

WB2ELW Colden Repeater Lives Again!

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The time has finally come. The WB2ELW Colden repeater system is being re-commissioned. It has been over a full year that the system was taken off line. The STARS Club made a decision it was time to remove the old system from operation and come up with a new solution at the Colden location. The old repeater has been retired and over the last year we have been contemplating what we would do with the Colden location. Over the last several years STARS has brought a full VHF and UHF repeater system on-line at the Hamburg club station location. It has proved to serve us very well in the South Towns locations and has brought repeater coverage to areas that we have never had before. When we only had the Colden repeater, there were always dark areas where we had coverage gaps around the south towns. In particular, some areas very important to a club considered a "South Towns" organization. The installation of the Hamburg system has over time proved to be great problem solver and has provided a great footprint of coverage.

The usage of the Hamburg repeater has been primarily with VHF. The UHF functionality has been really only a second thought. For a period of time we had VHF systems at the Hamburg and Colden site. This was really not the greatest arrangement and created competing coverage zones for remote users. These areas are always problematic. We always had a hesitation to take the Colden repeater off line and were in a constant decision making process as to what we should do with the Colden and Hamburg locations. We didn't want to lose the good location out in Colden and we really like the new extended coverage and functionality that the newer Hamburg site has brought to the table. A committee was formed to start discussions on this matter and come up with a good game plan for the STARS club repeater systems. We have been a club that has had the benefit of accumulating a decent amount of new equipment over the last several years and it is always a great thing to have these kinds of problems on hand such as; "how do we utilize all this great equipment"?

I started working with a few of our members and some other ham radio colleges to try to come up with a good plan for us. The club had to decide how much money we wanted to spend on this project as well. We were better able to decide on this, after we brought the old Colden repeater equipment back to Hamburg for analysis. We spent a bunch of time reviewing the old system and determining what was really worth salvaging and what was not. The system had been in place for many years and had been nursed along for quite some time. Some of the equipment is very old and obsolete and difficult to repair. The system design was not well documented and we had to break things down one by one. We did a lot of testing to determine what was worth keeping. The feedline and antennas already located at the site were still in good working order. We performed several feedline and antenna sweeps to characterize the installation. After a period of time collecting data, we discussed our findings with the board and made a recommendation. The good news was that some of the more expensive pieces such as the feedline, antennas, filtering and duplexing as well as the VHF high power amps were all worth working with. We decided that we would not make a substantial investment into new equipment just for our Colden site since we did not consider it our primary club repeater system. The Hamburg site serves this purpose and has our state of the art equipment and internet connectivity which will not be the case at the Colden location. The final decision was made that we would rebuild a functional system at Colden and take advantage of the great location for coverage. Whatever we would do, we would need to make sure that we didn't mess up the Hamburg repeater systems operation and coverage.

The first investigation we did was doing thorough RF coverage studies for each repeater location for both VHF and UHF frequency footprints. As I started on the electronics work I enlisted from a friend, Mike Fetto, KB2FX to start looking at

the coverage maps. Using our antenna sweep data that we collected at an earlier time we estimated the power, loss and gain budgets that we would get from our equipment and he began doing some extensive RF coverage modeling. We reviewed several scenarios using RF propagation analysis software. The results from these coverage studies are what we used to lead us down the path for our decision on how we would make the best use of our repeater equipment.

The best coverage scenario was to deploy the Hamburg repeater location for UHF and the Colden repeater location for VHF. The use of VHF at the Colden site cannot be beat by anything the Hamburg location has to offer. VHF propagation lends itself well to cover the terrain around the Colden site and the footprint is tremendous covering north and east. The Hamburg repeater does a great job south and west of the areas that the Colden signal is shadowed by. Take a look at the propagation studies shown in figures 1 and 2.

Whether Hamburg is used as VHF or UHF the radiation pattern is very similar. This works out perfect for us. We can't use VHF at both sites simultaneously. The perfect setup is for us to deploy a linked system which can tie the coverage areas together and produce an outstanding RF signal footprint for our club. The new system will be called the WB2ELW "STARlink Repeater System".

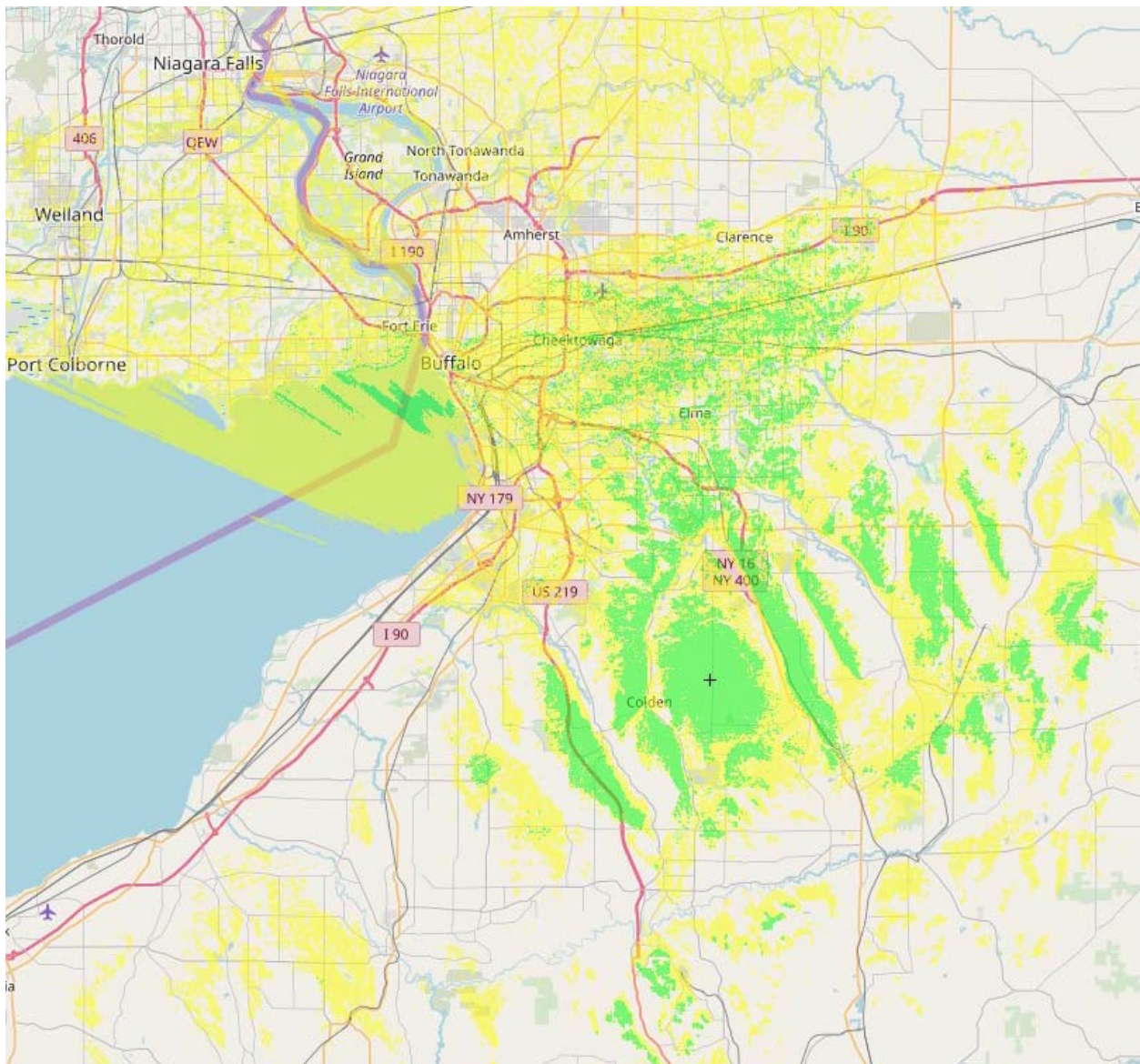


Figure 1: RF Coverage Area Expected from the Colden Site at VHF

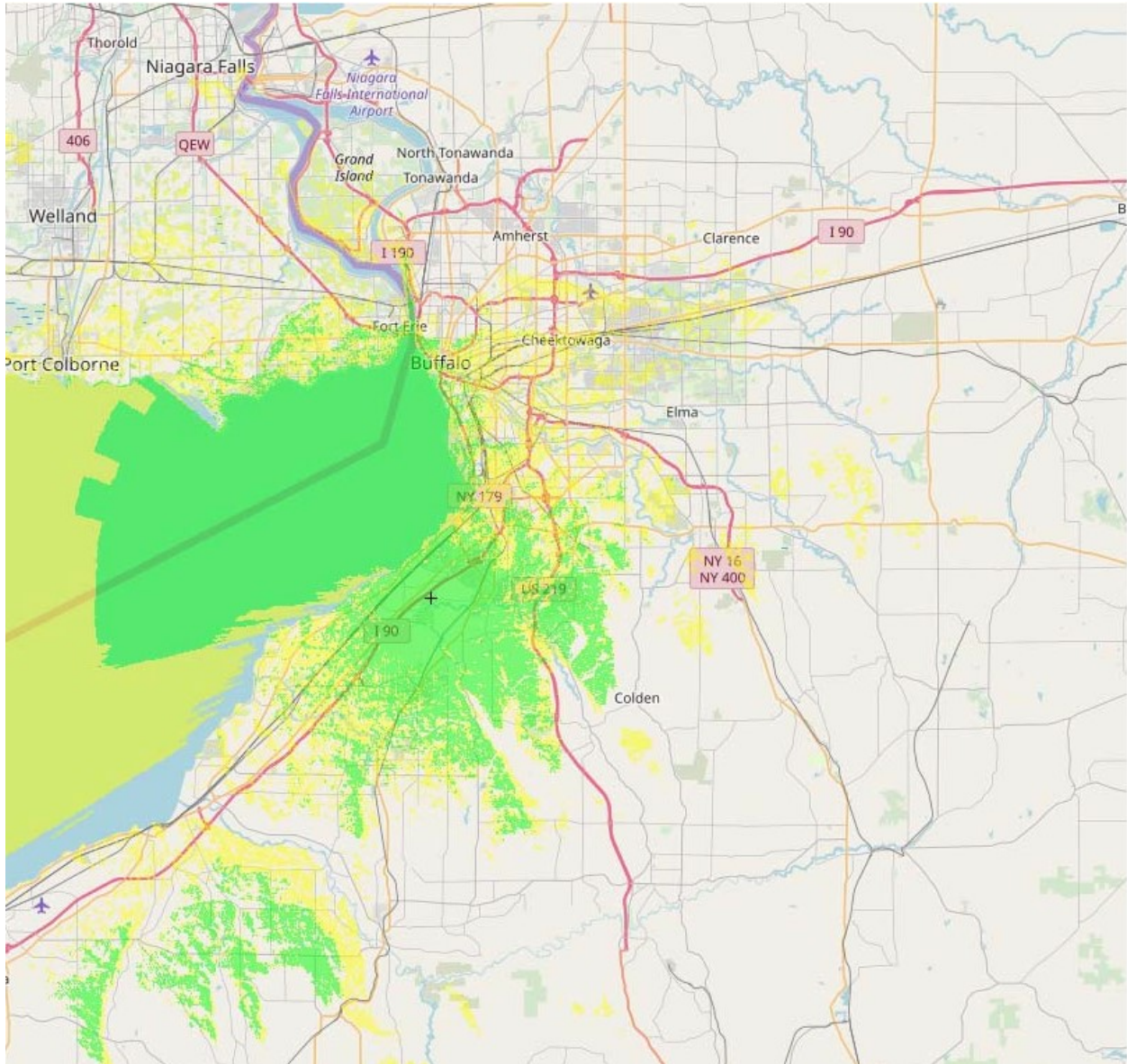


Figure 2: RF Coverage Area Expected from the Hamburg Site at UHF

Let's Talk About the New Colden Machine:

The new machine that we constructed for the Colden site is much smaller than the old system that was out there for many years. We have built everything into a single 5 foot tall 19" rack-mount cabinet. Figure 3 shows a picture of the completed machine.



Figure 3: New Colden Repeater

The main system components are:

- VHF repeater (Kenwood)
- VHF power amp (Mirage)
- VHF preamp (TX RX Systems)
- VHF duplexer (TX RX Systems)
- UHF link transmitters and receivers (Motorola)
- UHF control receiver (Motorola)
- UHF filtering (RFS Systems)
- Repeater control unit (ICS- Linker II)
- Voice ID and control module (Home brew)

(Refer to figure 4.)

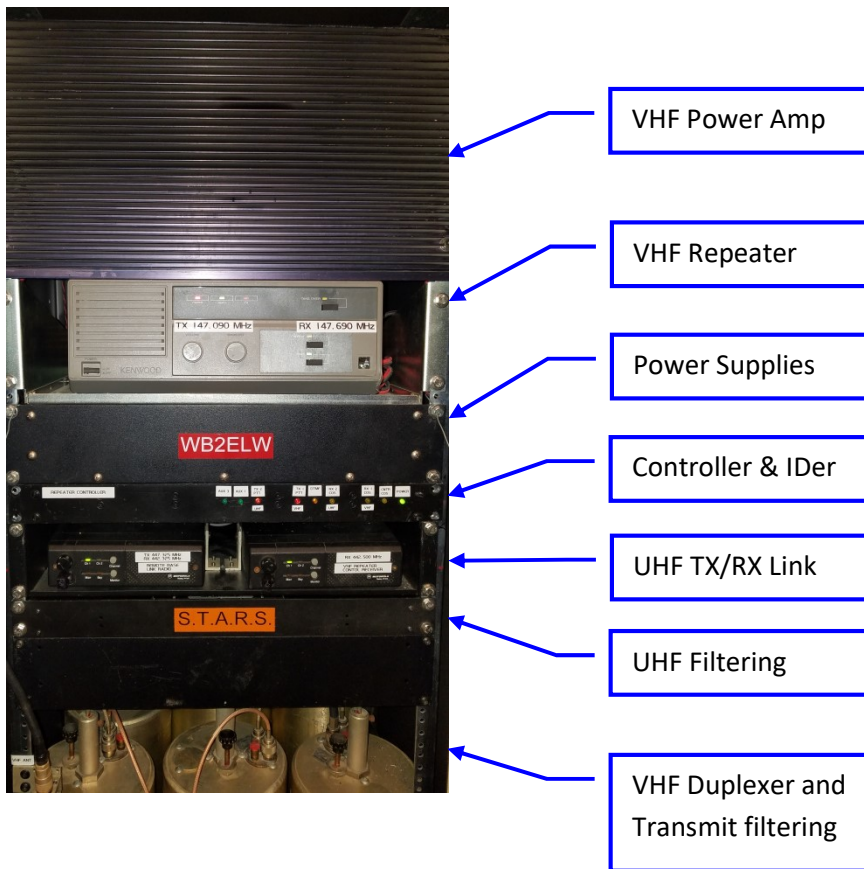


Figure 4: Main Component Breakdown

The new system is configured to have a main VHF output with UHF link control. The VHF repeater subsystem is a commercial Kenwood TKR-720 system which is a solid performer with great receiver sensitivity. This is setup to drive the high power Mirage amplifier. We have measured the transmitter power out of the cabinet port to the main feedline at Colden to be 110W or about 50.4 dBm. The feedline loss is low and the antenna produces a little bit of gain so we will have a nice effective radiated power output. To keep the receiver sensitivity balanced with transmit coverage footprint we have a preamp that can be installed and adjusted as may be required when we continue to optimize the system.

The UHF subsystem is comprised of Motorola M120 commercial UHF 2-way radios. The UHF link transmitter is setup for low power (about 10W) and this will be setup to establish a reliable link to our Hamburg UHF repeater system.

The controller manages the VHF and UHF subsystems and handles all the basic repeater functions as well as the link control. The controller is based on a modified Linker IIa from ICS. The only functionality we need is basic repeater and link control and we wanted a more reliable situation than we had before so the Linker from ICS is a great solution. We really can't do anything too fancy at the Colden site anyway since we have no internet access, so the functionality we get from this controller is good. As Hams always do, I have added some homebrew touches, of voice ID and talkback test features. I also included several indicators on the front panel to make on-site troubleshooting easier. We have also deployed courtesy tones and CW in addition to the voice ID. Refer to figure 5, a top view of repeater control shelf and figure 6 for the front panel view.

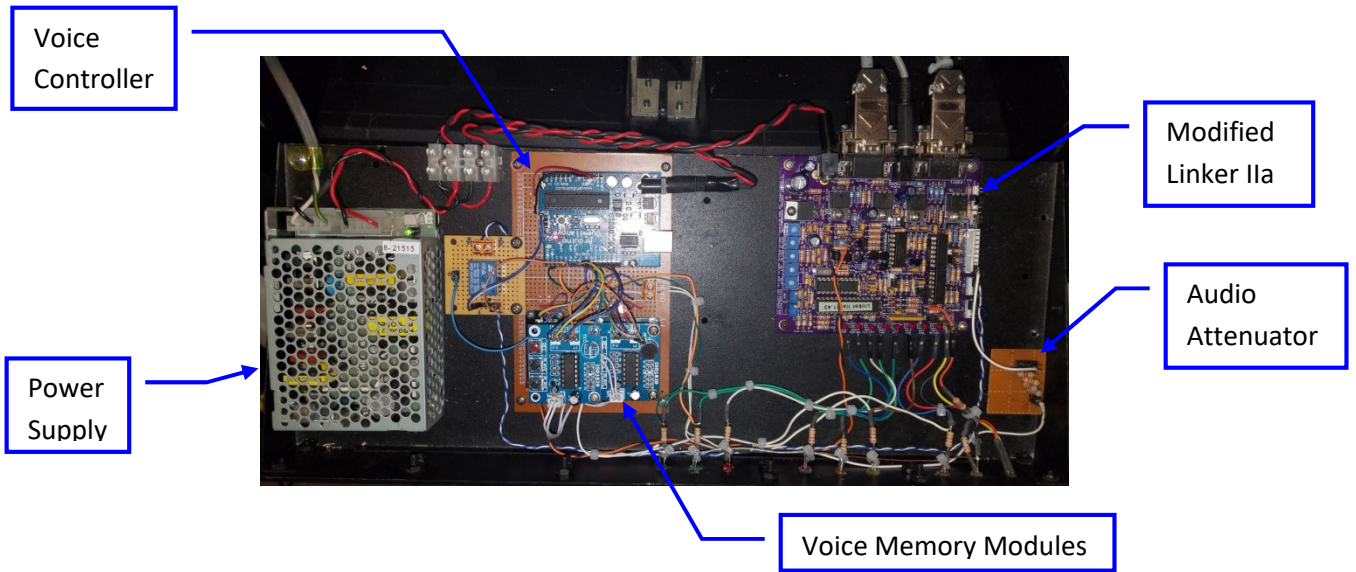


Figure 5: Repeater Controller (Top View)



Figure 6: Repeater Controller (Front View)

How does it all tie together?

The Colden VHF system is connected to the Hamburg UHF site with a half-duplex UHF transmit/receive link radio subsystem. There is also a secondary UHF control channel as well for remote repeater control and commissioning. VHF in Colden and UHF in Hamburg, operate as independent autonomous repeater systems. They use CTCSS tone control (ie PL) for operation. The uplink and downlink frequencies for each system are the WB2ELW licensed repeater frequency pairs. The Colden VHF system transmits on 147.090 MHz and receives on 147.690 MHz. It utilizes a PL tone of 107.2Hz for tone squelch. The Hamburg UHF system transmits on 442.325 MHz and receives on 447.325MHz and it utilizes a PL tone of 88.5 Hz for tone squelch. The VHF and UHF coverage zones have an overlapping region. An overview of the system is shown on figure 5 below.

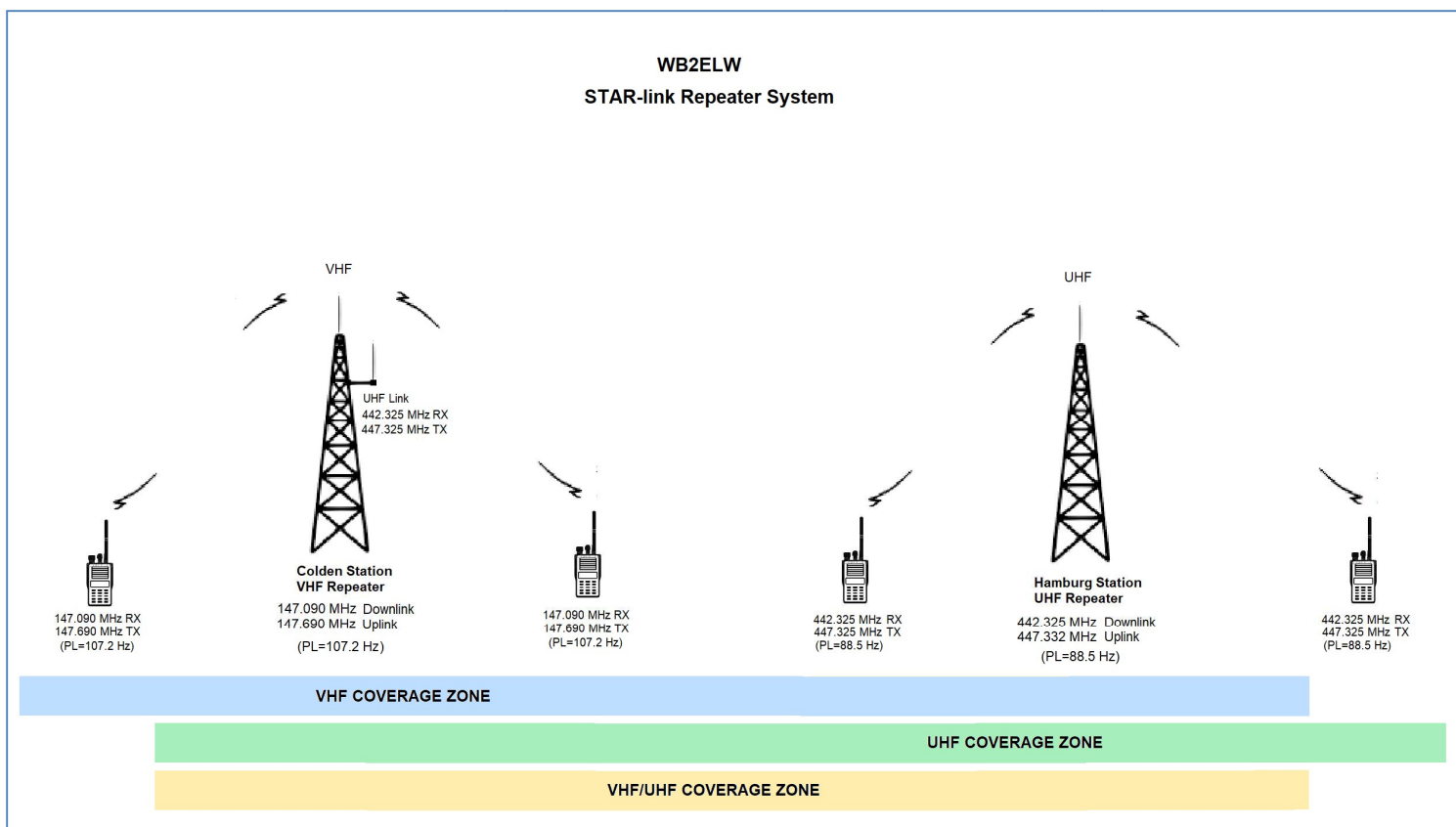


Figure 6: STAR-link Repeater System

How do I use this new system?

As mentioned earlier the STARlink repeater system combines the capabilities of the Hamburg location as UHF and the Colden location as VHF. A user has the ability to uplink into either system and talk to anyone on either system. There is an area where you can use either of UHF or VHF due to the coverage overlap. If you are using a dual band radio you can set it up so you can quickly decide on which is the better repeater for you to transmit into as your location changes, and switch back and forth at any time while you continue your QSO. To use the VHF repeater system you will listen on 147.090 MHz and set your radio to transmit on 147.690 MHz using a PL tone of 107.2 Hz. To use the UHF repeater system you will listen on 442.325 MHz and set your radio to transmit on 447.325 MHz using a PL tone of 88.5 Hz. If you want to you can program each of these into your mobile or HT as two different memories. Then you can easily switch between the two at anytime. The person you are conducting a QSO with would not be affected.

If you're listening and wonder which signals are which, there are two different courtesy tones which indicate what repeater the ham operator is using on a particular transmission. When the STAR-link repeater system is in normal operation the VHF system the courtesy tone is Dit, Dah, Dah (CW for letter W). The UHF transmission courtesy tone is: Dah, Dit, Dit (CW for letter D). When listening to the repeater system transmissions this will give you an idea who is talking on the repeater you are listening to.

I hope this has been a good overview of the new system and its basic operation. I wish that all STARS members can enjoy the use of new system. It has been a long time coming and our hard work is just beginning to pay off. Thanks to all who have helped with the work on this project. Special thanks goes to Mike Fetto, KB2FX, for help with the coverage studies, work in my garage testing the system and helping with the install on the frigid January day out in Colden. Also thanks to Mike Chmiel, KC2VWF, station engineer at WIVB/WNLO-TV for his support to us at the Colden radio site each time.

Some information about the Colden site:

The site is located in Colden New York at Lat: 42-39-33.0 N, Long: 78-37-32.0 W. The elevation at this location is 1640ft above sea level. The tower site was first used in 1948 by the Buffalo Evening News as the main broadcast tower for channel 4, the former WBEN-TV. There are two towers on the site; a newer tower, and the older original 1948 structure. The new tower is a 1056ft guyed steel mast tower and was constructed for WIVB-TV.

The WIVB-TV Tower is one of the oldest, supertall television masts in the United States. All added up, its elevation above sea level clocks in at 2696ft. WIVB vacated the tower site and moved to Grand Island April 2018 when it entered into a channel sharing agreement with sister station WNLO. WIVB voluntarily sold its standalone digital channel allocation in the broadcast spectrum auction to help free up spectrum to be used for next gen wireless technology. The tower continues to be used by WTSS (102.5, the former WBEN-FM) for radio broadcasting.

We are allowed to share some space in the equipment shelter and have a dedicated power backup circuit from the generator located on site. The WB2ELW repeater antennas are about 40ft above ground and measure in at 1680ft above sea level! It's a great site location for STARS.

Here are some pictures of the Colden site installation



WTSS-FM Tower
(formerly WIVB-TV)
1056 ft tall

Original WBEN-TV
tower constructed
in 1948

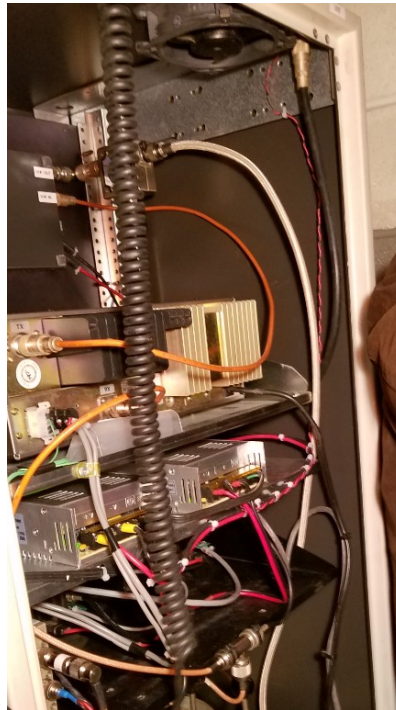
WB2ELW VHF
Antenna

WB2ELW UHF
Antenna

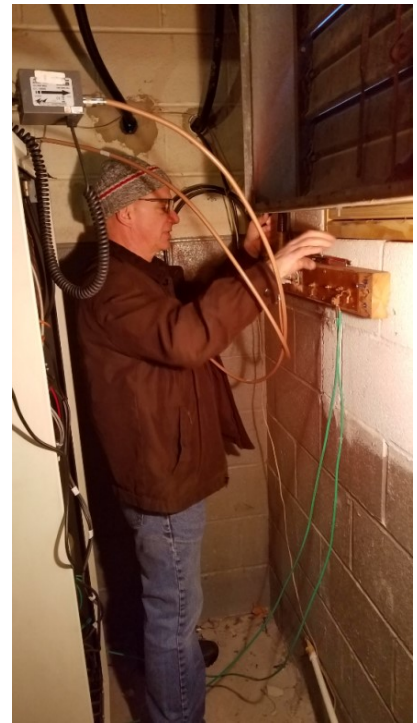
A chilled KB2FX



Mike, KB2FX, inspecting



The radio equipment



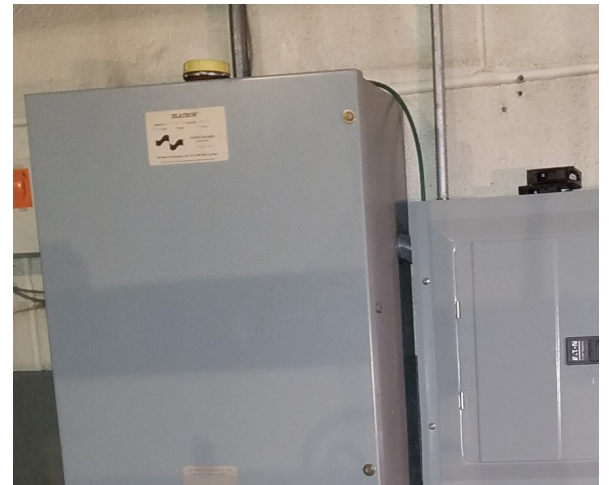
Mike, KB2FX, getting dirty



Mike Chmiel, KC2VWF



The main feedlines



The generator backup circuit



The New Colden Repeater



The New Colden Repeater



Ken Pokigo, KC2AYK and Mike Fetto, KB2FX after finishing installation