By Jim Weir

Getting a grip on BNCs (big nasty connectors).

So there you sit with $5000 worth of Kingko Loudenboomer MK-50 radio in your panel, $1000 worth of Davey Booze ANR headsets on your head, and you can't talk to Ground Control because somebody hamhanded the $2 BNC antenna connector during the installation. Sigh.

Well, cheer up, Bucko, because you are about to learn the right way to assemble a BNC connector and eliminate one possible source of failure in your radio system. That's right, two pages of words and pictures that will let you be the resident expert on one of the most common causes of radio failure: the antenna connector.

Step backward for a minute... back to WW-II. At the time, there were dozens of connector standards. Components like resistors, capacitors, and inductors had no real standards at the time. Planners knew that turning out hundreds of thousands of military radios needed standards.

The components were standardized with the RMA (Radio Manufacturers Association, later RETMA: Radio, Electronic, and TV Manufacturers Association) standard codes and values, and a group of RF (radio frequency) engineers got together and standardized the connectors. One of the connectors, which was to become by far the most popular RF connector ever designed was the *bayonet, normal impedance, type* C. The BNC was born.

Making It Work

So here we sit with a cellophane package of connector parts in one hand, a 50-ohm RG-58 coaxial cable in the other hand, and the desire to terminate the cable with the connector. What to do?

What to do is make sure that those connector parts are a regular old solder-on clamp-type connector. Yes, I am aware that there are BNC crimp-on connectors, but I thought you said right up front that you wanted a reliable connector. I've seen the crimp style fail; they are not as weatherproof as the solder-on style. The ultimate endorsement: In 40+ years of playing this avionics game, I have yet to have a solder-on BNC connector failure.

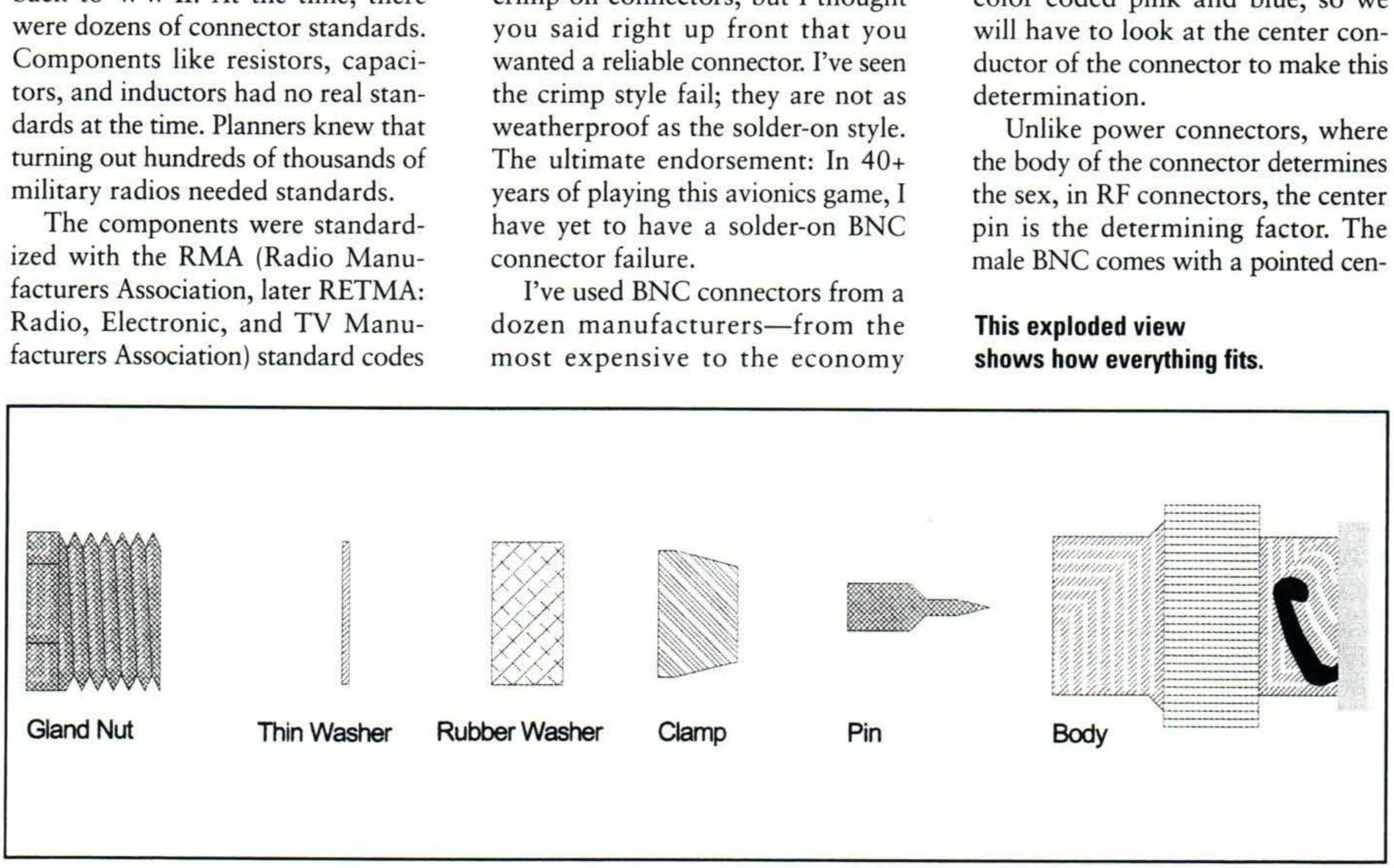
I've used BNC connectors from a dozen manufacturers—from the most expensive to the economy class—and I find practically no difference in the performance or the reliability. The reliability comes from the assembly and not from the components. The milspec variety and the bottom-end commercial variety are equally suited for light aircraft use at VHF up to and including transponder frequencies.

Gender

One thing we need to consider right up front is sex. And, as Chuck Berry so aptly noted back in the '70s, sex isn't a problem so long as you know how to handle it. And how we handle it with BNC connectors is to figure out which is the male connector and which is the female. No, the gaskets don't come color coded pink and blue, so we will have to look at the center conductor of the connector to make this determination.

Unlike power connectors, where the body of the connector determines the sex, in RF connectors, the center pin is the determining factor. The male BNC comes with a pointed cen-

This exploded view shows how everything fits.



ILLUSTRATIONS: JIM WEIR

ter pin, and the female BNC comes with a flared and open center pin. Now comes the first secret of this little rigmarole: The male cable connector is almost always referred to as a UG-88 type connector (even if it isn't a milspec connector, the milspec number is the common reference). The female connector is referred to as a UG-89 type.

Let's Get Started

Having said all that, it's time to get on with the assembly. The first step is to get a small container, like a sandwich keeper or another seamless box. Don't use a cardboard box with folded seams or I guarantee you will lose one of the tiny parts. And, heaven forbid, should you lose a washer or a gasket, please throw the rest of the parts away and write the connector off as a loss. Don't try to salvage the situation by leaving out one of these "nonessential" parts. That guarantees a reliability problem.

Let's inventory the parts (see the exploded-view drawing). The large cylinder is the body. Inside the body there is a machined nylon or Teflon insulator that will accept the center pin, and (invisible to you) there is an indentation in the insulator that will capture a corresponding ridge on the center pin and hold it firmly.

Then there is a tapered thick metal "washer" called a clamp. Next to the clamp there is a rubber washer, then a thin metal washer, then a thick metal "gland" nut. Finally, there is the center pin, generally gold or nickel plated.

Assembly by the Numbers

1. My personal secret for success is in this first step. Cut the coaxial cable (RG-58, usually called *coax*) off square where you are going to install the connector. Slip over the coax (in this order) the gland nut (threads toward the coax cut end), the thin metal washer, and the rubber washer. Slide all of these parts back onto the coax jacket out of the way and use a rubber band, piece of tape, or other mechanism to keep the parts out of the way.

2. Using a very sharp hobby knife such as an Exacto, carefully cut the black outer plastic sheath jacket of the coax back 10 mm. That's about 13/32 inch. Try not to nick wires from the braided shield just under the black plastic outer sheath. My rule of thumb is that if I accidentally cut more than 25% of the braid, or 100% of the braid in any one location, I start over.

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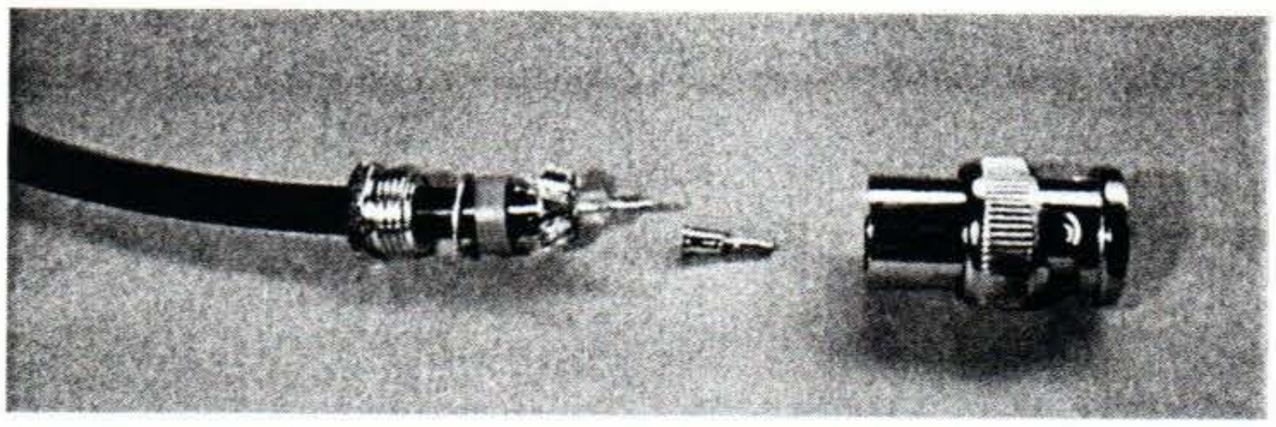
3. Unravel or flay the braid so that you have mostly individual braid wires instead of the mesh braid that the coax was manufactured with. Fold these braid wires back over the black plastic sheath.

4. Cut the center conductor *insulation* back to half of what is now exposed. Avoid cutting or scoring the solid center conductor. If you feel you have weakened the center conductor, cut the cable back and try again. More than anything else, a broken center conductor is the cause of connector failure. It takes a steady hand and a bit of practice, but it is possible to remove the insulation with little, if any, contact with the center conductor.

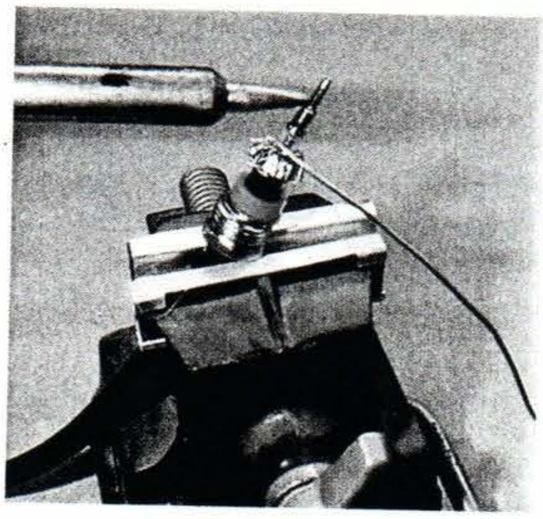
5. Second assembly secret: Put the coax in a small bench vise with the center conductor pointing up. Lightly tin the center conductor with a thin coating of solder. Now put the center pin onto the center conductor...it should fit almost all the way down to the center conductor insulation. Wipe your soldering iron on a sponge to get all the loose solder off and get a nice shiny solder surface on the iron tip. Put the iron tip onto the center pin just below where the pin takes a diameter cut to neck down to the tip. Touch some solder to the area at the base of the pin where the pin joins the center conductor. In about 5 seconds, this solder will melt. After the solder melts, count 3 seconds aloud and then remove the iron from the pin. Leave things alone for about 10 seconds.

6. Use a pair of longnose pliers and try to pull the pin (gently, now) off the coax. You should feel a nice rock-solid joint between the pin and the center conductor, and you should see a fillet of solder all the way around the pin base and the center conductor. If the pin passes this test, you have 95% reliability of the connector assured.

7. Now for the hard part and secret No. 3: Spread the braid out so that it stands at 90° to the coax and the clamp all the way around the cable. Now, using your thumbnail, wrap the braid around and over the clamp until the braid touches the



These BNC connector parts are ready for assembly.



Soldering the center-conductor tip is done easily using a small vise.

black sheath jacket. Use wirecutters or tiny scissors to trim the braid so that when you fold it up and over the thick part of the clamp, the braid just touches the black insulation. This, too, is a trick that takes some practice. A good technique is to trim a bit, fold up and check, trim a bit more, fold up and check until you get it just right. After three or four of these connector assemblies, you won't even have to measure. The famous old TLAR test (That looks about right!) works.

8. Insert the center pin and coax into the connector body. You should be able to push the center pin into the body and feel a click or snap when the center pin seats itself into the body's insulator. Sometimes it is necessary to pull gently on the center pin with longnose pliers to get it to seat properly. When it is seated properly, the tip of the pin will be flush with the outer edge of the body insulator. (Note that the outer edge of the body insulator, the thin metal sheath, and the body-locking ring are almost all flush with one another.)

9. Push the gland nut down into the body and begin to thread the nut into the body. *Do not let the body rotate relative to the coax.* The nut should be rotating, but the body and coax should remain steady. It is relatively easy to cross-thread this nut into the body, so before wrenching on this last part of the assembly, make sure you can get a thread or two finger-tight before using tools.

10. Here's the last secret. There is a *flat* on the connector body just between the bayonet ring and the body itself. A ⅜-inch ignition wrench will just barely squeeze onto this flat, and it is the tool of choice to hold the body while you tighten the nut. Yes, in a pinch I've used gas pliers to hold the body, but it isn't really the right way to do things. At any rate, hold the body with wrench or pliers and use a regular ⅜-inch open-end wrench to tighten the gland nut into the body. There should be half a thread to a thread showing between the nut and the body when the assembly is properly tightened.

That's it, folks. You are now a fully qualified BNC connector assembler. And, of course, the question becomes, "Where do I get BNC connectors?" Unfortunately, as much as I enjoy sending you to Radio Shack for your parts, I do not consider Radio Shack's BNC connectors to be aviation quality. They are all crimp or twist-on style and that just doesn't cut it with me. Mouser has the 171-9313 for about $2 a pop, Digi-Key has its A24424 for about the same, and the usual gang of avionics suspects (RST, Aircraft Spruce, Chief) are all in the same ballpark. Just be sure you get the clamp type and not the crimp type.

The weather as I write this in March has gone from a balmy 70° back into the low teens at night, so perhaps I'll be able to get some data in the next few days for the engine preheat warmer for the next article. Then we'll take a trip into the world of carb temp gauges, back to the engine warmer for an auto-on control, and then we'll wander aimlessly for a while. **KP**

Jim Weir is the chief avioniker at RST Engineering. He answers avionics questions in the Internet newsgroup rec.aviation.homebuilt. Check out his website at www.rst-engr.com/kitplanes for previous articles and supplements.