# An Antenna Autopsy

By Eugene Morgan (WB7RLX)


When buying an antenna usually our first priority is with regard to its performance as an antenna. I mean this seems logical. It is after all the key thing an antenna does, radiate energy and collect energy. But we often overlook the other aspects of an antenna, its mechanical engineering and its physical components. As a rule as much thought has to go into the mechanical engineering of an antenna as does its electrical engineering. The mechanical part of an antenna should not be over looked or discounted. It is after all what allows an antenna to do its thing.

The assembly of an antenna should also not be overlooked or trivialized. The proper assemble is critical to the *long term* performance of the antenna. Notice I used the phrase, "Long Term". Almost every antenna will perform as expected after it is first installed. But it's after an antenna has survived a few Utah winters and our hurricane like winds that we get from time to time, that skipped steps and shortcuts in assemble will start to show up. They will show up as intermittent performance in most cases and in the worst case the antenna will just mysteriously stop working and the SWR goes to infinity. In the very worst case there is a physical failure that results in the whole antenna tumbling to the ground putting a nice big scratch in your shiny new red truck. It is hoped the takeaways from this article will help you to not experience these kinds of issues with your antenna. Granted this article is about vertical antennas but the same rules apply to all antennas.

Over the summer I have had several opportunities to take down antennas that have been up for several years. In two cases they were my own antennas, a Comet X300 UHF/VHF antenna and a Butternut HF4V. And most recently a Hustler 4BTV that had been up for an undetermined time, judging from the condition it was in I would speculate at least couple of centuries.

This article will go step by step though what I found, the good the bad and the ugly. In some ways this article will sound like a review of the Hustler 4BTV, the Butternut, and the Comet, but that is not my intention. My intention is to document the condition of each antenna and point out the deterioration that has taken place over time and how to prevent some of the deterioration. I will also draw attention to areas where the manufacture should have used different materials to improve the antennas ability to survive long term exposure to weather and sun.

From this, my goal is to provide all of us with insights into choosing a good antenna solution for our particular situation. And to consider not only the performance aspects of an antenna but also it physical

and mechanical aspects as well. And finally my goal is to educate us about how to maximize and optimize our antennas by using a best practice approach to installing our antennas so they will endure years of exposure to the elements with little to no degradation in performance or loss of structural integrity.

## The Comet X300 – the Good

The Comet X300 is my UHF/VHF antenna. I purchased it new and mounted it to our chimney when we first move into our home on Buchanan Ave in 2005. Early this summer I needed to take it down given that we were going to have a new roof installed.

As many of you know the comet is a collinear vertical. The actual antenna elements are enclosed inside a fiberglass tube that is joined in the middle by a stainless steel fitting. The feed point is located at the bottom of the antenna and is enclosed inside an aluminum tube. Surrounding the base of the antenna are three radial elements.

**Findings:** When I disconnected the coaxial from the SO239 the connection looked as good as the day it was installed. The connection had been filled with dielectric grease. There was no sign of any corrosion. Given that the fitting is housed inside of the aluminum tube I didn't wrap the fitting with any tape, even so the inside of the connection showed no signs of corrosion. The assumption is that the dielectric grease prevented the formation of any corrosion.

I wanted to inspect the connection point inside of the fiberglass housing where the two halves of the antenna are joined. To do this I had to first loosen the stainless steel fitting. It came apart without binding or being forcing. I expected this given the use of an anti-seizing compound that was put on the threads when the antenna was assembled.

After exposing the antenna connection point I was able to easily loosen the screws that secures the two elements together. Again I was looking for signs of corrosion. Once again I found none. In this case I had use an anti-oxidant compound before assembling the antenna connection point.

I also inspected the radials to see if any had come loose, they hadn't. I attribute this to the use of thread lock when I assembled the antenna.

**Conclusion:** I found the antenna to be in like new condition. There was no corrosion on any of the electrical connection points. Further, the fiberglass was smooth and felt like new in spite of being in the outdoors for 15 years. Normally I observed that fiberglass tends to break down and can become prickly with fiberglass splinters over time. I found no such deterioration on the Comet X-300. Whatever they use it seems to work.

The Comet was reassembled as before taking due care to use anti-oxidant compound on the antenna elements, dielectric grease on the PL259/SO239 connection and anti-seizing compound on the stainless steel coupling and LocTite on the radials. Unlike my initial installation I wrapped the stainless steel coupling with Scotch brand white vinyl electrical tape. I expect this antenna will last another decade with no change in performance or appearance.

## The Okay – the Butternut HF4V

It may be a bit unfair to critique my own installations, but I find that I do learn from both my mistakes and my successes and my hope is that you will too. The Butternut was my go to HF antenna. It was a less than ideal installation given that it's only radial was a foot wide metal ridge vent that ran the full length of the house. I'm not even sure that the vent sections were bonded. Given the feed point impedance it was pretty clear that it was a marginal installation at best. I mounted the Butternut on the roof of my house in 2010 where it stayed until 2019. In 2019 I moved it from the top of my house to a 7' fence post on the edge of my yard and added a set of tuned radials for the intended bands. Its performance was much improved.

In 2020 I took this antenna down and replaced it with a full length ¼ vertical for the 40 and 30 meters and a ¾ wave vertical for the 10 meter band. I dissembled the Butternut and carefully packed it and promptly sold it on KSL.COM to a young man that lives in Brigham. Although I didn't document it's disassembly I remember it well.

**Findings:** Once again this is an antenna I assembled following my usual best practices. I assembled the aluminum elements using *Jet-Lube SS-30* to ensure the electrical connection between the elements would not corrode, they hadn't and to make sure that the antenna would come apart easily, which it did. The one area that I had not considered was the nuts and bolts that secure the loading coils and shorting bars to the vertical element. I didn't lubricate the fasteners and consequently a few of them were very hard to loosen. In the future I'll put a dab of anti-seizing compound on the bolts before assembly. As to the feed point, here again I followed best practices. The SO239/PL259 connection was filled with dielectric grease and the whole joint wrapped with self-vulcanizing tape and over wrapped with Scotch brand vinyl electrical tape. When I took this joint apart after laying for on my roof for 10 years I found no traces of corrosion.

The other thing I over looked was the small fiberglass rod at the base of the antenna. As fiberglass will do it will begin to deteriorate after prolonged exposure to the elements and it starts shedding fiberglass, in short it gets prickly. This element is perhaps the weakest point of the entire antenna. It supports the weight of the entire antenna and must not break as the antenna moves in the wind. The exposed surface of the fiberglass rod should be wrapped in electrical tape to protect it from exposure to the sun, I missed this step.

**Summary:** After ten years of exposure to the elements I found no corrosion on any of the antenna components or in the electrical connection between the feedline and the antenna. Validation came when the fellow that bought the antenna from me called and asked me what I had used. He said that unlike other used antennas he had bought the joints looked new. And finally, and already mentioned, is to wrap the fiberglass rod at the base of the antenna with electrical tape to protect it from the sun. If you do that it should last decades in the harshest environment.

## The Bad and the Ugly – the Hustler 4BTV

The Hustler 4-BTV is a four-band trap vertical antenna. The 4-BTV is designed as a self-supporting vertical to provide optimum operation in the 10,15, 20 and 40 meter bands. It can also be adapted to operate in the 75/80 meter band. This antenna is designed for installations with restricted space.

The Hustler 4BTV is one of those classic vertical antennas that has been around for decades. I actually have one of the very early models of this antenna that I bought for parts. It was interesting to compare my "parts antenna" with this clearly newer version of the 4BTV. Below is a little history on the Hustler 4BTV that I got from the assembly instructions that come with all BTV's purchased from DX Engineering. It's proper that I attribute them for the following information:

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***Over 50 Years Ago!***

*The Hustler HF Base Four Band Trap Vertical antenna was a new concept in 1959. This unique multiband antenna with an exclusive low-loss trap design was developed and introduced to Amateurs by Hustler, Inc. of Cleveland, Ohio, offering quarter-wave antenna performance for 40, 20 15 and 10 meters , but requiring no band switching!*

*Later, the Hustler Four Band Trap Vertical, known around the world as the 4-BTV, was made available with an 80 meter resonator, and the 5-BTV was born. When the Amateur bands expanded in 1979, the last of the series offerings designed by Hustler, the 6-BTV, added 30 meters, for an unequalled vertical antenna. Since 1985 the New-Tronics Antenna Corporation in Mineral Wells, Texas, has been making high quality antennas for HF, VHF and UHF Amateur and Commercial customers, including the "Hustler BTV Series".*

*Since 2003, DX Engineering has offered Hustler Antennas and has developed a complete system of innovative accessories and Add-On Kits specifically for the Hustler BTV series. Amateurs now have the choice of complete Hustler BTV Series High Performance packages for their HF needs, including the ability to turn their Hustler into a "9-BTV" covering all bands 80 through 10 meters.*

*DX Engineering joins New-Tronics Antenna Corporation in celebrating over 50 years of service with the famous Hustler HF Base Four Band Trap Vertical – The Hustler 4-BTV.*

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This particular antenna was included in a sale of a very nice Yaesu HF radio to one of our club members. It's was gifted to me for my efforts. I have no information on this antenna as to its history, who owned it, who assembled it, or how long it had been up or where it has been since it was sold to our peer.

To say this antenna was in bad shape is an understatement. If antennas were conscious entities I would have had pity on this poor, neglected example of a proud tradition of antennas. I give the Hustler verticals the same reverence and respect as I do the Mosley Classic beam antennas. To see one of these fine antennas in such disrepair was heart breaking. Once it hit my work bench I decided that I was going to resurrect it and bring it back to a fully operational state albeit with some wear and tarnish that would only add to its classic character but would not affect its performance. I would not let this antenna go to the scrap heap.

**Findings:** I began by separating the antenna at each of it joints. At each joint where one element slips into the other I found extensive corrosion. Of particular note is at the first joint at the base of the antenna. For extra strength hustler used what I believe is a stainless steel pipe that extends through the base and at least a foot into the first aluminum element. There the corrosion was at it worse. I suspect the issue is what we call galvanic action. Although the picture below is not of the specific corrosion I was referring to it is representative of the corrosion I found on virtually every connection point on the antenna. Corrosion inhibits the flow of power throughout the antenna and can waste valuable energy. In the worst case it can inhibit the flow of energy altogether. This kind of corrosion is why we sometimes see fluctuation in SWR and intermittent performance. This kind of corrosion can be minimized by using an anti-oxidizing compound like Penetrox or Jet-Lub and where possible sealing the connection with self-vulcanizing tape in an effort to keep water out of the connection.

*Figure 1: Extreme Corrosion at element connection points*


*Figure 2: Examples of more corrosion found inside the traps*

The second issue I found was the use of non-stainless steel components. In most cases this is the fault of the manufacture more than the builder. In the case of the Hustler antenna there were several examples of this. The screws had so badly rusted that it was not possible to unscrew the fasteners and instead a chisel had to be used to remove the screws.

*Figure 3: Rusted U Bolts.  I hate to think how many of these I've seen twist off because the bolts were so baldy rusted*

*Figure 4: A view of the spider hub.  The slots in the screws have all but rusted away!*

*Figure 5: Badly rusted metal fasteners – These aren't the worst ones*


*Figure 6: These are the worst examples – This one had enough of a slot left I could unscrew it. The other five screws had to be cut with a chisel*

**The Restoration:** After doing an assessment of the antenna I ordered a new spider assembly (HSR-9471) and a full set of trap caps (HSR-TRAPCVR-P). I also made a 3/8 x 24 bolt for the top element so I could attach a 75 meter resonator that I happened to have. I also fabricated a three element spider that sits just below the 75 meter resonator this allowed me to turn my 4BTV into a 5BTV. I was able to use the old 6 spoke hub to hold the 3 elements that I made from some scrap aluminum tubing I had left over from another project.

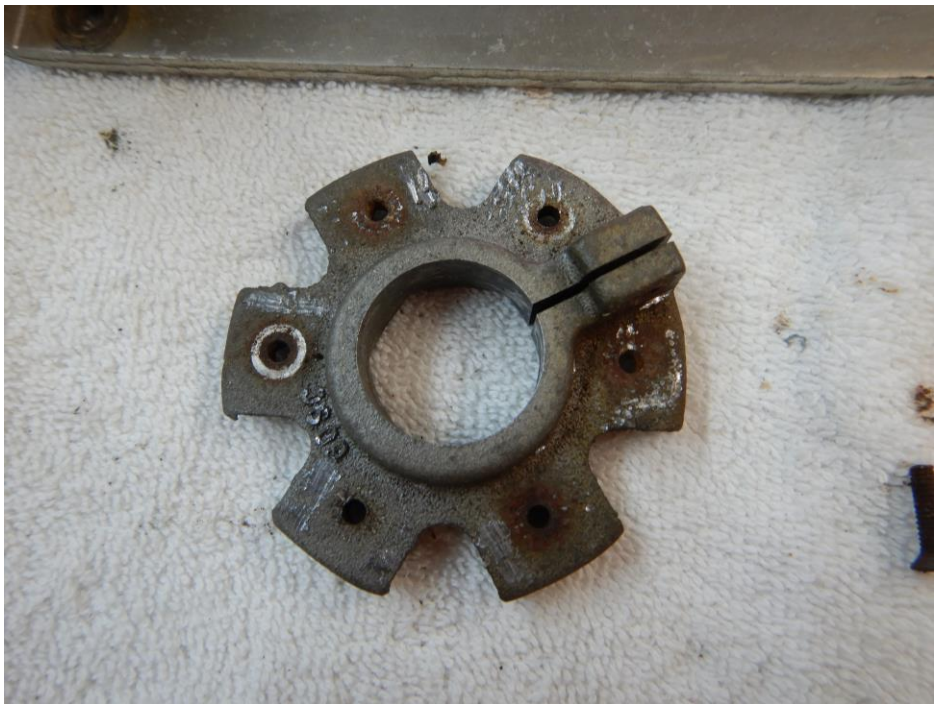

*Figure 7: The spider hub before restoration*

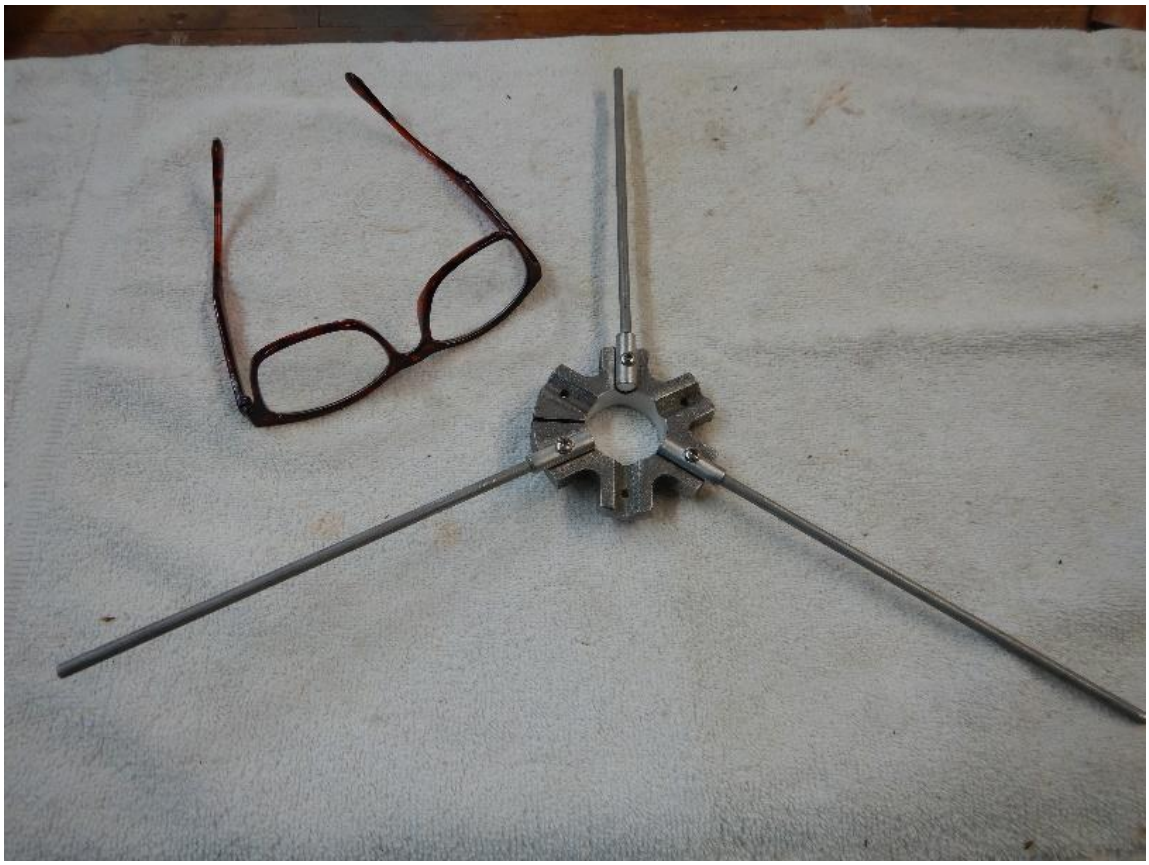

*Figure 8: The new spider for 80 meters*

I began my restoration at the base by removing the feedline attachment bolt at the very bottom of the antenna. I cleaned it removing all rust and corrosion and reattached it using Ox-Gard (an anti-oxidant compound) on the threads and replace all none-stainless nuts and washers with their stainless steel equivalent.

I carefully disabled each trap, cleaned them with a damp cloth and compressed air. I then checked each for resistance. They all checked out healthy. I then reassemble using Penetrox and the new plastic trap caps. I also made sure to set each metal trap cover back to the factory settings. One of the tuning steps I was not aware of with the BTV is the ability to adjust the metal trap covers.

I used a metal tubing cleaner on the end of a drill to clean out the inside of each element and remove corrosion. I use brass wool to clean and polish the outside of each element. The goal was to ensure that all corrosion had been removed from each connection point. To ensure a long lasting solid electrical connection between each antenna section I applied a liberal coating of Penetrox and installed new stainless steel hose clamps.

*Figure 9: Tubing Cleaner attachment*

I replaced all non-stainless steel nuts and bolts with a proper stainless steel equivalent. To each bolt I put a dab of anti-seize compound before assembly. I also replace all the element clamps with new stainless steel hose clamps.

Estimated total cost of restoration: about $60 and about 10 hours of elbow grease. Note that the cost of this antenna new around $200.

**Summary:** Taking this antenna apart drove home for me the importance of following a best practice approach to assembling an antenna. To restate the key points:

1. Follow the manufactures instructions.
2. Measure twice.
3. Determine the service life of your installation and build in accordance to that time frame. Example: a temporary installation such as for field day may not require the extra steps I'll outline below but installations that have an expected service life measure in years absolutely should.
4. Use an anti-oxidant compound on all aluminum tubing connections.
5. Use all stainless steel hardware where possible. You will need to also apply anti-sizing compound on stainless nut and bolts to avoid galling.
6. Use a dielectric grease on all coaxial fittings.
7. Use an anti-oxidant compound on all expose electrical connections.
8. Tighten all PL259 connections slightly more than hand tight. I use a pair of pliers to tighten the fitting slightly more than hand tight.
9. Seal all coaxial fittings with self-vulcanizing tape.

**Some Thoughts on the BVT Vertical:** Although I'm not a big fan of any antenna with traps I must say the Hustler is one of the best built verticals I've ever worked with. Given its very sturdy construction it should be able to stand up to a hurricane without guying provided that the base (the part that goes into the ground) was properly built. The other big advantage of the Hustler is the availability of replacement parts. DX Engineering stocks virtually every part one would need to repair, restore or even convert a 4 BTV into a 5 BTV or even a 6 BTV. One final point, I was able to obtain an early copy of the BTV manual. I was also able to get the latest version of the manual from DX engineering. I must say the DX

Engineering version of the manual is one of the finest and most complete manuals I've ever seen. Note that even they recommend the use of Penetrox ;-)

*Figure 10: The finished antenna ready to be put back into service.*

If you are the proud owner of one of these classic antennas take some time and assess your installation. If you were not careful in the assembly or didn't followed a best practice approach maybe it's time you took it down and inspected it for corrosion and wear. This is a very well-made antenna with a rich heritage, it deserves a little TLC every decade or so….

If you have any questions please don't hesitate to ask.

73, Gene (WB7RLX)