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# AREA REPEATER COORDINATION COUNCIL of EPA/SNJ

## ARCC COORDINATION POLICIES FOR NARROWBAND ANALOG/DIGITAL AND WIDEBAND DIGITAL OPERATIONS

*Revision D*

### INTRODUCTION

Narrowband FM, digital voice repeaters, and wideband digital operations are becoming more prevalent in the amateur radio bands. ARCC anticipated an increased demand for frequency coordinations for operations using these modes, and has prepared this document to outline the policies by which coordinations for these modes will be processed. Note that this document does not propose, nor define, any changes to existing ARCC bandplans. That is, the subbands in which ARCC coordinates repeaters and auxiliary links are not being altered. However, the policies detailed herein allow digital voice repeaters to coexist in subbands previously reserved exclusively for analog voice repeaters under certain conditions, and reducing the channel spacing for narrowband operations to less than that normally required for wideband operations. In order to promote efficient and orderly use of the spectrum available, and to continue to promote the use of emerging technologies and experimentation in the spirit of amateur radio, ARCC has established these policies.

### DEFINITIONS

Occupied Bandwidth (OBW). The spectral bandwidth of a radiofrequency emission within which 99.5% of the transmitted power is contained.

Necessary Bandwidth. The minimum bandwidth required to accomplish communication for a given combination of modulation type, baseband signal bandwidth, and/or data rate.

Wideband Frequency Modulation (WBFM). An analog frequency-modulation emission exceeding 11.25 kHz in occupied bandwidth. In ARCC's bandplans above 50 MHz, the maximum occupied bandwidth allowed varies from 15 kHz to 18 kHz depending on the channel spacing in the band or subband.

Narrowband Frequency Modulation (NBFM). An analog frequency-modulated emission of 11.25 kHz or less occupied bandwidth.

Narrowband Digital Voice (NBDV). A digital emission with a primary payload (> 50% of the data bandwidth) comprised of digitized voice (phone), with or without multiplexed ancillary data, with an occupied bandwidth of 11.25 kHz or less.

Wideband Digital. A digital emission with a primary payload (> 50% of the data bandwidth) of data, with or without multiplexed digitized voice as a secondary payload, with an occupied bandwidth greater than 11.25 kHz.

## CHANNEL SPACING DISCUSSION

The vast majority of FM repeaters and auxiliary links current in operation utilize wideband FM. The occupied bandwidth of WBFM repeaters and auxiliary links varies based on the channel spacing in a given subband. For example, repeaters operating on 15 kHz channels on 2m have a maximum occupied bandwidth of 15 kHz, while WBFM operations on 25 kHz channels on 70cm and above are allowed up to 18 kHz occupied bandwidth. NBFM reduces the occupied bandwidth sufficiently to allow for narrower spacing between adjacent channels.

It is important to note that channel spacing must always be sufficiently wider than occupied bandwidth to avoid interference to/from adjacent-channel operations for a number of reasons. The unused spectrum between the occupied bandwidth of adjacent-channel operations, or at subband edges, is referred to as a "guard band". Guard bands are required for a number of reasons, several of which are outlined below:

1. Receivers obtain selectivity (the ability to discern a desired signal from other off-channel signals) via filtering in the form of resonant circuits, intermediate-frequency (IF) and radiofrequency (RF) crystal filters, digital signal processing, and similar techniques. These filters, when optimally designed and tuned, typically have a frequency response comprised of a quasi-flat pass band centered on the frequency of operation (RF, IF, or otherwise), with steep rejection beyond the passband edges. However, filters are not perfect; the transition from pass band to reject band does not have an infinite slope. As such, a guard band between adjacent-channel operations is necessary to allow for the imperfections in receiver filtering.
2. The occupied bandwidth of an emission is defined by the spectrum within which 99.5% of all radiated power is contained. That still leaves 0.5% (23 dB below carrier power in the case of FM other carrier-based modulation types) outside of the occupied bandwidth. The process of frequency modulating a carrier produces an infinite number of sidebands which, theoretically, are spread infinitely wide, progressively decreasing in amplitude at frequencies significantly removed from the channel center, with the most-significant sidebands contained within the occupied bandwidth. However, lower-amplitude sidebands outside of the occupied bandwidth can still be of sufficient strength to affect adjacent channels. The guard band between adjacent channels helps to minimize interference from such emissions outside the occupied bandwidth.
3. Frequency stability also comes into play when determining channel spacing. Typically 5 parts per million (5 PPM) is the maximum frequency error tolerable on VHF/UHF, with 2 PPM generally being preferable up through 70cm, and even tighter stability at higher frequencies. For narrowband operations, 2.5 PPM is typically considered to be the maximum, with 1.5 PPM or better being preferable. At 146 MHz, 5 PPM equates to a possible error of +/- 730 Hz. At 445 MHz, 5 PPM equates to +/- 2.225 kHz, a significant error. Therefore, it is obviously desirable to have tighter frequency stability at higher operating frequencies. The guard band between adjacent channels helps insure that interference will not occur as transmitters vary slightly in frequency due to frequency stability imperfections.

The channel spacings specified in ARCC's bandplans and in this policy document were devised to provide a compromise between maximizing spectrum utilization and minimizing interference potential.

## NBFM ON 6M, 2M, AND 1.25M

1. Applications for new NBFM coordinations on 2m above 146 MHz (15 kHz channel spacing) will be processed without adjacent-channel interference analysis. This in contrast to WBFM operations on 15 kHz channels which normally require interference analysis with respect to both co-channel operations and adjacent-channel operations as well, since there does not exist a guard band between adjacent 15 kHz channels in the case of WBFM. As such, NBFM operations may be able to be coordinated on 2m channels in congested areas where frequencies may otherwise not be available for new WBFM operations. ARCC will not coordinate NBFM repeaters on interstitial frequencies between 15 kHz channel centers above 146 MHz.
2. Applications for new NBFM coordinations in subbands which have 20 kHz channel spacing (6m, 2m below 146 MHz, and 1.25m) will be processed in the same manner as WBFM operations. That is, they will be treated as co-equal with incumbent operations as well as those applications which may be on the waiting list. As is currently the case with WBFM coordinations on 20 kHz channels, coordination analyses will be limited to only prediction of interference to/from other co-channel operations. ARCC will not coordinate NBFM repeaters on interstitial frequencies between 20 kHz channel centers.
3. An existing WBFM coordination may be converted to change the emission from WBFM to NBFM as follows:
  - a. If the technical parameters of the NBFM operation will not be different than the currently-coordinated WBFM operation except for modulation type, no technical analysis will be performed and the application to convert from WBFM to NBFM will be processed as an administrative modification to the coordination. In order to qualify, the NBFM operation must meet the following requirements:
    - i. No change to the geographical coordinates of the repeater transmitter
    - ii. No increase in transmitting antenna height
    - iii. No change in transmitting antenna pattern
    - iv. No increase in effective radiated power
  - b. If the coverage of the NBFM operation does not qualify under a), it will be processed as would any other coordination application including full technical review within ARCC as well as cross-coordination by adjacent coordination councils.
  - c. In either case a) or b), if the proposed NBFM operation can operate on a different frequency pair such that the currently-coordinated WBFM pair could be utilized by a waiting list applicant not affiliated with the NBFM operation, the application may be processed for the alternative frequency pair unless the applicant submits a statement attached to application which demonstrates why such a frequency change would not be possible due to insurmountable or costly technical factors (equipment retuning, reprogramming, and similar adjustments would not normally be deemed insurmountable nor excessively costly).
  - d. NBFM transmitters must maintain a frequency stability of 1.5 PPM or less.
4. It is ARCC's long-term plan to refarm portions of the VHF spectrum which, at present, do not have channel spacings conducive to narrowband operations. On VHF, the channel centers are spaced at either 15 or 20 kHz intervals, whereas the ideal channel spacing for narrowband FM (as well as narrowband digital) is nominally 12.5 kHz. As such, a number of successive 15 kHz or 20 kHz channels would need to be amalgamated and then repartitioned into narrowband channels. As operations are converted to narrowband, ARCC will analyze the current geo-spectral allocation situation to determine how to proceed further in refarming spectrum for narrowband

operations. Please do not misconstrue this information! ARCC is NOT forcing any operation to convert to narrowband. We are merely taking a proactive approach to frequency management, with the goal of maximizing spectrum utilization as more narrowband systems are deployed.

## **NBFM ON 70CM AND ABOVE**

1. Applications for new NBFM coordinations on 70cm in subbands which have 25 kHz WBFM channel spacing must utilize a channel center that is +6.25 kHz or -6.25 kHz from the equivalent 25 kHz-spaced WBFM channel center. That is, new NBFM operations will be offset from the traditional channel center by either +6.25 kHz or -6.25 kHz. This will allow two NBFM operations to “fit” within the spectrum normally occupied by a single WBFM operation while only slightly reducing the guard band to the adjacent WBFM channel, yet still maintaining 12.5 kHz between adjacent NBFM operations. The 6.25 kHz offset NBFM operation will have the same transmit-receive offset (+5 MHz or -5 MHz) as would a WBFM repeater on the 25 kHz channel center.
2. An existing WBFM coordination on 70cm may be converted to change the emission from WBFM to NBFM as follows:
  - a. If the technical parameters of the NBFM operation will not be different than the currently-coordinated WBFM operation except for modulation type, no technical analysis will be performed and the application to convert from WBFM to NBFM will be processed as an administrative modification to the coordination. In order to qualify, the NBFM operation must meet the following requirements:
    - i. No change to the geographical coordinates of the repeater transmitter
    - ii. No increase in transmitting antenna height
    - iii. No change in transmitting antenna pattern
    - iv. No increase in effective radiated power
  - b. If the coverage of the narrowband operation does not qualify under a), it will be processed as would any other coordination application including full technical review within ARCC as well as cross-coordination by adjacent coordination councils.
  - c. In either case a) or b), if the proposed NBFM operation can operate on a different frequency pair such that the currently-coordinated pair could be utilized by a waiting list applicant not affiliated with the NBFM operation, the application may be processed for the alternative frequency pair unless the applicant submits a statement attached to application which demonstrates why such a frequency change would not be possible due to insurmountable or costly technical factors (equipment retuning, reprogramming, and similar adjustments would not normally be deemed neither insurmountable nor costly).
  - d. Conversion of a WBFM coordination to NBFM under either a) or b) above will result in the modified coordination issued with transmit and receive frequencies altered by either +6.25 kHz or -6.25 kHz from the currently-coordinated WBFM channel center.
3. Applications for new NBFM coordinations on 33cm and higher frequency bands will only be accepted within subbands which have 12.5 kHz channel spacing. If no 12.5 kHz channels are available for the proposed operation, the policies outlined above in the 70cm case for 6.25 kHz offset channel centers will apply.

## **NBDV ON 6M, 2M, AND 1.25M**

1. Applications for new narrowband digital voice (NBDV) coordinations on 2m above 146 MHz (15 kHz channel spacing) will be processed without adjacent-channel interference analysis in the same manner as NBFM detailed earlier. NBDV, like NBFM, operations may be able to be coordinated on 2m channels in congested areas where frequencies may otherwise not be available for new WBFM operations. ARCC will not coordinate NBDV repeaters on interstitial frequencies between 15 kHz channel centers above 146 MHz.
2. Applications for new NBDV coordinations on 2m below 146 MHz (20 kHz channel spacing) will be processed in the same manner as NBFM/WBFM operations. That is, they will be treated as co-equal with incumbent operations, as well as any applications which may exist on a waiting list. Interference analyses will be limited to only prediction of interference to/from other co-channel operations. ARCC will not coordinate NBDV repeaters on interstitial frequencies between 20 kHz channel centers below 146 MHz.
3. An existing 1.25m or 2m WBFM coordination may be converted to change the emission from WBFM to NBDV using the same policies outlined earlier for NBFM.
4. Applications for new narrowband digital voice (NBDV) operations on 1.25m will be issued in the analog (FM) repeater subbands using the same channel centers and coordination requirements currently used for WBFM operations on those channels.
5. Applications for new narrowband digital voice (NBDV) operations on 6m, or conversions of WBFM to NBDV, will be issued only in the subbands reserved for digital repeaters, using the same channel centers and coordination requirements currently used. If no frequencies are available in the digital repeater subbands for the proposed NBDV operation, it may be coordinated on a frequency pair in the analog (FM) repeater subband using the same channel centers and coordination requirements used for WBFM operations on those channels.
6. See note #4 under *NBFM on 6m, 2m, and 1.25m above*

## **NBDV ON 70CM AND ABOVE**

1. Applications for new NBDV repeaters on 70cm shall utilize frequency pairs in the digital repeater subband. NBDV repeaters will be coordinated using the +6.25 and -6.25 kHz offset channel centers as detailed previously for NBFM on 70cm (440.00625 through 440.08125 and 445.00625 through 445.08125 channel centers).
2. If no frequency pairs are available in the digital repeater subbands on 70cm, new NBDV repeaters may be coordinated in the analog (FM) repeater subbands using the same policies and procedures outlined previously for 70cm NBFM repeaters utilizing frequencies that are +6.25 kHz or -6.25 kHz from a standard 25 kHz WBFM channel center. ARCC will coordinate new NBDV repeaters operating in the analog repeater subbands starting at the bottom of the analog repeater subbands and progressing upward. The intent is to keep all digital operations clustered together spectrally such that maximum flexibility remains for future bandplan modifications.
3. It is strongly recommended that applicants for new NBDV repeaters on 70cm request a list of prospective frequencies rather than specifying a particular frequency when submitting an application. NBDV applications which specify a frequency pair within the FM repeater subband will be dismissed if there exists a frequency pair in the digital repeater subband available for the proposed operation.

4. An existing WBFM coordination on 70cm may be converted to change the emission from WBFM to NBDV using the same procedures as when converting from WBFM to NBFM as detailed previously.
5. Applications for new NBDV coordinations on 33cm and higher frequency bands must use frequencies within the digital repeater and digital auxiliary link subbands. If no frequencies are available in the digital subbands, the coordination policies for NBFM will apply and the NBDV repeater or auxiliary link may be coordinated in a non-digital-exclusive subband.

## WIDEBAND DIGITAL

On 33cm and shorter wavelength bands, there are subbands reserved for digital wideband operations, including digital repeaters, digital auxiliary links, and digital simplex operations. These subbands do not utilize a fixed channel spacing because the occupied bandwidth is varied. ARCC issues coordinations for repeaters and auxiliary links in these subbands. Digital simplex operations do not fall under the realm of frequency coordination, as Part 97 only recognizes frequency coordination for repeaters and auxiliary links.

With the advent and anticipated proliferation of wideband data technologies including D-STAR digital data (DD), ARCC anticipates an increase in the utilization of these wideband data subbands. However, depending on the intent and use of such systems, they may or may not be eligible for frequency coordination. D-STAR DD operates on a single frequency, thereby making it decidedly not a repeater, and cannot be coordinated as such. D-STAR DD is most often used as an “access point” to the Internet or a private network. When a DD node is used in such a manner whereby users accessing it vary in location, it is not eligible to be coordinated as an auxiliary link. Being neither a repeater nor auxiliary link, it would normally not be eligible for coordination.

However, ARCC believes that it would be highly beneficial if these non-repeater, non-auxiliary link operations could be organized such that interference among systems is prevented or at least minimized. ARCC intends to maintain a registry of wideband digital simplex operations, but will not issue formal coordinations for such systems. ARCC’s role will be limited to maintaining and publishing the registry on ARCC’s web site. ARCC will NOT issue coordinations for digital simplex operations, nor assist in the resolution of interference situations that may arise. All simplex subbands, whether digital or analog, are shared resources. It is not uncommon, nor unexpected, to have multiple users of the same spectrum in the same geographic area for such operations.

## EMISSION DESIGNATOR AS A COORDINATED PARAMETER

ARCC reiterates that emission designator and occupied bandwidth are coordinated parameters as are site coordinates, antenna height, effective radiated power, antenna pattern, PL tone, and all other technical variables that affect coverage and interference potential. Any change to any coordinated parameter, including emission type (such as converting from analog FM to narrowband digital voice), requires a coordination application be submitted and approved. As detailed previously, in some cases conversion from wideband FM to narrowband analog or digital voice may be able to be processed as an administrative change. In other cases, the modification requires full coordination review. In all cases, if the emission type or any other technical parameter is altered prior to receiving coordination approval, the coordination will be canceled.

## CONCLUSION

It is ARCC's belief that these policies will continue to promote experimentation and provide spectrum for emerging technologies in the amateur VHF/UHF bands, while still maintaining interference protection to incumbent operations. ARCC proactively revises its bandplans and policies to keep pace with changing technologies and operating practices. Comments or questions regarding these policies can be sent to the ARCC Executive Board via postal mail or via electronic mail to [info@arcc-inc.org](mailto:info@arcc-inc.org).