NVARC
Nashoba Valley Amateur Radio Club

SIGNAL

A club since 1992
Since 1993
Since 1996

de N1NC February 2020 Volume 29 Number 2

In this Issue

Last Month's Meeting

The January meeting was "Homebrew Night", wherein several members showed off their latest & greatest creations & discoveries. The variety of demos and the skills exhibited were impressive.

See the summary of the projects that were shown later in this issue of Signal.

This Month's Meeting

This month's meeting program is to be "Members Short Subjects". If you have a short presentation let one of the Officers or Board Members know so we can plan the meeting accordingly. Especially note if you need any particular equipment such as speakers.

The regular presentation equipment should be there with a screen, VGA LCD projector, and computer. Stan has an HDMI to VGA adapter if you want to use your own computer.

7:30pm, February 20, at the Pepperell Community Center.

From the President
***de* Stan, KD1LE**

With spring coming up soon (not fast enough) NVARC involvement in public service events will ramp up. There are the Groton Road Race, the Boston Marathon, many charity events like Walk for Hunger and the Jimmy Fund Walk.

Our providing support for public events is good publicity for Amateur Radio.

New Vehicular Features Discovered!
Since I keep my vehicles until they need to be towed away, I missed one trend until my van died last year: no cigarette lighter or ashtray in newer vehicles.

Neither bothers me very much, though in the past I used the ashtray for coins.

But I was curious so I did a little research.

Automakers started phasing them out in the late 1990's and by the 2000's they were only an option on some cars. So, the cigarette lighter port is now a Power Outlet which is still useful along with a USB charging port in my new vehicle.

Additionally, my new vehicle also has a couple of 115 VAC 400-watt outlets which are useful for charging items like laptops with the regular charger.

Other forces pushing for the deletion of the cigarette lighter are legal issues: some states and countries now consider it a form of distracted driving to smoke in a moving vehicle. There are also an increasing number of places that prohibit smoking in vehicles when children under 18 years old are present.

Electric Vehicle Update
At the last meeting someone commented on the price to charge a fully electric vehicle (EV).

The information I have found says in the US, on average, it costs about $13 to charge a Tesla model S from zero to 259 miles. The actual maximum vehicle range is 335 miles if it is discharged to zero, which isn't desirable since it may damage the battery.

Electricity prices vary considerably across the country so your mileage will vary.

People are noticing. Witness: a taxi company in Las Vegas is starting to replace their fleet with Teslas, and some police departments are beginning to use them. Electric vehicles are particularly attractive if regular use involves a lot of idling. In the police service example, the expected savings of electricity vs gas alone is expected to be near $14K per vehicle over three years.

United Parcel Service is working with Arrival, a company from the UK, on the second phase of testing electric delivery vehicles. This will be a test of 35 vehicles that were jointly designed by UPS and Arrival to be used for delivery in Paris and London. If this effort is successful, they have the option to buy 10,000 more vehicles to be used for delivery in the US and Europe over the next four years[1].

Tech Morning

Tech Morning continues to meet every week at 10:15am, Mondays at the Pepperell Community Center.

From week to week we engage in widely (and wildly) varying, ad hoc, discussions on topics of current interest. At times we have a major common project focus, as we had for many months with the Arduino Antenna Analyzer. Mostly though, we just ragchew on our radio interests and issues of the week.

In a recent session we discussed a kit Peter, N1ZRG, found for building a nixie tube digital clock for those with a bigtime hankering to solder.

It is made up of only discreet resistor-transistor and diode logic! Over 1,200 through-hole parts, with no IC's.

Another discussion we recently had was on propagation issues that are impacting our morning 40m CW nets.[2]

[1] https://arrival.com/news/ups-invests-in-arrival-and-orders-10000-generation-2-electric-vehicles

[2] Currently, mornings at 9:30am, ~7.062MHz May soon move down to 3.562MHz.

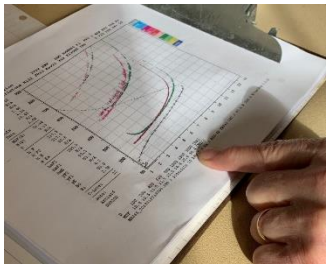
Since we are in relatively close proximity to each other (max ~17 miles), NVIS propagation is expected to be a determining factor in signal quality.

As it is, George, KB1HFT, in North Chelmsford is barely heard by Peter, N1ZRG, in Pepperell, even though George is pumping 50 watts into a resonant inverted vee. George reports that on the same antenna his 1watt 40M WSPR signal has been heard in Antarctica by DP0GVN. Hmmm. No NVIS? We set out to investigate.

The topo maps on the table in the picture below cover the area of our regular net members.

The "houses" with the little "antennas" represent the participant locations as we checked to see if there were topographical issues (there weren't).

We then got into a discussion and explanation of NVIS ionograms and propagation using the Millstone Hill Digisonde data.



We strongly suspect that at this point in the sunspot cycle and season the ionosphere doesn't support NVIS, even during the daytime, on bands above 80 meters!

The table below lists the Critical Frequency (maximum frequency that is refracted back down) for a

vertically incident wave hitting the three possible ionospheric layers at 9:30 in the morning.

	Jan 27	Jan 28
F2 layer	5.3 MHz	4.66 MHz
F1 layer	n/a	2.66 MHz
E layer	2.58	1.96 MHz

Since we have been trying to use 40 meters for our CW net, distant stations - those greater than six or eight miles - were weak. This resulted in a desire to test the NVIS theories by changing the frequency of the net.

To that end, George, KB1HFT, is in the process of installing a shortened 80M dipole.

I was in a discussion around what the California Solar Mandate required. So, here is a summary:

> Effective 1 January 2020 all new single-family and multi-family homes up to three stories high must include a large enough solar system to produce enough energy to equal the annual usage of the building. The size of the solar system can be reduced if other energy efficiency actions are taken or battery storage is included.
>
> -de Stan, KD1LE

Homebrew Night

This year's Homebrew night featured a varied collection of projects from the NVARC community. Here follows a few of the presentations.

Jim, N8VIM, showed a cool mini spot-welder[3] for spot welding the little metal straps between cells in battery packs.

The unit includes a huge capacitor bank of 1860 Farads, which can be made to dump several thousand amps in 250 milliseconds or less. Yiikes!

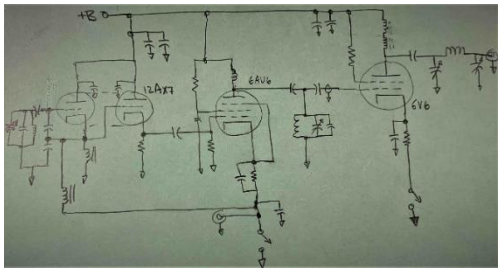
Jim also showed a GPS time server that he built from scratch.

[3] https://www.keenlab.de/index.php/portfolio-item/kweld/

Bob, W1XP, showed a clever innovation: a pair of 60p finish nails, wired together at the head end, to make up a long-legged staple for stapling your radials to the ground so the lawn mower doesn't catch them. Neat!

Jessica, WU3C, showed a pine-board, three tube transmitter that she has built:

Jessica reports: "it can transmit on 160, 80 and 40M, depending on how the multiplier is tuned. The VFO is 160M, using a 12ax7 (the second triode is a buffer), the multiplier is a 6ak5 pentode, can be tuned "linear" or to the second or third harmonic. The final is a 6V6 beam-power tetrode".



Jessica also showed a nice 630m transverter kit[4] that she built,

and she demonstrated a stochastic, nuclear-decay-based, one-time-pad generator for use in cryptography[5].

Dennis, K1LGQ, demonstrated a few innovative ideas for antennas on KX- transceivers.

[4] https://www.minikits.com.au/eme223

[5] An eBay link to the one-time-pad code book product that uses the nuclear decay stochastic process: https://www.ebay.com/itm/One-time-pad-OTP-code-book-sets-of-2-cryptography-100-codes-per-book-set/274251580524

Harry, WA1VVH, showed a very nicely crafted microwave module.

Rod, W1TAC, showed a simple, yet effective, relative power indicator that he uses to help tune up a rig or amplifier. It consists of a resistive power divider, a diode, a capacitor, a potentiometer and a meter.

Your Editor showed his version of the Arduino Antenna Analyzer, as well as his "Universal Human-Instrument Interface" (with a dead battery <sigh>).

Stan, KD1LE, showed his set of guy rings for the ultra-portable vertical mast that he is prepping for the Forest Rally. Stan also offered use of his vast array of Greenlee chassis punches.

Radio Community Help in a Time of Disaster: NVARC Helps Puerto Rico and the Arecibo Observatory

***de* Phil, W1PJE**

As we learned in geography class, Puerto Rico has been a Commonwealth of the United States - not a state in its own right - for just over a century now. Wikipedia[6] correctly points out that in 1898, following the Spanish-American War, the United States acquired Puerto Rico under the terms of the Treaty of Paris. Since then, Puerto Rico has remained an unincorporated territorial possession, making it the world's oldest colony. Residents of the island have been US citizens since 1917, and can freely travel between there and the mainland.

Pertinent to radio aficionados, Puerto Rico is also home to the world's largest radio and radar telescope[7] in the north center of the island, 2 hours west of San Juan.

Arecibo Observatory in Puerto Rico.
Source: University of Central Florida.

Arecibo Observatory, a 20th century IEEE Milestone and ASME Landmark[8], was commissioned in 1964 as the brainchild of Professor William Gordon, a Cornell University electrical engineering faculty member. Professor Gordon's realized vision was to construct a 1000 foot (305 meter) spherical reflector in the karst landscape of the island as a UHF frequency radar, powerful enough to directly measure the full altitude profile of ionospheric electron density, plasma temperature, ion composition, and line-of-sight velocity using the new technique of Thomson, or, "incoherent scatter". (True fact: Arecibo's location was selected by Gordon using a standard U.S. quarter coin on a proper scale topographic map, looking for a crater the right size that could be easily adapted and lined to create the huge reflector.)

Fortunately for science, the original theoretical calculations were in error and Arecibo was overdesigned by a factor of 50-100 for its primary purpose (62 dBi gain at 430 MHz!!), leading to its unique sensitivity and continued use today as not only an ionospheric radar but a world leading radio astronomy and S-band planetary radar facility.

It is also known in amateur radio circles as the TX site for a famous Earth-Moon-Earth (EME) QSO party at 70 cm wavelength in 2010[9] conducted by a group including Prof. Joe Taylor, K1JT (Princeton), who received the Nobel Prize for binary pulsar discoveries there in the 1970s with Russell Hulse.

Some of you might have seen the telescope featured in the 1997 film Contact from the novel by the late Cornell astronomer Carl Sagan. I have deep connections to Arecibo beginning with graduate work, and have used it in radar mode many times. Our science research programs at MIT Haystack conduct collaborative community studies today using its capabilities, and we communicate frequently with Arecibo staff who tend to have decades-long tenure there.

Unfortunately, things have not been very good lately in Puerto Rico. A severe economic downturn in the middle of the 2010s occurred, driven among other things by a change in tax status for the pharmaceutical industry which pushed many companies out of the area.

[6] https://en.wikipedia.org/wiki/Puerto_Rico

[7] Note that China has recently built a larger radio telescope - the 500 meter diameter FAST instrument in Guizhou province - but it is receive-only and does not do active transmissions.

[8] "Milestones:NAIC/Arecibo Radiotelescope, 1963"; https://ethw.org/Milestones:NAIC/Arecibo_Radiotelescope,_1963

[9] "Moonbounce from Arecibo Observatory"'; https://physics.princeton.edu/pulsar/K1JT/Moonbounce_at_Arecibo.pdf

These effects have led to a ballooning government debt, a decade-long recession, and unemployment rates reaching over 12 percent.

Against this backdrop, the island has been hit by catastrophic natural disasters of the 100-year variety, including the terrible August 2017 impacts of Hurricane Maria which took a path straight across the island from southeast to northwest.

Aside from the island-level devastation, lost lives, and destroyed homes, Maria wiped out water and power infrastructure, snapped off the original 70 cm line feed at Arecibo, and damaged the reflector. (Repair is still in planning stages for line feed replacement as of this writing, more than 2 years later.)

Most distressingly, in January of this year, Puerto Rico was struck by another natural disaster in the form of frequent significant earthquakes and aftershocks. Although quake epicenters were in the southwest island corner, violent shocks were felt all across the island at >6 Richter magnitude in another 100 year class series of events.

Upon hearing the news, I wanted to check on Arecibo and my friend Angel Vazquez, WP3R, the lead telescope operator and spectrum manager. WP3R has worked at AO since 1977, and his longtime ham radio credentials include the 2019 Yasme Foundation award for tireless work in disaster relief on the island during Hurricane Maria[10].

But how to reach Angel? Power lines were down and cell coverage was not functional, and I was off the air at home on HF for unrelated reasons.

NVARC to the rescue!

Within a few short hours after an initial email to the NVARC reflector, I had HF station offers from Rod, WA1TAC, and Jim, AB1WQ, along with backup offers from Bill, AB1XB, and Les, N1SV.

AB1WQ's station (and helper) during the WP3R daily skeds. Courtesy AB1WQ.

[10] https://www.yasme.org/news-releases/

Despite poor weather and band conditions,

End-fed half wave antenna at AB1WQ used for skeds. Courtesy AB1WQ

we were quickly able to join a daily sked on either 40 or 20 meters between WP3R and Arecibo friends including Hal Craft AA2JQ, a former Arecibo director, and Professor Jim Breakall, WA3FET, from Penn State, the designer of the HF heater facility at Arecibo.

Angel Vazquez WP3R, lead Arecibo telescope operator and spectrum manager. Source: Yasme Foundation.

Rod and Jim's primary daily contacts used a variety of HF systems including end-fed wire antennas and Yagis, with transceivers operated both barefoot (IC-7300 @ AB1WQ) and with amplifiers (WA1TAC's lovely Drake L4B). Combined with the powerful kilowatt class station and beam at WP3R, the link was made reliably.

In this way, NVARC provided support and inquired about potential assistance during a period of several days when no commercial power or water was available near Arecibo.

I was also able to use the reports, either from my own listening or from Rod and Jim's contacts, to pass along information to the HamSCI national collective, with many eager scientists and technical hams worried about Arecibo. Although conditions are now improved including reliable power and water, WP3R's reports continued to mention thousands of people displaced from their homes and camped outside in the south due to extensive structural damage and ongoing aftershocks - sometimes up to 30 per day at magnitudes up to 5 to 6! AB1WQ was

even on the air as one of them occurred during WP3R's QSO ("Hang on; the table is shaking").

NVARC's efforts furthermore meant I was able to pass along direct support from MIT Haystack staff and also from program officers in Washington DC at the National Science Foundation's Geospace Facilities division. (NSF funds observing programs and scientific research at the Observatory.) These meant a lot to Angel in the post-quake period where he was trying to just hang on and move forward, one shaky step at a time.

As of this writing in early February, the southwest corner of the island is still in disaster recovery mode and will be for a long time to come. But Arecibo successfully passed post-quake inspection, including the 18 large cables that hold the 900-ton feed platform over the reflector. Observations have begun again.

Angel's house is OK, and NVARC has made new friends with WP3R through Rod and Jim's tireless efforts. NVARC's work was noted at both the regional[11] and national[12] level. In the end, our club played an important part in helping a unique place for science and technology continue its knowledge quest and more importantly its help of fellow island citizens. Well done all - and a hearty 73. As Angel would say, "Puerto Rico se levanta": "Puerto Rico will rise up".

-de Phil, W1PJE

Paddle, Bug, or Straight Key?

***de* Bruce, K1BG**

Since giving my talk on CW Academy at NVARC and Billerica ARS last year, I have been asked this question a number of times. My personal answer is "All of them!", which further confuses the issue. Let's look at the history of Morse code sending devices and what it means.

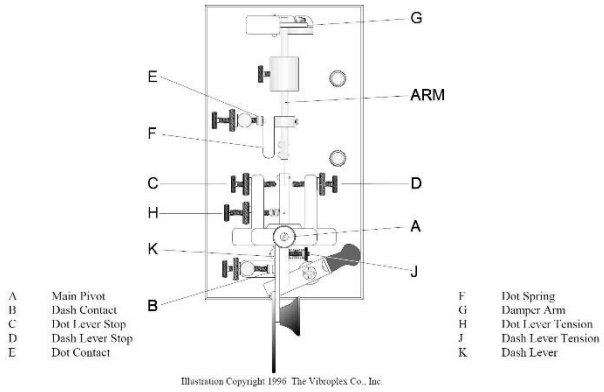
The "straight key", or traditional "hand key" has been around since the beginning of Morse code. It's what you typically see in old movies. With this mechanical device, Morse is sent by hand. The key is a simple switch that either turns your transmitter "on" or "off". The timing of dits and dahs and the quality of the code sent is determined by how long your hand keeps the key opened or closed.

The great benefit of the straight key is that it's simple and easy to understand. Its main limitation is that for most people, the quality of the sending suffers as speed increases. I've seen people send perfect code at 20+ words per minute (WPM), but my code suffers at speeds greater than 10 or 12 WPM. And the vertical hand motion, when sending for long periods of time, would give operators a condition known as "glass fist". Today we call this Carpal Tunnel Syndrome. Hand keys are used today by many, many operators. They continue to be popular, and I have several in my shack that I use when sending slow speed code.

The next development in keys was the "cootie" or "sideswiper". Think of this as a straight key, but instead of a vertical motion, it has a horizontal motion and two contacts. Some people just took two hand keys, bolted them back-to-back, and mounted them vertically. Dits and dahs were made manually, but the horizontal motion solved the problem of glass fist. Cooties went out of favor as better mechanical keys came along, but they have a following that has developed over recent years.

In 1904, Horace Greeley Martin of New York City patented[13,14] a mechanical side-to-side, semi-automatic Morse key, which was manufactured by Vibroplex and became known as the "bug".

Think of a cootie with one side being a mechanical switch, and the other side pushing a horizontally mounted pendulum. As long as the key is held to the pendulum side, the pendulum keeps mechanically swinging from left to right.



[11] Nashoba Valley Amateur Radio Club Assists in Post-earthquake Support for Arecibo Telescope in Puerto Rico" ; ARRL Eastern MA section news.

[12] Massachusetts Club Offers Support to Arecibo Observatory Following Earthquakes" ; ARRL News.

[13] Horace Martin's 1904 patent

[14] http://www.telegraph-history.org/horace-g-martin/hgmp1.htm

An electrical contact (the switch) is mounted along the pendulum, which continually makes and breaks contact until the key is released. Thus, this key allowed a series of dits to automatically be sent (from the pendulum side), and dahs to be mechanically formed on the other side of the key. Timing between dits was tricky (and the bug needed to be adjusted to get this right), as the dah timing was purely mechanical.

Sound complicated? It was, and is! But it's pure genius, and it allowed code to be sent at much higher speeds. For commercial operators, time was money. For hams, it meant that speeds could be achieved that were incomprehensible. Operators developed their own "swing" (unique automatic dit and manual dah timing that would identify an operator). Bugs continue to be popular today, and it's great to hear them on the air. But a word of caution: Bugs can be difficult to use, and even more difficult to master.

Everything I've described so far is considered a "mechanical" key. NO electronics. Many traditionalists stick to only mechanical devices for sending Morse code. Clubs such as SKCC embrace the history and continued use of these devices. For more info, check out https://www.skccgroup.com/.

So now the question: If we can make dits automatically, why not make dits and dahs automatically? Double sided bugs were tried, without much success. I believe that the independent timing of two pendulums, combined with all of the mechanical adjustments, etc, made them unwieldy. In the 1950s, vacuum tube (and later transistor and semiconductor) logic was used to make electronic "keyers". A "paddle" or double sided switch (much like a cootie) has a dit side and a dah side. Closing either side long enough results in an automatic stream of dits or dahs. With modern keyers, the spacing between the individual dits and dahs is made perfect by the keyer itself (with spacing between letters and words still made manually). Mastering paddles is relatively easy (compared to a bug), even at higher speeds. And sending at speeds un-imagined with older devices was possible.

Because of advances in semiconductor technology, transceivers with built in keyers started appearing in the late 1970.

Which leads us to the final methods for sending Morse code – keyboard and computer sending. Starting sometime in perhaps the 1970s, to fulfill the desire to send at still faster and faster speeds, keyboards started being employed. While you still needed Morse code skill to "copy" the code, a keyboard could be employed to send it. This meant that you could send perfect code as fast as you could type.

With modern computers, you can program the computer in advance to send whole exchanges, either in pre-prepared text messages or contest exchanges. They can also be programmed to just send what is inputted on the keyboard. The advantages are more accurate and faster sending, and less fatigue for the operator. Many operators, particularly the purists, feel that this is not Morse code at all, that it takes no operating skill to have a computer sending for you. Some will falsely accuse contest operators of not operating at all. They claim it's the computer copying the code at higher speeds (say 40+ WPM).

What do I use? I have hand keys, paddles, keyers, and computers in my shack, and I use them all. I don't have a cootie (nothing against them). I have a bug, but because I can't mentally switch between a bug and paddle/keyer combination, I don't use it. It's the same model I used as a kid, and I keep it for sentimental reasons. I've never gotten the hang of using a keyboard. For me it's a timing thing, and I wish I could learn how to use one. I usually use both a computer AND a paddle/keyer combination.

Rag chewing is done with the paddles. Contesting is done with the computer, but the paddles are available for those times when I need to send something that has not been pre-programmed.

If you are interested in learning more, come to Field Day and I will demonstrate some of these things to you.

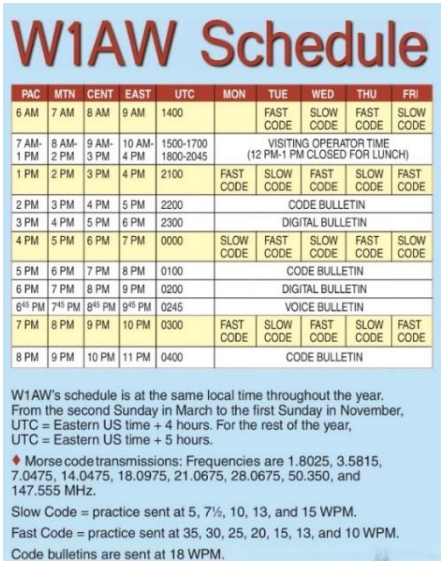
-*de* Bruce, K1BG

Around and About

Bob, W1XP, and Bill, AB1XB, recently attended HamCation 2020, west of Orlando, FL.

They seem to be having a good time at the flea market.

Calendar



W1AW Schedule

PAC	MTN	CENT	EAST	UTC	MON	TUE	WED	THU	FRI
6 AM	7 AM	8 AM	9 AM	1400		FAST CODE	SLOW CODE	FAST CODE	SLOW CODE
7 AM-1 PM	8 AM-2 PM	9 AM-3 PM	10 AM-4 PM	1500-1700 1800-2045	VISITING OPERATOR TIME (12 PM-1 PM CLOSED FOR LUNCH)				
1 PM	2 PM	3 PM	4 PM	2100	FAST CODE	SLOW CODE	FAST CODE	SLOW CODE	FAST CODE
2 PM	3 PM	4 PM	5 PM	2200	CODE BULLETIN				
3 PM	4 PM	5 PM	6 PM	2300	DIGITAL BULLETIN				
4 PM	5 PM	6 PM	7 PM	0000	SLOW CODE	FAST CODE	SLOW CODE	FAST CODE	SLOW CODE
5 PM	6 PM	7 PM	8 PM	0100	CODE BULLETIN				
6 PM	7 PM	8 PM	9 PM	0200	DIGITAL BULLETIN				
6:45 PM	7:45 PM	8:45 PM	9:45 PM	0245	VOICE BULLETIN				
7 PM	8 PM	9 PM	10 PM	0300	FAST CODE	SLOW CODE	FAST CODE	SLOW CODE	FAST CODE
8 PM	9 PM	10 PM	11 PM	0400	CODE BULLETIN				

W1AW's schedule is at the same local time throughout the year. From the second Sunday in March to the first Sunday in November, UTC = Eastern US time + 4 hours. For the rest of the year, UTC = Eastern US time + 5 hours.

♦ Morse code transmissions: Frequencies are 1.8025, 3.5815, 7.0475, 14.0475, 18.0975, 21.0675, 28.0675, 50.350, and 147.555 MHz.

Slow Code = practice sent at 5, 7½, 10, 13, and 15 WPM.

Fast Code = practice sent at 35, 30, 25, 20, 15, 13, and 10 WPM.

Code bulletins are sent at 18 WPM.

February

15 Russian PSK WW Contest. 1200Z 15FEB – 1159Z16FEB. BPSK31, BPSK63, BPSK125. 160, 80, 40, 20, 15, 10m.
http://www.rdrclub.ru/russian-ww-psk-contest/49-rus-ww-psk-rules

15 Algonquin ARC Fleamarket, Marlboro, MA.
http://n1em.org

17 Run for the Bacon QRP contest. 0200Z-0400Z. CW. 160, 80, 40, 20, 15, 10m. Max 5w.
http://qrpcontest.com/pigrun/

20 NVARC Meeting: Short Subjects Night. Pepperell Community Center. 7:30pm.

Board Meeting Notes

Attendees:

Stan, KD1LE
John, KK1X
Ralph, KD1SM
Ed, N1YFK
Bruce, K1BG,
Jim, AB1WQ

- Nobody has stepped forward with Short Subjects. Need to know what resources are needed.
- Bruce made a number of suggestions for membership growth. Billerica club uses postcards sent to new hams, and that seems to be working.

-de John, KK1X

Treasurer's Report

Income for January was $20 from membership dues. Expenses were $134 for the Post Office box leaving a net expense for the month of $114.

The Squannacook River Runners made a donation of $250 to our Community Fund, acknowledging our assistance with the 2019 Groton Road Race.

Current balances:

General fund	$2,640.67
Community fund	$5,948.25

As of 6 February we have 53 members who are current with their dues and 11 renewals outstanding. Thank you to those of you who mail or hand in your dues before Ralph comes to you. Please check your renewal status on the roster circulated at the monthly meeting or ask Ralph.

Membership dues can now be paid via PayPal:

Go to https://www.paypal.me/nvarc

- **Please <u>remove</u> the checkmark in the box "Paying for goods or a service"**, as PayPal deducts a fee for their "purchase protection" if you leave this checked. If your "shipping address" is still displayed, then the box is still checked, adding an expense to the Club.

- (Optional) enter your callsign in the "Add a note" field.

If you are joining ARRL or renewing your membership please consider letting Ralph send in the paperwork for you. The Club will buy the stamp and will get a commission from ARRL. ARRL membership checks should be made payable to NVARC; Ralph deducts the Club commission before forwarding your paperwork to Newington. As a Special Service Club, the ARRL expects a majority of Club members to also be ARRL members.

-de Ralph, KD1SM

STRAYS

Energy Trends

Current annual US solar panel manufacturing capacity is over 7.7 GW. 7.4 GW of solar was installed in the first three quarters of 2019 with 45 GW in the pipeline. While 3.5 GW of wind power were installed in the same period with another 42 GW in the pipeline.

There are now more than 37,000 MW of utility-scale solar projects operating in the US with 112,000 MW under development

In 2019 13.7 GW of coal fired power closed and 2020 may not be as bad but the amount retired is expected to be greater than in 2014, 2016 or 2017. With US electric consumption flat or slightly declining in 2020 and 2021 US wind power is expected to add 14.3 GW this year and 12+ GW in 2021 while solar will add 13+ GW in each of the two years.

Sponsors

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http://www.n1nc.org/

President: Stan Pozerski, KD1LE
Vice President: Jim Hein, N8VIM
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Treasurer: Ralph Swick, KD1SM
Board Members:
Jim Wilber, AB1WQ, 2016-2019
Ed Snapp, N1YFK, 2017-2020
Bruce Blain, K1BG, 2018-2021

Property Master: John Griswold, KK1X
Librarian: Peter Nordberg, N1ZRG
Emergency Coordinator: [open]
N1NC Trustee: Bruce Blain, K1BG

Join NVARC! Annual membership dues are $15; $20 for a family.

Meetings are held on the 3rd Thursday of the month at 7:30 p.m. in the Pepperell Community Center.

Contact us on the N1MNX repeater.
442.900 (+), 100Hz
147.345 (+), 100 Hz
53.890 (–), 100Hz

This newsletter is published monthly. Submissions, corrections and inquiries should be directed to the newsletter editor:
editor@n1nc.org.
Articles and graphics in most PC-compatible formats are OK.

Editor: George Kavanagh, KB1HFT

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