

TENNA TIP #7

ANTENNAS FOR STEEL TUBE AIRCRAFT

(W/ Wood or other type Wings)

by Bob Archer of Sportcraft Antennas

The art of installing antennas internally that really work properly into aircraft with tube fuselages and wood or other types of wing construction has left many people confused and perplexed and all the worlds flooby dust doesn't help so I have decided to try to give some tips and information on the subject. Some people have tried to install monopole antennas internally with a ground plane installed for the antenna to work against and this is just totally bad. One friend of mine informed me he had installed his COM antenna inside the aluminum box of his baggage compartment and it worked just fine. I beg to differ, but if he is happy with it who am I to knock it. Com antennas are vertically polarized and so need to be installed vertically. My number one preferred location for a COM antenna on any type aircraft is the top of the vertical stabilizer where it has a very nice field of view all the way around but that is not very practical on this type of aircraft. Lots of welding and approvals needed. At one time I was going to try a special feed device that I have developed to turn the entire vertical tail into an antenna but my friend with a spare fuselage moved away before I got a chance to attempt it. So there is no good way to install an internal COM antenna in a tube fuselage that will work the way I believe an antenna should work. I also believe that it is better to use one really good antenna rather than two mediocre (or poor) ones. I have on my airplane (an elderly Bellanca) a really good Transco broad band low drag antenna mounted to the belly pan next to the access panel and hooked up to both radios through a coaxial switch. It works very well and the VSWR checks out real well though I would prefer a larger ground plane. On my last trip to Phoenix I tuned in the Williams tower after crossing the river and could hear the aircraft in the pattern but not the tower. I didn't check the distance but I think it was well over 100 miles. I have had some problems in some locations talking to control towers while on the ground though. The landing gear legs will interfere with the gear down and I think the ground itself is lossy in some places and soaks up the RF energy. The last possible location

for a COM antenna to work well is the top of the fuselage but there are problems. The steel tube structure can be used as a ground plane but to work properly the antenna ground must be tied electrically into the tubing. Remember, a ground plane at these frequencies should be about 48 inches in diameter at least to work right. Larger is better. An antenna mounted to a smaller plate and the plate then attached to the tubing will be OK but the plate must be electrically attached to the tubing and I do not mean with a ground wire. Ideally the ground currents should go into the ground plane in a radial manner in several places but do the best you can. If the antenna ground is not done properly the VSWR of the antenna can be very high.

A word or two or several about VSWR. VSWR stands for Voltage Standing Wave Ratio, Not Variable Standing Wave Ratio as was reported in a recent KITPLANES article. It is the ratio of the incident RF waves (those being transmitted) to the reflected RF waves (those being reflected by an antenna that is not matched properly to the impedance of the transmitter and the transmission line). Most Aerospace companies require a VSWR of less than 2:1 for transmit and 3:1 for receive. I require all my antennas to be less than 2:1. A VSWR of 2:1 reflects about 10% of the energy and 3:1 reflects about 25% and above that is way to much.

With wood or glass wings you can install the VOR antennas, which are horizontally polarized, out near the tips for good coverage and a Transponder dipole, which will fit if you have about 6" of depth. With metal wings VOR antennas can be installed inside fiber glass tips if they are large enough. The ones that I make work very well because they are designed to be grounded to the airframe but normal type of antennas are very poor. The wing tip lights and wires are very low impedance to ground and so ground out the energy. Biplane wings normally are poor candidates for internal antennas because of all the struts and wires which mess up things badly. IF the leading edges are metal they can be used as a ground plane (counter poise is a better choice of words) if a metal end rib is used for the ground connection but should be used on the wing that does not have the light wires.

The following are my recommendations for antenna locations on tube type aircraft for both optimum radio performance and minimum drag. Also best visual. I hate the Stickle Back Trout look.

1. Com antenna. One antenna on the bottom of the cowl next to the access panel. Use a coaxial switch to connect two radios to one antenna. I would rather use one really good antenna for two radios than two lousy ones. On the ground at some airports you may have some problems. The gear may cause some trouble also.

2. Vor antennas. One antenna in each wing for each receiver out toward the tip. Install through the outer inspection hole using flat head screws through the top surface of wing to secure balun. I have drawings of baluns for anyone that wants them or I can provide the baluns.

3. Marker Beacon antenna. Standard boat type antenna may be installed in aft fuselage looking between the steel tubes. Or a 40 inch long conductor, metal tape or wire, could be installed inside on the bottom fabric alongside the bottom stringer with the center conductor of the coaxial cable connected to the conductor and the braid grounded to the aft edge of the bottom aluminum sheet behind the access panel.

4. GPS. Inside the top fabric. I have mine installed between the fabric and the headliner over the cabin. My tests show no significant signal loss due to the aluminized fabric. Do not need a ground plane. On top of the instrument panel works well. It is well to keep the cable run as short as possible. At these higher frequencies cable loss can be significant.

5. Transponder / DME. A standard external monopole may be installed on the bottom metal near the bottom access or install one of my SA-005 dipole transponder antennas as I did inside the wing about half way out to the tip. It needs about six inches of wing depth for the installation. I installed mine through an inspection hole by trimming off enough of the excess fiber glass to allow it to fit through the hole. I then bonded it to a rib with the six inch dimension vertical and connector pointed

toward the cabin. I used RG58/CU cable but if I had it to do over I would use a little better cable like RG55/U or RG 142/U cables perhaps. I am just too lazy to change it.

6. Glide slope. Just couple the glide slope signal off the VOR antenna with a coupler box. Unless you are using a towel bar antenna or one of the small blade types. They don't seem to support the glide slope frequencies.

7. Loran. Does anyone still use Loran? I do! Very sensitive to aircraft electrical noise. Need filters on every thing that could be noisy. Very low frequency with vertical polarization. A six foot ADF whip antenna would be great. Or a long wire antenna. Do the best you can. Get the maximum vertical dimension possible.

Below are terms used in antenna parlance with short definitions of their meanings.

Active Elements? The part of the antenna that actually does the radiating or the receiving of the RF energy.

Aperture? The capture area of the antenna. On a dipole or monopole it is the overall dimension of the active elements, plus the airplane, on dish antennas it is the diameter of the dish.

Feed point? Generally the point at which the coaxial cable attaches to the antenna but could be where the feed device attaches to the active elements

VSWR? Voltage Standing Wave Ratio. The measurement of the ratio of incident to reflected RF energy. An indication of the quality of energy transference. The lower the number the better. 1:1 is perfect. 2:1 is good ,3:1 is OK, 4:1 and up is poor to terrible.

Radiation Pattern? A pattern showing the relative signal level around an antenna. Signal strength can be severely reduced in particular directions by other antennas, vertical stabilizers, landing gears etc.

Balun? A device that converts a balanced transmission line (such as TV lead in) to a coaxial line which is an unbalanced line. Provides balanced currents on dipole antennas while matching the 50 ohm transmission line to the nominally 150 ohm antenna.

I would be happy to answer any questions that you may have on these subjects.