Some Thoughts on Vertical Ground Systems Over Saltwater

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Recently I received a query from Bill, N7OU, concerning the installation a multi-band verticals directly over saltwater. These are verticals which require some form of ground system. He and Bob, W7YAQ, are headed out for T30, Tarawa. Adjacent to the operating site there is a large shallow lagoon and the question was "can we just stick the verticals right out in the saltwater with some simple ground system and have a super signal?"

Unfortunately I had to tell Bill that I didn't know any easy, portable, solution to his problem. The following is a short discussion on some possible problems placing a vertical directly over the water.

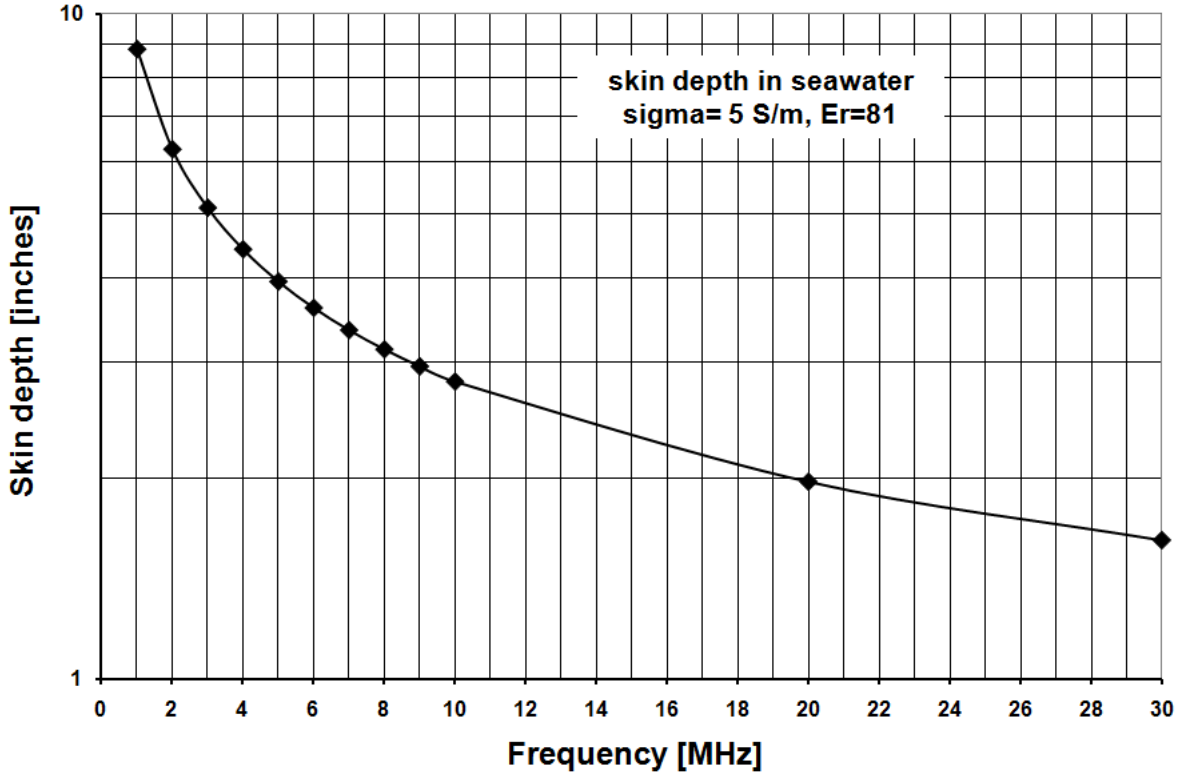

Figure 1, Skin depth in saltwater at HF in inches.

When an AC current is induced in a conductor the current tends to flow only near the surface. The depth of penetration where the current level is reduced to 1/e or about 37% of the surface amplitude is called the "skin depth". Almost all the current flows

within two skin depths of the surface. Saltwater is a pretty fair conductor so the skin depth isn't very large at HF, as shown in figure 1. On 40m for example, the skin depth is only about 3.3".

Figure 2 shows how this relates to a vertical which has its base connected to a pipe immersed in seawater.

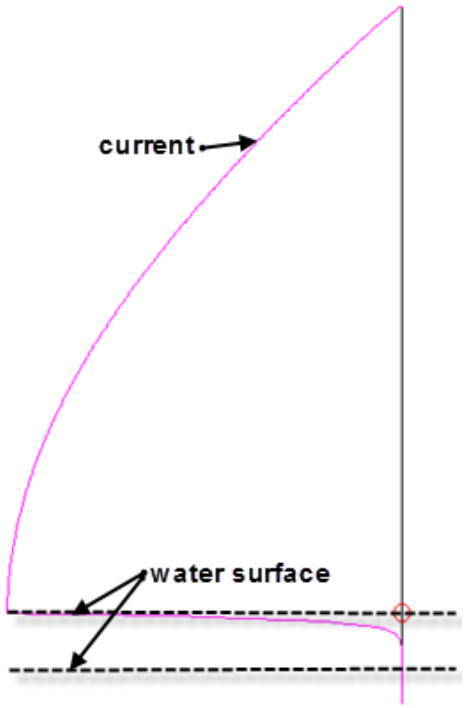

Figure 2, 40m λ/4 vertical over seawater supported with a conducting post immersed in the water. f= 7.2 MHz and h= 33.1'.

As you can see the current on the "ground connection" drops very quickly, becoming essentially zero by 10-12" down. The ground current for the vertical is restricted to a thin layer near the water surface. Two water surfaces are shown: the upper surface represents high tide and the lower one low tide. Over the world the local tidal range varies from a foot or so to fifty feet or more (al la Bay of Fundy). The point is that with the arrangement shown in figure 2 the effect length of the antenna will change, perhaps drastically, with the tide or a even a passing wave. This of course grossly detunes the vertical.

Plan A does not look very promising. However, there is an alternative that would work very well. If by chance you have a floating dock or even just a float substantial enough to support the vertical (which will rise and fall with the tide) then the arrangement in figure 2 will work great, even for a multi-band trap vertical. The conductor down into the

seawater need to be only about 12" but should have a diameter of several inches to provide a low resistance ground. For a DXpedition, bringing enough material for a float is not reasonable but if by chance there is a floating dock or marina at the operating QTH then it may be practical. Another alternative would be to rent several rowboats locally and anchor them off the beach for the duration of the DXpedition. Now of course we are getting silly! Bill pointed out that there is another solution al la VK9GMW: use an automatic antenna tuner at the feedpoint to compensate for changes in feedpoint impedance as the tide varies (http://vk9gmw.com/documents/VK9GMW ANTENNA.pdf).

For single band verticals a number of DXpeditions have placed their verticals out on a reef that floods with only two opposing λ/4 radials placed just high enough to be above the water at high tide. Putting aside the issues of cables in the water, corrosion of connections, anchoring guys, etc, this does work as Dean, N6BV, has shown (Antenna Compendium Vol. 6, page 216). But for a multi-band vertical the elevated radial approach over the water becomes a nightmare.

There is another option which George, W2VJN, reminded me of: use one of the multi-band verticals like a Cushcraft R7000 which are designed to be operated without any additional ground system. In my ground system experiments described in QEX (May/Jun 2009, pp. 41) I ran a few tests on that antenna, with and without a ground system. The presence of 60 λ/4 radials at the base of the antenna made only 0.1 dB difference in the signal strength. BTW that antenna was only about -1.5 dB from a full λ/4 vertical on 40m. The arrangement shown in figure 1 would work just fine with this kind of antenna since no connection to the saltwater is required. A wooden post for support would work.

All this seems like a lot of fuss for a small gain!

The ground system which Bill and Bob plan use is simply thirty five 10m radials connected to a base plate. The tests reported in QEX (Nov/Dec 2009, pp. 19) showed that thirty two 33' radials worked very well from 40 through 10m. With this many radials the wire size can be #18 or even smaller. Stranded, insulated hookup wire will work just fine. If the wires are attached to the plate in advance and simply coiled up for transport, laying out the ground system on the beach should only take a few minutes for each antenna. If the antenna is placed within λ/4 to the water the difference in performance between on the beach and out over the water should be very small.

GL and 73, Rudy N6LF