# GUY-WIRE REFLECTOR CONFIGURATIONS IN MEXICO

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12 August 1994

This paper addresses two sites in Mexico where a non-directional tower was converted to directional operation by tuning a guy-wire as a reflector. The first conversion was for 50 kw XEWB in Veracruz. The latest conversion was for 10 kw XEQI in Monterrey. In both cases, increased field was desired to the South in order to improve coverage in major population areas. Using an existing guy-wire as an element in a directional array eliminates the need for an additional tower and land.

## XEWB, Veracruz, Mexico

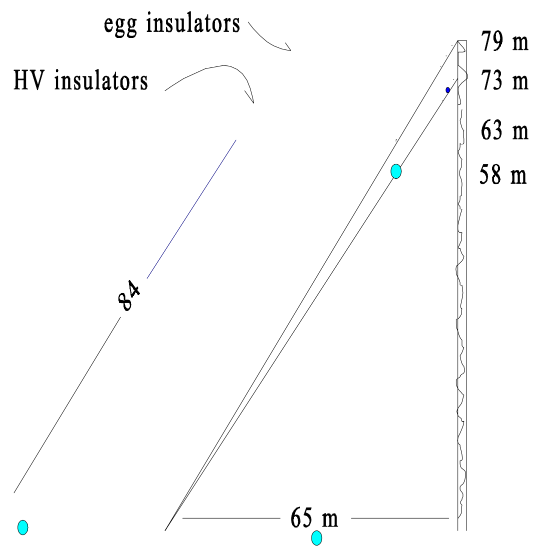
The desire of 50 KW XEWB is to provide maximum coverage of the population areas near and in Veracruz, while reducing skywave signal strength towards sister station XEW in Mexico City, which shares the same 900 kHz frequency assignment. To this end, a directional pattern with a minimum to the West and a maximum to the Southeast is desired. This is achieved by tuning a portion of the Northwest guy-wire as a reflector; a variable capacitor is used near the guy-wire anchor to adjust the electrical length of the guy-wire.

XEWB is located to the Northwest of Veracruz, on sandy soil close to the ocean. Comparison of the directional to the non-directional measured field intensities shows a reduction in gain towards the West of 4 to 5 dB, depending on exact bearing, and a maximum increase of 3.5 dB towards Boca del Rio, southeast of Veracruz. The major lobe of the field pattern is greater than the non-directional pattern on bearings (relative to the antenna) from the town of Valente Diaz on the western extreme to the northern coast of Veracruz on the eastern extreme.

Thus the technique of exciting a guy-wire as a parasitic element, thereby creating a two-element directional array out of a single tower, is a viable and economical means of doubling radiated power in a particular direction, and providing protection on one or two other bearings.

Conversion of the base-insulated, series-fed, quarter-wave tower to directional operation entailed adding jumpers across some of the existing guy-wire insulators, replacing the remaining guy-wire insulators with larger sizes having a higher voltage rating, laying 20 ground radials each 50 meters long around the guy-wire anchor, adding a tuning capacitor between the nexus of these new ground wires and the bottom of the hot guy-wire, and adjusting the tower impedance matcher for the reduced base resistance and increased base reactance.

The choice of what appears to be too small a number of ground radials bears some explanation. The minimum number of ground radials can be determined by knowing the RF current rating of the size of wire used for the radials. For example, if the wire can handle one ampere without undue temperature rise, and you have 20 amperes at the bottom of the guy-wire, then you know that you need at least 20 radials. The second consideration is a compromise between efficiency and cost.




An effective empirical approach to the question of how much copper should be used in the ground system, is to measure the self base impedance of the active guy-wire while radials are added to the circuit (don't forget to open the tower base circuit when you do this). When the self resistance no longer drops significantly with increasing radials, you have a good compromise. Keep in mind that the existing radials from the tower can assist, and may be brazed to the new radials where they intersect.

In the case of 50 KW XEWB, it was decided that the guy-wire current was better shared between two guy-wires, so the top two Northwest guy-wires were excited simultaneously (Figure 1). That is, they were simply jumpered together near the anchor, and received the same insulator modifications. It is important to note that the voltage gradient at the top of the hot guy-wire can be quite high, and requires careful corona treatment. The insulator needs to be a high-voltage type with corona rings for all but the lowest power stations. Experiments at XEWB determined that a string of large egg insulators is adequate for no more than 10 kilowatts with modulation, for the given tuning. Synthetic wire rope such as Philistran is not an acceptable insulating material for an active guy-wire because the very high voltage gradient can melt the Philistran in a matter of seconds.

Theoretical antenna analysis indicates that the reflector configuration is preferable to a director configuration from the standpoints of current and voltage stresses, and bandwidth. But if a director is required, it can easily be produced by adjusting the guy-wire tuning reactance, or using a shorter portion of the guy-wire as the active element.

The non-directional bandwidth at XEWB was measured for resonance at carrier (VSWR = 1.0), and yields a VSWR 10 kHz on either side of carrier of about 1.13, while the directional case has a sideband VSWR of 1.38. This latter number is quite reasonable for good audio fidelity, and is expected as an unavoidable by-product of increased gain. Keep in mind that two closely-spaced guy-wires were active at XEWB, and that this tends to improve bandwidth. If the active portion of the guy-wires had been a bit shorter, less tuning reactance would have been required, and bandwidth would have been slightly better.

The self base impedance of the XEWB tower as measured by a Delta OIB-3, and corrected for frequency, is as follows:

| kHz | resistance | reactance |
|---|---|---|
| 870 | 46 | 53 ohms |
| 875 | 47 | 57 |
| 880 | 47 | 60 |
| 885 | 49 | 63 |
| 890 | 49 | 66 |
| 895 | 50 | 68 |
| 900 | 50 | 72 |
| 905 | 52 | 72 |
| 910 | 53 | 77 |
| 915 | 54 | 77 |
| 920 | 54 | 83 |
| 925 | 58 | 86 |

The directional base impedance of the tower, with 100 ohms of capacitive reactance inserted at the base of the hot guy-wire, was:

| kHz | resistance | reactance |
|---|---|---|
| 890 | 35 | 86 ohms |
| 900 | 36 | 97 |
| 910 | 44 | 108 |

The field intensity measurements were made at low power such that 9200 watts was developed at the antenna for both the directional and non-directional cases. This made field intensity comparison intuitively more evident during the measurement process. Fitting the non-directional measurements on the Southeast bearing (locations 7, 8, 9) to FCC curve 10 shows a 10 mmho/m ground conductivity in this direction. Similarly, the Western bearing (locations 1, 2, 3) shows a ground conductivity of about 4 mmho/m. The lower conductivity in a direction away from the sea coast is to be expected, since the Southeast bearing parallels the salt-marsh coastal area.

The specific field intensities in mV/m for the low-power case are as follows:

| LOCATION | DISTANCE | BEARING | NON-DA | DA | GAIN |
|---|---|---|---|---|---|
| 1. El Pollito | 4.5 km | 273 deg | 182 mv/m | 102 | -5.0 dB |
| 2. HWY 180 overpass | 9.4 | 287 | 38 | 21 | -5.2 |
| 3. Delfino Victoria | 9.3 | 266 | 61 | 38 | -4.1 |

| | | | | | |
|---|---|---|---|---|---|
| 4. HWY 140 E of St Fe | 8.8 | 241 | 54 | 34 | -4.0 |
| 5. Bruno de Pagliai | 7.8 | 129 | 72 | 58 | -1.9 |
| 6. HWY 140 W airport | 7.0 | 193 | 101 | 122 | 1.6 |
| 7. Paso Colorado | 17.3 | 163 | 35 | 46 | 2.4 |
| 8. Boca del Rio | 15.0 | 157 | 48 | 72 | 3.5 |
| 9. Torremar beach | 12.6 | 144 | 60 | 90 | 3.5 |
| 10. Pt Mocambo S | 11.5 | 138 | 51 | 65 | 2.1 |
| 11. Pt Mocambo beach | 11.0 | 132 | 62 | 80 | 2.2 |
| 12. Pt Mocambo park | 10.7 | 132 | 73 | 90 | 1.8 |
| 13. C. Colon beach | 7.0 | 128 | 96 | 120 | 1.9 |

A complete field intensity proof will be performed when the insulator strings in the two active guy-wires are replaced with high-voltage insulators sufficient to withstand the stress of 50 kw operation.

The technique used to determine the initial setting of the guy-wire tuning reactance is to measure the tower base impedance as a function of guy-wire tuning reactance. A dip will be noted in the tower base resistance. At this point, the directional pattern forms a figure eight on the axis formed by a line drawn through the tower base and the hot guy-wire anchor. If one increases the tuning reactance, thereby making the guy-wire electrically longer, one creates a reflector and a cardioid pattern emerges. As the reactance is increased farther, the cardioid null becomes two nulls on either side of a minor lobe out the back. Ultimately, as more and more reactance is added, the pattern degenerates to the non-directional shape.

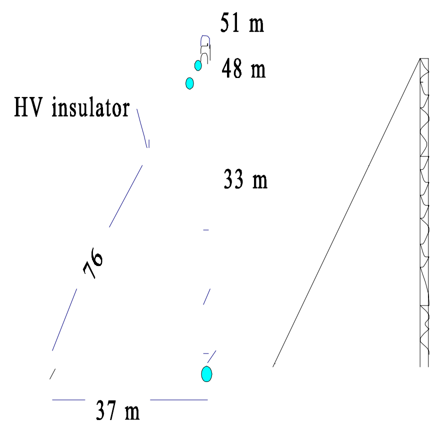
On the other hand, if the guy-wire tuning reactance is decreased, the guy-wire becomes a director, and the pattern forms a cardioid in the opposite direction. Depending on the physical length of the active portion of the guy-wire, one may have either a capacitor or an inductor at the base of the guy. That is, if the guy-wire is shorter, a coil will be required to make it longer electrically, but if the guy-wire is longer, a capacitor may be required to make it shorter electrically. If one is very lucky, he will insert the insulator at the exact location at the top of the active portion of the guy-wire such that no tuning reactance is required.

A weatherproof tuning box and a fence need to be erected around the hot guy-wire anchor, as considerable voltage may be developed across the guy-wire's bottom insulator. It is a good idea to provide an RF ammeter in series with the tuning reactance. In general, in order to avoid uncommonly high voltages and currents, and possibly bandwidth problems, it is a good practice to keep the guy-wire base current below the level of the tower base current. In the case of XEWB, the guy-wire current was about 80 percent of the tower current. More gain may be had with higher currents, but the cost of increased insulation or bandwidth treatments may not be justified for a few tenths of a dB.

XEQI, Monterrey, Mexico

XEQI recently increased power from five to ten kilowatts, and implemented an active guy-wire directional antenna to improve coverage in Monterrey, and reduce skywave field intensity towards the United States. The location of one of the guy-wires was sufficiently close to the azimuthal bearing between the transmitter site and Monterrey to permit its use as a reflector. Adding a fourth wire strictly for pattern adjustment in order to get a more direct beam towards Monterrey (and direct null towards San Antonio) was not necessary in this case, but could be an attractive solution at other sites where existing guy-wire alignment is not favorable.

A fiberglass and polymer high-voltage suspension insulator with corona rings typically used for 60 Hertz power lines was tested at Continental Electronics in Dallas at HF frequencies. HF was chosen over MF, in order to increase dielectric heating stress. No decrease in strength or unusual heating was noted when the insulator was subjected to 100 kw carrier and 100 percent modulation at the plate of a 418E transmitter (about 40 kvp). This insulator was an Ohio Brass 232008-3002 about 39 inches long and weighing eight pounds, having a wet flashover rating of 375 kvp at 60 Hz. The overall weight of the insulator assembly became about 15 pounds using a 15 inch diameter 271751-3001 corona ring, and an 8 inch diameter 271761-3001 corona ring. The insulator has recently been superceded by part number 511204-1000.




This insulator assembly was placed about 33 meters off the ground in the guy-wire. The existing guy-wire was attached to the 51 meter tower about 48 meters off the ground. The original small egg insulators were removed from this guy-wire. One large egg insulator was placed at the bottom of the hot guy-wire, and two large egg insulators placed at the tower. Careful attention was given to the treatment of the guy-wire mechanical connections to the insulators. In order to avoid sharp edges, the guy-wire pigtails were served (wrapped) with wire. This also had the benefit of increasing the effective radius of the wire, thereby reducing voltage gradient. Only one guy-wire clamp was used near each corona ring of the high-voltage insulator, and its U-bolt thread was hidden with a second nut having rounded edges.

I do not know if this fiberglass suspension insulator would perform adequately at 50 kw. Certainly an expensive ribbed ceramic insulator with corona rings would work at the higher power level. The cost of the ceramic insulator is three to four times that of the plastic suspension insulator, but that may be a small price to pay if it prevents mechanical failure of the guy-wire and tower. Of course, if two active guy-wires with separate tower connections are used, the cost differential is doubled. I recommend that two large corona rings be used with the fiberglass insulator, rather than the standard large and small ring, if the more economical insulator is used at high power levels.

A careful corona test procedure is an important part of the initial adjustment of the active guy-wire antenna. Several observers should be stationed near the active guy-wire at night, and communications established with the transmitter operator. An infra-red scope is very useful for observing hard-to-reach components of the antenna system, such as guy-wire insulators. Barring that, a five-inch diameter reflector telescope can be trained on the insulator. Begin operation at low power and no modulation. If any arcing or corona is observed on the hot guy-wire, turn off the transmitter immediately. Otherwise, after several minutes turn off the transmitter and check for unusual heating in all components and the guy-wire. Repeat this process at full power and no modulation. Now return to low power, but modulate 100 percent. Finally, switch to full power and 100 percent modulation. Plans should also be made to observe the high-voltage insulator again when rain or dew are present, so somebody should keep an eye on the weather with this in mind.

Short bare copper ground wires were added around the base of the guy-wire. These were 12 gauge, and 40 meters long at most, depending on the property boundary. The electrical length of these ground wires varied from about 40 to 70 degrees. A ground rod was placed at the end of each ground wire. These ground wires were not directly tied to the existing 20 year old ground system. The customary large copper strap was not run between the bases of the two radiators. This is not a problem if the two ground systems do not touch intermittently. As the ground was very hard, the new wires were laid in shallow trenches and later covered with several truck-loads of earth, in order to provide some stability to the ground system. Stability appeared to be a problem before the ground wires were properly buried. Following burial, no changes in tower and guy-wire base currents were noted after heavy rainfall. The guy-wire anchor was located about 37 meters from the base of the tower, and was attached to four guy-wire levels. The active guy-wire lower insulator was placed right at the anchor.

From the standpoint of personnel safety, it is a good idea to erect a fence or at least install a warning sign at the hot guy-wire anchor. It may not be obvious even to experienced broadcast personnel that a lot of RF is present on the bottom of the hot guy-wire, since the active guy-wire antenna configuration is uncommon. Guy-wires normally have insulators, and it is quite possible to suffer an RF burn by touching de-tuned guy-wires. A much worse RF burn could result from touching a tuned guy-wire.

The base impedance of the tower at 1510 kHz was 52 + j89 ohms non-directional with the hot guy-wire disconnected from ground, but the tower static drain and lighting chokes in place. This impedance became 60 + j112 ohms directional when a coil of about j83 ohms was inserted at the base of the hot guy-wire. This coil more-or-less resonated the self-reactance of the guy-wire. It is interesting to note that the feed resistance increased with increased pattern gain, which is contrary to intuition and the situation at XEWB. However, more gain could probably have been obtained if the hot guy-wire had been tuned for a lower feed resistance, albeit at the expense of decreased bandwidth and increased current and voltage stresses.

The currents in the tower and guy-wire base were similar, about 13 amperes at 10 kw operation. When final adjustment has been achieved, it would be possible to improve bandwidth and efficiency slightly by increasing the length of the active guy-wire so that very little parasitic tuning coil is required. Also a parallel wire can be added about one meter from the active guy-wire. In the specific case of XEQI, if the equivalent radius of the tower and the active guy-wire were the same, about half as much reactance would be required at the base of the guy-wire to tune it for the same pattern.

In general, I would only recommend adding a parallel wire to the active guy-wire if the theoretical +/- 10 kHz VSWR were greater than about 1.5. Otherwise, adjusting the antenna coupler for sideband impedance balance at the PA should be sufficient for reasonable audio fidelity. However, when in doubt, use parallel wires. Theoretical analysis of the tower base impedance and patterns across the 20 kHz channel for the case of a one-meter diameter active guy-wire tuned with five micro-Henries yields the following:

| kHz | base impedance | resonated | VSWR | South gain | North gain |
|---|---|---|---|---|---|
| 1500 | 53.0 + j81.1 ohms | 53.0 - j0.5 | 1.11 | +3.5 dB | -14.4 dB |
| 1510 | 58.6 + j81.1 | 58.6 + j0 | 1.00 | +3.2 | -11.3 |
| 1520 | 63.0 + j80.7 | 63.0 + j0.1 | 1.08 | +3.1 | -9.4 |

Bandwidth of an active guy-wire antenna system is directly related to the directional base resistance of the tower. Worst bandwidth occurs when the base resistance is at its minimum value and system currents are at their maximums, which occurs when the active guy-wire has been tuned to produce a figure-eight pattern. Best bandwidth occurs when the active guy-wire is completely de-tuned, producing an omni-directional pattern. In order to maximize pattern and impedance bandwidth and stability, one must avoid the minimum resistance point, and tune the active guy-wire to produce the least gain adequate for the situation. Consider the same one-meter diameter active guy-wire case as before, but now tuned with four instead of five micro-Henries (big changes in bandwidth with just a small adjustment in tuning):

| kHz | base impedance | resonated | VSWR | South gain | North gain |
|---|---|---|---|---|---|
| 1500 | 27.6 + j79.9 ohms | 27.6 - j6.5 | 1.36 | +4.2 dB | -5.6 dB |
| 1510 | 34.4 + j85.8 | 34.4 + j0 | 1.00 | +4.1 | -9.3 |
| 1520 | 41.7 + j90.0 | 41.7 + j4.8 | 1.26 | +3.9 | -13.4 |

Referring to Figure 1, it can be seen that the average length of the active guy-wire is about 80 degrees, and the average height of the high-voltage insulator from ground is about 64 degrees. The average guy-wire tuning reactance at the two sites was about -10 ohms, so I would expect best bandwidth to occur in the general case when the active portion of the tuned guy-wire is about 79 degrees long.

Since the percent bandwidth of a +/- 10 kHz channel at the high end of the standard AM broadcast band is less than at the low end, it was decided to try only a single active guy-wire at XEQI, as opposed to a ladder configuration. However, if stability, losses or bandwidth are deemed a problem at XEQI, a second wire can be added in parallel with the original active portion of guy-wire. Spacers about two feet long would be sufficient.

Theoretical analysis indicates that a significant improvement in bandwidth at XEQI could be obtained if the effective radius of the active guy-wire were increased. Unlike XEWB, the second level of XEQI guy-wires is too far below the first level to use one of the existing lower guy-wires as the second hot wire without significantly reducing the effective height of the reflector. However, this should not preclude the use of a lower level guy-wire in other applications.

Impedance and pattern stability are important considerations when modifying an omni-directional tower for directional operation with an active guy-wire. If movement of the active guy-wire is not adequately controlled (not enough guy-wire tension, for example), or tower sections are not adequately bonded, or the tower lighting conduit is not properly bonded to the tower, or paint has encroached on the insulators, or the old ground system has decayed, etc, then performance will vary according to the weather. It may be necessary to perform some maintenance on older existing towers and ground systems to ensure compatibility with the directional mode of operation where currents and voltages will surely increase. Since a tower crew will install the high-voltage insulator in the active guy-wire, take advantage of their visit by having them expertly arc-weld tower sections together, replace broken insulators and lamps, and anything else that is appropriate.

I was a bit surprised to measure strong pattern shaping when the XEQI directional tower base resistance was higher than the non-directional base resistance (remember it changed from 52 to 60 ohms). However, it turns out that this effect is normal over lossy earth, which was not modeled in the original moment-method studies. Probably more forward gain and lower reverse gain can be obtained by farther adjustment of the guy-wire tuning coil towards a lower base resistance. The minimum tower base resistance was about 35 ohms, with a reactance near 98 ohms, and this is where we would expect a figure-eight pattern and worst currents and bandwidth. But one less active turn in the guy-wire tuning coil would still avoid the resistance minimum, and is a good place to start the next set of radiated field intensity measurements. At the time this paper was written, the final set of measurements was not yet available, as the new guy-wire ground system was not yet fully covered with earth.

It appears that the technique of adjusting the guy-wire tuning to produce minimum resistance at the base of the tower may not be necessary in order to find a good starting point for the guy-wire tuning reactance. It may save time to simply measure the self reactance of the guy-wire with the tower disconnected from its coupler, and then set the guy-wire tuning reactance to resonance. However, it is always a good idea to find the minimum resistance setting as a reference point, since a mistake in the initial setting (too close to the minimum resistance, for example) can waste a lot of field intensity travel and measurement time.

The ultimate adjustment tool would be an antenna monitor using current sampling transformers at the base of the active guy-wire and the tower. Indeed, this may be required by the appropriate regulatory agency in some situations. However, the direct method of field intensity measurement is proof enough in most cases. If an antenna monitor is available, a 180 degree shift in the phase relationship between the two samples can be observed at the minimum resistance point.

The 10 kw field intensities showed an initial 3 dB improvement over the non-directional case towards Monterrey, for the given tuning. Another benefit from this hot guy-wire configuration was a decrease in signal towards Texas, thereby avoiding potential interference with other stations. The initial decrease was measured at 8 dB.

Final measured values were not available at the time this article was written, but will be greater than 8 dB.

At any rate, the question of antenna efficiency has been answered. In other words, practical pattern shaping and gain can be obtained with the active guy-wire approach, even when small ground systems are used around the active guy-wire anchor. Also the question of guy-wire voltage gradient has been adequately addressed at 10 kw. The questions of impedance and pattern stability when using only a single 1/4 inch diameter active guy-wire must wait until additional data have been collected from the XEQI site.

Extensive moment-method analyses of the array characteristics for both XEWB and XEQI were performed before site modifications were begun. The usual application procedures should always be followed in order to obtain government authorization to proceed with the implementation of an active guy-wire antenna.

## CHUC, Cobourg, Ontario, Canada

An 8 kw DA-D operating on 1450 kHz was implemented by Canadian consulting firm Elder Engineering in 1989, using an active guy-wire composed of twin wires with spacers, giving the appearance of a ladder. Elder Engineering believes that this double-wire configuration has the advantages of reduced heat loss, and better bandwidth and stability, compared to a single guy-wire. However, the cost of this approach is higher, since a number of metal spacers must be installed as rungs of the ladder, and windage is increased. Mr Elder's configuration also differed in that a long vertical drop-wire pair was used to connect the active guy-wire to its tuning hut on the ground. The array consisted of two towers and one active guy-wire. The pattern is asymmetrical, since the active guy-wire was not in line with the towers. The active guy-wire was used to increase overall gain in one direction, and decrease gain in the opposite direction, thus producing a pattern normally obtained with a three-tower dog-leg configuration.

Elder Engineering's work at CHUC provides independent validation of the active guy-wire technique at medium power levels. The approach was based primarily on work done in England at several one-kilowatt stations. There is a paper in the 1983 ICAP ("A Directional Medium-frequency Transmitting Antenna Comprising a Single Guyed Mast and a Sloping-wire Parasitic Reflector," Norwich, Great Britain: 1753) written by E. T. Ford of the Independent Broadcasting Authority, which discusses the ladder type of active guy-wires. The maximum gains of the IBA antennas were less than 3 dB, but most of them were electrically short, so had greater losses than the Mexican cases discussed above.

## Mandele, St. Lucia

A ten kilowatt, 840 kHz hot guy-wire configuration designed by Continental Electronics (based on work begun in January 1983) was installed by St. Lucia engineer Winston Foster in 1989 on the southeast coast of the island. Engineers flew in from France to study the antenna.

The series-fed, base insulated tower is a quarter wavelength tall.  It may no longer be in operation at this time, as a power increase and multi-tower array was planned.

Bordeaux-Neac, France

A 300 kilowatt, 1296 kHz hot guy-wire configuration using a cage of wires tuned by a coil began operation in Bordeaux-Neac in 1990.  The tower is a quarter wavelength tall.

WXCT, Hamden, Connecticut

United States consultant Clarence Beverage has proposed a slant-wire element as part of a directional antenna for WXCT.  Mr Beverage submitted a Petition for Rule-making on August 4, 1994, to encourage the FCC to amend the regulations regarding the use of slant-wire radiators.  It is very interesting to note that former FCC Chief Engineer Harry Fine developed a general set of equations describing the patterns produced by sloping radiators in 1951.  The FCC has been slow to respond to this petition.

XEDX, Ensenada, Baja California

In early 1995, Sr Eduardo Liano installed a 1010 kHz, 2 kw hot guy-wire using a ladder arrangement of two parallel wires.  These wires were spaced about three feet apart at the tower, and brought to a common insulator near the anchor.  Metal spacers were used to separate the two parallel guy-wires.  Fiberglass rod insulators were used (18 inches at the anchor, 36 inches at the tower top and the top of the hot guy section).  The series-fed, base insulated tower is about 92 degrees tall, and the active portion of the guy-wire is about 86 degrees long.  The guy anchor is about 69 degrees from the tower base.  The guy-wire tuning consists of a variable tubing coil in series with a mica capacitor and RF ammeter.  With 6.0 amps in the reflector and 4.5 amps in the tower, forward gain was measured at 3.1 dB and reverse gain at -12.0 dB.  The hot-guy ground system consists of 40 radials, each 20 meters long, buried around the guy anchor and bonded to the existing ground system.  Sr Liano designed and implemented this antenna based on the published XEWB and XEQI results, using his own moment-method program, and should be commended for a job well done.

Also see Grant Bingeman's "An Economical Directional Antenna for AM Stations" which was published in the *1987 NAB Engineering Conference Proceedings*, and "Antenas de AM con Retenidas Activas" which appeared in the *Resumen de Platicas* of the 1989 CIRT XII Seminario de Actualizacion Tecnica, and "Lower-cost Directional Antenna Systems" which appeared in the July 1994 issue of *Broadcast Engineering Radio.*

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I wish to thank Sr Miguel Barrientos of Sistema Radiopolis, and Sr Aguilar and his staff at XEWB for their patience and capable assistance with this novel project, and with their foresight in pioneering a new antenna for the broadcast industry.

I also wish to thank Sr Gustavo Leva and Fernando Medina of Radio Nuevo Leon, and Jesus Canela, Angel Espana, Jesus Navela, and Jesus Navarro Franco of AURI for their assistance in Monterrey.  XEQI may be the first radio station in Mexico to receive formal approval of the active guy-wire pattern from the Secretaria de Comunicaciones y Transportes (the SCT is equivalent to the US FCC), following final field intensity measurements.

file: amitra 8-12-94 (updated 6-15-95 and 1-12-98)