



TELONICS

TELEMETRY-ELECTRONICS CONSULTANTS

932 E. IMPALA AVENUE • MESA, ARIZONA 85204-6699 U.S.A.

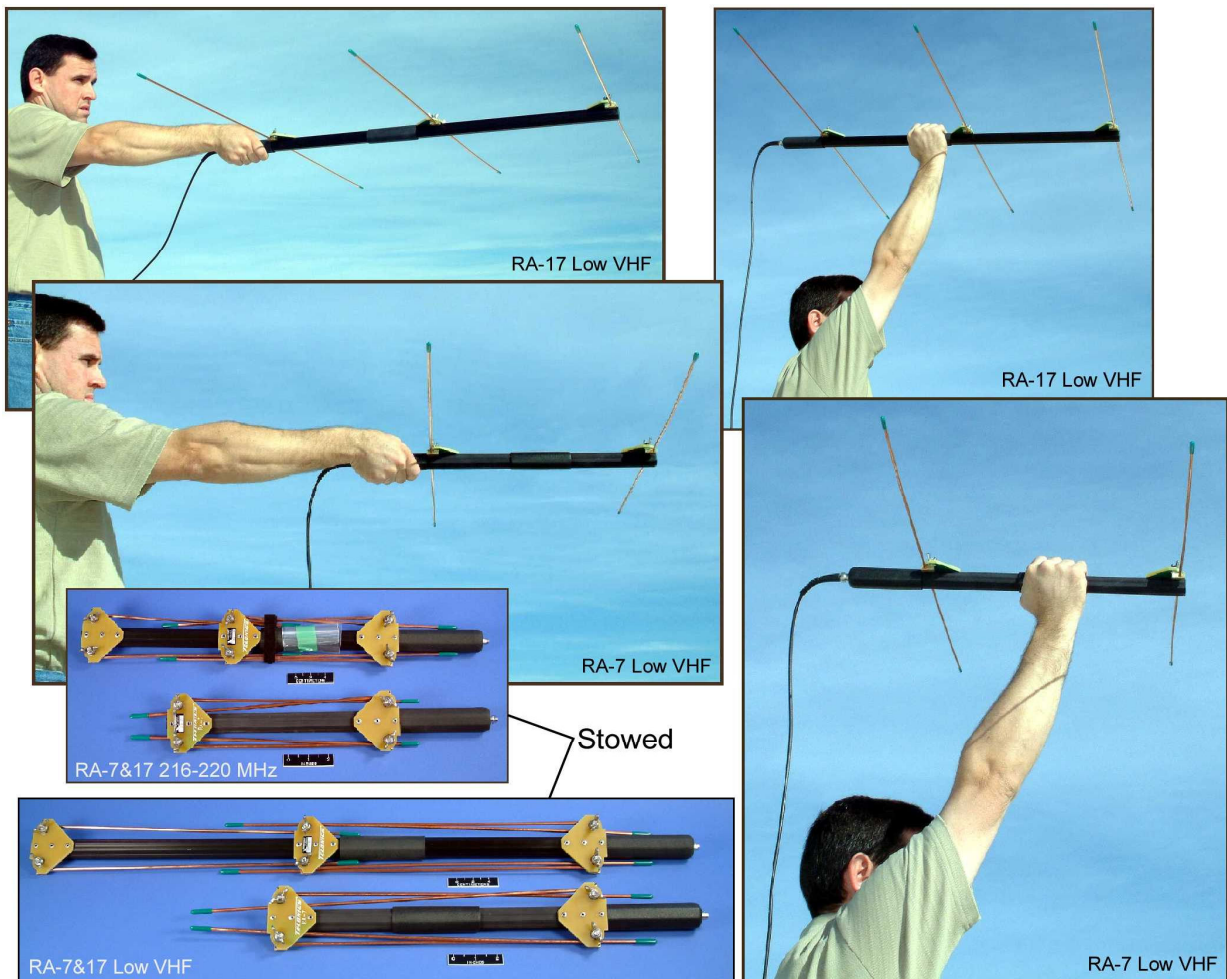
TEL (480) 892-4444 • FAX (480) 892-9139

E-MAIL info@telonics.com

www.telonics.com

MODEL RA-7, 2-Element and MODEL RA-17, 3-Element RUGGEDIZED Folding VHF Directional Hand-held Antennas

User's Guide and Specifications



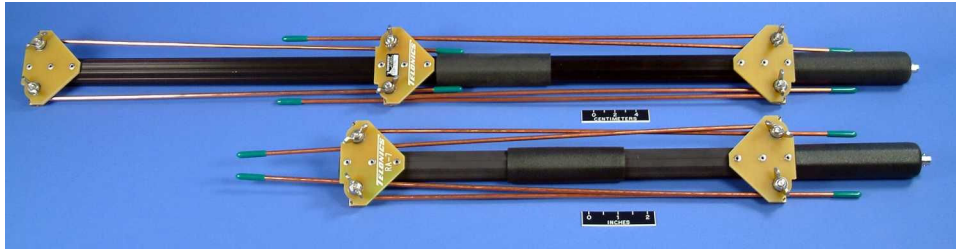
MODEL RA-7/RA-17 VHF Ruggedized Folding Directional Hand-held Antenna User's Guide and Specifications

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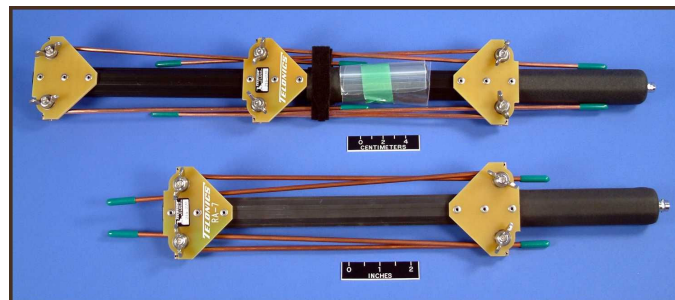
INTRODUCTION

Telonics' Model RA-7 and Model RA-17 VHF folding, directional hand-held antennas are ruggedized, portable receiving antennas designed specifically for wildlife research telemetry applications such as locating telemetered animals in remote locations.

The RA-7 is the smaller and more compact unit, and offers two (2) elements, each element formed by two (2) element sections. The RA-17 has three (3) elements and is accordingly, larger and slightly heavier. The design of both antennas is based upon linearly polarized Yagi-Uda array with a readily discernable front-to-back ratio with deep side nulls.



RA-17 and RA-7 LowVHF Frequency Bands (148-152 MHz shown)



RA-17 and RA-7, 216-220 MHz Frequency Band

The RA-7 and RA-17 antennas are specifically designed to be carried conveniently to the study site as a package with relatively small outline dimensions. Unlike most other antennas, they do not employ fragile, rigid tubular aluminum elements. Although no antenna can be made to be “indestructible”, the RA-7 and RA-17 antennas are specifically designed to withstand an extraordinary amount of abuse in the field. The element sections are made such that if (when) accidentally deformed, they can be readily straightened by hand and if necessary, quickly replaced in the field. The element sections may be “nested” for transport, then quickly opened and locked into position for usage. The element sections are designed to be deformed multiple times before damage occurs.

When unfolded, the Telonics RA-7 and RA-17 antennas exhibit essentially the same gain, directional characteristics, 50 ohm feed impedance and BNC female connector as any other well designed and well made two- or three-element antenna, at that point however, similarities to other hand-held “tracking” antennas essentially end.

The antennas can easily be stowed in a convenient piece of PVC pipe, a cardboard tube, under a vehicle seat, on a rack in the workbox of a truck, in a backpack, or in a baggage compartment. They are designed exclusively for hand-held, portable usage. *Telonics supplies a wide range of other receiving antennas for fixed site and vehicular applications.*

The weight of these antennas varies as a function of the operating frequency range within the VHF frequency band for which their elements are tuned. The two-element Model RA-7 antenna ranges in weight from 1.2 pounds for the 148 MHz range, to 0.95 pounds for the 216 MHz range. The three-element Model RA-17 antenna ranges from 1.75 pounds for the 148 MHz range, to 1.40 pounds for the 216 MHz range. Please refer to the *Specifications* section for additional information.

Telonics’ model RW-2 or RW-3 series coaxial cable assemblies are recommended for use with these antennas.

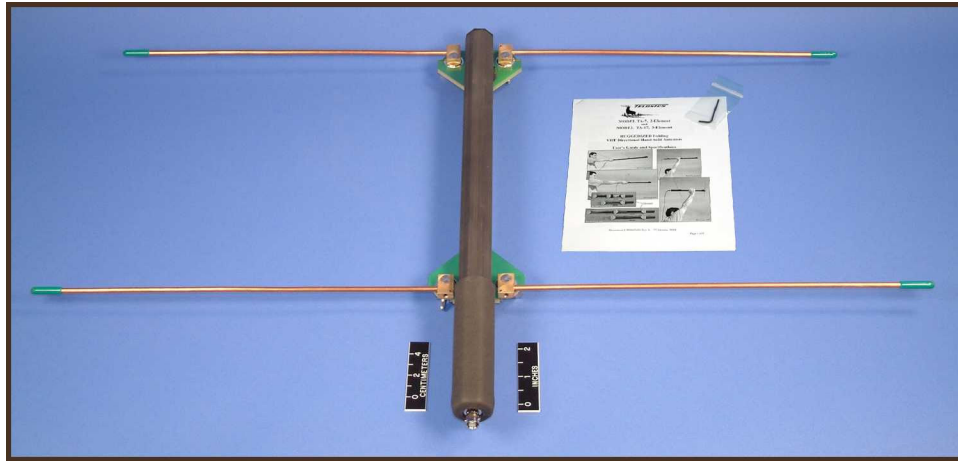
The RA-7 and RA-17 Antennas are available for all conventional VHF telemetry frequency bands from 148 to 220 MHz and can be produced for virtually any non-standard frequency band on a special order basis. Special wide bandwidth units can also be fabricated on virtually any frequency band on special order.

BACKGROUND

Other hand-held tracking antennas suffer a number of operational drawbacks and constraints due to their susceptibility to damage during transport and handling. In particular, antennas employing rigid elements are often difficult to transport without damage and require a protective package/shipping carton dimensionally related to the length of the elements and/or the center boom in the case of folding antennas. Shipping, transport by horseback, backpack or simply carrying around a site has been a continuing problem, as has assembly in and around trees, wires or near obstructions. Damaged or deformed elements (typically made of tubular aluminum or brass), often broke when attempts were made to straighten them in the field. The overall result has often been that the antenna does not function as well as it should for the application – which is indeed unfortunate since the antenna is a key element of a study and can significantly reduce the operational characteristics of the transmitter or receiver to which it is connected.

SUPPLIED HARDWARE & DOCUMENTATION

The RA-7 and RA-17 Antennas are supplied with following items:



1. RA-7 or RA-17 antenna, complete with specified element sections
2. Element section wrench for Allen-head set screws
3. Velcro cable tie
4. User's Guide and Specifications, Document #PB007490

AVAILABLE ACCESSORIES

Cables

Telonics can supply virtually any type of coaxial cable and connector configuration the user desires. However, the majority of receiving configurations associated with the RA-7 and RA-17 antennas utilize BNC connectors at both ends of a short length of low-loss RG-58 A/U-type 50 ohm impedance cable. The Model RW-2 cable (5 feet/1.5 meters in length) is most commonly employed.

The following cables are recommended for use with RA-7 and RA-17 antennas (although virtually all applications can be accommodated by the RW-2 cable):

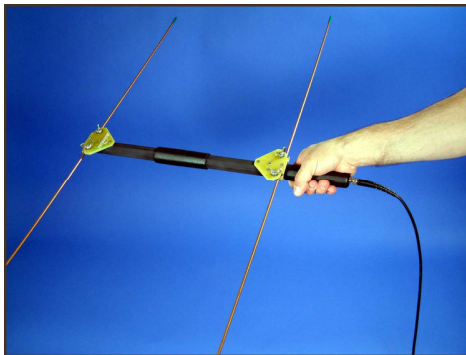
<u>Model</u>	<u>Length (feet/meters)</u>
RW-2	5/1.5
RW-3-6-(BNC/BNC)	6/1.8
RW-3-9-(BNC/BNC)	9/2.7

For long-term installations that require special cables, please contact Telonics with specifics.

USAGE INSTRUCTIONS

The RA-7 and RA-17 antennas require no assembly or critical alignment. To deploy the antennas, it is only necessary for the user to unlock the tension nut for each element section, swing each element section outward until it reaches the mechanical stop, and tighten each tension nut.

Always make sure the cable to the receiver is not in close proximity to the antenna elements, as the gain and electrical pattern of the antenna will be disrupted. The coaxial cable connects to the back of the antenna generally assuring that it is well away and prevented from electrically interfering with the antenna.

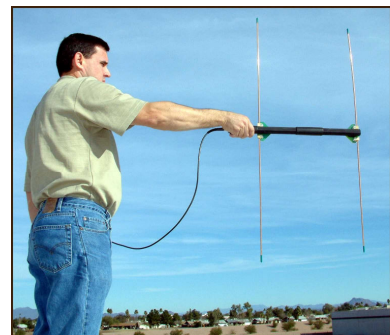


Both antenna types are designed to be held by the foam grips on the back of the antenna. In some cases the user may wish to hold the 3-element RA-17 antenna in the center and overhead. In such case, a second foam hand grip is provided in the proper location for a generally balanced grip.



NOTE: Remember that the antenna “wants” to be up in free space to work properly, a minimum of two electrical wavelengths (approximately 4 meters) away from any other object, with its connecting cable exiting directly from the back and away. In a practical sense, such deployment is not possible, HOWEVER one can approach ideal deployment by observing a few simple rules:

1. Keep the antenna away from coaxial cables, wires, metal objects, and wet or otherwise electrically conductive limbs and other materials.
2. Always hold the antenna out and away from the body.
3. Stand behind and/or below the antenna, keeping your body at least 0.5 meters away from the rear element (the rear element is always the longest element).
4. While it is often necessary to rotate the antenna in order to maximize reception by orienting it with the changing polarization of the incoming waves, always hold it as far as possible above the ground or any other objects – particularly when it is vertical or near-vertically oriented.
Remember that it is most sensitive to proximity at the ends of its elements and placing objects (such as your head), detrimentally affects the gain and pattern of any antenna.



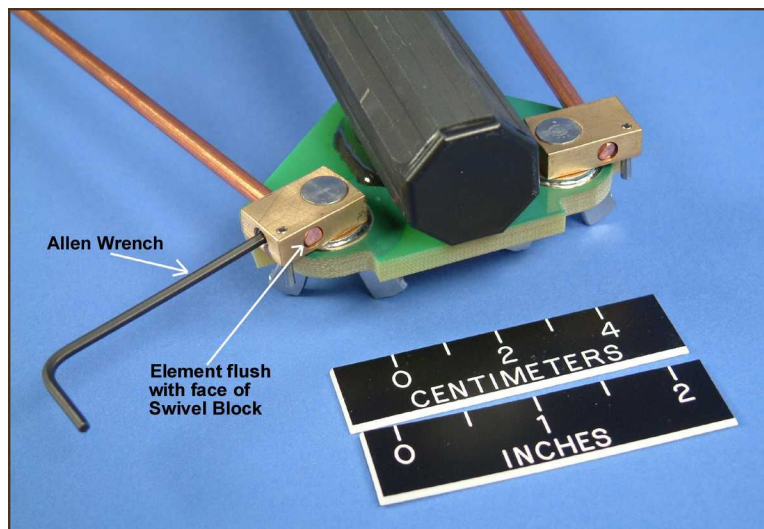
5. Always hold the antenna by the handgrips provided. It will not work well if you hold or touch the elements.
6. Use a quality coaxial cable that is in good condition to connect the antenna to the receiver. Replace any cables that are damaged or have been flattened or otherwise deformed by being closed in a door, etc. Simply testing coaxial cables with DC continuity checkers (ohmmeters, etc.) is not adequate and tells you nothing about the Radio Frequency (RF) characteristics of a cable. Proper testing requires more sophisticated RF sweep equipment so, if there is any question, replace the cable.
7. Take care not to bend the BNC connector on the end of the handle. If the antenna is dropped on this connector, it may deform, preventing the acceptance of mating cable connectors.

*A safe approach is to **leave the coaxial cable connected at all times.** This will shield the connector from most damage, while preventing dirt and foreign material from entering the connector. In the event that the connector has been unprotected for some time, it is a good idea to inspect it for damage, entrapped foreign material and/or water.*

Replacing Original Element Sections

The element sections supplied with the RA-7 and RA-17 antennas are designed to last as long as possible under heavy field usage, but at some point, like any metal, they may fatigue and break. Accordingly, they are designed to be easily replaced in the field. Each element section is locked into its respective brass swivel block by an 8-32 x 3/16 inch stainless steel Allen head set screw. (The proper Allen hex wrench (5/64 inch) is supplied with each antenna).

To replace an element section, loosen the Allen head set screw (using the Allen wrench provided) and remove the broken section. Insert a new element section until the end is flush with the edge of the swivel block and tighten the set screw.



Swivel block, element section, set screw, and Allen wrench

Spare Element sections

Telonics offers a universal spare element section replacement kit that includes three (3) element sections capable of replacing any elements on the RA-7 and RA-17 antennas. Instructions for cutting these spare element sections to length are included as Appendix A at the end of this manual.

Making Replacement Element sections In The Field

A significant feature of the RA-7 and RA-17 antennas is the provision within their design to allow the user to replace, and if necessary, substitute replacement element sections made from other materials while in the field. Universal replacement element section kits may be obtained from the factory and kept on hand, however element sections fashioned from materials that may be obtained in the field or from nearby locations can be used as well. The factory element sections are produced from #6 gauge solid copper electrical wire, typically measuring 0.160 inch in diameter. In many cases this same wire can be obtained from electrical supply houses or home repair centers. If this is not available, the user can utilize any brass welding rod which is 0.160” in diameter or smaller – as long as it is rigid enough to support its own weight. (Bear in mind that smaller diameter element sections are lighter, however they may be more prone to breakage due to flexion, particularly next to the brass swivel block with the set screw, as there is essentially no bend radius at this point.)

Materials such as copper and brass are suggested due to their high conductivity at these frequencies and minimal corrosion problems. However, if the user is in the field with a broken antenna element section, virtually any metal wire or rod can be used in an emergency – from coat hangers to aluminum rod to fence wire. The only consideration is that the wire must be cleaned/scraped well at the end that is inserted into the brass swivel block with the set screw. And, the user must be aware that this is a temporary fix – if an iron-bearing wire or rod is used, it will corrode in a relatively short time (days or weeks, depending upon the moisture present), where it is connected to the antenna and will not work properly. Substitute element sections should be replaced with the proper type at the first opportunity.

The length of a replacement element section can be judged by simply matching the opposite element section on the antenna. *(This will not be exact - as the proper length is a function of the material from which it is made, however this approach is sufficiently close to work satisfactorily in the field.)* If a universal replacement element section kit supplied by Telonics is available, it will include an accompanying cutting chart that lists the proper length for each frequency band, for both the RA-7 and RA-17 antennas. Bear in mind that the total element length (in the case of both antenna models) increases from front to back. The front elements are always the shortest and the rear elements (the “reflector” elements – nearest to the BNC connector) are always the longest. Each pair of element sections (regardless of position along the center “boom” of the antennas), are always the same length.

For additional assistance or if you have further questions, please contact Telonics' Technical Support staff at: **techsupport@telonics.com**

Technical Specifications

Electrical

Gain	>+5 dBi
Radiation Pattern	Directional, cardioid pattern with side nulls
Front-to-Back Ratio	>10 dB typical
Polarization	Linear
Feed Impedance	50 Ohms
VSWR	Less than 1.2:1 at operating center frequency
Frequency	

<u>Model RA-7 (or RA-17)-xxx</u>	<u>Fcoverage*</u>
-148	148-152 MHz
-150	150-154 MHz
-159	159-161 MHz
-164	164-168 MHz
-170	170-174 MHz
-216	216-220 MHz

*** NOTE:**

RA-7 and RA-17 antennas can be fabricated for any other VHF frequency band and for wider frequency coverage (increased bandwidth) as a special order item at added cost. (As an example, a special order unit can be supplied which covers a frequency range such as 159-161 MHz.) Please request a quotation for special frequencies and options not listed.



Mechanical

Maximum Envelope Outline Dimensions - Length x Width x Height (148 MHz band)

RA-7 deployed 20.7 x 39.75 x 1.85 inches (52.6 x 101 x 4.7 cm)
RA-7 folded 24.5 x 3.0 x 1.85 inches (62.2 x 7.6 x 4.7 cm)

RA-17 deployed 34.5 x 39.7 x 1.85 inches (87.6 x 101 x 4.7 cm)
RA-17 folded 34.5 x 3.0 x 1.85 inches (87.6 x 7.6 x 4.7 cm)

Maximum Envelope Outline Dimensions - Length x Width x Height (216 MHz band)

RA-7 deployed 16.5 x 27.7 x 1.85 inches (41.9 x 70.4 x 4.7 cm)
RA-7 folded 18.5 x 3.0 x 1.85 inches (47.0 x 7.6 x 4.7 cm)

RA-17 deployed 22.1 x 26.75 x 1.85 inches (56.1 x 67.9 x 4.7 cm)
RA-17 folded 22.1 x 3.0 x 1.85 inches (56.1 x 7.6 x 4.7 cm)

Total Weight

RA-7 (148 MHz Band) 1.2 pounds (0.54 kg)
RA-7 (216 MHz Band) 0.95 pounds (0.43 kg)

RA-17 (148 MHz Band) 1.75 pounds (0.79 kg)
RA-17 (216 MHz Band) 1.4 pounds (0.64 kg)

RF Connector BNC female

Set Screw Tool Allen hex wrench, 5/64 inch/0.078 inch (1.95mm)



APPENDIX A

INSTRUCTIONS For UNIVERSAL SPARE ELEMENT REPLACEMENT KIT

(Telonics part # CM-007350-001)



The universal spare element section replacement kit (part # CM-007350-001) is supplied with cutting instructions for the more popular telemetry frequency bands. The spare element sections, after being cut to the proper length by the customer, can replace any element section supplied on standard RA-7 or RA-17 antennas.

Each replacement element section kit includes the following items:

1. Three (3) replacement element sections (not cut to length), with end caps
2. Six (6) #8-32 x 3/16 inch stainless steel set screws
3. One (1) 5/64 inch Allen wrench
4. Frequency chart with cutting instructions

(Note that this kit includes only three (3) replacement element sections. The Model RA-7 antenna requires a total of four (4) such element sections, the RA-17 antenna requires a total of six (6) individual element sections.)

Notes:

- (1) **The center booms on Model RA-17 antennas are unique to specific Frequency bands. When replacing element sections, the center boom cannot be converted to another band. Always utilize element sections cut for the original frequency band.**

- (2) **The center booms on the two element Model RA-7 antennas are a different situation; only two boom designs are utilized to cover all VHF frequencies. One specific (small) boom design is utilized for the 216-220 MHz model, and one (the larger) boom design is used for all lower VHF frequency band designs from 148 to 174 MHz – only the element length is varied as a function of the desired frequency band.**

The net result to the user is that, on all RA-7 models (other than the 216-220 MHz model), the antenna can be readily converted – in the field, to any other band from 148 to 172 MHz by changing the four element sections.

Element Names

An antenna “element”, as applied to the RA-7 and RA-17 antennas, is composed of two (2) equal length sections, referred to herein as “element sections”.

In order to discuss the various elements on antennas it is necessary to know their respective “names”, and to understand that elements are discussed as if they were made from a single, one-piece rod (as opposed to two sections). For the purpose of naming convention, it is also necessary to know that antennas are bi-directional devices. That is, they transmit with exactly the same characteristics as they receive. As such, the accepted convention is to discuss them as if they were being employed as transmitting, or “radiating” devices. Hence, names for their elements such as “director”, “driven element” and “reflector” are utilized. An antenna is also referred to as an “array of elements” - since the design is intended to produce the desired gain and pattern characteristics by arraying a group of elements in such a way to achieve the desired end goal. The RA-7 and RA-17 antennas are of a design configuration technically called a Yagi-Uda Array, named after the original inventors long ago. The name was later shortened to “Yagi” (probably much to the dismay of Mr. Uda). The “Yagi “ is only one among thousands of possible antenna configurations/designs.

Driven Element:

The primary element in a Yagi antenna array is called the “driven element” because the coaxial feedline is connected to this element. If one were to “drive” this element by connecting a transmitter to the feedline, this would then be the “driven” element.

Reflector:

In a Yagi array, an element that is slightly longer than the driven element is placed approximately $\frac{1}{4}$ wavelength behind the driven element. It’s function is to reflect electromagnetic energy back to the driven element with the proper phase relationship such that this energy is additive to that which is received by the “driven” element. By so doing, important characteristics are achieved:

1. The effective “gain” of the antenna array is increased somewhat.
2. A “front-to-back” ratio is established, giving the antenna directionality.
3. A defined pattern is established which is stronger in the forward direction, weaker off the back, and much weaker on the sides.

*The RA-7 two-element antenna has only a **driven element** (placed at the front of the antenna), and a **reflector element** (placed at the rear of the antenna, immediately forward of the BNC coaxial hand grip).*

Director:

A Yagi antenna array is increased in “gain” characteristics (and in physical size), by adding one or more elements in front of the “radiating element”. In general, the first director element to be added is placed slightly less than $\frac{1}{4}$ wavelength in front of the driven element.

This element increases both the gain of the array and the directivity characteristics ever so slightly. In order to add this element, the center support boom of the antenna must be extended and the weight of the antenna is increase by both the longer boom and the element, accordingly, the resultant benefit of adding this element is debatable.

The RA-17 three-element antenna provides this additional element, in the form of a single “director” element (at the front of the antenna), a driven element (in the center of the antenna), and a reflector (placed at the rear of the antenna, immediately forward of the BNC coaxial hand grip).

Cutting Element Sections

The copper element sections supplied in the kit may be cut to length using any convenient method, **however** bear in mind that it may be difficult or impossible to insert the end of the rod into the hole in it’s brass swivel block if it is severely deformed in the cutting process. Electrician’s wire cutters with curved cutting blades are preferred, however a fine-tooth metal saw or any other suitable cutter can be utilized. It is a good idea to dress the end of the rod slightly with a fine file in order to ensure a smooth fit into the swivel block.

The cutting charts list precise dimensions; however cutting element sections to within approximately +/- 0.1 inch (+/- 2.5 mm) is adequate for fieldwork.

Element Section Length Tables

The following tables list the length of each element section for the RA-7 and RA-17 antennas. (Note that between antenna types, the length of element sections is generally different, even though the element they form has the same name).

Model RA-7, Two Element Antenna Section Lengths (inches/cm)

<u>Model</u>	<u>Frequency Band</u>	<u>Director</u>	<u>Driven Element</u>	<u>Reflector</u>
RA-7-148	148-152 MHz	N/A	17.60/44.70	19.05/48.39
RA-7-150	150-154 MHz	N/A	17.40/44.20	18.90/48.01
RA-7-159	159-161 MHz	N/A	16.50/41.91	17.80/45.21
RA-7-164	164-168 MHz	N/A	15.70/39.88	17.15/43.56
RA-7-170	170-174 MHz	N/A	15.20/38.61	16.70/42.42
RA-7-216	216-220 MHz	N/A	12.10/30.73	13.05/33.15

Model RA-17, Three Element Antenna Section Lengths (inches/cm)

<u>Model</u>	<u>Frequency Band</u>	<u>Director</u>	<u>Driven Element</u>	<u>Reflector</u>
RA-17-148	148-152 MHz	16.80/42.67	17.75/45.09	19.05/48.39
RA-17-150	150-154 MHz	16.60/42.16	17.55/44.58	18.90/48.01
RA-17-159	159-161 MHz	15.30/38.86	16.15/41.02	17.80/45.21
RA-17-164	164-168 MHz	14.90/37.85	15.70/39.88	17.15/43.56
RA-17-170	170-174 MHz	14.30/36.32	14.95/37.97	16.70/42.42
RA-17-216	216-220 MHz	11.50/29.21	12.35/31.37	12.60/32.00

