Modifying a Tek2000 12 ft (3.5 m) Mesh Dish for Az/El Rotation with a SPID BIG-RAS Rotator for EME and Amateur DSN

David Prutchi, Ph.D., N2QG

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Figure 1 – Current status of my 12 ft dish for EME and amateur DSN. The boom also carries a GOES-16 antenna, a small Ku TVRO dish used to verify az/el calibration, and a high-resolution TV camera to show me at what the antenna is pointing.

I am now concentrating the bulk of my ham activities in the microwave region, and have CW EME and amateur DSN as my top projects. My goal was thus to install an 8 ft or larger prime-focus dish to be moved by a heavy-duty Az/El rotator. In this whitepaper I describe how I modified a Tek2000.com 12 ft TVRO mesh dish so that it can be moved by a Polish-made surplus SPID BIG-RAS Az/El rotator.

Preparing the Grounds

Fortunately, my wife doesn't mind my weird hobbies, my deed doesn't have HOA restrictions regarding antennas, and New Jersey has a specific law that bans municipalities from adopting zoning ordinances that prohibit construction or use of antenna structures by federally licensed amateur radio operators (Act from Assembly No. 3641 of the State of New Jersey, 211th Legislature, introduced January 10, 2005)!

NJ Act 3641 allows a ham to have a 70ft tower, and then place the antennas on top of that without municipalities being able to interfere:

> "No governing body shall adopt a zoning ordinance that prohibits or has the effect of prohibiting the construction, maintenance or use of an antenna and support structure therefor by a federally licensed amateur radio operator. Zoning ordinances may reasonably regulate the location and height of those antenna structures for the purposes of health, safety or aesthetics; provided, however, that those ordinances permit sufficient height of those antennas and support structures so as to reasonably accommodate amateur radio communications by federally licensed amateur radio operators.
>
> Restrictions imposed on such antennas and support structures by ordinances shall constitute the minimum practicable regulation necessary to accomplish the legitimate purposes of the governing body enacting that ordinance. For purposes of this section, it is presumed that any ordinance that prohibits or has the effect of prohibiting any antenna support structure that is 70 feet or less in height above ground level, exclusive of any antenna upon the structure, is unreasonable. No federally licensed amateur radio operator, applying for permission to install or modify an amateur radio antenna or amateur radio antenna structure, shall be required to pay an application fee that is in excess of that which may be assessed for residential variances generally, nor shall such applicant be assessed any amounts for legal, technical, or other consultation or advisory costs incurred by the reviewing agency in evaluating the application submitted."

Thanks to the nice people at the municipal office, I was able to get a zoning/construction permit from my township for the new antenna with no issue. At the same time I applied for moving the other antennas within my backyard, so my setup is all kosher in case of bothersome neighbors.

I took advantage that we were changing our fence to ask the people installing it to help me dig the holes and pour the footings for the antennas.

Figure 2 – Masts being planted in my backyard. My wife doesn't mind my weird hobbies, we don't have HoA deed restrictions regarding antennas, and NJ Act 3641 bans municipalities from adopting zoning ordinances that prohibit construction or use of antenna structures by federally licensed amateur radio operators, so I'm free to install really nice antennas without interference.

Mast

The main mast is a 9 ft 4 ½" steel pipe with anti-rotation fins welded to the bottom. The common guideline is to place at least 1/3 of the mast inside the ground, and making the cement footing at least 3 times as wide as the diameter of the pipe. I made my footing 24" in diameter to give it additional stability. Many, many bags of cement were used to fill that hole…

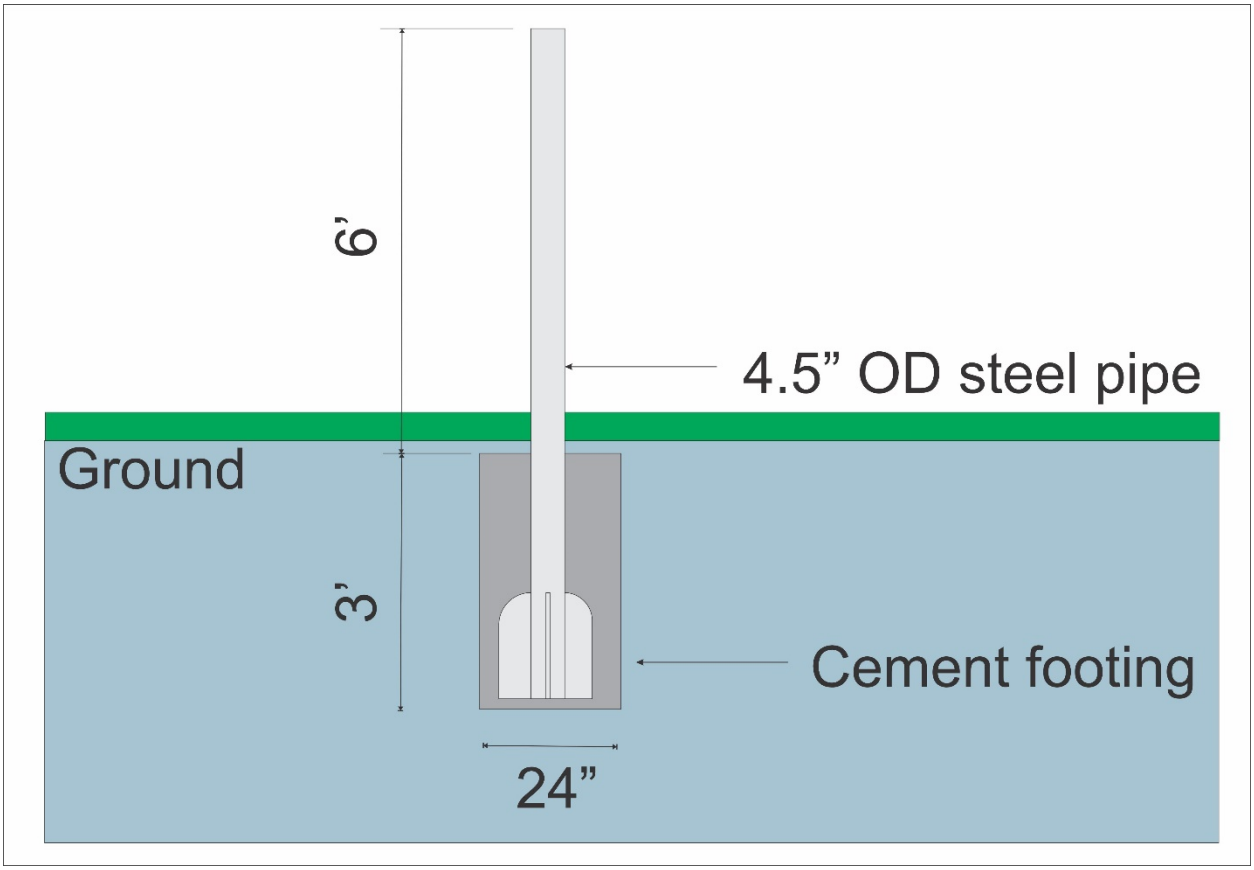

Figure 3 – The main post for my 12' dish is a thick-wall steel pipe with anti-rotation fins set on a 24"-diameter, 3'-deep cement footing.

The SPID BIG-RAS rotator is made to mount on a mast of up to 2.6" outer diameter, so the actual mast onto which the rotator is mounted is a 6'-long, 2.5" OD thick-wall stainless steel tube held against the main mast by heavy-duty pole-to-pole mounts of the type commonly used to mount cellular antennas.

In addition, I built a hinge from heavy duty stainless-steel plate and square-U channel so that I could assemble the rotor and hub on the ground and then lift the mast in place. The hinge does not bear load once the pole-to-pole mounts are tightened.

Figure 4 - The actual mast onto which the rotator is mounted is a 6'-long, 2.5" OD thick-wall stainless steel tube held by heavy-duty pole-to-pole mounts. A tilting bracket is used to allow the rotator and hub to be assembled and at floor level. The hinge bears no load once the mast is secured by the pole-to-pole mounts.

SPID BIG-RAS Rotator

I bought my SPID BIG-RAS as surplus without the controller. It appeared new, but the seller didn't know its functional state. I received it in its original box, with shipping grease and bits of Styrofoam, so it was indeed new. I quickly checked it with a DC power supply and it worked perfectly.

The SPID BIG-RAS is a very heavy-duty azimuth and elevation rotator designed to move very large antenna arrays, as well as large parabolic dishes. It has a turning torque of 1300 Nm, and a brake torque of 2712 Nm. It withstands a vertical load of over 700 lbs (318 Kg). The rotator has an Az/El resolution of 0.5^{o}. These rotators are used by RF HamDesign to move mesh dishes as large as 4.5m in diameter!

12 ft (3.5m) Mesh Dish Mount

The availability of new large consumer-grade TVRO dishes is becoming very scarce in the US. One of the few sources in North America is www.tek2000.com in Ontario, Canada, who import these dishes from a Far-East manufacturer. Although some people have reported bad experiences with their mesh Tek2000 dishes at www.satelliteguys.us, most of these seem to relate to the quality of nut welds, which as described below, shouldn't be an issue for my application.

Getting the dish was not easy. UPS damaged the package containing the petals in transit, and the changeover between Purolator and UPS wasn't smooth. There is no phone listing at all for Tek2000, so

all exchanges need to be through email which is most commonly answered in the middle of the night. As such, it took quite a while for me to receive a set of petals.

The other items came well packaged, but no instructions were included. These have to be figured out from the "C-Band Polar Mount Dish Installation Guide" at www.tvrosat.com.

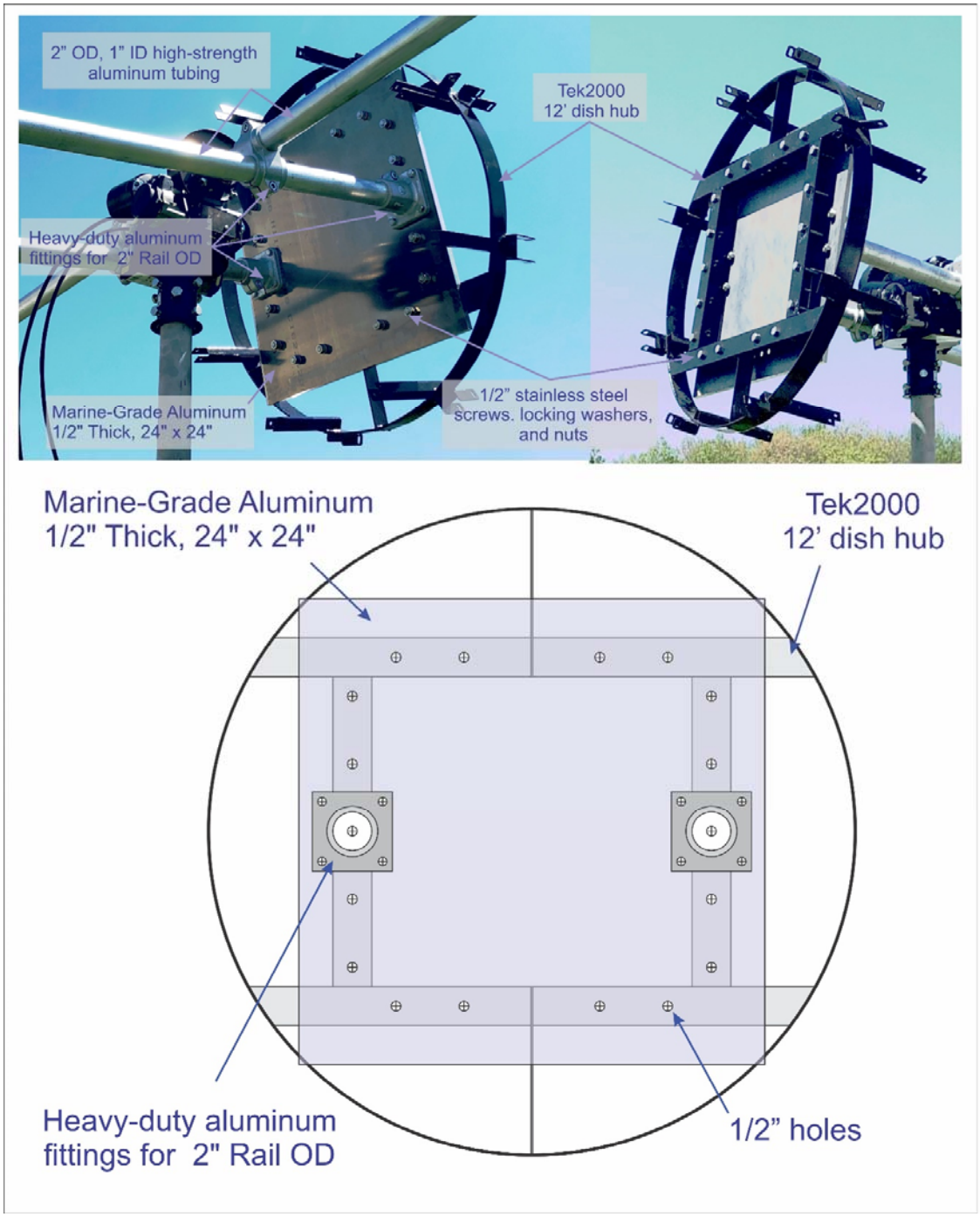

Figure 5 – A ½" thick 24"x24" marine-grade aluminum plate is used as the interface between heavy-duty aluminum tubing fittings and the Tek2000 12' dish hub piece.

Figure 6 – The boom and dish arms are made of 2” OD, 1” ID high-strength aluminum tubing

Counterweights

Smooth elevation rotation requires the use of counterweights to balance the weight of the antenna. Use of counterweights also prevents overloading the elevation rotor.

As shown in Figure 7, I use 1 ft x 2” OD aluminum rods as mounts for standard Olympic-size barbell plates. Since the feed packages that I intend to use vary quite a bit in weight and length, I need to be able to quickly change the counterweight, so I lock the weight plates with 2” Olympic-size barbell clamp collars.

Figure 7 – My antenna is set up so that I can add Olympic-size barbell plates as counterweights. The weight plates are locked in place using barbell clamp collars, allowing me to quickly adjust the counterweight depending on the feed package installed at the focal point.

Assembling the 12 ft Dish

I mounted the petals onto the hub with the mast in its erect position. It took me a couple of hours to assemble 7 petals, and then some extra time trying to get the last one in place. I wasn't especially impressed by the hardware that came with the antenna, so I ordered stainless steel (grade 316) hardware from McMaster and spent the next day replacing screws one at a time (thanks Greg for the help!). I think that the legit McMaster hardware will do much better against the weather than the screws that came with the antenna.

Once everything was tightened, I mounted a Chaparral C/Ku feed to calibrate the rotor against the geostationary satellites. My elevation (0^o to 90^o) is quite accurate, but azimuth does have some error, so I need to use an interpolation table for automatic tracking.

Conclusion

I've been working with this antenna for a few months now, and it's held well against stormy weather (summer rains and high winds) so far. I've had it pointing at Galaxy 13/Horizons 1 at 127.0°W (which carry the NASA channels) and I haven't experienced any change in pointing accuracy during high wind conditions.

Jason Meyers KC2TDS and I are now working on replacing the original conduit feed arms by steel square tubes with waterjet-cut supports in order to hold a feed bracket that Jason designed. This should enable us to quickly exchange feedhorns and feed packages for our upcoming EME and DSN experiments.