A DIAMOND IN THE ROUGH – THE GGREC RHOMBIC AT ANTENNAPALOOZA
By Ian Jackson VK3BUF

Back in March we had our antenna field weekend where we put up the experimental Rhombic antenna for 40 metres. It was a team effort that was not without adversity, as the storm preceding the event demolished a few of the temporary 12 metre high poles before it could be completed. But as a prominent VK4 amateur once told me, nothing succeeds like a bird with no beak and we persisted until the antenna was in the air and fully operational.

The motivation for this effort was multifold. Rhombic antennas have been around a long time, but they are really big and nobody I knew had worked with one before. I was keen to see one up close. To build this antenna as a temporary construction for the field weekend also meant there would be sufficient manpower at hand to put it all together. Then there was the hardware factor, where it was going to be interesting to see how 90mm plastic water pipe would perform as a temporary mast, with tough MIG welding wire as a temporary radiating element.

Preparing one of the four poles

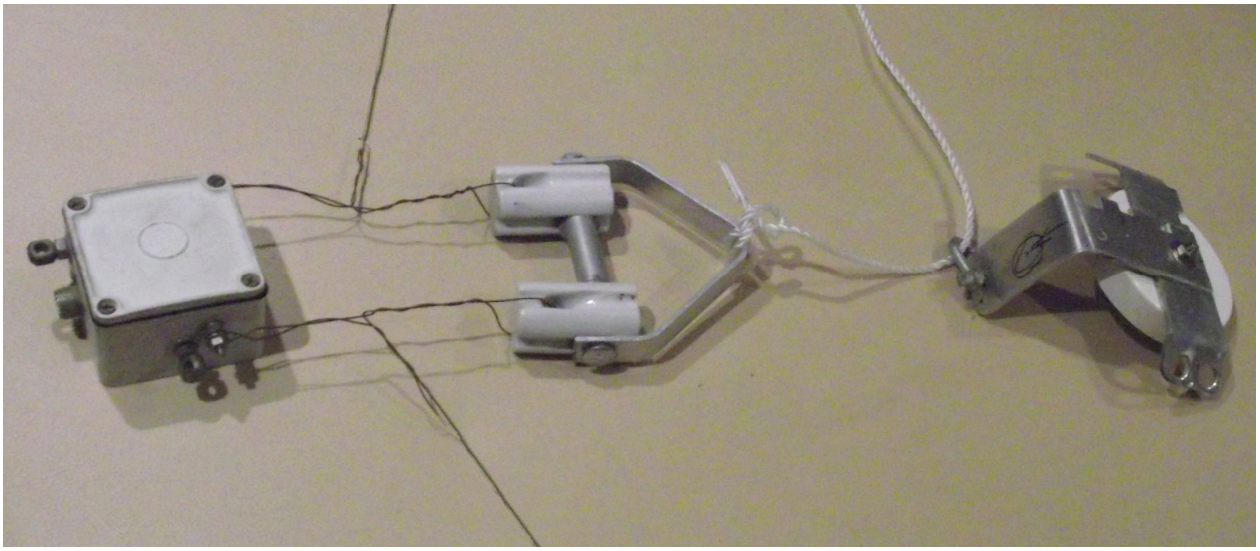
As it turned out, the plastic masts were fine to winds of 70kph, but not so good at 90kph. Horizontal wind pressure was so great that the centre of the 6 metre sections bowed horribly until the downwind face of the pipe literally shattered into lots of tiny bits. After the event one of the resident alpacas tried to bring the antenna down by eating two of the nylon guy ropes from the star pickets, but fortunately they ate the *inside* guy ropes and the antenna wire 12 metres up acted as top guys and stopped the poles from coming down.

A Google Earth view of the antenna site.

Back to the science of the antenna. The common inverted-V antenna is like half of a rhombic where the other half has been buried in the ground. By digging up the other half and putting it up into the air as far as possible from ground reflections, it becomes a large diamond where each leg exhibits its own set of radiating lobes. When the diamond is in the correct aspect ratio, many of these lobes coincide to a common direction away from the feedpoint. The wire length can be in multiples of 2, 3 or 4 wavelengths to increase this lobe alignment and thus increasing forward gain. Our antenna had about 3 acres of available space and we could only squeeze a baby 2 wavelengths on 40 metres into it. It should be noted that a proper Rhombic antenna needs to be higher, to minumise ground effects and to lower the radiation angle. (the lower the radiation angle, the fewer the number of ground-sky hops required for long range communications.) A good Rhombic should be 20 metres up, but ours was only a humble 12.

Google Earth proved to be very useful to plan the pole placement. Using the measuring tool, I was able to plan where the wires had to be to dodge trees and still fit within the available space. Using

a wheel counter at ground level I proved that these measurements from the internet were good to within half a metre in the real world. The antenna wire was a little over 300 metres of 0.9mm copper-coated MIG welding wire. It is both tough and cheap. A single strand of this wire had a breaking strain of around 70kg. A 3km roll of the stuff was about $35 from a welding supplies shop. It is hooked up in two sections. One end had a 4:1 impedance matching balun and the far end had an 800 ohm terminating resistor. The wires were insulated using cheap electric fence ceramic insulators (about $3.50 each) and a jury-rigged aluminium strap assembly to keep the wires apart.



The image here shows the relationship of the coax balun, the insulators and the rope to hoist the assembly into the air. This rope passed through a small D-shackle on another bracket that was a 90mm rope-guying cap located at the top of the PVC mast.

Having hoisted this lot into the air, the performance of the antenna was the next consideration. Would it actually work? The answer was a strong 'yes', but this is difficult to quantify with just a few contacts. It certainly was directional. I had some big signals on 40 into NSW and QLD. Quite a few contacts were made. Some comparisons were made between this antenna and a simple of-centre-fed dipole erected in the bottom paddock by Chris VK3QB. Into South Australia his antenna outperformed the rhombic, which being difficult to rotate, was beaming North. Having said that the OCF dipole still performed well to the North with a few contacts from up that way. Still, this was an anecdotal comparison as it did not take into consideration where our respective angles of radiation were landing.

VSWR on 40M was around 1.5:1, which was fine. What surprised us was that it was also fine on other HF bands. We connected the Sark antenna analyser to it and did some sweeps, then compared the results with a sweep of the GGREC field kit Off-centre-fed dipole, which is also a multi band antenna.

Left – the flat HF response of the Rhombic. *Right – the multi-band Off-centre-fed dipole*

In the two plots, the horizontal scale is the radio spectrum up to 32MHz. The Red lines show feedpoint impedance, while the green line shows VSWR on greatly different scales of magnitude. It can be seen that the multi-band dipole is cut so that it resonates exactly on four different bands and badly in between those points. The Rhombic on the other hand had a surprisingly flat response from 3 to 30 MHz, with the highest VSWR barely 2.5:1. It shows how the Rhombic would make a terrific general purpose receive antenna.

I tried to take a picture of this antenna from ground level and it made little sense. The wire, if it could be seen at all, just disappeared at a skewed angle. I decided that to get a proper image I had to get both behind and above the end termination point. The next day I shifted the boom lift to a new position and took it up about 14 metres for some wide-angle views.

The Rhombic viewed from behind the terminating resistor. The position of the radiating wire has been digitally enhanced, as it would otherwise be invisible

Time to sum it all up. The Rhombic experiment was successful and we learned much about their good and bad points. In its northerly direction, it exhibited a gain of around 7 to 9 db over a half-wave dipole, which is a lot. Without being able to take precise -3db beamwidth angle measurements of the main lobe, it is hard to get a better reading and I needed more space in order to do that. Probably, if you were in the mood for building a monster antenna, it would produce a better outcome if a 3-element beam on 40 metres was erected. At least then you could point it at different places. After two weeks we took the assembly down and wound up the wire, which was already showing some signs of corrosion. I didn't notice any more than the normal number of decapitated birds and light aircraft on the ground afterwards, so I suppose it wasn't as much of an avian hazard as some had suggested it would be.

The final problem was what to do with the storm damaged sections of 90mm pipe that were scattered around the paddock like sun-bleached whale bones.

Dianne VK3JDI came up with an idea. After several weeks of slicing and cable-tying came up with an innovative solution. I wanted to call him 'Rhombie' after his chequered ancestry, but the name was disallowed.

If it doesn't scare the foxes away, at least it will give the delivery guys a fright.