RDF PRODUCTS
Vancouver, Washington, USA 98682
Tel: +1-360-253-2181 Fax: +1-360-892-0393
E-Mail: mail@rdfproducts.com Website: www@rdfproducts.com

WN-008

Web Note

QUESTIONS & ANSWERS: A USER'S GUIDE TO RADIO DIRECTION FINDING ANTENNA SELECTION

This Web Note discusses the issues associated with selecting a radio direction finding antenna in an informal, easy-to-read Question & Answer format. It is especially intended for users who are new to the field, and specifically addresses frequently asked questions.

Rev A02/01-09/wn008_apl_01

Original Writing: December 2007

About RDF Products Application Notes...

In keeping with RDF Products' business philosophy that the best customer is well informed, RDF Products publishes Application Notes from time to time in an effort to illuminate various aspects of DF technology, provide important insights how to interpret manufacturers' product specifications, and how to avoid "specsmanship" traps. In general, these Application Notes are written for the benefit of the more technical user.

RDF Products also publishes Web Notes, which are short papers covering topics of general interest to DF users. These Web Notes are written in an easy-to-read format for users more focused on the practical (rather than theoretical) aspects of radio direction finding technology. Where more technical discussion is required, it is presented in plain language with an absolute minimum of supporting mathematics. Web Notes and Application Notes are distributed on the RDF Products Publications CD and can also be conveniently downloaded from the RDF Products website at www.rdfproducts.com.

About Adobe Acrobat...

All RDF Products publications are published as Adobe Acrobat portable documentation files (PDFs). Although documents published in PDF format can be viewed on a wide variety of computer platforms and operating systems, they require that the Adobe Acrobat Reader be installed on the recipient's computer. This reader is free and a suitable version for almost any computer operating system can be downloaded from Adobe's website at www.adobe.com.

If the print quality of an Acrobat PDF document is unsatisfactory, check the following guidelines:

1. If the printer is Post Script compatible, use the Post Script print driver if possible. This usually results in best print quality.

2. Use the most current version of the Acrobat Reader (V6.x or higher) if available. Version 6.x contains specific improvements for better graphics printing quality and is strongly recommended. It also provides improved print quality for the large number of printers employing HP PCL print drivers.

All Acrobat documents produced by RDF Products have been carefully mastered for good screen and print quality *as viewed on RDF Products' computer system.*

Question: I notice that RDF Products offers a wide selection of DF antenna models. How do I go about selecting the one most suitable for my application?

Answer: In most instances, the first issue is whether the DF antenna will be mobile or fixed-site.

Q: What are the applications for which mobile DF antennas would be most suitable?

A: Mobile DF antennas are designed primarily for vehicle-top applications where the remaining DF system components are mounted inside the car, van, truck, or other vehicle. Mobile DF systems are primarily used to find transmitters by tracking and homing. A typical car-top mobile DF antenna installation is illustrated in Figure 1.

Figure 1 - Car-Top Mobile DF Antenna Installation

Q: Can mobile DF antennas be used on aircraft?

A: Yes, many of our customers deploy their mobile DF systems on aircraft. Keep in mind that RDF Products mobile DF antennas are not specifically designed for aircraft applications, and that all installations must be done in full compliance with all applicable FAA rules and regulations and must certified by an FAA airframe mechanic. Installation on high-speed aircraft will require aerodynamic radomes and other special accommodations.

Q: How about helicopters?

A: Helicopter installations are usually more difficult than fixed-wing installations. The main problem is that the underside of most helicopters is often cluttered with various objects (skids, Nav/Com antennas, searchlights, loudspeakers, etc.) that can interfere with DF antenna operation. Also, some helicopter bodies are constructed with non-metallic composite materials that can cause poor mobile DF antenna performance (keeping in mind that mobile DF antennas are designed to be mounted on a conductive surface of substantial size). Even so, RDF Products mobile DF antennas have been successfully fitted on many helicopters (mostly for search-and-rescue missions). A typical installation is illustrated in Figure 2.

Figure 2 - Helicopter Mobile DF Antenna Installation

Q: Can mobile DF antennas be used on boats?

A: In most cases, no. The problem on most boats is that there are no large flat metallic surfaces available that aren't surrounded by various structures that would degrade performance. The best solution for maritime applications is to employ mast-mounted (i.e., "fixed-site") DF antennas that can be elevated above all these structures.

Q: Where else would fixed-site DF antennas be used?

A: Fundamentally, fixed-site DF antennas would be used for any stationary location where the antenna is intended to be permanently installed. These antennas are typically mounted atop buildings, towers, and masts so that they are high enough to clear nearby obstructions. A typical fixed-site DF antenna is illustrated in Figure 3.

Figure 3 - Mast-Mounted H-Dipole Adcock DF Antenna

Q: You mentioned that fixed-site DF antennas are suitable for boats. Can they also be used for vehicles?

A: They can in certain transportable applications. The vehicle would typically be large enough so that the fixed-site DF antenna could be mounted on a tilt-up or pneumatic mast. In contrast to smaller vehicles with mobile DF antennas that can DF "on-the-move", these transportable large-vehicle installations need to stop before raising the DF antennas. Also, they would not attempt to move with the antennas deployed.

Q: Can mobile DF antennas be used in fixed-site applications by installing them on a large elevated metal surface?

A: No, such installations provide very poor results for reasons explained in detail in our 1999 Application Note AN-005 ("An Introduction to Dipole Adcock Fixed-Site DF Antennas").

Q: I've noticed that one vendor advertises a radial system that is intended to allow mobile DF antennas to be elevated on masts for use as fixed-site DF systems. Do these really work?

A: Again, no, and for the same reasons as explained in AN-005. A vendor who offers such a product most likely does not understand the issues raised in AN-005 and is trying to avoid the difficult and complicated design issues associated with a well-engineered mast-mounted DF antenna.

Q: Can mobile DF antennas be installed atop vehicles with fiberglass or other non-metallic tops?

A: No, such installations will yield poor performance. If the vehicle roof-top is non-metallic, it is best to fasten a large sheet of aluminum onto the roof and then mount the mobile DF antenna on top of this sheet.

Q: Once I've decided whether the DF antenna is to be mobile or fixed-site, what is the next issue I should consider?

A: The next major issue is frequency coverage. In most instances, frequency coverage requirements will be driven primarily by your application.

Q: Are wide frequency coverage models significantly more expensive that narrow frequency coverage versions?

A: Yes. This is one of the two reasons why you should select a model that covers only the necessary frequency ranges.

Q: And the other reason?

A: Designing for wide frequency coverage entails additional performance trade-offs and compromises over and beyond those that must be made with narrower coverage models.

Q: I notice that your wide coverage mobile DF models have two arrays. Do aerials have to be removed when changing antenna bands?

A: No. For multiple array mobile DF antennas, all the aerials must be installed, but once this is done all of them must be left in place regardless of the selected operating frequency. A typical RDF Products dual-array mobile DF antenna is illustrated in Figure 4.

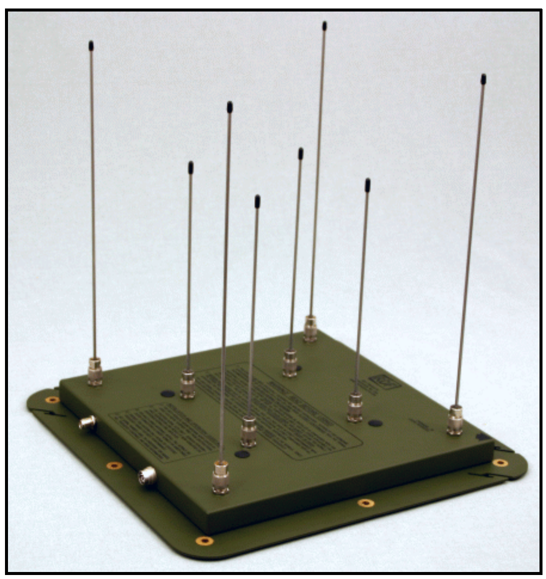

Figure 4 - DMA-1315B1 Dual-Array (80-250/250-520 MHz) Mobile Adcock DF Antenna

Q: For a dual-array mobile DF antenna, is it necessary that all the aerials be installed even if my frequency coverage requirements rely on only one array?

A: Yes, it is still important that all aerials be installed. If this is not done, performance will likely be poor or marginal in certain portions of the specified frequency range.

Q: Can I cut down aerials if I want to reduce the overall mobile DF antenna height?

A: We don't recommend this. Although performance will be satisfactory at some frequencies, it will very likely be degraded at others. If you need a lower-profile version of a particular mobile DF antenna model, we can usually build a customized version to meet your requirements.

Q: I'm looking at your 20-174 MHz DMA-1248B1 and your 27-220 MHz DMA-1271B1. The frequency coverages of these two mobile DF antennas are similar and suitable for my application, but these models look different. Can you advise as to what factors to consider in my selection?

A: The answer to this question speaks to the compromises and performance trade-offs mentioned earlier. But to specifically answer your question, the DMA-1248B1 is a larger unit (having a larger chassis and taller aerials with wider spacing) whereas the DMA-1271B is more compact. This being the case, an obvious advantage of the DMA-1271B is that it would be more suitable for applications where space is at a premium. (An aircraft installation would be a good case in point.)

The reason that the DMA-1248B1 is larger is that it was designed more specifically for applications in the 20-88 MHz low-VHF band, with the taller aerials and wider spacing providing better sensitivity. We would therefore recommend this model for applications where low-VHF performance is particularly important. On the other hand, the more compact DMA-1271B provides better sensitivity in the high-VHF range (above 150 MHz) so we would recommend this model for applications where the primary emphasis is on compactness or best high-VHF performance.

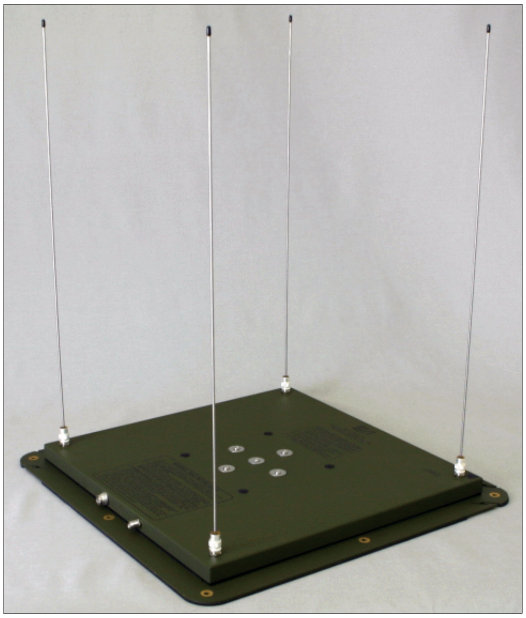

Figure 5 - DMA-1248B1 Mobile Adcock DF Antenna (20-174 MHz)

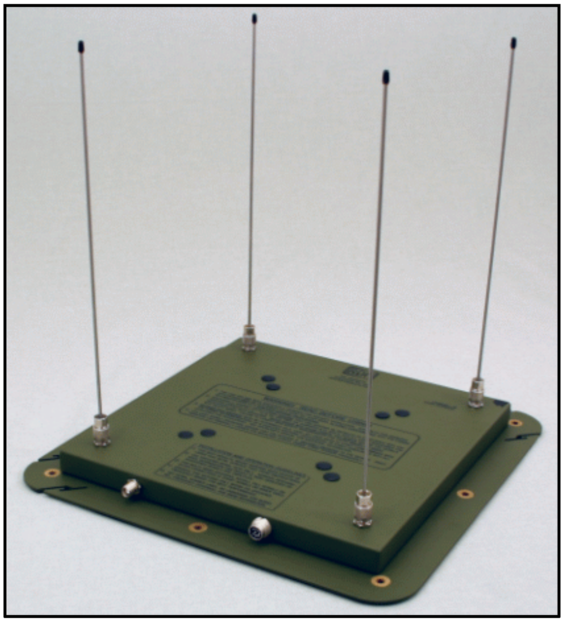

Figure 6 - DMA-1271B1 Mobile Adcock DF Antenna (27-220 MHz)

Q: What are the additional performance compromises associated with dual-array mobile Adcock DF antennas?

A: The primary issue is that there is some degradation in high-band bearing accuracy resulting from the presence of the outer (low-band) aerials. This results from outer aerial shadowing and re-radiation.

Q: Is there any advantage to using two separate single-array mobile DF antennas to cover a wide frequency range as opposed to a single dual-array model?

A: If only one of the two single-array models will be deployed on the vehicle at a time, then this approach will yield the best performance. If there is no particular inconvenience in using two different models in this fashion, then this is usually the best solution. On the other hand, if this arrangement is inconvenient (i.e., if the typical operational profile is such that the user needs both low- and high-band coverage during the course of the same mission), then most users will opt for the wide-coverage dual-array model. Most users seem to prefer this latter approach, even though it does require that a modest degradation in high-band performance must be accepted as a trade-off for convenience of deployment.

Q: Can I mount two single-array antennas on the same vehicle top and then use a selector switch?

A: This can be done, but the low-band antenna is still going to degrade performance of the high-band unit to some degree. This works best on a large vehicle where the two units can be spaced far apart from each other. In most cases though, using a single wide-coverage dual-array unit is the best performing, lowest cost, and most convenient overall approach.

Q: Is this proximity issue a problem with fixed-site DF antennas?

A: If two fixed-site arrays are located near each other (i.e., a separate VHF and UHF unit), then the same problem will occur. However, fixed-site DF antennas have an important advantage over mobile units in that fixed-site units can be constructed with vertically "stacked" arrays. With sufficient vertical separation, there is no significant interaction between the arrays and thus no performance compromise. A typical RDF Products fixed-site stacked Adcock array is illustrated in Figure 7. This unit (the DFA-1325B1) employs an underhanging lower sleeve-dipole Adcock array for 75-300 MHz and an upper sleeve-dipole Adcock array for 300-1000 MHz.

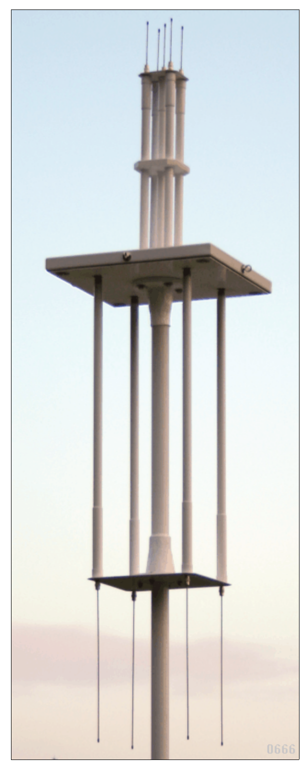

Figure 7 - DFA-1325B1 75-300/300-1000 MHz Fixed-Site Adcock DF Antenna

Q: I noticed that the appearance of the DFA-1310B1 and DFA-1325B1 dipole Adcock DF antennas (Figures 3 and 7, respectively) are quite different. Why is this?

A: The 75-300 MHz DFA-1310B1 is a classical single-array "H"-dipole Adcock using four symmetrical vertical dipoles (one near each corner of the chassis). The necessary antenna electronics is contained on circuit boards inside the chassis. Other factors being equal, this H-dipole configuration is preferred due to it's simplicity and economy. H-dipole Adcocks work well through the VHF range.

Above 300 MHz, however (i.e., in the UHF range), H-dipoles become impractical for two reasons. First, the spacing between the two dipole terminals becomes significant compared to a wavelength at the operating frequency (due to the chassis thickness), thus resulting in dipole feed difficulties and pattern distortion. Second, since the H-dipoles must be placed at the chassis corners, the required smaller inter-aerial spacing at UHF results in a chassis that is too small to contain all the necessary electronics modules.

RDF Products has solved this problem by developing special self-isolating end-fed coaxial "sleeve-dipoles". These sleeve-dipoles attach to chassis-mounted coaxial connectors in a fashion very similar to the way monopoles are attached to mobile DF antennas.

This sleeve-dipole design overcomes both of the afore-mentioned limitations of H-dipoles. Since the dipole junction is no longer inside the chassis, the dipole terminal separation problem no longer exists (the sleeve-dipole junction is inherently compact and easy to build). Also, since the sleeve-dipoles are elevated on isolation stalks, they do not need to be mounted at the chassis corners. This in turn permits the chassis to be as large as necessary to contain the required electronics modules. As illustrated in Figure 7, the 75-1000 MHz DFA-1325B1 employs a large chassis that contains the electronics modules for both the VHF (mounted on the chassis topside) and UHF (mounted on the chassis underside) sleeve-dipoles.

To our knowledge, RDF Products is the only DF vendor that supplies sleeve-dipole Adcock arrays.

Q: Why is it that RDF Products does not offer DF antenna models that operate above 1000 MHz?

A: Narrow-aperture DF antennas (i.e., Adcocks and pseudo-Dopplers) employ low-gain omni-directional monopoles or dipoles. At higher frequencies, the signal "capture area" (conceptually similar to size) becomes smaller with the result that sensitivity correspondingly diminishes. This phenomenon is often referred to as "space loss".

The nature of space loss is that a resonant dipole or monopole has 6 dB less sensitivity at 200 MHz than at 100 MHz (i.e., doubling the operating frequency of a resonant dipole or monopole reduces its sensitivity by a factor of 4). At frequencies much above 1000 MHz, the resonant monopole or dipole is both physically very small and electrically insensitive as a result.

As a consequence, although Adcocks and pseudo-Dopplers can be built for coverage well beyond 1000 MHz, their poor sensitivity at such high frequencies severely limits their usefulness.

Q: What would be a more appropriate DF technique above 1000 MHz?

A: An appropriate technical approach above 1000 MHz would make use of true microwave DF techniques that rely on highly directive arrays for improved sensitivity.

Q: Are RDF Products DF systems suitable for manpack applications?

A: No. Although the mobile DF antennas are compact and light-weight, they must be mounted atop a large ground-plane (e.g., a car-top) to function properly. Although the fixed-site DF antennas do not require a ground-plane, they are too heavy and cumbersome for manpack applications. Finally, the DF receiver/processors are not designed for low power consumption as would be required for battery-operated applications.

<>