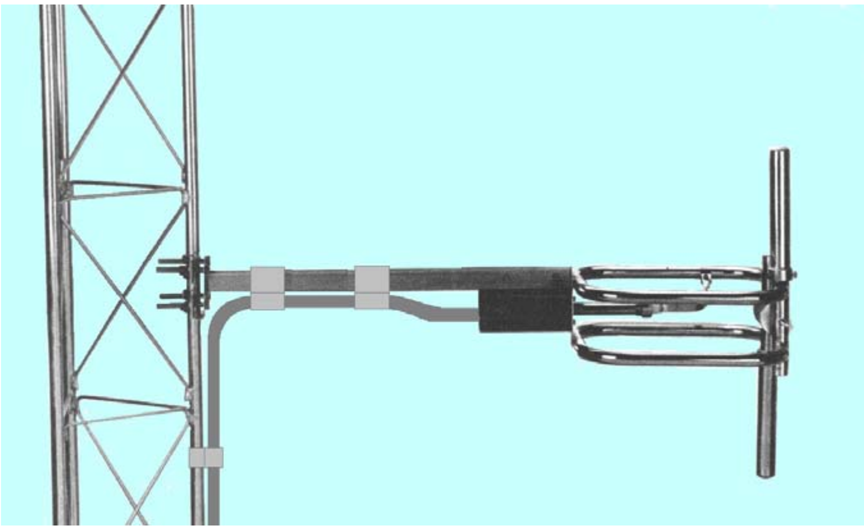
TECHNICAL MANUAL

FREQUENCY MODULATION BAND II OMNIDIRECTIONAL BROADCAST ANTENNA

SGP-1



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LimitedWarranty

I.- About Installation.

1.- Mains Voltage must be kept between ± 10% about its nominal value, unless otherwise specified. If were variations exceeding this tolerance, it will be indispensable to install a voltage stabilizer system within station. If transient overvoltages, due to electric motors, or other devices of this sort connected to the distribution line, were present, or if the distribution line is exposed to atmospheric electrical discharges, it must be indispensable the installation of isolation transformers and gaseous dischargers before connecting any equipment within station.

2.- All equipments must be connected to station ground system in order to avoid damage both to equipments and maintenance personnel too. It is necessary to connect a differential automatic switch (lifesaver) at station.

3.- Some equipments does not include interlock protection for open doors, covers or connectors. In that case, these equipments must be kept in key-locked places, with access only to conveniently qualified personnel that is previously noticed about not to open doors, covers or connectors without disconnecting station mains switch before performing this job.

4.- Transmitter equipments NEVER will be operated with output powers over its nominal values, or with signals or input informations others than those specified in its individual characteristics.

5.- Ambient temperature inside equipments' room, will accomplish technical specifications of equipments installed at station lodge. In absence of such specifications, maximum allowable temperatures will be from -5 to + 45 º C for Television equipments, and from 0 to + 40 º C for Sound Broadcast equipments.

6.- In case of operation at abnormally high or extremely high temperatures (over 30 to 40 º C), it is obligatory to install a forced cooling system that will keep temperature below its upper limit. In case of operation at abnormally or extremely low temperatures, it will be obligatory to install a thermostatic controlled heating system for equipment's room.

7.- Both equipment's surroundings and room must be free of dust and dirt. Ambient relative humidity will be kept below equipment's extreme specifications. In case of absence of this specification, allowable maximum will be 90 % of relative humidity, non-condensing. Average relative humidity will be kept under 70 %, non-condensing.

8.- Every transmission equipment that can radiate some quantity of RF power, must be connected to a load or antenna system, suited to its individual specifications, before being energized.

9.- Maximum allowable VSWR in antenna systems both for Television or FM Radio Broadcast operation of a given transmitter, will be 1.25:1, unless otherwise specified.

10.- For those transmitter equipments having power valve amplifiers, and that doesn't has an automatic shutoff cycle, and must be manually turned off, as a first step high voltage, or anode voltage, will be disconnected, keeping forced cooling system working during at least 5 minutes after high voltage disconnection, and only after this time, cooling system & filament voltage can be shutted off. O.M.B. Sistemas Electrónicos, S.A., is not responsible of damages to those power valves caused by sudden AC mains failures at station where our equipments are installed.

11.- Periodically, monthly as a maximum, technical personnel must visit station in order to perform a general equipment maintenance, unless otherwise specified. This maintenance will include output power check, VSWR of antenna systems, forced cooling or heating systems checks, both for equipments and station itself, including air filters cleaning, measuring of transmission frequency with eventual correction if necessary, and will perform a general check of fundamental parameters of equipments. In the event of any important change in some operation parameter, that will require replacement or readjustment of any unit, Customer MUST CONTACT FIRST WITH O.M.B. SISTEMAS ELECTRONICOS, S.A. BEFORE ANY ATTEMPT TO READJUST OR REPLACE ANY COMPONENT OR UNIT INSIDE EQUIPMENTS, IN ORDER TO KEEP VALID THIS WARRANTY.

12.- For equipments who are located in fixed racks or cabinets, those equipments must be effectively connected, according to International Installations Standards, to station ground system, whose total impedance measured to ground can't be higher than 5 ohms. Equipments must be connected to ground system so that they can be kept out of main discharge path between tower and ground.

II.- About Transportation.

1.- O.M.B. Sistemas Electrónicos, S.A. is not responsible of damages and/or detriments derived from mishandling, steal, robbery, theft or vandalism during the act of transportation of equipments to final or intermediate destination.

III.- About Storage.

1.- O.M.B. Sistemas Electrónicos, S.A. is not responsible of damages and/or detriments derived from unappropiate storage of equipments, within inadequate warehouses or outdoors, once equipments are delivered to transportist agency.

IV.- About Projects.

1.- O.M.B. Sistemas Electronicos, S.A. is not responsible of inadequate use of equipments made or registered by our Company, accomplishing propagation projects that are not performed by our Specialists.

V.- About Systems.

1.- O.M.B. Sistemas Electrónicos, S.A. is not responsible for performance of those equipments or systems that are not made, certified or registered by our Company.

VI.- About Operation

1.- O.M.B. Sistemas Electrónicos, S.A. is not responsible of damages and/or detriments derived from inadequate or negligent operation of equipments made, certified or registered by our Company, once those equipments are operated by personnel hired and/or employed by Customer.

VII.- General.

This Warranty covers and protects, during a period of 18 months after start of operations, all equipments made , certified or registered by O.M.B. Sistemas Electrónicos, S.A., including its components and units, against failures in workmanship that may occur during operation of those equipments, with the exception of power valves or semiconductor devices that are covered by its particular Factory's Guarantee. In this case, O.M.B. Sistemas Electrónicos, S.A. only can act as intermediary for negotiation with such Factory, about accomplishment of individual Guarantees.

For Validity of this Warranty, it is indispensable that all Paragraphs, from I to VI, be respected by the Customer. Otherwise, this Warranty will be automatically voided. This Warranty is self-activated with the reception by OMB Sistemas Electrónicos, S.A. of the "Guarantee Activation Manual". returned to OMB by Customer. If such Document is not received, this Warranty will be voided.

All repairings or adjustments covered by this Warranty are free of workmanship & materials costs and expenses, but postage and transportation expenses of equipments and O.M.B. technical personnel & specialists, if required, will be carried out by the Customer.

O.M.B. Sistemas Electrónicos, S.A.

➢ GENERAL SAFETY RECOMMENDATIONS

When connecting the equipment to the Mains power , please follow these important recommendations:

- ➢ This product is intended to operate from a power source that will not apply more than 10% of the voltage specified on the rear panel between the supply conductors or between either supply conductor and ground. A protective-ground connection by way of the grounding conductor in the power cord is essential for safe operation.
- ➢ This equipment is also grounded through the grounding conductor of the power cord. To avoid electrical shock, plug the power cord into a properly wired socket before connecting to the product input or output terminals.
- ➢ Upon loss of the protective-ground connection, all accessible conductive parts (including parts that may appear to be insulating) can render an electric shock. Equipment must be throughly connected to Station's ground system before any attempt to connect it to Mains electrical supply.
- ➢ To avoid fire hazard, use only the fuses of correct type, voltage rating, and current rating. Refer fuse replacement to Technical Manual and qualified service personnel.
- ➢ To avoid explosion, do not operate this equipment in an explosive atmosphere.
- ➢ To avoid personal injury, do not remove the product covers or panels. Do not operate the product without the covers and panels properly installed.

➢ GOOD PRACTICES

In maintaining the equipment covered in this Manual, please keep in mind the following, standard good practices:

- ➢ When connecting any instrument (wattmeter, spectrum analyzer, etc.) to a high frequency output, use the appropriate attenuator or dummy load to protect the final amplifiers and the instrument input.
- ➢ When inserting or removing printed circuit boards (PCBs), cable connectors, or fuses, always turn off power to the affected portion of the equipment. After power is removed, allow sufficient time for the power supplies to bleed down before reinserting PCBs. Always use discharge stick when available.
- ➢ When troubleshooting, remember that FETs and other metal-oxide semiconductor (MOS) devices may appear defective because of leakage between traces or component leads on the printed circuit board. Clean the printed circuit board and recheck the MOS device before assuming it is defective.

- When replacing MOS devices, follow standard practices to avoid damage caused by static charges and soldering.

- When removing components from PCBs (particularly ICs), use care to avoid damaging PCB traces.

FIRST AID IN CASE OF ELECTRICAL SHOCK

If someone seems unable to free himself while receiving an electric shock, **turn power off** before rendering aid. A muscular spasm or unconsciousness can make a victim unable to free himself from the electrical power.

If power cannot be turned off immediately, **very carefully** loop a length of dry non-conducting

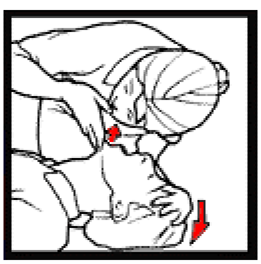
DO NOT TOUCH VICTIM OR HIS CLOTHING BEFORE POWER IS DISCONNECTED OR YOU CAN ALSO BECOME A SHOCK VICTIM

material (such as a rope, insulating material, or clothing) around the victim and pull him free of the power. Carefully avoid touching him or his clothing until free of power.

➢ *EMERGENCY RESUSCITATION TECHNIQUE*

Step 1

Check the victim for unresponsiveness. If there is no response, **immediately call for medical assistance**, and then return to the person.

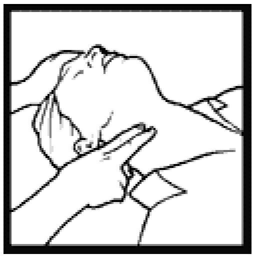


Step 2

Position the person flat on their back. Kneel by their side and place one hand on the forehead and the other under the chin. Tilt the head back and lift the chin until teeth almost touch. Look and listen for breathing.

Step 3

If not breathing normally, pinch the nose and cover the mouth with yours. Give two full breaths. The person's chest will rise if you are giving enough air.

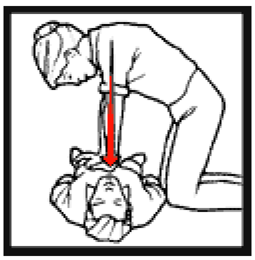


Step 4

Put the fingertips of your hand on the Adam's apple, slide them into the groove next to the windpipe. Feel for a pulse. If you can not feel a pulse or are unsure, move on to the next step.

Step 5

Position your hands in the center of the chest between the nipples. Place one hand on top of the other.



Step 6

Push down firmly two inches. Push on chest 15 times.

CONTINUE WITH TWO BREATHS AND 15 PUMPS UNTIL HELP ARRIVES.

➢ *TREATMENT FOR BURNS*

- Continue treating victim for electrical shock.
- Check for points of entry and exit of current.
- Cover burned surface with a clean dressing.
- Remove all clothing from the injured area, but cut around any clothing that adheres to the skin and leave it in place. Keep the patient covered, except the injured part, since there is a tendency to chill.

- Splint all fractures. (Violent muscle contractions caused by the electricity may result in fractures.)
- Never allow burned surfaces to be in contact with each other, such as: areas between the fingers or toes, the ears and the side of the head, the undersurface of the arm and the chest wall, the folds of the groin, and similar places..
- Transport as soon as possible to a medical facility

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CIRCULAR POLARIZATION FM BROADCAST OMNIDIRECTIONAL ANTENNA

SGP-1

TECHNICAL MANUAL

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chapter 1
GENERAL DESCRIPTION

SGP-1 is a composite FM Broadcast antenna intended for use at medium-high RF input levels not greater than 4000 watts/dipole. Essentially, SGP-1 antenna is composed of a twin coil-linear series element who gives this antenna a twin-spiral, right-handed circular polarization. It is almost entirely built on high conductance-covered stainless steel tubing and plates in order to withstand the worst agressive environments and meteorological conditions, do not requiring practically any maintenance procedures. Its careful building, assembling and endurance treatment processes allows to use it in the worst environmental conditions, and at the same time also allows an easy mounting procedure.

Use of circular polarization is advisable both in high mountains or hilly terrains, and also in big cities having lots of tall buildings and skyscrapers. It automatically overcomes the multipath reflections that characterizes these installation environments, being mainly used in composite-carrier broadcasts using SCA or RDS supplementary channels when a continuous, non-interrupted reception in mobile vehicles is desired.

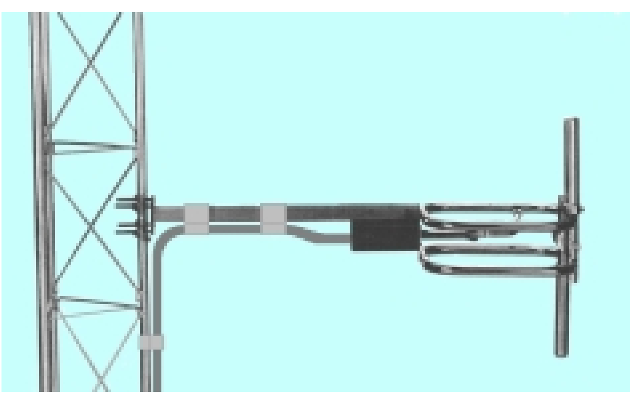

Fig. # 1. MP-1 ANTENNA IN POLE MOUNTING

Design of radiating element is very simple. There is a short (L <lambda/4) dipole connected in series with a half-turn coil physically situated 90 degrees apart. Combined electromagnetic induction on both phase-leading series elements produces a Poynting vector virtually rotating in a plane that is 90º apart of its propagation direction, since radiation on both planes, E & H, are 90º apart, and also both radiating elements are also located physically 90º apart. This is the most simple and reliable design of circular polarization elements. Resonance in the whole FM band II is obtained by obtained by adjusting three variable elements: the plane E dipole, reducing or enlarging its tips length, the antenna feeding point, along the horizontal coil, and the two small capacitive plates located at dipole's feeding point. These plates are used only for the low-middle part of Band II, that is, 87.5-101 MHz. For the middle-upper part they are replaced by screwed caps.

From electrical point of view, the linear dipole located at both coil ends is capacitively loading it, and when the value of coil impedance at a frequency equals the value of this capacitive load (including plates at low frequencies), antenna comes into resonance and its input impedance becomes completely resistive, since both reactive components mutually cancels.

SGP-1 technical specifications are better than those prescribed both by CCIR (Inf. # 464-5) and FCC for FM broadcasting transmissions.

1.1.- Use of Antenna Arrays.

Due to its omnidirectional propagation characteristics, SGP-1 antenna gain do not assumes the high value sometimes required at certain installations. This fact requires the SGP-1 antenna to being stacked in multiple-unit arrays, as shown in Figure # 2 below:

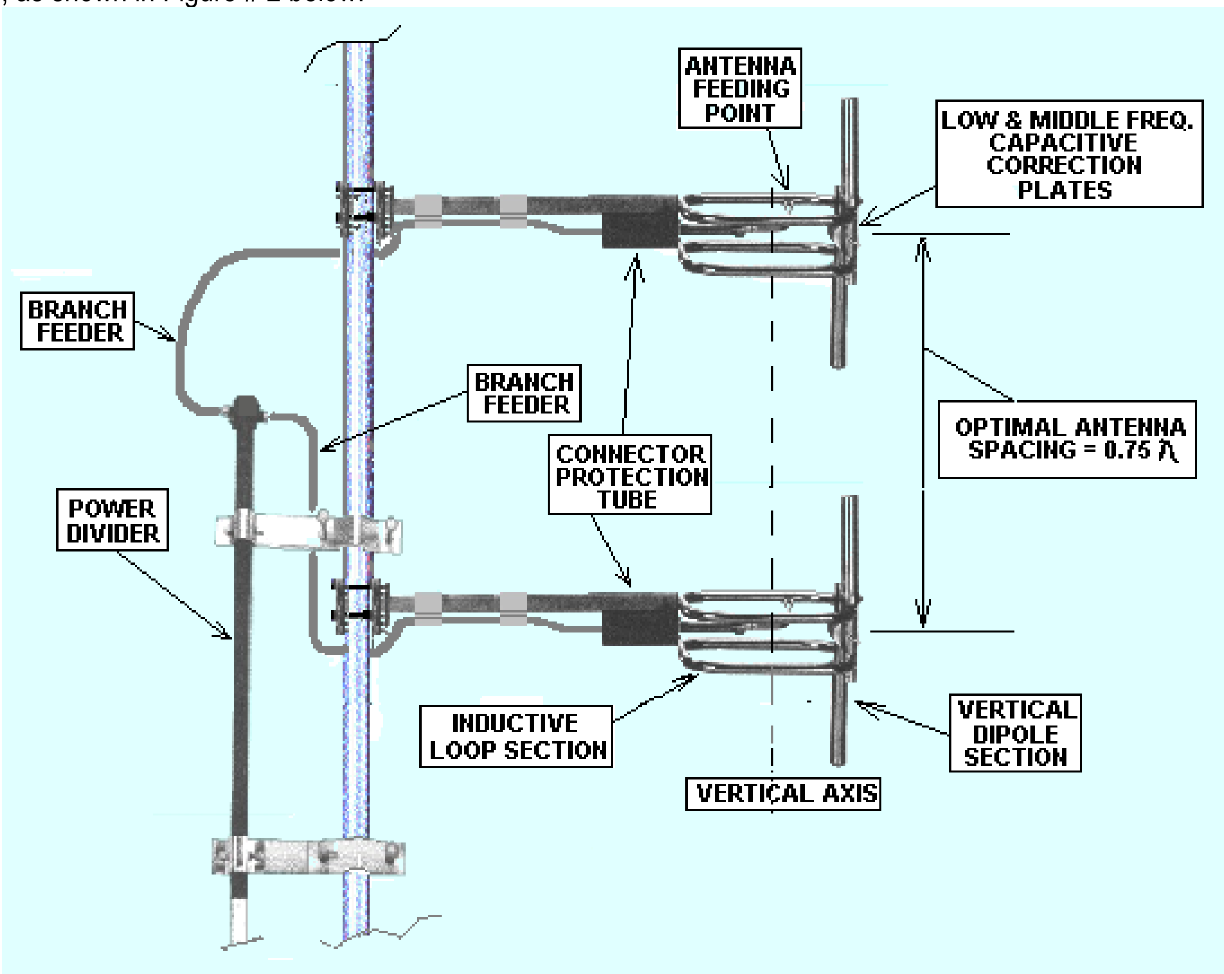

Fig. # 2. TWO SGP-1 ANTENNAS STACKED IN A COLLINEAR ARRAY. POLE MOUNTED.

Figure # 2 shows the main elements forming the simplest array who can be made, called the SGP-2. These composite collinear arrays are generally used to form the required SGP configurations. In this case, the complete antenna array is renamed considering the number of stacked units, that is, SGP-**N.** Following this consideration, Figure # 2 above shows a SGP-2 array, because N=2 (number of stacked antennas). Normally, SGP-6 or SGP-8, even SGP-16 arrays are currently used at FM stations, in accordance with the Station's required covering area, in order to increase overall gain of array.

WARNING

These omnidirectional antennas are not designed to be stacked in parallel arrays, because of the "holes" that sometimes are produced in the horizontal radiation pattern, due to the phase difference among the propagated wavefronts. When it's required to use some antennas, these should be stacked only in collinear arrays as shown in Figure # 2. Independently of the number of stacked antennas, the vertical axis (Fig. # 2) must be always kept. In other words, antennas must be stacked over the same axis. Otherwise, the same undesirable "holes" or silence zones should appear in the radiation pattern. All branch and secondary feeder lines must have the same length.

Gain of a certain composite array changes with the number of stacked antennas, and with the vertical spacing between two adjacent units. In a single unit, individual gain is 0 dBi, that is approximately the same gain as an isotropic unit. But this power gain can be divided into the horizontal and vertical planes, resulting in a -3 dB net gain over each plane. This is the reason to use these antennas in stacked arrays, in order to accomplish the gain requirements of each installation. When stacked, SGP antennas will have a composite array gain that can be represented in the empirical curves shown at Figure # 3 below:

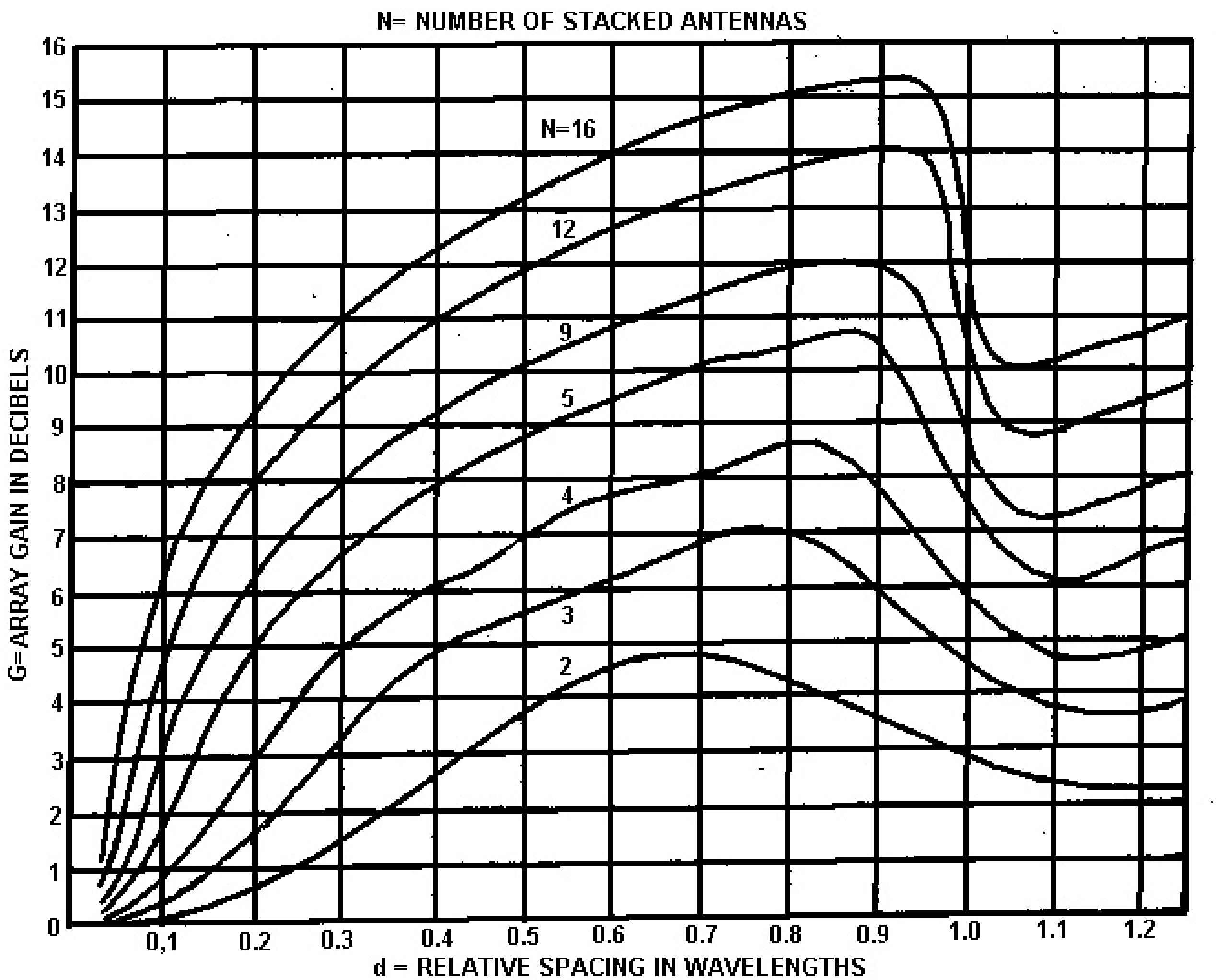

Fig. # 3. GAIN vs. SPACING DISTANCE CURVES FOR DIFFERENT NUMBER OF STACKED ANTENNAS.

As can be seen in above Figure # 3, optimal gain for any array can be reached when d=0.75 lambda as an average value, that is, in order to optimize the array gain, SGP antennas should be installed at approximately 3/4 wavelengths between two adjacent units. Remember that a wavelength is defined following the expression:

lambda = c/f

Where: lambda = wavelength in meters.
and: c = propagation speed in Km/seg (take it as 299,792.458 Km/seg)
f = transmission frequency in MHz.

As an example, if f = 98.3 MHz, then lambda = 299.792458 x 10^6 / 98.3 x 10 ^{6} = 3.05 meters. In this case, spacing distance will be around 2.2875 meters between succesive antennas. The higher degree of accuracy in this measurement, the better will be the resultant array gain.

Use of SGP antennas stacked in some array, requires to use at least one power divider device, as shown in Figure # 2. These devices divides the incoming RF power into two, three, four or more, in order to feed the separate stacked antennas. Since the incoming RF signal at each antenna must be completely in phase with the other signals injected at the remaining units, all the branch feeders (See Figure # 2) must has **exactly** the same length. Accuracy of these relative lengths must be within **1 mm** in order to assure a correct in-phase feeding of the antennas composing the array.

Power dividers, also known as splitters or distribuitors, contains an step-down impedance transformer built using 1/4 lambda transmission line stubs, in order to keep all divider outputs at the same impedance level as the device's input port.

When it's required to use a large number of stacked antennas in a certain array, it may be necessary to use more than one power divider device, as shown in Figure # 4 below:

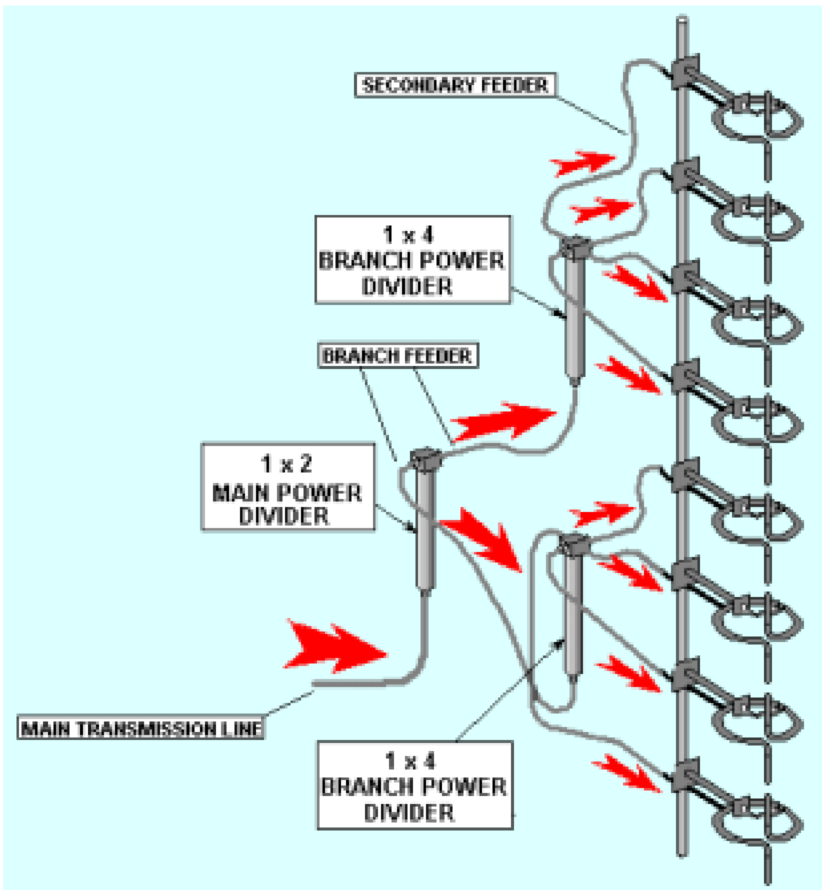

Fig. # 4. ARRAY USING MORE THAN ONE POWER DIVIDER

Using combinations as shown in Figure # 4 above, is possible to assemble practically any array of antennas having the required gain for a given station.

Stacking the antennas in arrays has another effect over propagation characteristics: vertical radiation pattern narrows in the same amount that antennas are added to the array. Lets analyze in first place the horizontal and vertical radiation patterns for the SGP-1 single antenna.

Horizontal radiation pattern is defined as the polar (or cartesian) plot of the antenna normalized gain (referred to its maximum value [G/G_{max}] , so its maximum plotted gain only reaches 1.0) versus the angle at which each gain value is obtained, around the antenna site. Figure # 5 shows the horizontal radiation pattern for SGP-1 antenna:

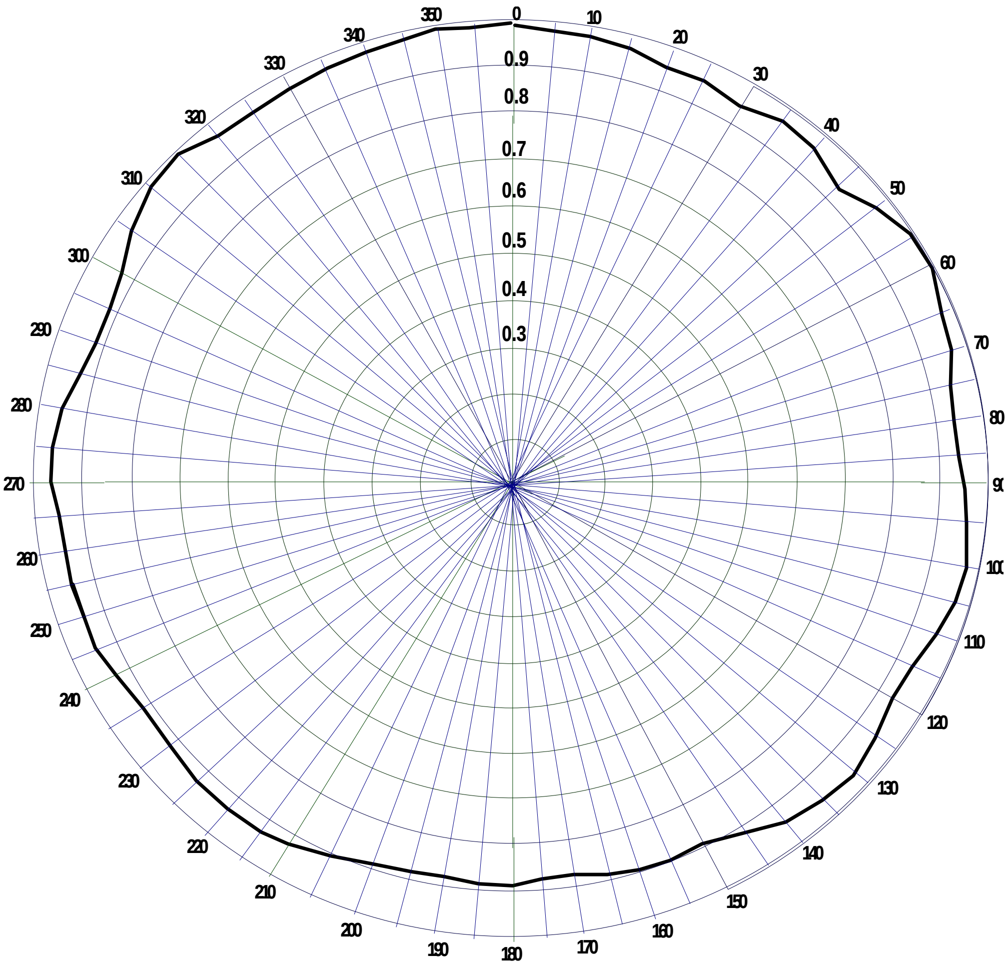

Fig. # 5. HORIZONTAL RADIATION PATTERN OF SGP-1 (SINGLE) ANTENNA.

As shown in Figure # 5, the average horizontal radiation pattern of SGP-1 antenna (a single unit, non-stacked) shows only small variations over the maximum normalized gain, thus displaying excellent omnidirectional characteristics. The higher reduction is shown at 180º angle, and is due to the tower screening effect. In order to evaluate in decibels this screening effect, we can use the expression:

$$\text{delta G} = 10 \log G_{max} - 10 \log(\text{delta } G_n)$$

Where: delta G = Reduced Gain in decibels due to Tower Screening effect.
delta G_n= Reduced normalized gain as shown in the polar diagram. = 0.88
And: G_{max} = 0 dBi = maximum theoretical gain = 10 log (1.0)

Then: delta G = 0 - 10 log (0.88) = 0.55 dB

This means a gain reduction of less than 1 dB due to tower screening effect. There is no relevant variation in the pattern shape when some antennas are properly stacked over the same vertical axis. Only the gain is increased as shown in the graphics at former Figure # 3.

Vertical radiation pattern suffers in turn a noticeable variation when some antennas are stacked in array. The normalized vertical radiation pattern is shown in the Figure # 6 at next page:

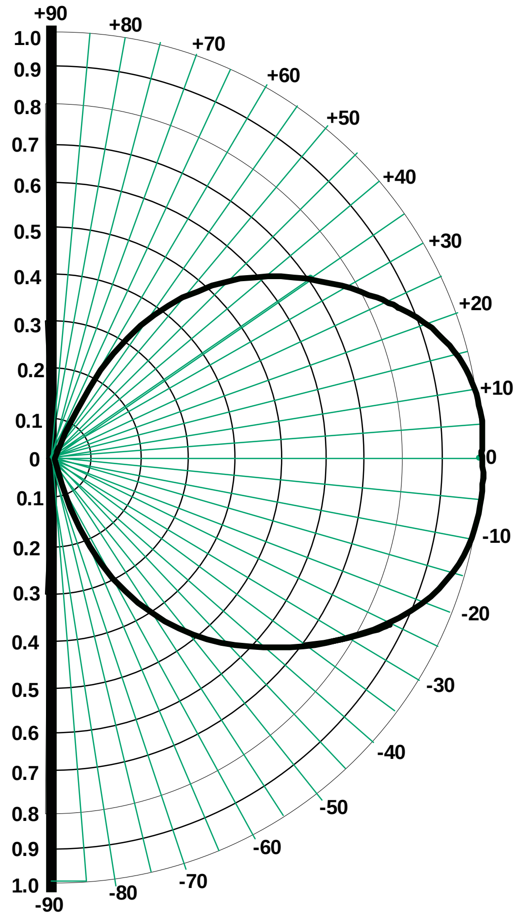

Fig. # 6. VERTICAL RADIATION PATTERN OF SGP-1 ANTENNA (ONE UNIT)

A half of this pattern is drawn only, since the other half is identical. Complete radiation pattern of SGP-1 antenna at both planes, vertical and horizontal, will have a form like a doughnut, as shown in the three-dimensional sketch of Figure # 7:

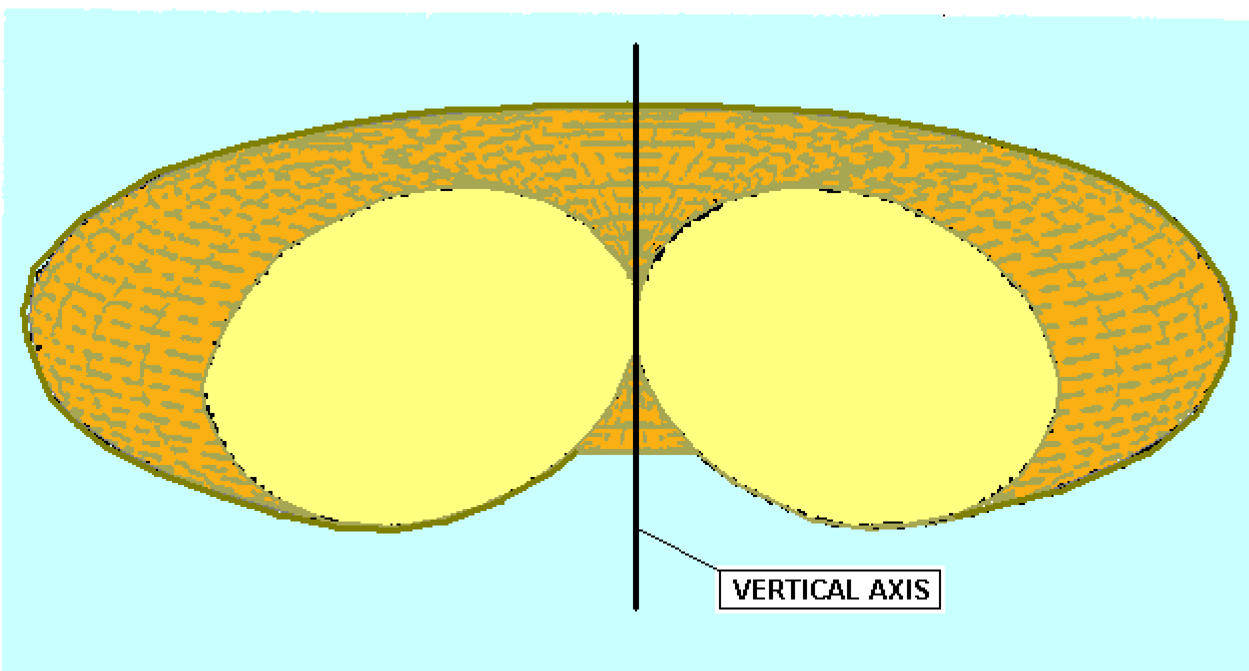

Fig. # 7. IMAGINARY ASPECT OF THE COMBINED HORIZONTAL AND VERTICAL RADIATION FIELD OF SGP-1 (ONE UNIT) OMNIDIRECTIONAL ANTENNA

An important parameter to be kept in mind is the called "half-power angle". This is defined as the angle in the radiation pattern that covers the pattern's region where power equals or exceeds the half (-3 dB) of maximum power available. This parameter is defined only for directional antennas, but in the case of SGP-1 and other omnidirectional devices, these antennas are omnidirectional at horizontal plane, but are directional in the vertical plane, as can be seen in the respective radiation patterns. SGP-1 single antenna has a total (up and downwards) half-power angle of 70º, as can be seen in Figure # 6 above. Half-power points can be identified in the normalized gain pattern as the points where antenna gain drops to 70% (0.707) of the maximum available gain (took as 1.0).

If some antennas are stacked, the vertical radiation pattern will be narrower as the number of stacked antennas raises, according with the following Table:

SGP-1 ANTENNA ARRAYS.HALF-POWER ANGLE	
number of stacked antennas	half-power angle
2	60º
3	52º
4	51º
5	50º
6	49º
7	48º
8	47º
9	46º
10	44º
11	43º
12	42º
13	41º
14	40º
15	39º
16	38º

In the other hand, as half-power angle is narrower, the overall gain increases and vertical sidelobes begins to appear. If two antennas are stacked at the optimal separation of 0.75 lambda, the following vertical pattern is obtained:

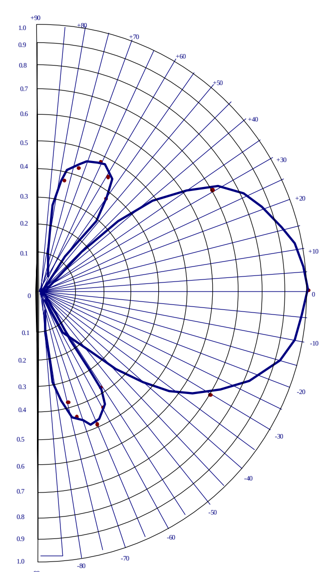

Fig. # 8. VERTICAL RADIATION PATTERN FOR TWO SGP STACKED ANTENNAS AT 0.75 lambda APART. NOTE THE TWO VERTICAL SIDELOBES

In the same way, four antennas, stacked at 0.75 lambda will give the following radiation pattern in the vertical plane:

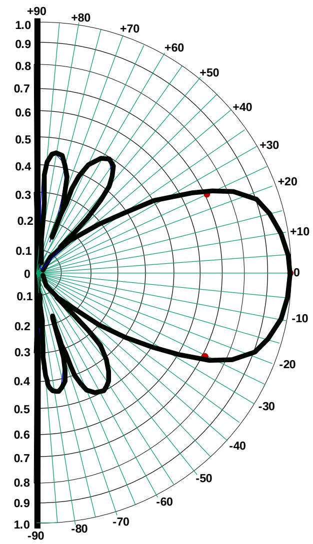

Fig. # 9. VERTICAL RADIATION PATTERN FOR FOUR SGP STACKED ANTENNAS AT 0.75lambda APART. NOTE THE FOUR VERTICAL SIDELOBES

As shown in Figures # 8 & 9, number of sidelobes increases as more antennas are stacked in a given array. Array gain at the maximum point of each sidelobe also decreases, yielding their amplitude to the main lobe, who is narrower and having increasing gain as the number of stacked antennas are increased. Note that, in all cases, the spacing distance of 0.75 lambda has been kept, in order to maximize the array gain.

Three-dimensional radiation diagrams of two, four and eight stacked antennas are included in the following Figures # 9,10 & 11 below:

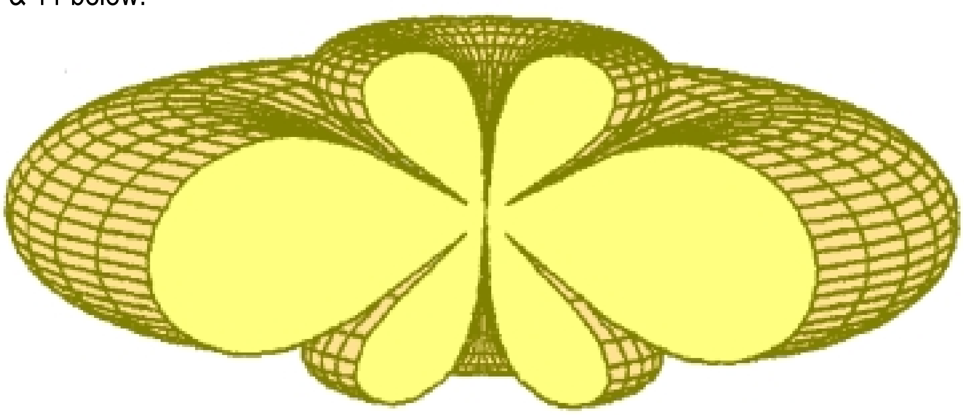

Fig. # 9. THREE DIMENSIONAL VIEW OF FIELD CONFIGURATION FOR TWO ANTENNAS ARRAY.

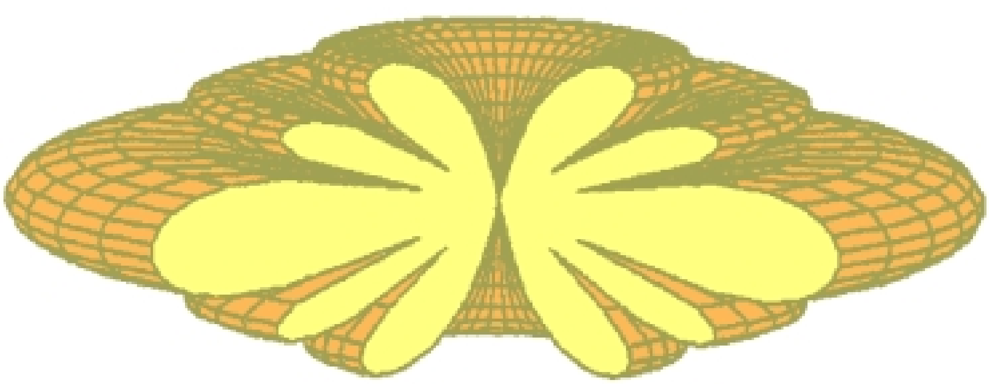

Fig. # 10. THREE DIMENSIONAL VIEW OF FIELD CONFIGURATION FOR FOUR ANTENNAS ARRAY.

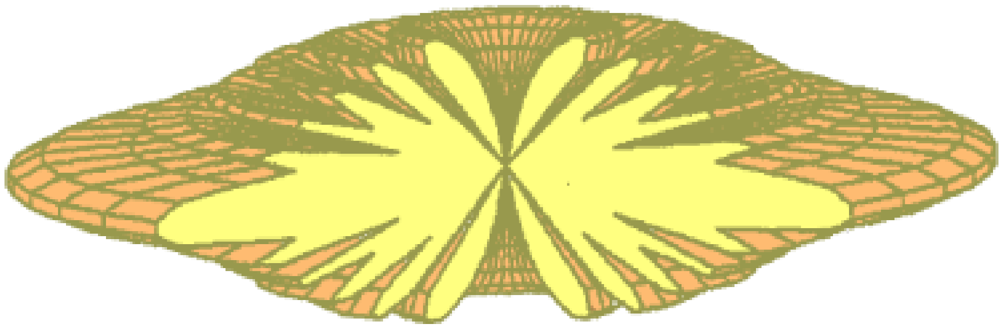

Fig. # 11. THREE DIMENSIONAL VIEW OF FIELD CONFIGURATION FOR EIGHT ANTENNAS ARRAY.

About transmission line used to feed SGP arrays, it is advisable to keep in mind that technical criteria must prevail over economical criteria. Otherwise, results can be fatal for the installation. Transmission line used to feed the array depends on: a) transmitter's power output. b) tower height c) antenna input impedance d) installation facilities for nitrogen tank or dry air compressor/dehydrator within Station's housing. These factors are the main to consider at the time of purchasing the main transmission line. Coaxial cables are used to feed SGP antenna systems.

In first place, we determine the maximum power input to the coaxial cable. Peak-power rating of any coaxial cable is given by the following expression:

$$P_{PK} = (Ep \times 0.707 \times 0.7/SF)^2 / Zc \qquad [1]$$

Where:
- P_{PK} = Cable power rating under standard conditions.
- Ep = DC Production test voltage.
- 0.707 = RMS factor
- 0.7 = DC to RF factor (empirically verified).
- SF = Safety factor on voltage:
  - = 1.4 for Heliax® semiflexible cables.
  - = 2.0 for right coaxial lines.
- Zc = Characteristic impedance.

Typical production test voltages for various sizes of semiflexible coaxial cable and rigid lines are shown below:

Nominal Size	Impedance (ohms)	Ep value (kV) Flexible Cables	Ep value(kV) Rigid Cables
7/8"	50	6	-----
1 - 1/4"	50	9	-----
1 -5/8"	50	11	11
2 - 1/4"	50	13	----
3 "	50	16	-----
3 - 1/8"	50	---	19
4 "	50	21	-----
5 "	50	27.5	-----
6 - 1/8"	50 75	-----	36
7 - 3/16"	75	-----	41.8
8 - 3/16"	75	------	47

PRODUCTION TEST VOLTAGES FOR FLEXIBLE AND RIGID COAXIAL LINES.

Foam-dielectric cables have a greater dielectric strength than air-dielectric cables of similar size. For this reason, they might be expected to have higher peak-power ratings than air cables. Higher peak-power ratings usually can not be realized, however, because the commonly used connectors for foam cables have air spaces at the cable/connector interface which limit the allowable RF voltage to "air cable" values. This table, offered by Andrew®, rates similar size foam- and air- dielectric cables alike for this reason.

Once P_{PK} is calculated, maximum power input of cable can be evaluated following the expression:

For FM broadcasting: $P_{MAX} = P_{PK} / VSWR$ [2]

In second place, we determine the maximum allowable attenuation for transmission line to be used, in accordance with total line length from transmitter to antenna array. Given this value, together with maximum power allowable obtained before, we can find the required transmission line from the following table:

Line type (or equivalent)	Diameter	Max. Allowable Power (kW)	Attenuation (dB/100 feet)
LDF1-50	1/4"	1.79	1.23
LDF2-50	3/8"	2.24	1.04
LDF4-50A	1/2"	3.49	3.49
LDF5-50A	7/8"	7.56	0.364
LDF6-50	1-1/4"	11.7	0.254
LDF7-50A	1-5/8"	16.4	0.205

For higher values, user can consult the corresponding cable manufacturer catalog. Attenuation should be kept as lower as possible, not only in order to keep ERP (Effective Radiated Power) at a top value, but to reduce the possible increasing in VSWR due to these line losses. This increasing effect is reflected in the following Table # 3 besides:

As an example, given a certain transmission line and antenna system, if at antenna end we measure a VSWR = 2.0:1, and transmission line has known losses of 2 dB, VSWR view from transmitter end towards antenna will measure 1.533:1.

If we use a given transmitter power output, having a certain line VSWR > 1, the following Table # 4 will show the real power delivered to antenna, since real power delivered to antenna takes into account the additional losses caused by the real VSWR of antenna (higher than the measured value at the end of transmission line).

As an example, given a certain transmission line having 2 dB of losses, and a measured VSWR=3.0:1 at transmitter end, only 31.3 watts of a total transmitter power of 100 watts will reach antenna system.

V.S.W.R. AT ANTENNA	LOSSES 1 dB	LOSSES 2 dB	LOSSES 3 dB	LOSSES 4 dB	LOSSES 5 dB	LOSSES 6 dB
1.00	1.000	1.000	1.000	1.000	1.000	1.000
1.20	1.135	1.122	1.097	1.073	1.059	1.047
1.40	1.305	1.235	1.183	1.142	1.111	1.087
1.60	1.449	1.341	1.262	1.202	1.157	1.123
1.80	1.587	1.440	1.334	1.257	1.199	1.159
2.00	1.710	1.533	1.401	1.308	1.236	1.183
2.20	1.848	1.620	1.463	1.351	1.269	1.208
2.40	1.972	1.702	1.520	1.392	1.299	1.231
2.60	2.091	1.779	1.573	1.430	1.327	1.251
2.80	2.206	1.852	1.623	1.465	1.352	1.270
3.00	2.318	1.922	1.668	1.497	1.376	1.287
3.20	2.425	1.987	1.712	1.527	1.397	1.303
3.40	2.529	2.049	1.752	1.555	1.417	1.317
3.60	2.629	2.109	1.790	1.581	1.435	1.331
3.80	2.727	2.165	1.826	1.605	1.452	1.343
4.00	2.821	2.218	1.860	1.628	1.468	1.355
4.20	2.912	2.269	1.892	1.649	1.483	1.366
4.40	3.001	2.318	1.922	1.669	1.497	1.376
4.60	3.087	2.365	1.951	1.688	1.510	1.385
4.80	3.170	2.409	1.978	1.706	1.523	1.394
5.00	3.251	2.452	2.003	1.722	1.534	1.402
5.20	3.330	2.493	2.028	1.738	1.545	1.410
5.40	3.406	2.532	2.051	1.754	1.555	1.417
5.60	3.480	2.570	2.074	1.768	1.565	1.424
5.80	3.553	2.606	2.095	1.782	1.575	1.431
6.00	3.623	2.641	2.115	1.795	1.583	1.437
6.20	3.691	2.674	2.135	1.807	1.592	1.443
6.40	3.758	2.706	2.153	1.819	1.600	1.449
6.60	3.823	2.738	2.171	1.830	1.608	1.454
6.80	3.886	2.768	2.188	1.841	1.615	1.459
7.00	3.947	2.798	2.204	1.851	1.622	1.464
7.20	4.007	2.824	2.220	1.861	1.628	1.469
7.40	4.066	2.851	2.235	1.871	1.635	1.473
7.60	4.123	2.877	2.250	1.880	1.641	1.478
7.80	4.178	2.903	2.264	1.889	1.647	1.482
8.00	4.233	2.927	2.278	1.897	1.652	1.486
8.20	4.286	2.951	2.291	1.905	1.658	1.489
8.40	4.338	2.974	2.303	1.913	1.663	1.493
8.60	4.388	2.996	2.315	1.920	1.668	1.496
8.80	4.438	3.017	2.327	1.928	1.673	1.500
9.00	4.486	3.038	2.338	1.935	1.677	1.503
9.20	4.533	3.059	2.349	1.941	1.682	1.506
9.40	4.580	3.078	2.360	1.948	1.686	1.509
9.60	4.625	3.097	2.370	1.954	1.690	1.512
9.80	4.669	3.116	2.380	1.960	1.694	1.515
10.00	4.712	3.134	2.390	1.966	1.698	1.517

Table # 3. EFFECT OF INCREASING VSWR VIEW FROM ANTENNA END WITH INCREASING LOSSES AT TRANSMISSION LINE

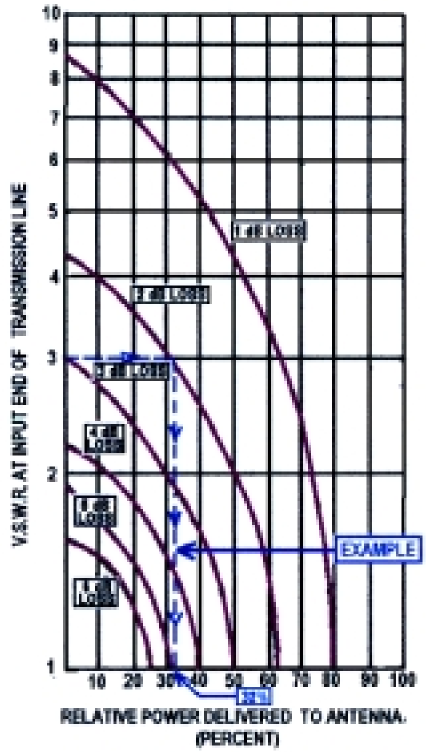

Fig. # 12. PERCENT OF RELATIVE POWER DELIVERED TO ANTENNA, CONSIDERING LINE LOSSES.

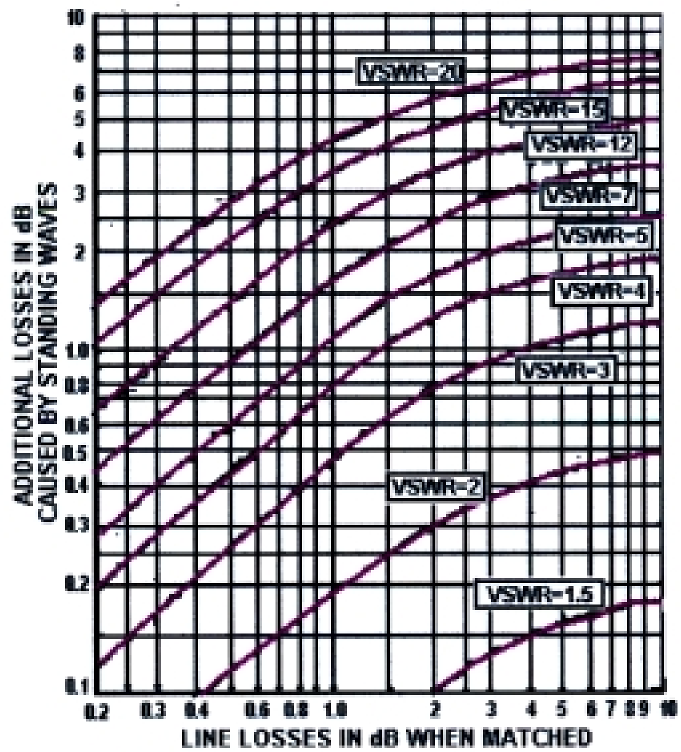

Fig. # 13. ADDITIONAL LOSSES DUE TO THE PRESENCE OF STANDING WAVES IN LINE

Line losses will as lowest as possible. If transmission line is well matched to load, that is, if line is loaded with a purely resistive load having the same value as its characteristic impedance,(Zo = [LC]½). These line losses quicly increases as VSWR in line raises, since thermal losses (I^2R) increases and also the losses due to leak currents across dielectric (E^2/R). **So, it's important to keep the antenna system correctly tuned**. Figure # 14 shows ow quickly raises the difference in VSWR at source (transmitter) and load (antenna system) when transmission line losses are increased:

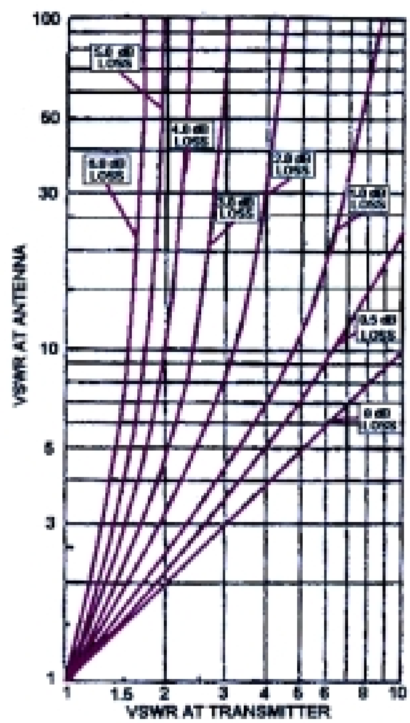

Fig. # 14. DIFFERENCE IN VSWR VIEW FROM ANTENNA AND TRANSMITTER AT DIFFERENT VALUES OF LINE LOSSES

CIRCULAR POLARIZATION FM BROADCAST OMNIDIRECTIONAL ANTENNA

SGP-1

TECHNICAL MANUAL

chapter 2
TECHNICAL SPECIFICATIONS

2.1.- Individual Antennas:

Frequency Band …………………………………………………………………………………… 87.5- 108.0 MHz.

Input Impedance ………………………………………………………………………………….…. 50 ohms

Maximum Input Power ……………………………………………………………………………….. 4000 w.

Recommended Input Power ……………………………………………………………………… 4000 w.

Polarization ……………………………………………………………………………………….. Circular ± 1 dB.

Total Gain ………………………………………………………………………………………… 0 dB/dipole.

Gain Plane H: …………………………………………………………………………………….. – 3 dB/dipole.

Gain Plane E ……………………………………………………………………………………… - 3 dB/dipole.

VSWR ……………………………………………………………………………………………….. 1.1:1

Field Strength Change with Rotation of Polarization ………………………………………………..± 1.2 dB.

Tower Effect ………………………………………………………………………………….. From –1 to –1.5 dB.

Dimensions ………………………………………………………………………………….. 965 x 986 x 305 mm.

Weight ……………………………………………………………………………….……….………… 5.0 Kg.

Max. Wind Speed ………………………………………………………………………………… Bursts: 210 Km/h.
Constant: 130 Km/h.

Wind Load …………………………………………………………………………………….. 8 Kg at 120 Km/h.

Lightning Protection …………………………………………………………………………….. Grounded Structure.

Mounting ………………………………………………………..….………… Pole mounting. From 25 to 70 mm diam.

Input Connector …………………………………………………………………………………………….. 7/8" EIA.

Materials ……………………………………………………………Conductive-coated Stainless Steel, Brass, Teflon®.

Option …………………………………………………………………... Internal Heating for High Mountain Installations.

2.2.- Arrays Characteristics.

For 0.75 λ vertically stacked collinear arrays:

NUMBER OF STACKED ANTENNAS	GAIN (db) OVER A ½ λ DIPOLE	GAIN OVER ROTARY FIELD VECTOR (db)	POWER DIVIDERS CONNECTORS USED Input - outputs	BRANCH & SECONDARY FEEDER CABLES	TOTAL WEIGHT ANTENNAS + POWER DIVIDERS	MAXIMUM POWER INPUT (Kw)
2 (ARRAY SGP-2)	0	3	1 5/8" EIA – 7/8" EIA	Heliax ½"	19.9 Kg	4 Kw
2 (ARRAY SGP-2R)	0	3	1 5/8"EIA -- 7/8"EIA	Heliax 7/8"	31.7 Kg	8 Kw
4 (ARRAY SGP-4)	3	6	1 5/8"EIA -- 7/8"EIA	Heliax ½"	43.5 Kg	8 Kw
4(ARRAY SGP-4R)	3	6	1 5/8"EIA -- 7/8" EIA	Heliax 7/8"	62.5 Kg	15 Kw
6 (ARRAY SGP-6R)	4.8	7.8	1 5/8" or -- 7/8" EIA 3 1/8" EIA	Heliax 7/8"	78.3 Kg	15 – 20 Kw

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CIRCULAR POLARIZATION FM BROADCAST OMNIDIRECTIONAL ANTENNA

SGP-1

TECHNICAL MANUAL

chapter 3

ASSEMBLING, TUNING, INSTALLATION & MAINTENANCE

3.1.- Unpacking, Assembling & Tuning Procedure.

Under normal conditions, antenna sets are previously adjusted at Factory. Vertical dipole spacing distance is protected with a small piece of wood , tied to both dipole ends, in order to avoid any alteration, bending or misadjustment of this gap. This piece of wood must be removed before antenna installation. When unpacking the antennas and power dividers or splitters , check that all elements are in optimal conditions and both antenna elements and cables are not twisted or bent. Check all connectors, both in feeders and antennas. Verify that complete array is tuned to the prescribed broadcasting frequency. This is normally Factory-made at Customer request.

If broadcast frequency is changed for any reason, or antenna should be adjusted just before installation, three main adjustment factors must be taken into account: Coarse frequency tuning is performed by changing the feeding point over the horizontal loop (**D1**), and fine frequency adjustment is reached by changing the vertical dipole length (**D2**).

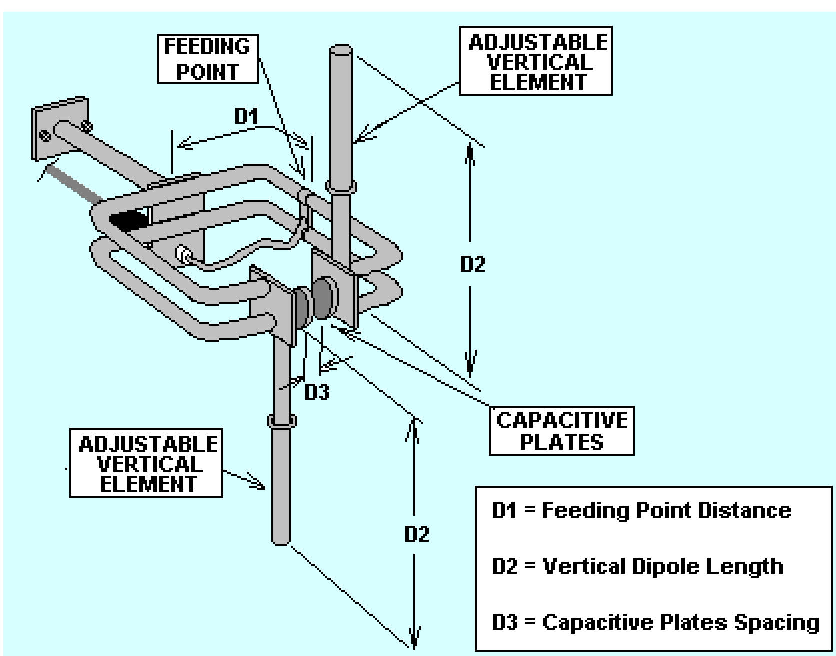

Fig. # 15. POINTS FOR ANTENNA TUNING.

There is another element in the SGP-1 antenna determining the tuning frequency of the device. These are the capacitive plates, whose spacing distance **D3** is adjusted (in the lower half of the Band II) to the minimum return losses view from input. This method is generally used to measure both tuning frequency and input impedance values. Return Losses Method requires of some instrument to execute the tuning procedure:

a) A Digital Antenna Analyzer such as Bird AT-400 Antenna Tester. (from 65 to 520 MHz).

This instrument is very complete and accurate to perform this test. Follow the indications and instructions given by the User's Manual of the instrument to connect the antenna under test to its input port, using the required length and type of coaxial connecting cable, etc.

An alternative method may be used, using a Sweep Generator covering the CCIR Band II (87.5-108.0 MHz). This procedure requires the following instruments:

a) A Sweep Generator having external locking sweep output for oscilloscope connection.

b) An oscilloscope with 10 MHz minimum vertical bandwidth, having facilities for external horizontal sweep.

c) A calibrated Directional Coupler intended to work at Band II.

d) A Detector Probe to connect at Oscilloscope's vertical input.

e) Cables fitted with the adequate connectors to mount the complete Setup shown at Figure # 16:

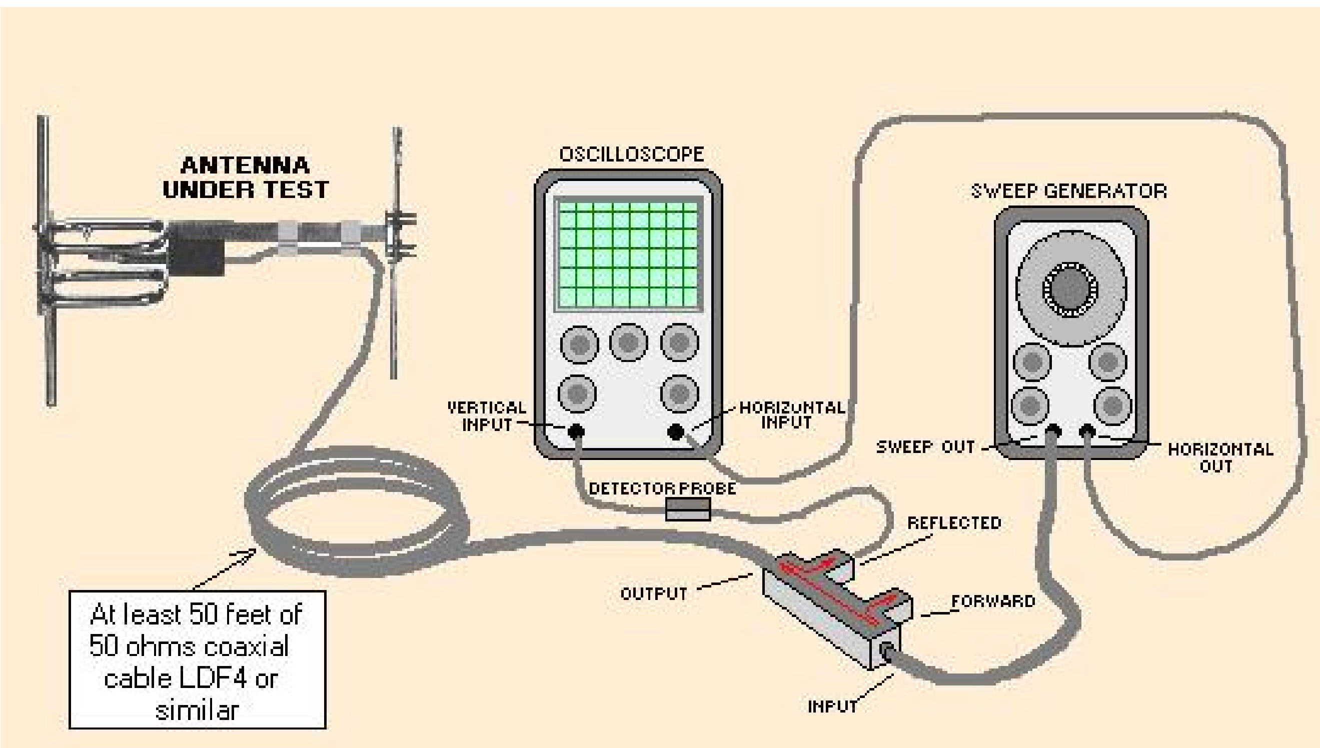

Fig. # 16. ALTERNATIVE SETUP FOR SGP-1 FREQUENCY ADJUSTMENT.

Oscilloscope screen should be calibrated to obtain a maximum of 40 dB range of Reflected Power, adjusting Sweep Generator to the desired antenna's center frequency with a sweep width of about ± 5 MHz.

WARNING

Prior attempting to execute this tuning procedure, Technician must pass the training offered by OMB at no extra charges. Only technical personnel certified by OMB is authorized to execute these tuning procedures. Otherwise, Warranty of antenna or antennas array should be voided. Contact OMB for such training seminar.

1.- After alternative Setup is mounted or Antenna Tester is connected, in first place, adjust **D1** (see Fig. # 15) at both dipole tips to 50% of its maximum length, and D2 to approximately ¼ turn of the total horizontal loop perimeter. Slightly readjust position of both elements in order to see the following curve at instrument's screen:

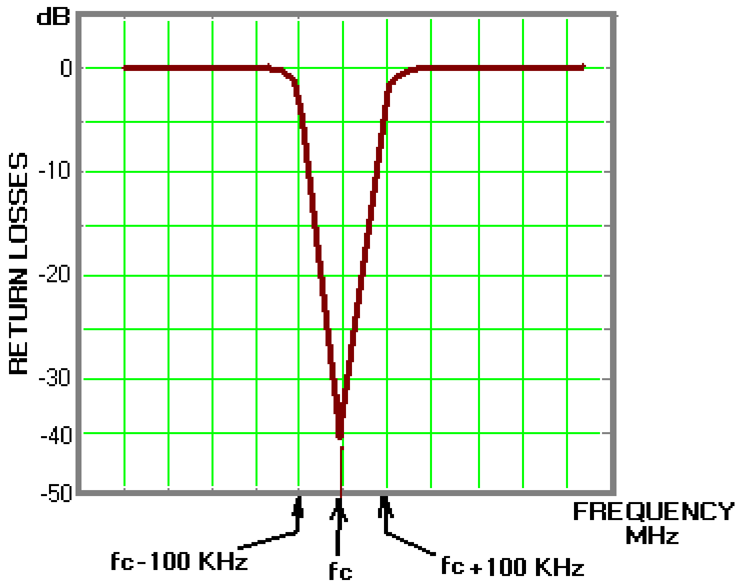

Fig. # 17. IDEAL RETURN LOSSES CURVE AS SEEN IN OSCILLOSCOPE OR ANTENNA TESTER.

2.- If a frequency in the middle of Band II or downwards is to be tuned, capacitive plates (Fig. # 15) should be connected in place, and pre-adjusted to approximately 50% of its maximum spacing **D3**. If the frequency to be tuned is beyond 101 MHz, these capacitive plates can be removed and the protective caps screwed in its place.

3.- When curve is visualized in the instrument's screen, generally it will be out of frequency. Slightly loose plate fixing screw and carefully adjust (millimeter-to-millimeter) the plate feeding point, shifting the curve to show its minimum dip at exactly the desired frequency **fc** (Fig. # 17). Now readjust **D2** and eventually **D3** to obtain a minimum dip of the highest amplitude, at a level always higher than 40 dB, as shown in Figure # 15 above, tightening the fixing screws after each movement and **going apart as farther as possible** from antenna to make each reading, in order to avoid external interference to antenna's near field. Both dipole lengths must be kept equal, in other words, both distances **D2** should be equal.

4.- Once antenna is properly tuned, tighten all nuts and bolts and remove antenna from test tower. In case of tuning several antennas of the same array, having all power dividers connected, all antennas should be tuned to the same center frequency, but finally, complete array should be checked for tuning and desired bandwidth. This final check should be carried out, in the system's final mounting.

5.- In all cases, verify that Return Losses of measured system are higher than –40 dB, as shown in Figure # 17 above.

3.2.- General Recommendations.

1.- If it is feasible, install FM transmitter and associated antenna system as far as possible from urban center, giving preference to non-obstructed high hills or mountains located within desired coverage area, in order to optimize it, increasing the radiation efficiency of the installation. Avoid the "signal shadows" due to tall buildings or forests.

2.- In case of using a medium or high power FM transmitter, avoid TVI (Television interference) to be produced in TV receivers near transmission site, by installing "traps" at antenna receiving lines of such receivers. These traps can be built using parallel open stubs of a length equal to $50250/f_c$ (f_c in MHz, length in mm) where fc is your interferent FM frequency. Stubs can be easily built using the same type of receiving line the receivers has installed.

3.- In order to avoid undesirable "shadow cones", Antenna system should be installed at a horizontal distance of the desired covering area that is equal or higher than five times the antenna system's height over terrain.

4.- Verify the easy access to the transmitter's station site, in order to facilitate both the installation and maintenance of equipments and antenna system. Check also the commercial AC supply for continuity and stability.

5.- Station and antenna system should be protected against electrical atmospheric discharges. This condition is reached if two conditions are accomplished: the first is a good ground system, having a ground impedance of less than 5 ohms, as specified in the Warranty of our equipments, and the second is a good lightning arrester installed in the top of tower, having separate discharge line and connection to ground system. You can use a expensive radioactive lightning arrester, but it's enough to employ a Franklyn type device, having at least four tips at its head, in a 50 mm^2 isolated stainless or galvanized steel pole, with a braided copper discharge line connected to an independent ground system built by undergrounding vertical copper sheets, parallel-connected and embedded in a mix of mineral coal and salt, looking for a minimum of electrical resistance. All connections should be silver-soldered or brazed. Connection of discharge line to ground system should be made using a undergrounded copper bar of 1.5 m length.

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3.3.- Maintenance.

SGP systems are very resistant both to corrosion and oxidation, because of its lots of Stainless Steel parts, and isolation is assured by using Teflon® connectors. For these reasons, maintenance of this system is greatly reduced. Nevertheless, it is required to perform some routine operations in order to keep system in optimal operating conditions:

1.- Every month, a visual inspection should be made, verifying that connectors, feedlines, power dividers, etc. are clean and free of birds' excrements, and other dirty substances.

2.- Every six months, an inspection of the system bandwidth and VSWR over the working frequency ± 200 KHz should be made, storing these records in a log book which is to be kept at Station's site.

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