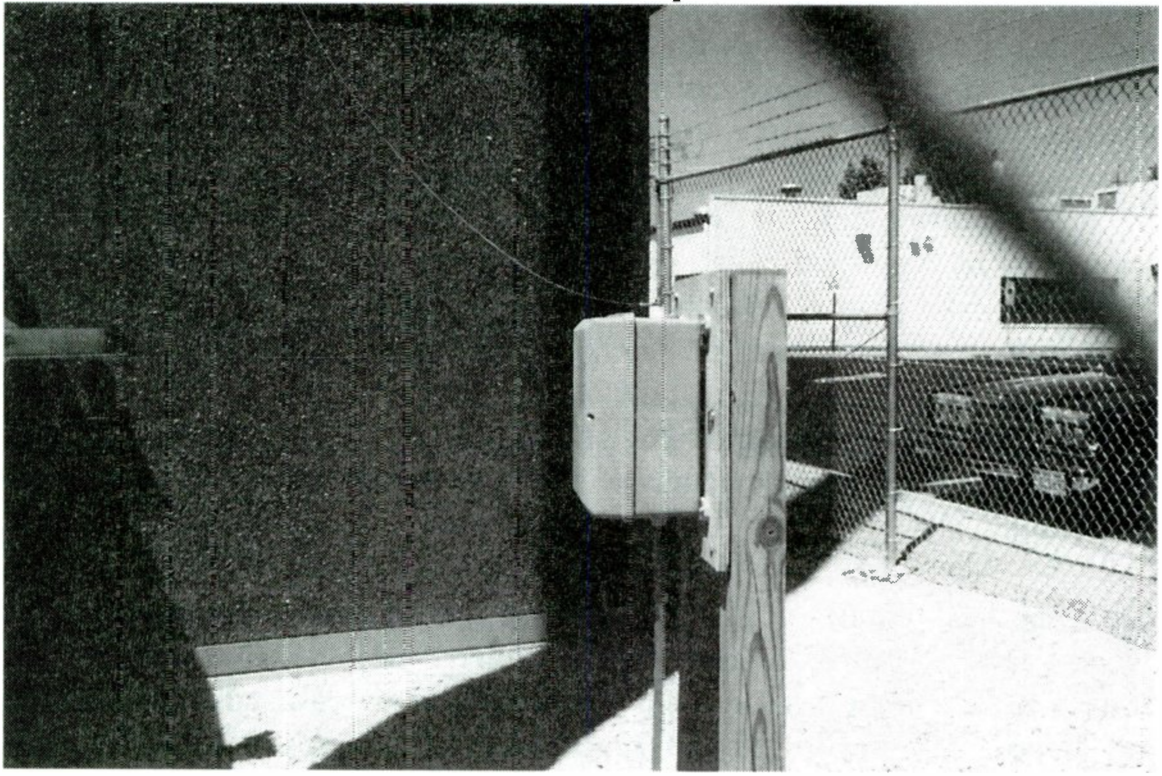

photo 6.2 – Closeup view of the detuning unit in photo 6.1. The copper wire at the top connects to the detuning skirt. The conduit at the bottom connects to the ground rod.

The FCC and the FAA together establish and enforce regulations on the painting and lighting of antenna towers. Antennas below 200 feet in height are frequently exempt from these requirements. The rules are subject to a great many variables (see photo 6.3).

Some considerations that influence antenna lighting and painting requirements include distance from the nearest specified airport, heliport, or instrument runway approach and 'shielding' by existing structures, terrain, or topographical features.

Towers that are required by the rules to be painted and/or lighted must be registered with the FCC and the registration number must be posted at the facility. Paint must be well maintained to provide high visibility to aircraft (see photo 6.4) and lighting must be checked for proper operation every 24 hours.

FCC regulations require that AM towers, or the entire field in which the towers are located, must be fenced to protect persons from the electrical and RF hazards present (see photo 6.5). Warning signs (see photo 6.6) are also recommended.

Because of the increased costs of real estate, towers, and other peripherals associated with an AM antenna array, multiplexing has recently become increasingly popular in the industry. In multiplexing, two or more AM broadcast stations (see photo 6.7) share one or more towers in an antenna array. This can cut both the initial costs and the ongoing costs of an AM station significantly. While gaining recent popularity, multiplexing has actually been available for many years. New York City's WFAN/660 (formerly WNBC) and WCBS/880, for example, have been multiplexed into the same highly efficient top-loaded, salt water grounded tower on High Island in the Bronx for about 30 years.

Another method being employed today is the sharing of real estate for AM antenna systems. In the past, AM stations wanted to be as far from each other as possible to avoid the possibility of their towers interacting with one another. With today's technology, this is no longer necessary and stations can actually be co-located on the same site (see photo 6.8) as a cost savings benefit.

photo 6.3 – While located less than 2 miles from a very busy airport's instrument runway, the 4 tower array of KCUV/1150 in Englewood, CO was exempted from any painting or lighting requirements. Each tower is about 138 feet tall and the array is 'shielded' by several tall buildings nearby.

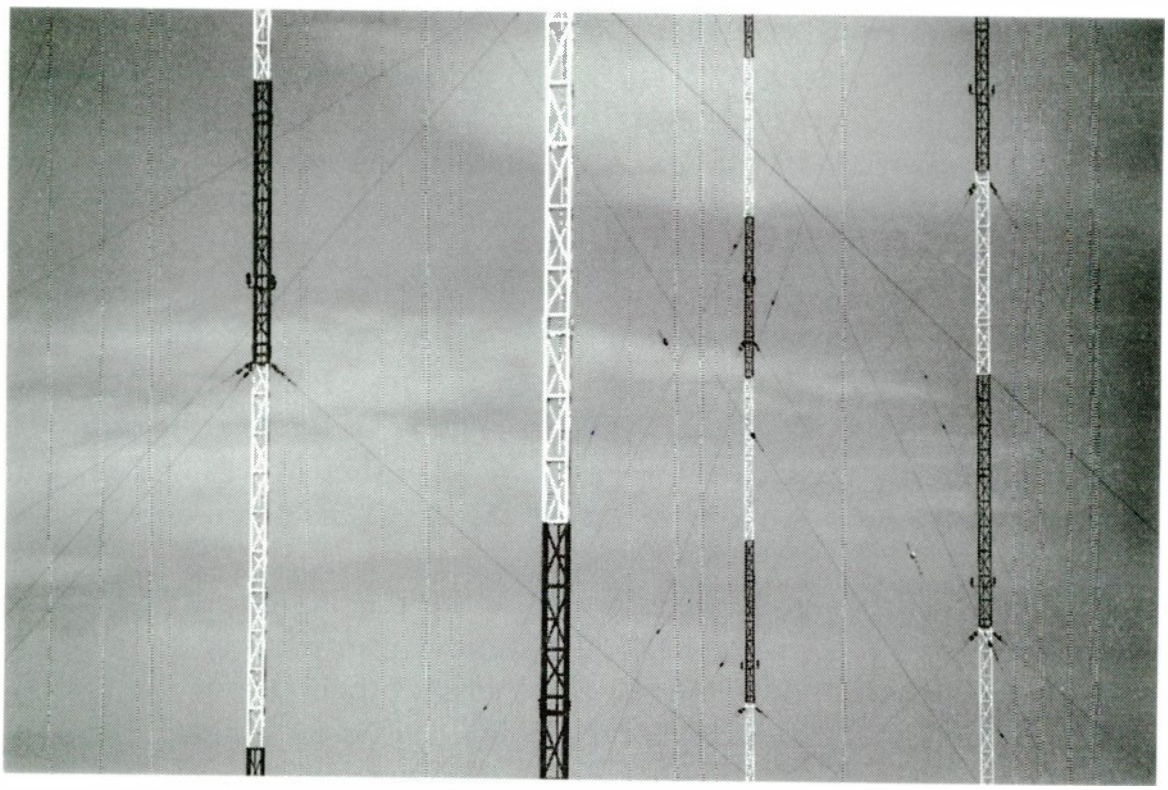

photo 6.4 – Well maintained paint on these towers help to make them highly visible to aircraft even under low light conditions.

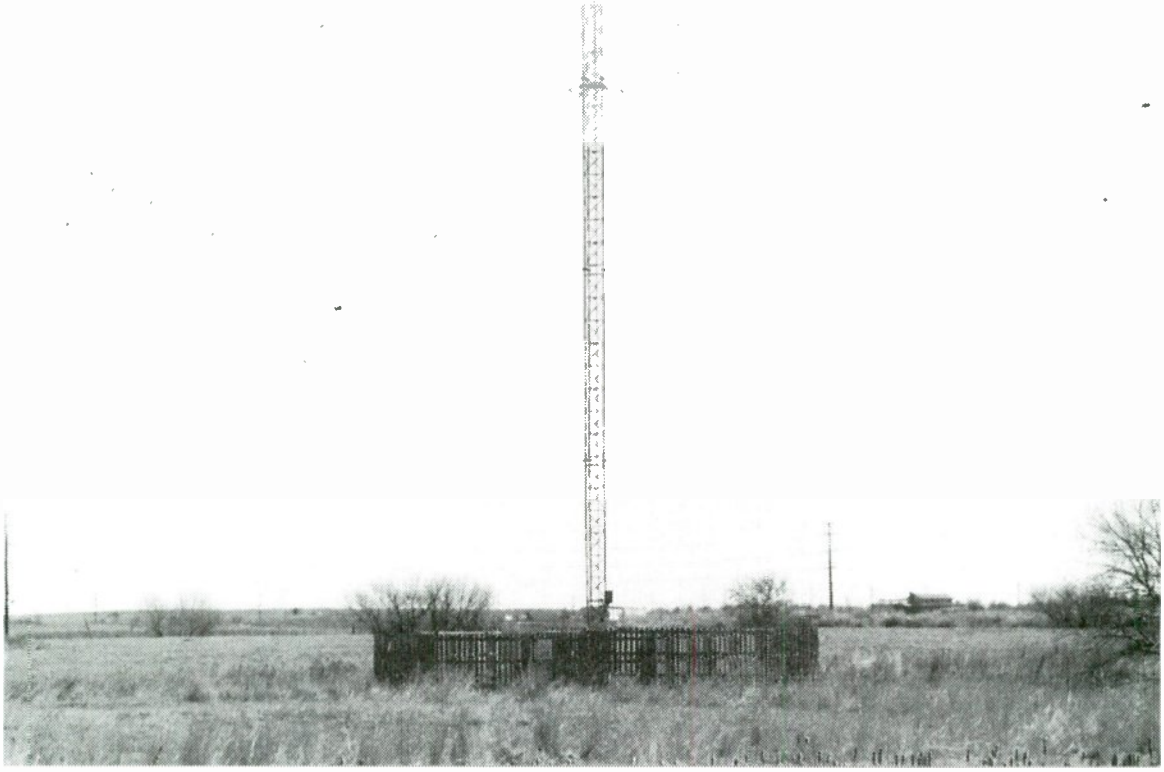

photo 6.5 – Fencing helps to prevent unauthorized persons from getting too close to the electrically energized base of an AM tower.

photo 6.6 – This sign warns of the potential for harmful RF radiation at an AM transmitter site.

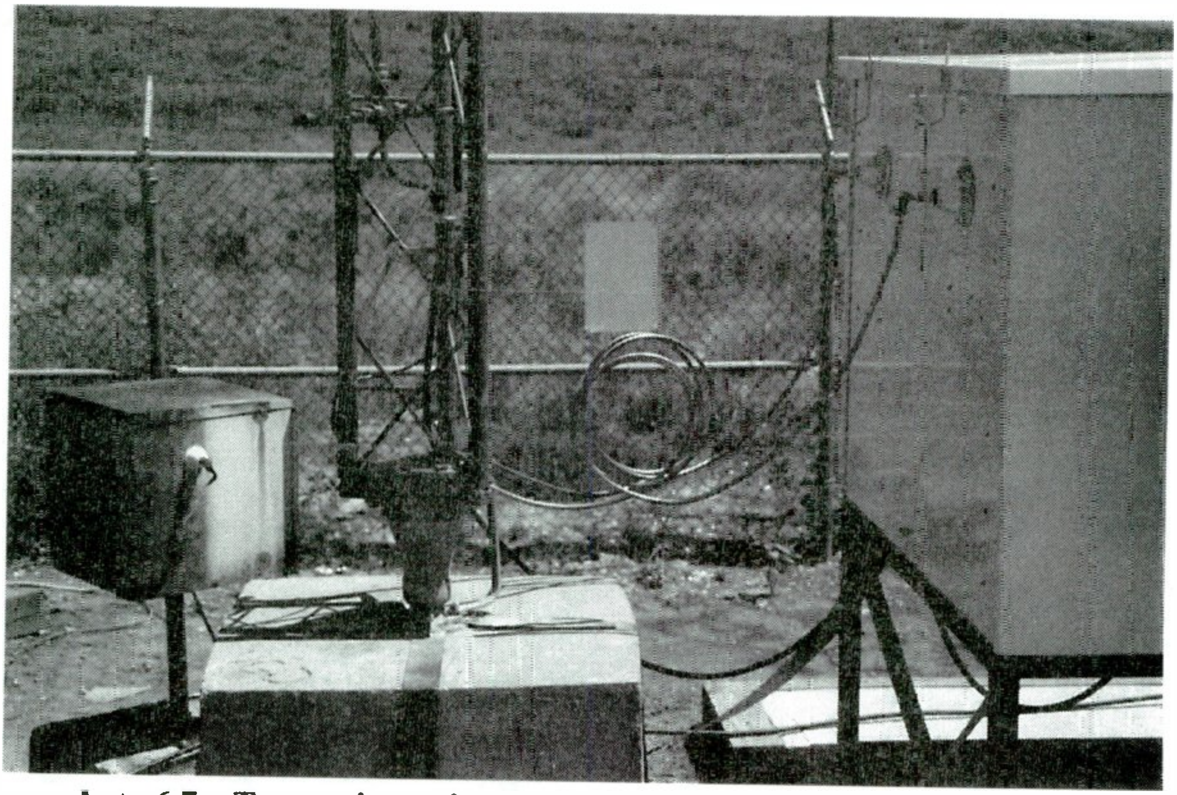

photo 6.7 – Two tuning unit outputs, each connected to a copper tubing feedline, indicates that this series fed AM tower in Pueblo, CO has two stations multiplexed into it. The old tuning unit, used when this was a single station site, is to the left of the tower.

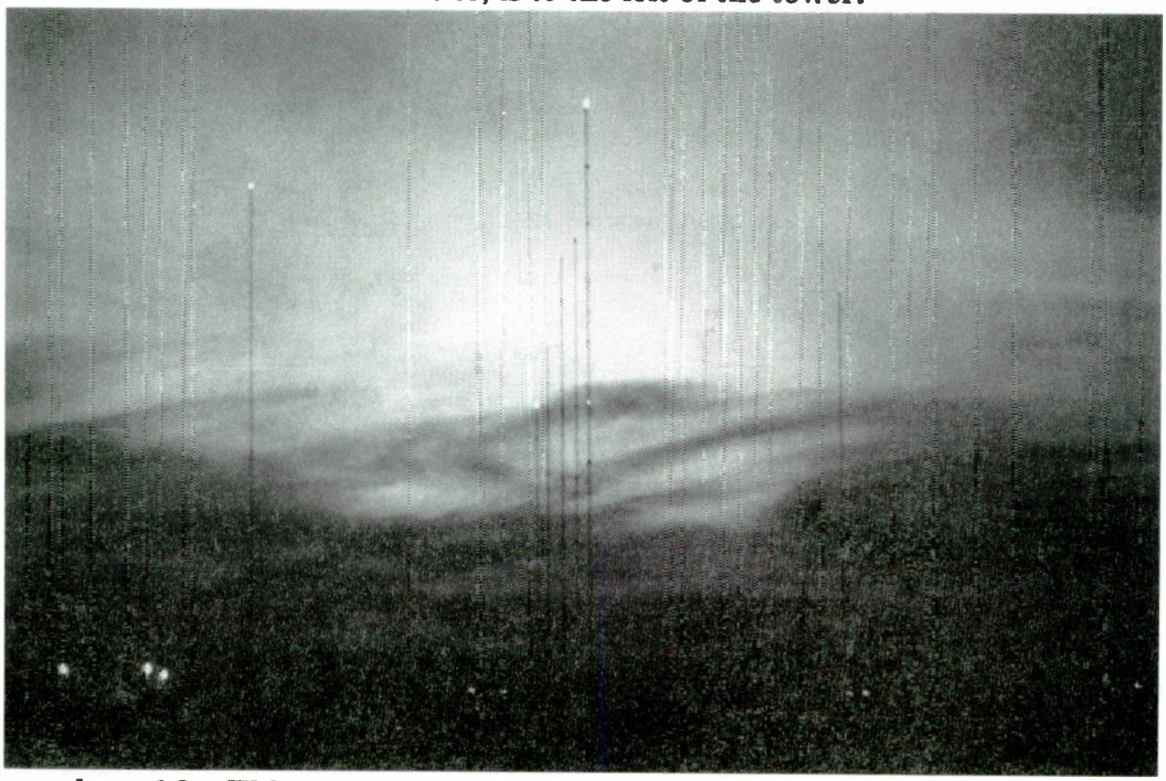

photo 6.8 – This shared transmitter site located north of Cheyenne, WY contains the 3 tower array of KGAB/650 and the 4 tower array of KJJL/1530. The tower layouts actually cross each other.

Many considerations are involved in the construction of an AM transmitter plant. Reliable AC power and air conditioning for the transmitter are among those considerations. Security is another important detail. Modern transmitter buildings (see photo 6.9) incorporate all of these considerations in their design.

Control and monitoring of the transmitter must also be considered. While this can be done by leased wireline, in many remote sites it is economically superior to use a wireless studio to transmitter link (STL) to accomplish this. The FCC has set aside specific frequencies for this purpose. These frequencies are in the microwave region. It is common to see an STL antenna (see photo 6.10) co-located at the transmitter site.

Tower and obstruction light maintenance can represent a significant portion of an AM station's operating budget, especially in the case of multi-tower arrays. Obstruction lights are usually changed at least annually and sooner, of course, if they fail. Towers that are required to have red and white obstruction markings must be repainted every few years depending on the local environment. In most cases these duties are handled by specially trained and equipped outside experts rather than the station engineering staff (see photos 6.11, 6.12, 6.13, 6.14). Some towers are strobe lighted and are illuminated 24 hours a day. This eliminates the need for painting the tower. The strobe lights usually reduce the intensity of the light at night to about 1/10th of its daytime intensity. Some towers also use a combination of strobes during the day and obstruction lights at night.

Many AM stations find it useful to create *coverage* or *contour maps* to demonstrate their coverage patterns. A coverage map (see figures 6.1 and 6.2) is created by transferring various measured or calculated field strength contours, such as the 0.5 mV/m or 2.0 mV/m contour, onto a map showing cities, villages and towns.

Coverage maps can be very useful to the station's sales staff to demonstrate to the potential advertising client where they might expect their advertisements to be heard.

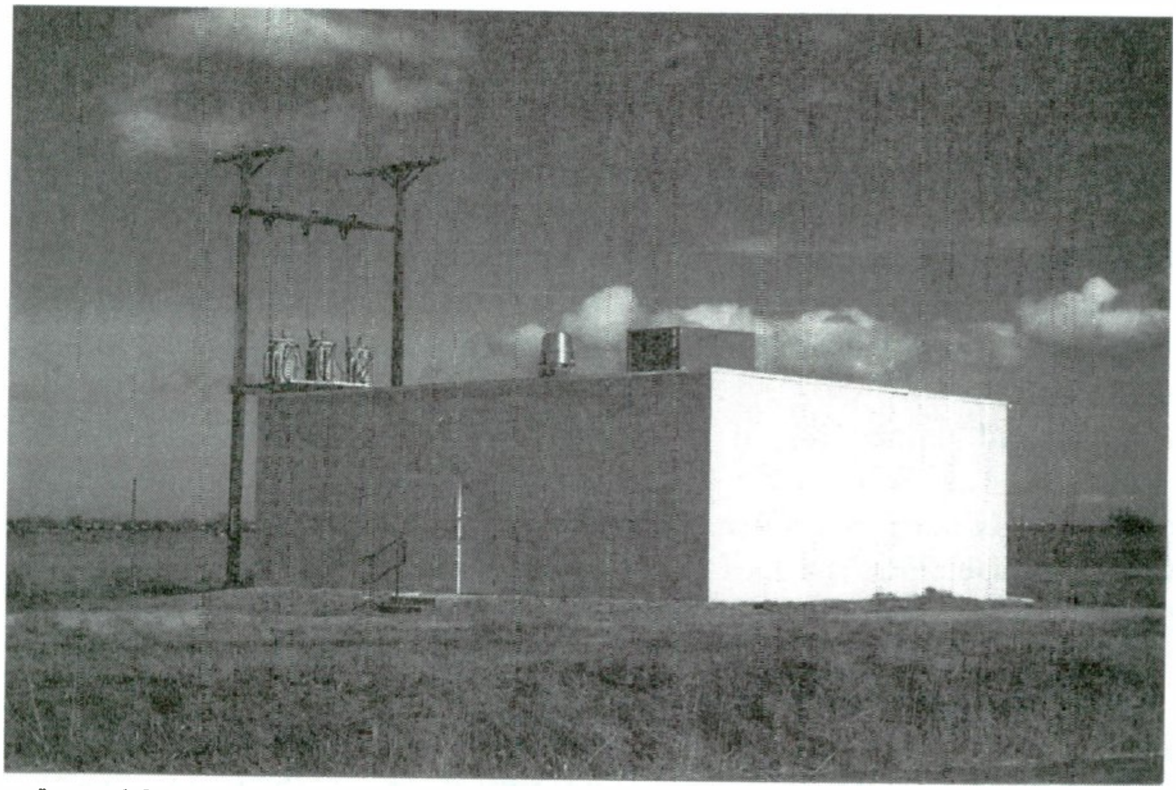

photo 6.9 – A modern, climate controlled AM transmitter 'shack'. Security is an important consideration at unmanned remote sites. Note the lack of windows.

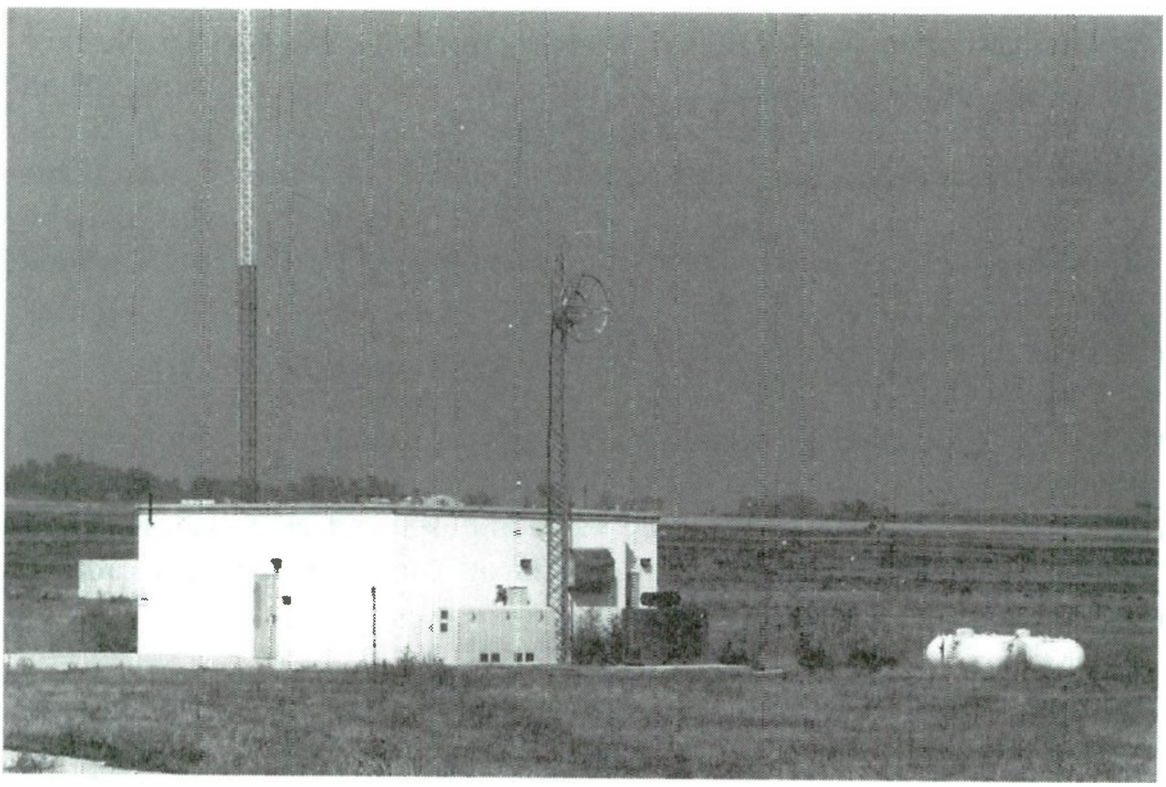

photo 6.10 – The small tower at the rear of this transmitter building supports the studio-transmitter link (STL) antennas. Also visible is the backup power generator and it's fuel supply tanks.

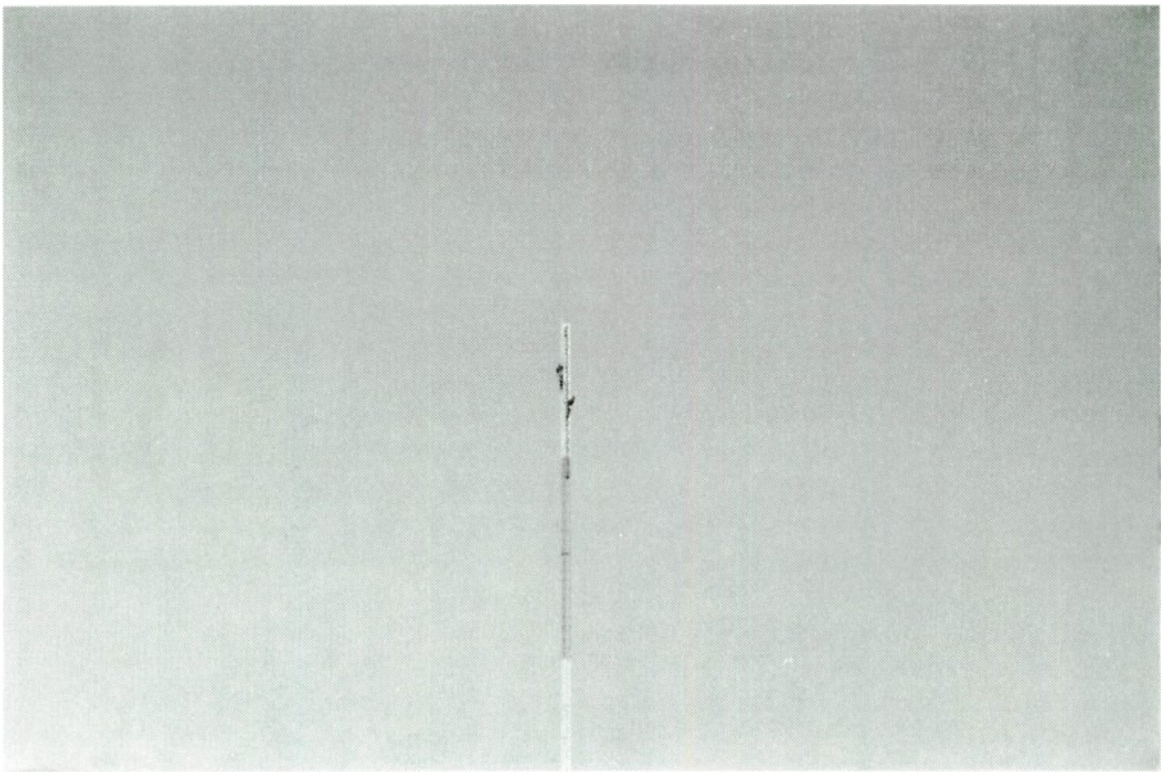

photo 6.11 – Tower installation experts from the Rocky Mountain Erection Company in Oklahoma City work near the top of a new AM tower under construction near Brighton, CO.

photo 6.12 – Sections of a new tower await installation as another tower in the background nears completion.

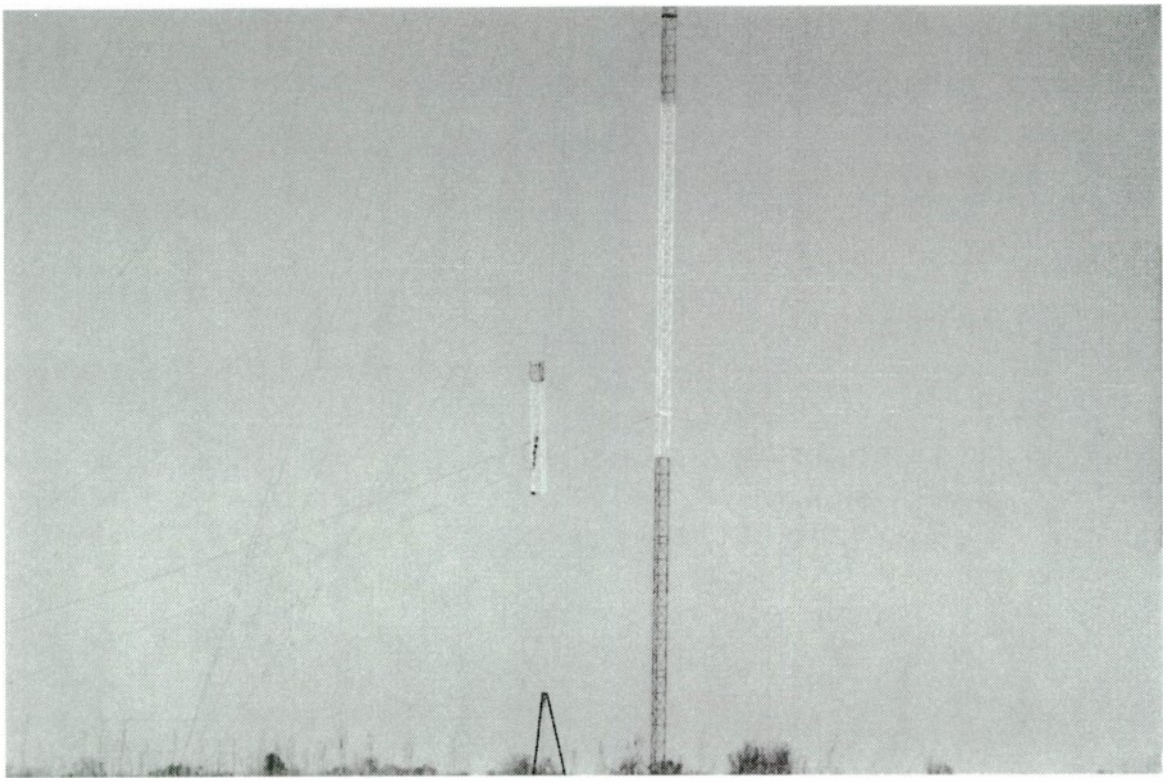

photo 6.13 – Another section of new tower is hoisted into place at this AM station construction site.

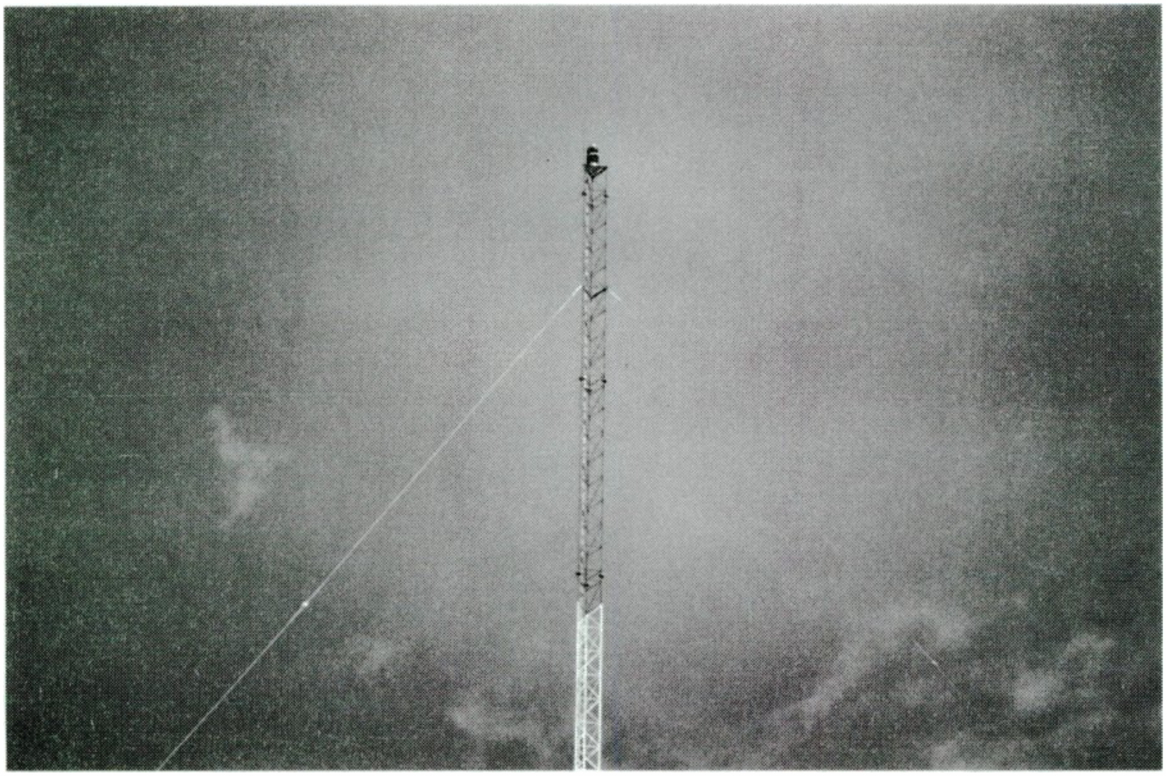

photo 6.14 – Part of the station's ongoing maintenance costs might include the cost of repainting and relamping the towers on a regular basis. One local AM station told the author that they usually pay about $1 per foot of tower height for someone to climb the tower and replace the lights.

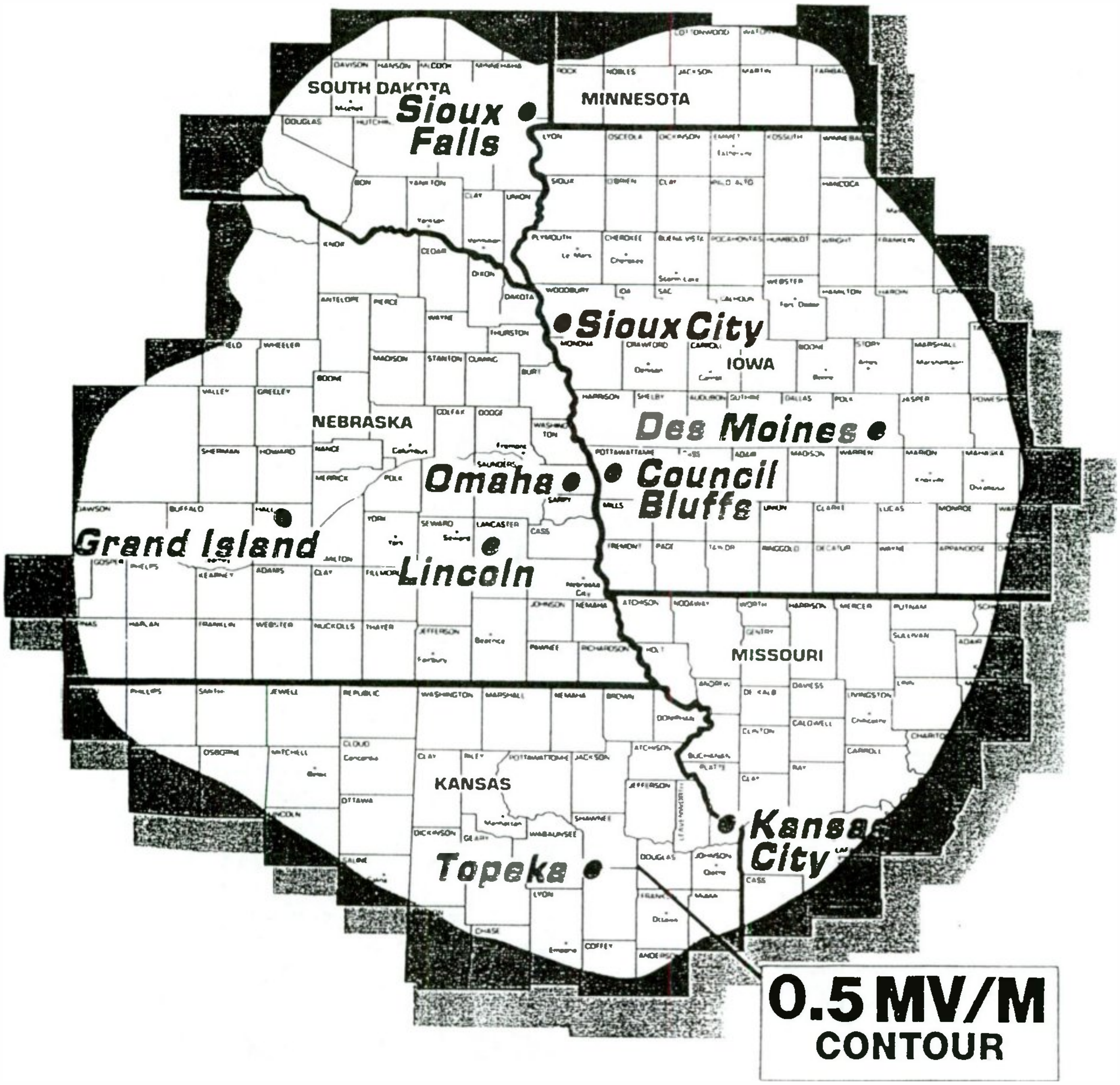

figure 6.1 – This coverage map displays the 0.5 mV/m contour of WOW/590 in Omaha, NE. [courtesy WOW]

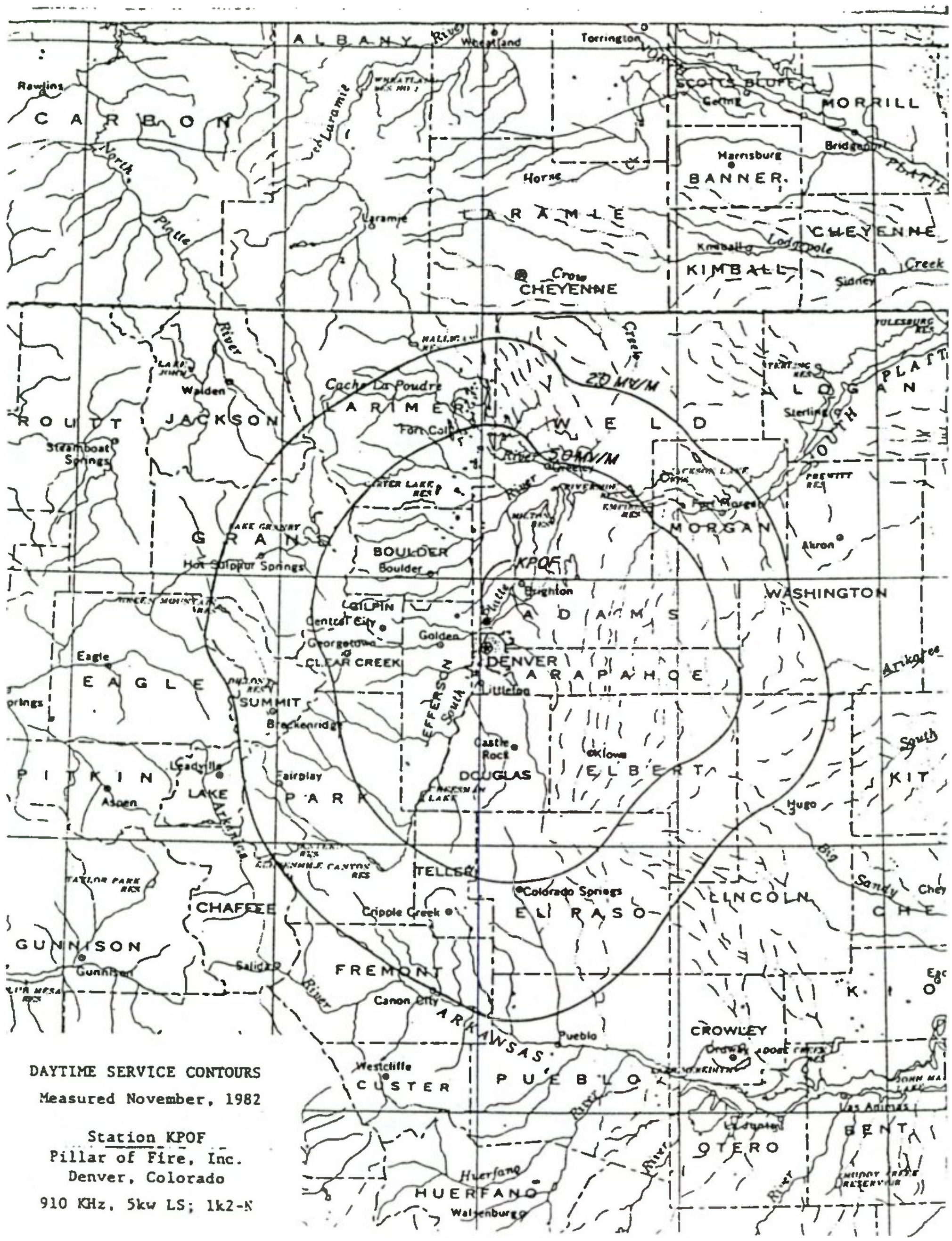

figure 6.2 – Another style of coverage map. This one displays both the 2.0 and the 5.0 mV/m contours of KPOF/910 in Denver. **[courtesy KPOF/Pillar of Fire, Inc]**

The National Radio Club produces a publication, the 'NRC Nighttime Antenna Pattern Book', which is currently in it's 4th edition. This book uses contours to illustrate the night patterns of most U.S., Canadian and north Mexican AM stations overlaid onto a map (see figure 6.3) for each AM frequency. This book graphically demonstrates why each station uses the night directional pattern that it does and can be an extremely valuable tool for the broadcast professional and the AM DXer.

Reception reports are another useful tool for the engineering and sales staffs. Some radio listeners are involved in the hobby of listening to distant radio stations and reporting the reception to the station's staff in the hope of receiving a 'QSL' or verification reply back from the station. These listeners, sometimes referred to as 'DXers' (DX being a common abbreviation for *distance*) collect the QSLs and other station momentos. Some DXers are also contest oriented trying to set records on the number of stations heard or the farthest distance heard.

While some stations may simply ignore reception reports and might even consider them a nuisance, they can be very beneficial if used properly. The engineering staff might use reception reports as a means to help ensure that the transmission equipment is operating properly and efficiently. Reception reports might also be useful to the sales staff in demonstrating proof of the station's coverage to potential clients.

The QSL response to the DXer is considered as a courtesy or a 'thank you for listening' message. It is a positive public relations tool helping to ensure that the recipient will listen to the station again and will tell others about the station.

The QSL can be in one of many various formats. The most common are the 'QSL letter' (see figure 6.4) written on the radio station's own stationary and a 'QSL card' (see figure 6.5) which is preprinted so that the staff has only to fill in the blanks.

In the past, some stations also issued a verification stamp which the listener could collect in a book. These stamps are now sought after collector items.

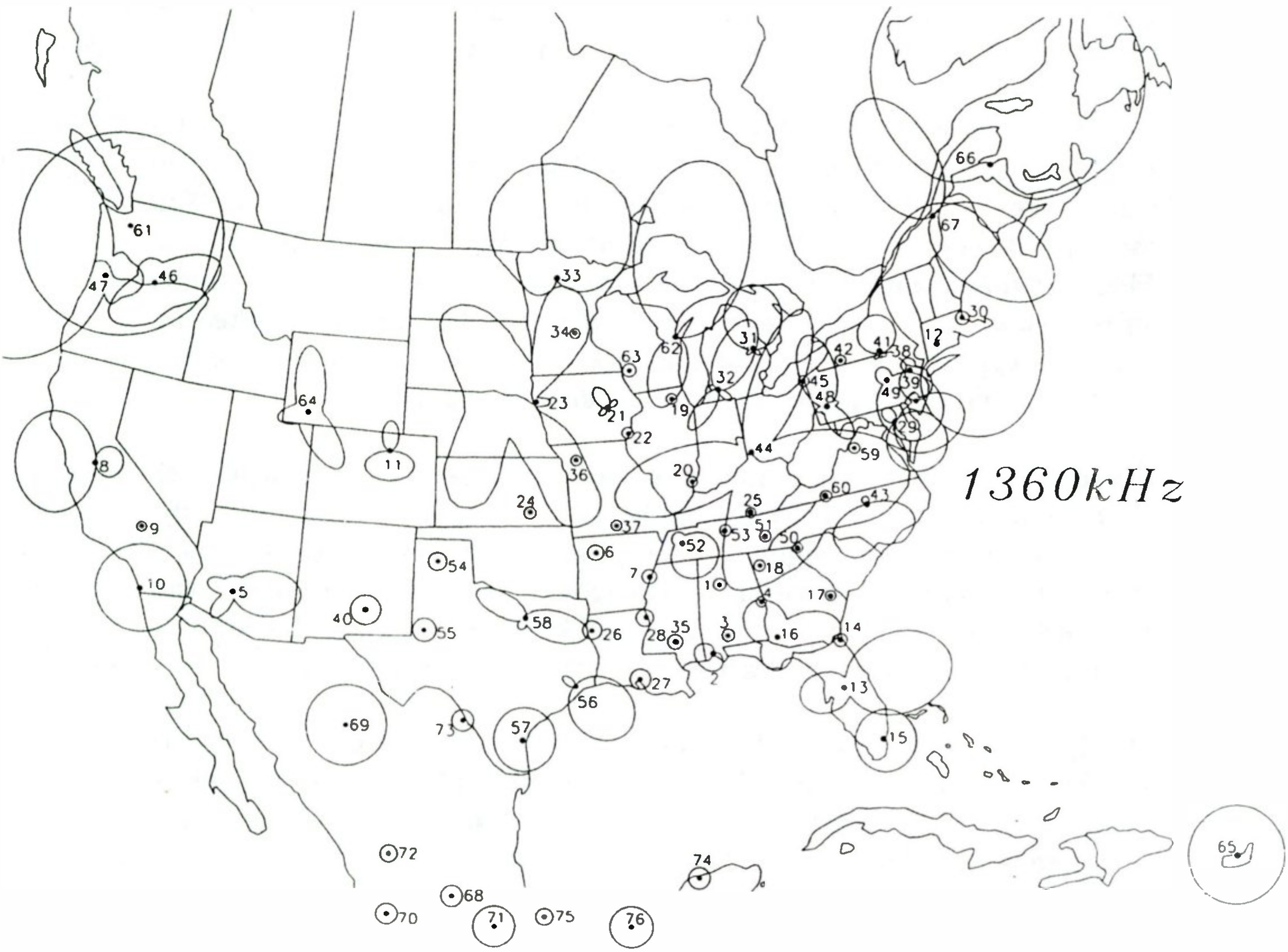

figure 6.3 – A page from the NRC Night Pattern Book (4th edition, 1996) showing the night patterns for AM stations on 1360 kHz.
[reproduced by permission of the National Radio Club]

KFWB RADIO 98

8230 YUCCA ST LOS ANGELES CALIF 90028 TELEPHONE (213) 462-KFWB

GROUP W

WBZ · WBZ-TV BOSTON
WINS NEW YORK
KYW · KYW-TV PHILADELPHIA
WJZ-TV BALTIMORE
KDKA · KDKA-TV PITTSBURGH
WOWO FT WAYNE
WIND CHICAGO
KPIX SAN FRANCISCO
KFWB LOS ANGELES

WESTINGHOUSE BROADCASTING COMPANY INC

December 18, 1981

Patrick M. Griffith

Dear Mr. Griffith,

We have checked our records and can verify you recieved KFWB on November 2, 1981 at 0048 to 0050 PST.

KFWB operates with a power of 5000 watts non directional 24 hours a day on 980 kHz.

Thank you very much for your reception report.

Sincerely yours,

Richard A. Rudman
Engineering Manager

RAR/sl
Encl.

figure 6.4 – An example of a QSL letter received by the author in 1981.

figure 6.5 – A sample of QSL cards from the authors collection.

One of the author's favorite hobbies is identifying AM radio station transmitter sites. Frequently, mostly for security reasons, these sites bear no indication of which station they belong to. Over the years I have developed a method for identifying transmitter sites using the 'seek' switch on my car radio. This method is successful most of the time.

When I spot a tower that appears to be an AM transmitter site (this also works for FM stations) I park in the general vicinity. In order to decrease the amount of signal entering the radio, I remove the whip portion of the antenna from the car. If the radio has a 'DX' or 'distance' switch, turn it to the off position. Then activate the 'seek' function. With the antenna removed, usually only a very close station will provide enough signal to halt the 'seek' function. You have now identified the station.

Of course the station must be on the air at the time you are doing this. Remember not all station have 24/7 schedules.

It is also a good idea to reactivate the 'seek' function a few times to ensure that there is only one station transmitting from the site. Remember, multiplexing and site sharing is gaining in popularity.

And above all, remember to park safely and NEVER trespass when seeking out these sites. In addition to violating the law, trespassing could be dangerous at a radio transmitter site due to the high levels of radio frequency energy radiating from the towers. Remember that the entire tower is the radiating element and many of them carry enough current to kill or seriously injure someone.

I prefer to stay back a safe distance and let my mind wander as I relax and think about how many people in distant and sometimes exotic locations may be listening to the signals emanating from the very tower I am viewing.

APPENDIX A

DEFINITIONS

ANTI-FADE ANTENNA – an AM antenna whose design provides sufficient signal strength to help prevent fading in the fringe area of the station's ground wave pattern

AM – amplitude modulation

AM BROADCAST BAND – the frequencies located between 535 and 1705 kHz

CLEAR CHANNEL STATION – an AM station that provides primary and secondary coverage over an extended area of the country

CONTOUR MAP – a map that plots a specific signal level radiated from the AM station antenna to demonstrate it's horizontal coverage pattern

CRITICAL HOURS – the 2 hour period immediately following local sunrise and the 2 hour period immediately preceding local sunset – the license of some stations require them to modify their operations during this period for the protection of signals from other stations on the same frequency

DA – common abbreviation for directional antenna

DAYTIME – the period of time between local sunrise and local sunset

DOMINANT STATION – the station whose signal is superior to all others on the frequency

DXer – one whose hobby is listening to distant radio stations

ERP – common abbreviation for effective radiated power

EXPANDED BAND – the section of the AM broadcast band located between 1605 and 1705 kHz (also referred to as the 'X-band')

EXPERIMENTAL PERIOD – the time between 12 midnight local time and local sunrise – this period may be used by AM stations for tests, maintenance and experimentation

FCC – Federal Communications Commission

FLOATING – broadcast term making reference to de-tuning an antenna or other structure to make it electrically invisible at the AM frequency of interest

GROUND WAVE (GROUNDWAVE) – a radio wave that is propagated along the surface of the earth

GROUND WAVE SIGNALS – the RF emissions from a radio transmitting antenna that radiate out generally horizontally in respect to the earth's surface

Hz – common abbreviation for hertz – a unit of measure for radio frequency waves – Hz is equivalent to cycles per second

INTERMITTENT COVERAGE AREA – the area between an AM station's primary and secondary coverage areas that is subject to some interference and fading due to the cancellation effects of those signals arriving at the same location out of phase

IONOSPHERE – the section of the earth's atmosphere in which ionization of atmospheric gases affects the propagation of radio waves

kHz – common abbreviation for kilohertz – a unit of measure for radio frequency waves – 1 kHz = 1,000 hertz (cycles per second)

LOCAL CHANNEL STATION – an AM station that provides coverage to a primary community and the suburban areas around it

MHz – common abbreviation for megahertz – a unit of measure for radio frequency waves - 1 MHz = 1,000,000 hertz (cycles per second)

MULTIPLEXING – the use of an AM radio antenna tower to broadcast signals from more than one transmitter simultaneously

mV/m – common abbreviation for milli-volt per meter

MW – medium wave – a reference to the medium frequency radio band so named because it is located between the low frequency and high frequency bands

NIGHTTIME – the period of time between local sunset and local sunrise

PARASITIC RE-RADIATION – the ability of a nearby electrically conductive structure to alter or interfere with the radiation pattern from an AM station transmitter site

PRIMARY COVERAGE AREA – the area served primarily by an AM station's ground wave signal and not subject to objectionable interference or fading

QSL – a card, letter, or other device sent to a listener to confirm or verify the reception of a radio station – derived from the amateur radio 'Q' signals

RECEPTION REPORT – a letter sent to a radio station by a radio hobbyist reporting that he has heard the station (usually from a far distance)

REGIONAL CHANNEL STATION – an AM station that provides coverage to a specific geographic region or population center

RF – radio frequency energy

SECONDARY COVERAGE AREA – the area served primarily by an AM station's sky wave signal and subject to variations in strength but not to objectionable interference

SKIP – nickname given to sky wave radio signals that bounce off of the ionosphere and return to earth at a distant location

SKY WAVE (SKYWAVE) – a radio wave that is propagated by means of the ionosphere

SKY WAVE SIGNALS – the RF emissions from a radio transmitting antenna that radiate out at any angle above horizontal in respect to the earth's surface and therefore toward the ionosphere

VERIFICATION CARD or LETTER – see 'QSL'

APPENDIX B

RESOURCES

-BOOKS-

This list of books is supplied as a reference for additional information on this subject. This list is only a sampling and is not intended to be all-inclusive. Your local library and other sources may offer many additional books on this subject.

Carr, Joseph J.: PRACTICAL ANTENNA HANDBOOK, second edition, TAB Books, New York, 1994

CODE OF FEDERAL REGULATIONS, CFR 47, parts 70 to 79, U.S. Government Printing Office, Washington DC, 1996

Ennes, Harold E.: AM-FM BROADCASTING EQUIPMENT, OPERATIONS, and MAINTENANCE, first edition, Howard W. Sams & Co., Indianapolis, IN, 1974

Ennes, Harold E.: BROADCAST OPERATORS HANDBOOK, John F. Rider Publisher, New York, 1947

Jasik, Henry: ANTENNA ENGINEERING HANDBOOK, first edition, McGraw-Hill Book Company, New York, 1961

Johnson, Joseph S. and Jones, Kenneth K., MODERN RADIO STATION PRACTICES, Wadsworth Publishing Co., Belmont, CA, 1972

Layton, Jack: DIRECTIONAL ANTENNAS MADE SIMPLE, Layton Technical Services, McMurray, PA, 1996

Marcus, A. and Wm.: ELEMENTS of RADIO, fourth edition, Prentice Hall Inc., Englewood Cliffs, NJ, 1959

Noll, Edward M.: BROADCAST RADIO and TELEVISION HANDBOOK, sixth edition, Howard W. Sams & Co., Indianapolis, IN

Weeks, W. L.: ANTENNA ENGINEERING, McGraw-Hill Book Company, New York, 1968

-MAGAZINES-

This list of magazine resources is supplied as a reference. It is only a sampling of the many resources available and is not intended to be all-inclusive.

MONITORING TIMES, P.O. Box 98, 7540 Highway 64 West, Brasstown, NC 28902-0098
http://www.grove-ent.com

POPULAR COMMUNICATIONS, 76 North Broadway, Hicksville, NY 11801-2953
http://www.popcomm.com

RADIO SHOPPER, 511 18th St. SE, Rochester, MN 55904
http://www.radioshopper.com

RADIO WORLD, P.O. Box 1214, Falls Church, VA 22041,
http://www.rwonline.com

-INTERNET-

This list of clubs and Internet resources is supplied as a reference. It is only a sampling of the many resources available and is not intended to be all-inclusive. Some of these resources were chosen for their contents and some were chosen for the excellent links that they contain to other resources.

Airwaves MediaWeb
http://www.airwaves.com/

AMQ AM Radio Station Database Query (FCC)
http://www.fcc.gov/mmb/asd/amq.html

The Association of North American Radio Clubs (ANARC)
http://www.anarc.org/

Bellingham Radio Museum Home Page
http://www.antique-radio.org/

Bill's Ultimate TIS Digest
http://www.erols.com/wharms/tis/

The Broadcast Archive
http://www.oldradio.com/

Broadcast History – Voices Out Of the Fog
http://members.aa.net/~jfs/

Broadcast Station Location Page
http://207.91.54.150/radiostation/

BRS Radio Directory
http://www.radio-directory.com/

DX-midAMerica!
http://www.angelfire.com/wi/dxmidamerica/index.html

Funkenhauser's WHAMLOG & Mediumwave DX Links
http://home.inforamp.net/~funk/

The International Radio Club of America
http://www.geocities.com/Heartland/5792
P.O. Box 1813, Perris, CA 92572

Jeff Miller's Broadcasting History Collection
http://members.aol.com/jeff560/jeff.html

Jim Hawkins' Radio Room
http://www.exit109.com/~jimh/radio.shtml

KDKA Radio 1020 History
http://www.kdkaradio.com/history/index.html

Medium Wave Alliance
http://members.xoom.com/mediumwave/mwa.html

The MIT List of Radio Stations on the Internet
http://wmbr.mit.edu/stations/list.html

MLTEC Radio Broadcasting Homepage
http://www.webcom.com/radioweb/

The National Radio Club
http://www2.wcoil.com/~gnbc/
P.O. Box 118, Poquonock, CT 06064-0118

Ontario DX Association
http://www.durhamradio.ca/odxa/
Box 161, Station A, Willowdale, Ontario, M2N 5S8 Canada

The Original Old Time Radio (OTR) WWW Pages
http://www.old-time.com/

Radio/DX Information from Wisconsin
http://www.angelfire.com/wi/dxing/index.html

Robert Kramer's DX Home Page
http://members.aol.com/rkdx/index.html

ABOUT THE AUTHOR

The author has been an avid AM broadcast band listener and DXer since 1964. He holds one of the original Popular Electronics magazine listener call signs issued in the 1960s, WPE9HVW. He is a licensed amateur radio operator, call sign NØNNK.

Since 1988 his articles and photographs have been published regularly in periodicals such as Popular Communications, the APCO Bulletin, 9-1-1 Magazine, American Fire Journal, and Monitoring Times. He authored the cover story for the April 1998 issue of Monitoring Times, entitled *AM Radio Transmitter Sites*, which was derived from his work in this publication.

He is an associate member of the Colorado Press Association and holds *Working Press* credentials through that organization. He also maintains memberships in the National Radio Club, the American Radio Relay League, the Association of Public-Safety Communications Officials, the Colorado Repeater Association, and the Rocky Mountain Radio League.

One of his favorite hobbies is locating and photographing AM radio station transmitter sites.

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ISBN 0-7392-0085-2
90000>
EAN
9 780739 200858