Shively 6014 Dual Hybrid Antenna Solves a Dilemma

by Rich Parker

"The laws of physics are fairly predictable - but not so the laws of zoning," observed Rich Parker of Vermont Public Radio. The broadcaster was faced with a need to rectify a downward radiation issue. A solution satisfying tough technical and political demands was required.

Over ten years ago, new FCC Regulations for public exposure to radio frequency radiation (RFR) dictated a substantial decrease in levels was necessary for WVPS (109.7) at our Mt. Mansfield tower site. The existing six-bay Shively 6810 – side-mounted with a center of radiation (COR) only thirteen meters above ground level – was clearly not going to be able to be brought into compliance.

SEEKING A SOLUTION

The downward radiation from WVPS' 49 kW signal had to be lowered to 20% of its original value – from 1000 uW/cm2 down to 200 uW/cm2.

At this pristine mountaintop site there was no fencing allowed, so permission was granted to close the trails temporarily to restrict access to the area while a solution was sought. Then we called Shively's Bob Surette for advice.

One option was to move to a nearby 200-foot tower, where station WEZF (92.9) had been operating for many years into a Shively 6015 panel antenna. The easiest option seemed to be replacing that antenna with a broadband Shively 6014 panel antenna array and using a diplex combiner to feed both stations into the antenna. Shively started work and produced a new three-around, four level, 0.9 wavelength antenna.

In the meantime, heavy political forces were at work on the shared mountaintop site. HD TV was on the horizon and, because of the unique environmental and regulatory environment in Vermont, all the parties had to bond together in what was called the Mt. Mansfield Colocation Committee.

DEVELOPING A MASTER PLAN

The Master Plan was to coordinate the transition to HD TV, reduce RFR at the site to meet the new stricter guidelines, and work to combine as many radiators into as few towers as possible. Because of this, it was not possible to simply replace the 6014 panel antenna and move over to the new transmitter building. That would have been too easy. Thus, the antenna would sit at the factory for years, waiting.

During the ensuing years, the project morphed into one wherein the final plan involved the building of three new towers (each under 200 feet so lighting would not be required) and combining as many radiators as possible on each tower. (The older towers are to be removed after the transition to HD TV this winter). After extensive debate and discussion of more than a dozen options, combining the FM signals into a panel antenna was still the most viable.

As time went on, it became apparent that HD radio was close on the horizon. The original plan was to use analog/digital combiners with the Shively-developed Digital Injector. An existing Harris FM35K transmitter would supply the analog portion of the signal; the HD signal would be generated by a solid-state 6 kW digital transmitter, which would promptly dump something like 5+ kW into a dummy load as heat. However, some exciting new changes were happening in the world of HD transmission systems.

SHIVELY DEVELOPS REVERSE INJECTION

Shively had recently proven the concept of employing the previously unused hybrid port of their panel antenna for HD signal injection. This produced an HD signal at the antenna of opposite polarity from the analog signal. A station's analog signal could be applied to one port of the hybrid, and the digital signal to the other.

As built, the new broadband panel antenna exhibits an isolation of about 20 dB across the band between the ports. An isolator – essentially a circulator with a dummy load – was then placed at the output of the HD radio transmitter, to provide higher isolation between the additional RF coming back down the line from the higher-powered analog FM transmitter and the HD transmitter.

The Shively 6014 panel antenna.

In order to optimize system isolation, a Shively fine-matching transformer was placed between the circulator and its dummy load, improving the match. Overall system isolation was improved sufficiently to produce a voltage standing wave ratio (VSWR) of approximately 1:1.02 as seen at the digital transmitter – good by any standard. As a bonus, the Shively fine-matching transformer, used previously on the old system, had been repurposed.

REDUCING HD POWER REQUIREMENT

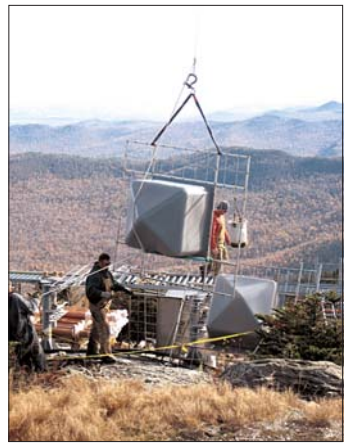
The remarkable thing about all this was that by using the dual input hybrid, it was possible to scale down the requirements for the HD transmitter from more than 6 kW transmitter power output (TPO) to less than 750 watts TPO.

Additionally, when WEZF moves off of the existing older tower and onto the new antenna, the dual-input system will allow this simply by adding combiners. The WVPS 107.9 analog signal will be combined with the WEZF 92.9 HD signal up one transmission line; the WVPS HD signal will be combined with the WEZF analog signal up the other transmission line. Each line will feed a separate input of the antenna hybrids.

A benefit of this arrangement was that we could specify a slightly larger than necessary HD transmitter and use it in FM+HD mode as a backup transmitter for each system. To go to low power backup, it is simply a matter of placing the Z2000 in HD+FM mode and turning off the FM35K main analog transmitter. We have found that when feeding the 6014 antenna in this way, the station's coverage is still quite remarkable for such a large reduction in power.

A PLAN FOR SURVIVAL

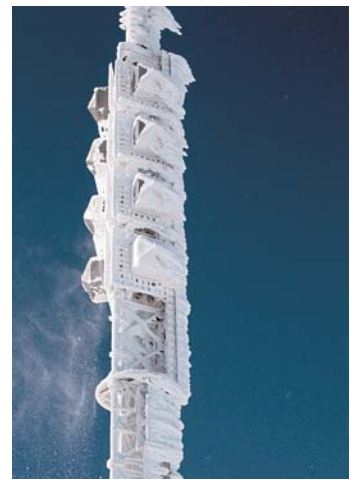
Due to the harsh nature of the weather at the site, Shively was asked to design and build a radome for each of the radiating elements of the panels – something they had never been requested to do before for this particular panel antenna. Additionally, because of visual and other environmental factors, they produced a new grey color formulation for the radomes on this installation.



Custom designed radomes.

The project was finished not a moment too soon. The final antenna installation happened fairly late in the year for Vermont mountaintop sites, and it was early October before everything was powered up. Within a couple of weeks the site was hit with a major snowstorm. The new antennas under the radomes performed perfectly even though they were covered with snow and rime ice.

Another protective measure was to place the power dividers of the feed lines below an ice guard inside the tower structure. As designed, the tower is a standard lattice tower with a shell of steel surrounding it. The surround is on special mounts to simulate the look of a large monopole.



The Shively 6014 performed well in this environment.

There is an access panel in the bottom with a standard ladder up through a circular ice guard at the base of the FM antenna bays. It was beneath this platform – but between the tower and the shrouds – that the coupling elements of the power dividers for each of the individual antenna element feed lines were located. Additional protection was thus provided.

EASY ACCESS

Due to the dozens of feed lines for the FM and HD TV antennas it was no longer possible to climb up the interior of the tower. In a bit of innovative design and fabrication, Shively was able to incorporate a reinforced climbing ladder into one face of the FM antenna's reflective backplanes. This allows tower workers to climb up to the TV antennas above by going onto the tower platform and then climbing the rest of the way on the rungs integrated into the FM panel antenna.

Mount Mansfield is an extremely harsh environment with many challenges. Now that this installation has been through its first winter, it is clear that the design provided by Shively was right on target. With another winter season approaching, a Shively engineer will be coming up one more time to sweep the antenna system.

The dual, equally-sized transmission lines allow the transmitters to be split between the two lines so swapping the lines will be easier if damage were to occur to either line. The system also was designed to maintain pressurization up through the feed points of each bay. Even if there were to be damage to an individual line, the entire system would still be protected.

Now with our antenna COR more than 150 feet above the surface of the mountain, there are no more problems with public exposure to RFR. Furthermore, the additional height has eliminated much of the low radiation-center "bounce" from the old antenna that had caused additional reflections and multi-path.

FUTURE PROOF

The new Shively 6014 is "future proof." As it is a broadband panel, it can accommodate expansion opportunities such as other tenants seeking to locate at the site.

The installation promises to be the crown jewel of Vermont Public Radio's statewide network. With WVPS 107.9 now broadcasting in HD multicast, the station is able to provide a multitude of services to its listeners.

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