



TECHNICAL COLUMNS

Official archives of articles and columns written by Ron Hranac for Communications Technology and some of its sister publications, published by Access Intelligence, LLC. Reprinted with permission of the author.

By **Ron Hranac**, former *Senior Technology Editor*, *Access Intelligence* and *Communications Technology Magazine*

Originally appeared in the **February 2010** issue of *Communications Technology*.

F CONNECTOR TIGHTNESS

By RON HRANAC

In early December 2009 there was a post on cabletv-list, an industry e-mail reflector, asking about F connector tightness on set-tops and cable modems. I replied that a general tightening torque guideline has long been 20 to 30 inch-pounds for mating connectors on taps, ground blocks, drop splitters, and so forth, and finger tight plus one-eighth-of-a-turn on connectors mounted in plastic (VCRs, cable-ready TVs). I went on to say that I've not personally seen a problem tightening to as much as 20 to 30 inch-pounds on cable modems and set-tops.

Boy, was I wrong.

Loose connectors: A history

We know that loose connectors have been with us for as long as connectors have existed. A loose connector creates a potential source of signal leakage and ingress. Toss in a likely impedance mismatch, and micro-reflections might come into play, too. It's no surprise that the lowly F connector contributes to a significant percentage of service calls, and most of those connector-related calls have some sort of craftsmanship problem written all over them.

"What happens when a connector is tightened another eighth of a turn beyond finger tight?"

Years ago comprehensive tests clearly showed that improperly installed F connectors can cause all sorts of technical issues, so an effort was made to educate our workforce about installing the things correctly the first time.

Connector manufacturers responded with new designs that reduced the craft-sensitivity side of the equation. Tool manufacturers gave us cable preparation tools to do away with the inconsistency of pocket knife-prepped interfaces, as well as 7/16-inch F connector torque wrenches factory set to a value somewhere in the 20 to 30 inch-pounds range. Various cable operators and even SCTE introduced installer training and certification courses, and installation quality control programs were rolled out in many systems.

Things got better, but because F connectors are installed by people the craft-sensitivity part can never be completely eliminated. Indeed, a North American case study cited by PPC's Rick Haube in the European SCTE's December 2009 Broadband indicates that loose F connectors are still a problem. The study found that on average, 27 percent of indoor connectors were less than finger tight (1.5 inch-pounds).

That ought to be easy to fix, right? Just tighten those indoor connectors one-eighth-of-a-turn beyond finger tight. Um, not so fast.

I spoke with an engineer from another connector manufacturer, and he noted that his company has found that "finger tight" can vary from around 1 inch-pound to as much as 3.5 inch-pounds, with most people ending up finger tightening to somewhere in the 1.5 to 2.5 inch-pounds range.

Too tight



I think it's safe to say that nobody would ever recommend using a torque wrench preset to 20 or 30 inch-pounds to tighten F connectors on a cable-ready TV or VCR. The risk is breaking off the connector, which is often mounted in plastic.

The soldered connection to the printed circuit board is for the most part all that holds the TV's or VCR's connector in place — the plastic doesn't do much to keep the connector from rotating. In some cases as little as 15 to 20 inch-pounds may be enough to break the soldered joint on the printed circuit board, hence the caution about not over-tightening F connectors on most cable-ready TVs and VCRs. So what happens when a connector is tightened another eighth of a turn beyond finger tight? Way more than I ever imagined.

One-eighth-of-a-turn is the same as 45 degrees of rotation ($360 \text{ degrees} / 8 = 45 \text{ degrees}$). According to the previously mentioned engineer, that much rotation results in torque well in excess of 30 inch-pounds on most connectors used in the industry.

In fact, some connectors exceed 80 inch-pounds before even getting to that 45-degree rotation point! This engineer showed me a graph of several tested connectors, which varied from less than 10 inch-pounds to as much as 60 or more inch-pounds at 45 degrees rotation beyond nominal finger tight.

CommScope's Chris Gemme corroborated the previous information in a follow-up post on cabletv-list: "We have found that finger tight [plus] one-eighth of a turn will present torque values above 30 inch-pounds (this will vary from connector to F-port design) with numbers as high as 42 inch-pounds."

Among the reasons for the final tightness variations with different connectors is the nature of their internal construction. For instance, most connector manufacturers use some type of O-ring to prevent moisture migration through the back of the nut. The way the O-ring is installed, its size, and the durometer of the O-ring material all will impact to some degree how much rotation is necessary to fully compress the O-ring. Toss in variations in mating F connector design on splitters, tap ports, and customer premises equipment, and you can see that the old finger-tight-plus-an-eighth-of-a-turn rule-of-thumb is not such a good rule-of-thumb, after all.

Other interfaces

What about connector tightness on non-CPE interfaces? It's long been my understanding and a general industry guideline that 20 to 30 inch-pounds is suitable for tap ports, splitters, ground blocks, and similar connectors.

But that understanding is being challenged by modern research. "We have been doing some work recently on F-interface torque," Gemme noted. "The concept of 30 inch-pounds is excessive from an ingress perspective. In most instances there is some deformation occurring in the face of the connector/port that is causing a ground plane break permitting ingress to creep higher than an interface torque of 10 inch-pounds.

"Every connector will vary and each will vary with different port designs being mated to. But in general, 5 to 11 inch-pounds seems to be [an] optimum range for electrical performance and minimizing the amount of ingress at the interface. That range is also sufficient to create a secure nut that will not back off from normal vibrations and thermal cycles."

Bottom line

What all of this does this mean?

It seems we may have been overtightening F connectors, both indoors and outdoors. Well, except for those that weren't tightened enough in the first place. The information discussed here makes it clear that CPE

connector tightening torque shouldn't exceed about 10 inch-pounds, but definitely needs to be greater than finger tight. Outdoor connectors shouldn't be tightened as much as previously thought acceptable.

As previously noted, CommScope's Chris Gemme suggests values in the 5 to 11 inch-pounds range appear to be about ideal for most applications.

Here's some additional advice: Consult with the manufacturer(s) of F connectors being used by your company, and see what tightening torque value is recommended. If you're currently using torque wrenches that are set for 20 inch-pounds to 30 inch-pounds, it might be a good idea to get those reset to a lower value. If you're not using torque wrenches — and some will argue that using a torque wrench doesn't always provide consistent torque — how are you ensuring at least reasonably proper connector tightening torque?

If connectors are too loose, leakage, ingress, and possibly micro-reflections crop up. Too tight may mean connector and/or mating interface damage (especially on cable-ready TVs and VCRs), and possibly an increase in leakage and ingress.

Ron Hranac is technical leader, HFC Network Architectures, for Cisco Systems, and former senior technology editor for *Communications Technology*. Reach him at rhranac@aol.com.