2-meter refarming proposal

Uniform 15 kHz proposal

Overview

The submitters of this proposal would strongly prefer not to change the current 20 kHz channel spacing used in the NARCC area 145 MHz repeater segment. This spacing is widely used throughout the United States and elsewhere, provides a beneficial "guard band" between repeater channels which helps keep adjacent-channel interference to a minimum, and operates well without requiring the use of "reversed" (interleaved) frequency pairs.

However, we recognize that there is a significant drive within NARCC to move to a narrower channel spacing, in order to provide additional channels within this segment. If such a change is to be made, we feel that this proposal is the proper and responsible way to make such a change. It proposes a channel arrangement and spacing which has been used elsewhere in the 2-meter band for decades, it is highly compatible with the radios currently in use within the NARCC coordination area, it allows for full use of all channels within the repeater sub-band (whether new, shifted, or unchanged), and it accommodates new repeater technologies (e.g. D*Star) in a fashion which is fair and unbiased (either towards or against any given repeater modulation).

We base this proposal on the following points:

1. On the 2-meter band, FM modulation with a peak deviation reaching 4 to 5 kHz, and a channel spacing of 15 kHz or wider, is the standard of "good amateur practice" not only here in Northern California, but throughout the United States and most of the world. It's what the radios we buy are designed for, it's what they come pre-configured to use, and in many cases it is the only transmission mode they support. Most 2-meter amateur radios sold today do *not* have effective support for narrower channels. Roughly half of the radios recently surveyed have *no* user-accessible capability to switch to a narrower deviation limit, and most of the radios which do support this feature do so only in an inflexible (and probably error-prone) fashion.[1]
2. There appears to be no indication from the FCC that they intend to change the above, either by mandating that 2-meter amateur radios must be built with (let alone use) a narrowband modulation capability, or by imposing repeater-channel frequency spacings on the amateur radio community. In fact, the FCC places very few technical restrictions on amateur radio

1 See http://www.specsnet.org/2m-nfm-data.htm for the results of a survey and test of radios in use in this area.

repeater systems, preferring to allow amateurs to choose appropriate repeater modes via consensus.

3. NARCC and its fellow coordinating councils throughout the country are able to help create and manage such a consensus. However, these councils have only a limited and indirect influence on repeater users and radio manufacturers, as these councils have no legal powers of enforcement or mandate. A coordinating council can approve or deny a new coordination, or revoke an existing one, but cannot control the equipment selection or on-air behaviors of users of repeaters (coordinated or otherwise). Events in NARCC's past suggest that revoking an existing repeater's coordination can result in a painful and lengthy legal conflict.
4. Switching to a narrow channel spacing (e.g. 12.5 kHz) which requires a reduced peak deviation, in an environment where so many radios lack this feature, is a recipe for chaos. It would almost certainly result in large amounts of QRM, would degrade the quality and reliability of 2-meter communications throughout the area, and in general would not be in the best interest of the amateur radio community. It could be subject to lengthy legal challenges (either via petition to the FCC, or in the courts).
5. The recent FCC ruling on D*Star makes it clear that "a repeater is a repeater." In the eyes of the FCC, a repeater is not defined by whether the signal it bears is continuous analog, or packetized digital, nor by whether the signal is delayed briefly in a bucket-brigade circuit or a memory packet buffer. Rather, a repeater is defined by the fact that it receives a signal on one frequency and simultaneously transmits on another frequency. D*Star repeaters meet the FCC definition, and their primary mode of use (phone QSOs and ragchewing) is essentially indistinguishable from how analog FM repeaters are used. Other digital-voice repeater systems (e.g. APCO P25) behave similarly, and should be treated in a comparable fashion. The FCC has allowed the amateur radio community to self-manage repeater frequency allocations, and the recent FCC ruling supports the belief that traditional repeater coordination procedures are the most appropriate way to handle D*Star and similar digital repeater systems.

For the above reasons, we feel that *if* narrowing of the existing 20 kHz channels is to be done, the best (most technically efficient, most economically sensible, and fairest) approach is to re-farm the repeater segment into a set of 15 kHz channels, and to treat all of these channels in a uniform manner. In our proposal, any FCC-authorized modulation technology can be used in any of the 15 kHz channels, and may make full use of that 15 kHz channel width. We do *not* propose limiting use of the newly-created 15 kHz channels to only narrow-band repeaters – doing so guarantees that some channel bandwidth will be wasted, and could preclude the development of newer digital repeater systems which could make beneficial use of the full 15 kHz of bandwidth (for a wider auxiliary data channel, for instance).

Section 1: Contact information

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NARCC organization number:	150

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Section 2: Proposed channel plan

To Interleave or Not To Interleave: That Is The Question

A uniform channel spacing within a repeater sub-band could be utilized in either of two ways: directly, or by interleaving of reversed frequency pairs.

The simplest setup is a direct utilization, with (e.g.) all repeater outputs in the 145.100 – 145.500 frequency range, and all repeater inputs at a 600 kHz negative offset from their corresponding outputs. This is the way that this particular repeater segment is currently managed and coordinated by NARCC (presently with 20 kHz spacing).

Based on reports of experiences in other coordination areas in the United States, there is some reason to be concerned that a direct channel plan with 15 kHz spacing may result in significant adjacent-channel interference problems.

An alternative arrangement is to switch the input and output frequencies of every second channel, operating these “reversed” repeaters with their output in the 144.500 – 144.900 frequency range, and their inputs at a 600 kHz positive offset. An interleaved structure of this sort is currently used successfully by NARCC in the other two repeater segments in the 2-meter band.

Both of these arrangements can suffer from “bleed-through” problems, when a user of one frequency is affected by an equally strong (or stronger) signal on an adjacent channel. In the case of a direct channel plan, this will most commonly happen when a user is trying to access a repeater at some distance from his/her location, and a signal from a closer (or stronger) repeater on the adjacent channel “bleeds in”. If the adjacent-channel repeater is in heavy use, the bleed-through problem may continue for quite some time.

This particular scenario is somewhat less of a problem in an interleaved/reversed channel plan, as the repeater output frequencies are 30 kHz apart – too great a separation to cause significant problems on today's radios. A user's receiver can still suffer bleed-through from transmissions on an adjacent channel 15 kHz away. However, in the interleaved plan this adjacent channel frequency will be assigned to a repeater *input*, and transmissions on this frequency will be coming from people using the repeater, not from the repeater itself. Since individual users of a repeater do not usually transmit non-stop at high power from high-altitude antennas, bleed-over problems of this sort are likely to be relatively short-lived and to be limited to a relatively small area around the location of a user's transmitter.

The interleaved channel plan does suffer from one additional vulnerability. In the worst case of two misadjusted repeaters on adjacent channels, one repeater's output signal can bleed into the adjacent repeater's input. If these repeaters use the same CTCSS tone, the bleed-over can even create “repeater loops”, where each repeater's signal opens the squelch on its neighbor's receiver and the two repeaters “shout at one another”. For this reason, an interleaved channel plan requires that repeaters be accurately tuned and carefully adjusted (always good practice, of course!), and it is strongly recommended that repeaters on adjacent channels use different

CTCSS tones. Operating a repeater without CTCSS (i.e. carrier squelch) under this channel plan is probably quite unwise.

Use of an interleaved/reversed channel plan on this repeater segment may create an inconvenience for repeater users. Many 2-meter radios do *not* automatically switch to duplex operation, with a positive offset, if tuned to a frequency between 144.500 and 144.900 MHz. Users would need to select/program the appropriate duplex mode and offset when tuning to any repeater which is operating with its output in this frequency range.

Based on NARCC's decades of experience in managing an interleaved channel plan in the other 2-meter sub-bands, we are specifying an interleaved channel plan as part of this proposal. This will result in a consistent approach to repeater frequency allocation within the NARCC 2-meter coordination region.

Proposed repeater channel allocations (144.500 – 145.500 section)

New TX Freq	*Offset*	*New RX Freq*
144.510	+600 kHz	145.110
144.540	+600 kHz	145.140
144.570	+600 kHz	145.170
144.600	+600 kHz	145.200
144.630	+600 kHz	145.230
144.660	+600 kHz	145.260
144.690	+600 kHz	145.290
144.720	+600 kHz	145.320
144.750	+600 kHz	145.350
144.780	+600 kHz	145.380
144.810	+600 kHz	145.410
144.840	+600 kHz	145.440
144.870	+600 kHz	145.470
145.125	-600 kHz	144.525
145.155	-600 kHz	144.555
145.185	-600 kHz	144.585
145.215	-600 kHz	144.615
145.245	-600 kHz	144.645
145.275	-600 kHz	144.675
145.305	-600 kHz	144.705
145.335	-600 kHz	144.735
145.365	-600 kHz	144.765
145.395	-600 kHz	144.795
145.425	-600 kHz	144.825
145.455	-600 kHz	144.855
145.485	-600 kHz	144.885

Proposed implementation

Old Tx Freq	*Changes*	*New TX Freq*	*Offset*	*New RX Freq*
145.11	Reverse pair	144.510	+600 kHz	145.110
145.13	-5 kHz	145.125	-600 kHz	144.525
	New (reversed)	144.540	+600 kHz	145.140
145.15	+5 kHz	145.155	-600 kHz	144.555
145.17	Reverse pair	144.570	+600 kHz	145.170
145.19	-5 kHz	145.185	-600 kHz	144.585
	New (reversed)	144.600	+600 kHz	145.200
145.21	+5 kHz	145.215	-600 kHz	144.615
145.23	Reverse pair	144.630	+600 kHz	145.230
145.25	-5 kHz	145.245	-600 kHz	144.645
	New (reversed)	144.660	+600 kHz	145.260
145.27	+5 kHz	145.275	-600 kHz	144.675
145.29	Reverse pair	144.690	+600 kHz	145.290
145.31	-5 kHz	145.305	-600 kHz	144.705
	New (reversed)	144.720	+600 kHz	145.320
145.33	+5 kHz	145.335	-600 kHz	144.735
145.35	Reverse pair	144.750	+600 kHz	145.350
145.37	-5 kHz	145.365	-600 kHz	144.765
	New (reversed)	144.780	+600 kHz	145.380
145.39	+5 kHz	145.395	-600 kHz	144.795
145.41	Reverse pair	144.810	+600 kHz	145.410
145.43	-5 kHz	145.425	-600 kHz	144.825
	New (reversed)	144.840	+600 kHz	145.440
145.45	+5 kHz	145.455	-600 kHz	144.855
145.47	Reverse pair	144.870	+600 kHz	145.470
145.49	-5 kHz	145.485	-600 kHz	144.885

Section 3: Final bandwidth of stations on new and relocated channels

In this proposal, stations operating on any channel in this portion of the 2-meter band (either new or relocated) may utilize up to 15 kHz of bandwidth centered on the specified channel frequencies. This bandwidth may be utilized in any FCC-authorized mode desired by the station: traditional FM (e.g. 4 or 4.5 kHz peak deviation), narrowband FM (e.g. 2.5 kHz peak deviation), GMSK digital (e.g. D*Star), COFDM, a pair of ultra-narrowband (e.g. FM or GMSK) channels through co-located repeaters (or separately-located cooperating repeaters with equivalent service areas), or other common-practice or experimental modulations.

Significant emissions outside of the 15 kHz channel are unacceptable for any mode or modulation. Per current practice, actual over-the-air measurements would be used to characterize the emission behavior of any station whose transmissions were believed to be excessively broad or off-frequency.

Section 4: Steps required to achieve transition to the new plan

Little or no major equipment replacement should be required for repeaters affected by this proposal; however, the transmitter and receiver frequencies of all repeaters within the affected sub-band will be changed. Roughly one-third of existing repeaters in this sub-band will reverse their transmit and receive frequency pair; the others will raise or lower their transmit and receive frequencies by 5 kHz. Some re-tuning of duplexers may be required for stations which change frequencies by 5 kHz. Much greater alteration or re-tuning of duplexers will be required for any repeater which operates with a reversed frequency pair, or which moves to a different channel in the sub-band.

Repeaters subsequently coordinated onto the newly-created frequency pairs will operate with a reverse split (repeater outputs between 144.540 and 144.840 Mhz, +600 kHz offset).

The peak deviation of existing FM repeaters should be reduced to 4.0 kHz in order to minimize adjacent-channel interference. All repeaters should require CTCSS on their inputs. Repeaters on adjacent channels should agree to use different CTCSS tones.

It is expected that no modifications will be required to the radios of repeater users other than reprogramming of radio memory banks. Manual specification of transmitter offset may be required on some users' radios, on some channels.

The closer spacing between channels may increase the severity of pre-existing adjacent channel interference between strong, closely-located repeaters and repeater users (due to bleed-over and/or intermodulation), and problems with local interference (e.g. Cable-TV signal leakage) may change. It is suggested that the Coordination Committee give existing coordinated repeaters the opportunity to switch to one of the newly-created channels before new coordinations are accepted, in order to mitigate such problems.

Section 5: Technical issues that have been considered

NARCC has been using 15 kHz interleaved channel spacing on the two other repeater segments of the 2-meter band for some years, and a 15 kHz spacing is currently used for 2-meter simplex channels within the NARCC service area. Existing 2-meter radios throughout the NARCC area (and in fact throughout the world) are compatible with 15 kHz tuning and spacing, and with the peak modulations normally used in this spacing. This proposal would simply expand NARCC's use of 15 kHz interleaved channel spacing to all three repeater segments. It does not introduce novel (or narrow) tuning or spacing requirements, and should be fully compatible with local, national, and world standards for 2-meter amateur radios.

- Emissions outside the Part 97 repeater band: this has been considered and is believed not to be a problem. All channel-center frequencies in this proposal are 10 kHz or further from the edges of the FCC's “no repeaters here!” ranges, leaving a minimum of 2.5 kHz of guard-band space between the outer edge of the channel and any forbidden frequency range.
- Capability of user radios to use new and reallocated channels: as noted above, this proposal simply expands the use of an existing NARCC channel-spacing protocol to cover this repeater segment. Existing radios are known to be compatible with the 15 kHz spacing. Some user radios may, however, require a manual selection of duplex operation with a positive input offset when tuned to “reverse” repeaters operating with outputs between 144.500 and 144.900 MHz.
- Frequency tolerance of mobile and portable radios over real-world temperature ranges: as noted above, existing radios are already used successfully with other 2-meter repeater segments using this spacing, and should work equally well in this segment.
- Adjacent and co-channel interference to repeaters: as noted above, NARCC has been using interleaved 15 kHz spacing in two other 2-meter repeater segments and has extensive experience with the adjacent-channel interference issues. Some additional care in assigning channel frequencies may help mitigate adjacent-channel bleedover. Co-channel interference should be no more, and no less than with today's 20 kHz channel spacing.
- Adjacent and co-channel interference to users: as noted above, NARCC has years of experience with interleaved 15 kHz spacing and its adjacent-channel interference behavior. Preventing adjacent-channel interference to users is largely up to the repeater owners/operators, who must ensure that their transmitters are on-frequency and that their deviations / spectra are not wide enough to “bleed out” of their channel to a significant extent. Recent tests by Santa Clara County ARES/RACES show that most radios do exhibit more effect from bleed-over at a 15 kHz spacing with 5.0 kHz deviation than they do at 20 kHz spacing. Slight reductions in deviation by analog FM repeaters, careful control of emission spectra by digital repeaters, and the use of an interleaved channel plan should keep the bleed-over down to levels which will not cause objectionable interference. Co-channel interference should be no more and no less than is present with today's 20 kHz channel spacing.

- Adjacent coordination areas: making *any* change to this repeater segment's channel spacing will reduce the NARCC area's frequency compatibility with adjacent coordination areas. Both Nevada and Oregon appear to be using a channel spacing identical with the present NARCC spacing (20 kHz, on the “odd tens”) throughout this repeater segment. Southern California appears to be using a 20 kHz spacing of the opposite stride (“even tens”). NARCC's present use of 15 kHz spacing on the two other repeater segments is *already* incompatible with the 20 kHz spacing apparently used throughout Oregon, Nevada, and Southern California. If this proposal is accepted, NARCC's channel spacings will be *entirely* incompatible with those in adjacent areas, rather than just *mostly* incompatible.
- Future transition to 6.25 kHz channels: considered. This proposal explicitly allows stations using a 15 kHz channel to run a pair of 6.25 kHz sub-channels (either co-located as part of one repeater system, or located separately in a cooperating manner to cover a single service area). This should allow for adequate opportunity for interested repeater owners to experiment with, and place into service, some 6.25 kHz ultra-narrow repeater systems, when and if such hardware actually becomes available to the amateur radio community.