FEBRUARY 2023

PROPAGATION

Newsletter of the Longview East Texas Amateur Radio Club

Repeater issue

Join LETARC at our next meeting on March 25th

This issue:

RANDAL MAY KG5IEE TEACHES LETARC CW

BERT SHARP KI5DYI AND PETER XU K1GER ARE AWARDED LETARC HAM OF THE YEAR

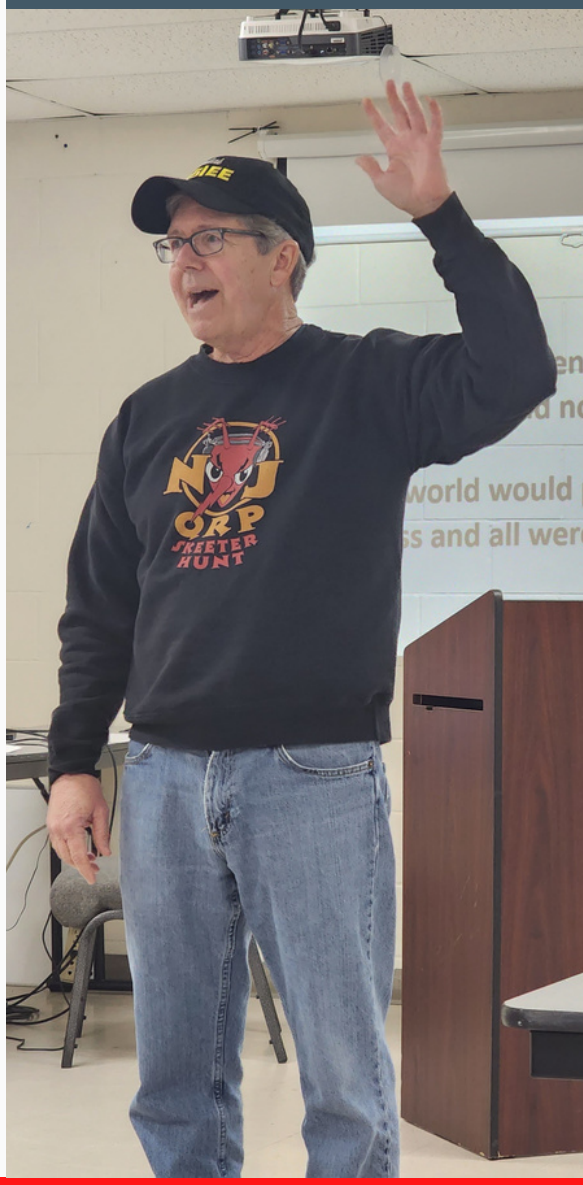
KEITH BALLOW KN5G SHARES SOME GREAT INFO ABOUT REPEATERS

LETARC activities

LETARC held our monthly meeting on February 25th. Randal May KG5IEE gave one of the best presentations we have ever seen about CW. Bert Sharp KI5DYI showed off an SWR bridge kit and displayed a home brew half square antenna for 10 meters. Our friend James Bray KG5OFX was kind enough to donate a NanoVNA that was raffled off. Congrats to Dave Luchak KL7BX who won the raffle.

In ARRL VE testing news John Eckstadt of Kilgore and Eddie Partney of Longview both earned their technician class license. LETARC would like to congratulate these new hams and welcome them to the world's greatest hobby.

Thank you Randal for the presentation



Thanks to Rhett Pilcher KG5NWI for the minutes.

Below is Randal Mays KG5IEE at a POTA where he used CW

February minutes

I. Opening Ceremonies
  a. Call to order at 0905
  b. Prayer and Pledge by Bert Sharp and John Zenter
  c. Introductions
  d. Welcome from Bert Sharp
II. Adoption of Agenda
  a. Meeting agenda adopted.
III. Adoption of Minutes
  a. Reading of minutes from the January meeting. No objections. Adopted.
  b. Reading of finance report from January. No objections. Adopted.
IV. Reports from Officers
  a. President Bert Sharp – Spoke about the tower being donated to the club. We will need to spend some time cleaning up the fences at the tower site. We also need to work to pay Jim for the electricity for running the tower.
  b. Vice President Chris Crawford – Asked the club for ideas on presentation for club meetings.
  c. Secretary/Treasurer Rhett Pilcher – Spoke about club membership dues and ARRL membership.
  d. Media Director Don Gamble – Spoke about the Bodcau POTA activation on 2/4/23. Make sure to leave the two spots closest to the door of the Fire Training facility empty for fire personnel.
  e. Communications Director Jim Rogers – Not Present

V. Reports of the Board
a. none.
VI. Reports by Committees
a. Social Dinner Committee Recommendation – Posados Mexican Cafe on March 14, 2023
VII. Reports by Members

a. James Bray spoke about a program the fire department is doing called "Stop the Bleed" on March 13, 2023 at 6pm

VIII. Recess

IX. Reconvene

X. Program
a. Don Gamble spoke about the QSO today podcast and the virtual ham-fest. They are doing a build on a 5w CW radio if anyone is interested.
b. Bert Sharp spoke about a bridge kit that he built. $20 from Pacific Antennas. He also showed the club a good homemade antenna for 10m. Hypoweratenna.com sells the antenna prebuilt.
c. Randal gave a presentation on learning CW and CW Academy.

XI. Unfinished Business
a. None

XII. New Business

a. James Bray donated a NanoVNA to the club to give away. Dave Luchak won the device.

XIII. VE Testing headcount

a. There are enough VE's available for testing.

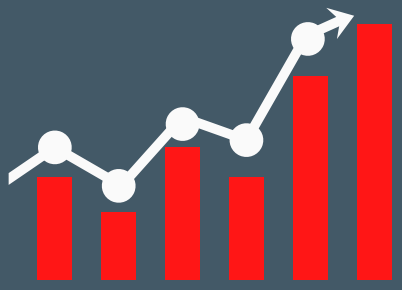
XIV. Adjourn – 1100

Congrats!

This year LETARC had two HAM radio operators of the year. Congrats to Bert Sharp KI5DYI and Peter Xu K1GER!

Congrats!

Above - SKYWARN class from Feb. 6. Left - Don KG5CMS and Rhett KG5NWI visit the San Antonio HAM club.

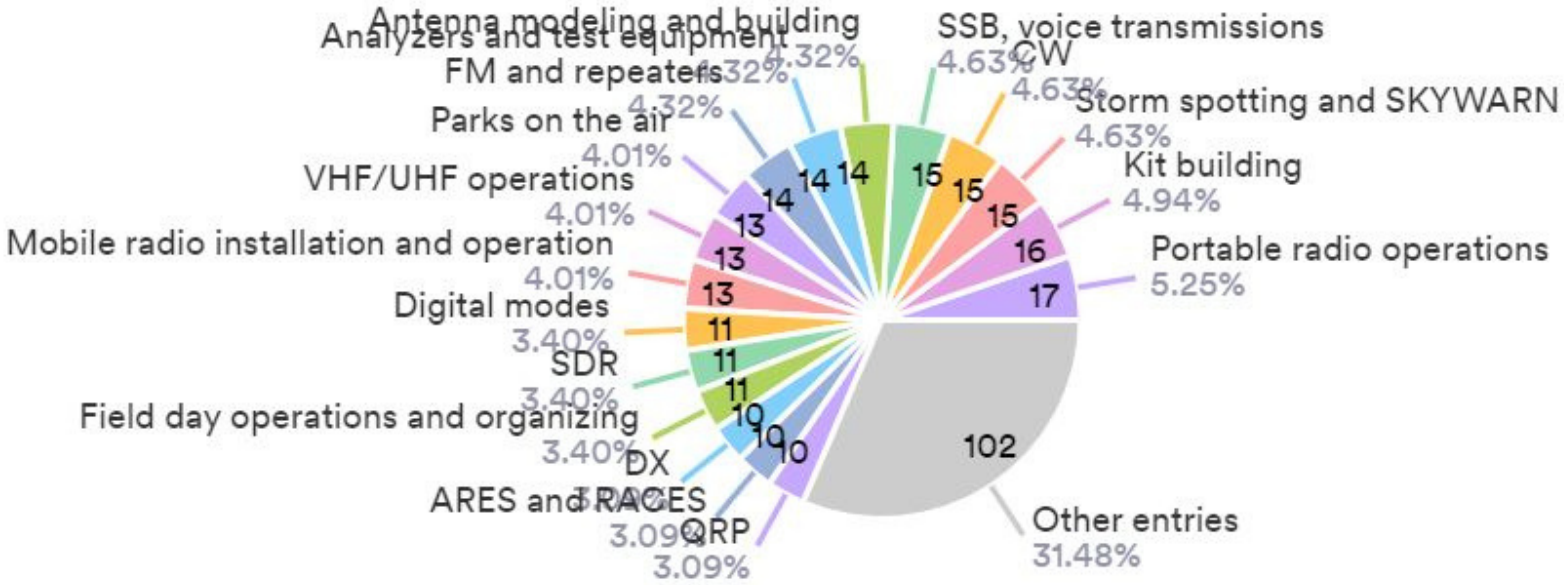


This is the first year that antenna modeling did not place first.

Thank you to all the LETARC members who participate in our surveys.

LETARC Survey "what are you interested in?

1st - Portable operations
2nd - Kit building
3rd - Storm spotting / SKYWARM
4th - CW
5th - SSB/Voice
6th - Antenna building & modeling
7th - Analyzers & test equipment
8th - Parks on the air (POTA)
9th - VHF/UHF operations
10th - Mobile radio installation & operation
11th - Digital modes
12th - SDR
13th - Field Day
14th - DX
15th - ARES
16th - QRP



Our friend Keith Ballow KN5G writes a great article on repeaters.

Let's Talk Repeaters:

We are all familiar with Repeaters since we use them every day while enjoying our Amateur Radio hobby. Talking through a repeater is one of the first technical skills a newly licensed operator normally learns. We learn about the Transmit and Receive frequencies and what PL tone needs to be programed into our radios so that we can access and use the local repeater.

However, there is a lot more involved with a typical repeater that may not be obvious to the casual user and those considerations are what we will be discussing here. A local repeater is the hub or heart of a local club or group of amateur operators. The Common Watering Hole if you will, where local Hams gather to communicate with each other. A common, local repeater adds an element of cohesiveness and comradery to the local amateur radio community and helps the club or group focus its efforts, be that Emergency Communications or support of a community event. The local repeater also provides for an efficient means for asking and answering technical questions and a medium for experienced members to coach and mentor newer, less experienced members.

Most repeaters are sponsored and supported by a club or group of Amateur Radio Operators within a local area with the goal of sharing the considerable amount of time, effort, and cost of installing and maintaining a repeater and then being able to share in the benefits of having a reliable repeater in the local area for the group of amateurs to use.

When a repeater is owned or sponsored by a club and is operated using the callsign of that club the FCC requires that the club appoint an individual as a Trustee for the club callsign and this trustee is also responsible for ensuring that the club's repeater, or repeaters meet all the FCC regulations. In small clubs the Trustee is often the same person who maintains and repairs the repeater when needed. The club should maintain documentation identifying who it has appointed as it's Trustee and record any succession of Trustee when one individual vacates the position and is replaced by a new individual.

Since a repeater is such an integral part of a local Ham community its physical location is an important consideration in how well it will serve the community. With VHF and UHF radio waves being mostly line-of-sight, a repeater's antenna should ideally be located on the tallest tower possible which will provide for the widest coverage possible in the desired area. Unfortunately it has become more and more difficult for amateur radio organizations to secure free or low cost tower space on commercial towers. Over the past few decades, the cell phone industry has purchased many of the most favorable tower sites and towers and forced amateur organizations to remove their equipment from the towers or pay commercial rental fees to retain these desirable sites.

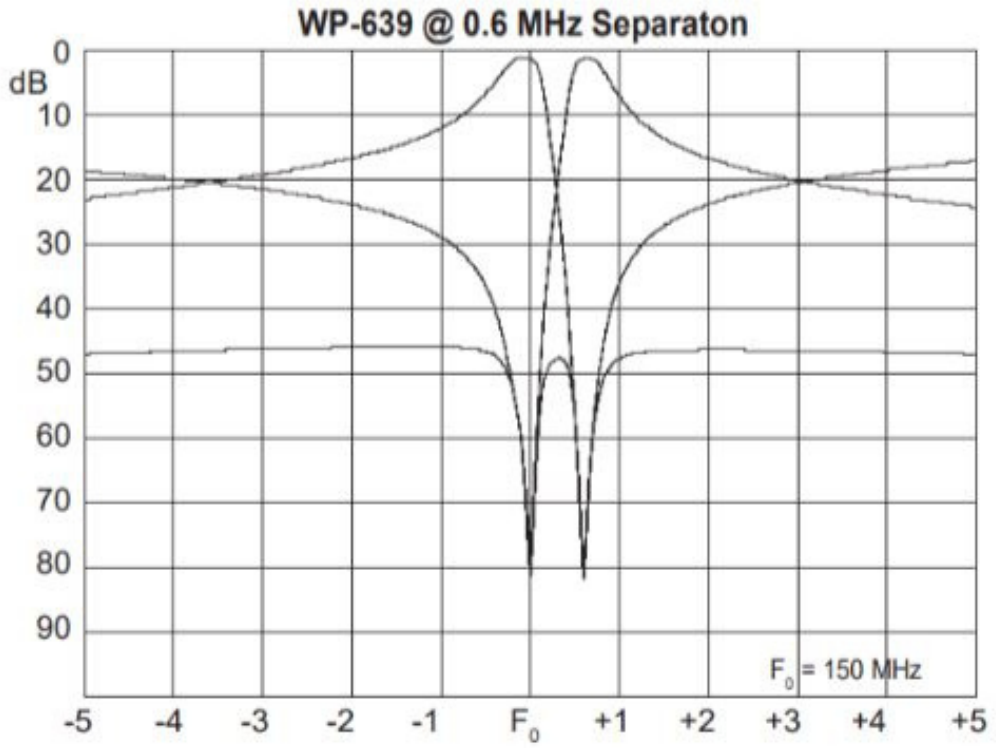
The cost of acquiring property, erecting, and maintaining a tower site is well out of range of most amateur radio clubs and organizations so we are fortunate when we are allowed to place our repeater systems on third party sites and towers.

When amateur clubs can obtain a site on another company's tower the site is often saturated in various radio frequency signals. This dictates that the Amateur repeater must use high quality parts and good engineering practices to ensure that the amateur radio repeater equipment can operate reliably in this high-density RF environment while also not interfering with the commercial radio systems co-located at the site. What reasonably priced equipment you and I might use at our home stations would be totally inadequate in a high-density RF environment where most repeater systems are required to operate. The repeater transmitter and receiver should be in separate, metal enclosures, shielded, and grounded to prevent RF leakage into or out of the enclosures. The coax jumpers between the transmitter, receiver, and the duplexers should be made from high quality, double shielded coax, with high quality N connectors. By the way, those same jumpers need to be cut to precise lengths in regard to the repeater's frequencies to maintain a 50-ohm impedance between the transmitter and the transmit duplexer cavities and the receiver and the receiver duplexer cavities.

The duplexer or cavities of a repeater are where the magic happens. As we all know a repeater consist of a transmitter and a receiver, most often using a common feedline and antenna. On 2-meters the transmit and receive frequencies are only 600 KHz apart from each other. For example, 146.780 and 146.180 MHz.

The magic of a repeater is that the transmitter is able to transmit or repeat the incoming signal at the same time as the receiver is receiving the incoming signal without the transmitter desensing the receiver. We have all experienced desense in a 2-meter receiver when we are standing near another radio operator, and we key up our trusty Baofeng HT to talk to someone over the repeater. We can hear the distant operator fine but when we are talking our buddy standing nearby with his HT or sitting in his vehicle listening to his mobile radio is not able to hear what we are saying. That is because our HT is transmitting a 5-watt RF signal into the air only a few feet from our buddy's radio which is designed to receive a milli or microwatt signal off the air. Our 5-watt signal is simply swamping our buddy's radio's frontend with avery strong signal, only 600 KHz from its receive frequency. In this case we are only talking about 5 watts. How in the world can a repeater putting out 50 to 100 watts, and using the same feedline and antenna ever hope to work without being desensed? The secret sauce is the duplexer!

A typical repeater duplexer is a series of physical, RF filters set up in a Band-Pass/Band-Reject configuration, typically described as (BpBr) which describes the trace pattern you would see when sweeping the cavity with a spectrum analyzer. Remember that a 2-meter repeater is operating with a split frequency pair only 600 KHz from each other.On 70 centimeters, or 440 MHz the repeater frequency split is a whopping 5 MHz! This means that a 2-meter duplexer has a very difficult job to do.



Sweep Trace of a receive and transmit cavity as seen on a Spectrum Analyzer screen.

The duplexer's physical size is a ratio of the frequency at which it is designed to operate so a typical 2-meter cavity will be about 9 inches in diameter by 22 inches tall and to get the separation in dB needed by a 50-to-60-watt repeater a duplexer will normally need six cavities, (three receive and three transmit).

The duplexer does a couple of things for our repeater system. Typically there is a Receive side or string of cavities and Transmit side or string of cavities making up a duplexer. Depending on the application and the amount of separation needed, (measured in dBs) there will be two or three cavities in each string for a total of four or six cavities. Depending on the transmitter's output power and the amount of separation between the transmitter frequency and the receiver frequency a four-cavity duplexer may suffice, (two cavities in the transmit string and two cavities in the receive string) and provide all the separation needed.

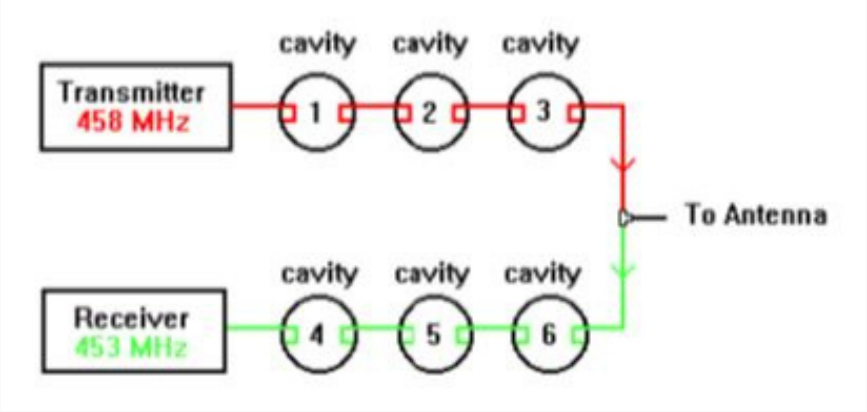
However, at the relatively narrow, 600 kHz separation used on two meters, and if the transmitter is putting out 50 or more watts three cavities in each string may be required.

Transmit String Cavities:

The three cavities in the Transmit string are all three in series and they are tuned so that they will pass only the transmit frequency and present an RF ground to frequencies at or near the repeater's receiver frequency. Since the cavities are in series their properties add together to make two sharp spikes, 600 kHz apart when swept with a spectrum analyzer.

The transmit frequency will be indicated by the tallest peak on the trace, indicating a very low dB loss for any frequency at or near the repeater transmit frequency. These are the "Band Pass" frequencies for the transmit string.

Any frequencies at or near the receiver or repeater input frequency will be represented by the sharp downward spike on the spectrum analyzer's trace, indicating that those frequencies are attenuated in the cavities of the transmit string and are not passed to the output port of the duplexer. These are the "Band Reject" frequencies for the transmit string cavities.



Receive String Cavities:

The cavities in the receive string are tuned so that they will only pass frequencies at or near the repeater receive frequency, (coming from the antenna) and will attenuate all other frequencies including those at or near the repeater's transmit frequencies. The cavities in both strings are designed and constructed in such a way that the RF signals being fed into and out of them are subjected to a tunable capacitor and inductor, (LC circuit) which produces the desired filter characteristics where one band of frequencies is allowed to pass through the cavities with little attenuation while another band of frequencies, 6 kHz away is presented with a low impedance path to ground which attenuates them many decibels so that they can never reach the output port of the cavity.

In other words the duplexer is a tuned circuit that will only allow the transmit frequency to pass through the transmit string cavities to the repeater's antenna and attenuates any other frequencies produced by the transmitter. This selective filter also keeps the repeater transmitter's output signal clean of any spurs or harmonics that might affect the receiver or other nearby receivers at the site. In the receive string, the tuned cavities there will only allow signals or frequencies at or very near to the receiver frequency to reach the receiver's input port. Attenuating all other signals from the repeater's transmitter or other nearby transmitters at the site.

Antenna System:

The repeater's antenna system is comprised of all the devices from the transmitter's output port including the duplexer, any coax jumpers, lightening suppression devices, the feedline, and the antenna itself. All of these devices should have a 50-ohm impedance at the operating frequency of the repeater to allow the maximum RF signal to be transmitted by the antenna and out into the air as RF power. Since all of these devices are designed to provide a 50-ohm impedance across a band of frequencies rather than a specific frequency there will always be a little bit of a mis-match in an antenna system and this will produce reflections of a percentage of the transmitter's output power back towards the transmitter that will not be transmitted by the antenna. This reflected power is eventually used up by ohmic losses or heat generated in the antenna system devices and feedline. This is a loss in efficiency of the antenna system and is described as Return Loss, measured in dBs, or as VSWR stated as a ratio of output vs reflected power.

In an ideal antenna system we would like to see every milli-watt of power produced by the transmitter delivered to and transmitted as RF power by the antenna. Unfortunately, there are such things as losses in any real life antenna system that we have to deal with. The Duplexers of a typical repeater introduce what we call an insertion loss, measured in dBs. Typical 2-meter duplexers have an insertion loss around 2.5 dB meaning that if we have a 100-watt transmitter that we will lose around 45 watts in the duplexers, leaving us with 55 watts coming out of the duplexers. (A loss of 3 dB is equal to a 50% loss).

At this point we become interested in the loss of our 300 to 400 foot or longer run of coax. To alleviate the potential loss of such a long run of coax like LMR-400 or RG-8 we use ½ inch or even 7/8 inch or larger hardline or heliax. These large diameter coax or heliax cables range from $6 to $8 per foot, plus the cost of having it installed on the tower.

And finally we have to choose a high quality antenna that is rated to withstand the weather and elements for years because we can't easily and inexpensively run up the tower to repair or replace a damaged antenna. Repeater antennas are often built so that they can be mounted with a percentage of down-tilt since they are installed at such high altitudes on tall towers and we want them to deliver the RF signal down towards the surface where the users are located rather than at the horizon where the signal would be wasted, and we don't want them wasting RF Power by transmitting it up vertically into the sky where there are no users.

So, as you can see there is a lot to be considered when choosing a location for an amateur repeater and purchasing the needed equipment to make it a reality. We also need to plan the installation carefully since we will most likely be hiring a contractor to climb the tower and install the feedline and antenna and we don't want to find that we are missing an important part that would require an additional climb up and down the tower at an added expense.

As with all radio systems a repeater system is based on a series of compromises.

At our home stations we can accept more compromises that allow us to reduce expenses, such as not buying the highest quality feedline, or the highest quality connectors to put on the ends of our coax, but on a repeater system we have to raise the bar on compromises because we need and expect a repeater to be more robust and operate at a higher level and for a longer period of time between repairs and or replacement of parts since it is often difficult to gain access to the repeater's site and the components that are located up on the repeater tower. As a result we have to source higher quality and more expensive parts to build our repeater with. Parts that will give us a reasonable expectation of working as designed and for a longer period of time under harsher conditions than we would expect a home-based system to operate under.

Keep this all in mind, the next time you enjoy using your local repeater and consider supporting your local club and repeater with your membership dues, and whenever you get a chance, thank your club repeater's Trustee for their donation of their time and efforts to maintain the repeaters we all enjoy using and if you really want to support your club and repeater then volunteer to lend your club's Trustee a hand the next time, he or she has to go out to the repeater site to reset, replace, or repair something to keep the repeater going. I promise you thatyou will learn something new and that your assistance will be very much appreciated!

A huge thank you to Keith for the incredible article. Keith does a great job as repeater trustee and he is a vital part of the great Rusk County Amateur Radio Club.

Thank you to

Keith Ballow KN5G
Mims volunteer fire department
The Longview fire training center on American Legion BLVD
Dave Luchak KL7BX LETARC dinner Chairman
Jim Perry KA5BCM for our radio room
John Zenter AE5OY and our VE team
Marty Duplissey N5KBP for his great work on the ARRL audio news
Steven Lott Smith KG5VK - ARRL North Texas Section Manager
JoAnn Keith KA5AZK - ARES Section Manager
David Chenault W5CWT - Rusk County ARES
John Keith W5BWC - Upshur County ARES
Tom Noe W5TDN - Gregg County SKYWARN coordinator
Jim Rogers N5VGQ - Repeater trustee
Ron Case W2RLC - letarc.org webmaster
Jim Quinn AJ1MQ - groups.io coordinator
Dr. Hoo Kim AG5ZS - Letourneau university liaison
Dr. Ron Morton KF5GMA & Carolyn Morton KF5GLT Longview CERT
Our Wednesday night net control stations:
Jim Rogers N5VGQ
Dave Luchak KL7BX
Don Gamble KG5CMS
John Zenter AE5OY
Rhett Pilcher KG5NWI

Thank you for reading our newsletter. If you would like to contribute please email Don gambledon@gmail.com.

Please visit our website at letarc.org.

-73 de Don KG5CMS

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