

Technical Recommendations of IARU Region 1

An introduction

In order to facilitate the operations of Amateur Radio Stations the IARU at its triennial conferences adopts Recommendations. Most of those are so-called "operational recommendations" (such as band-plans and contest-rules). But during the past 30 years several "technical recommendations" have been adopted as well. This note deals with the content and background of those technical recommendations.

A.1. FREQUENCY MODULATED TELEPHONY

A.1.a. The basic NBFM standard (Recommendation FM.1.)

One of the longest standing IARU Region 1 technical recommendations, adopted at the Region 1 Conference in Brussels (1969) deals with the basic parameters of Narrow Band FM Telephony. It states : "*For NBFM within Region 1 a maximum modulation index of 1 and an audio band restricted to 3 kHz shall be used*"

Between 1963 and 1969 the gradual introduction of VFO controlled SSB, replacing AM(x-tal controlled), was taking place on VHF. At the same time, however, the problems with LF break-through in radio-, TV- and audio equipment became embarrassing. Using FM and PM appeared to be the right solution in this case. Of course the recently acquired habit of VFO control and co-channel working was used with NBFM as well.

In order for an efficient use of NBFM it appeared necessary to agree upon a few basic parameters which would determine the optimum filter to be used in the receiver. A 12 kHz receiver bandwidth was finally chosen. This appeared to be the minimum value giving distinctly better quality than 6 kHz AM without showing too much of a threshold effect (at least not much more than conventional AM). Soon after the recommendation had been adopted several manufacturers of crystal-filters marketed 12 kHz wide filters.

Almost 30 years later this basic recommendation still is in force, although VFO controlled NBFM has almost disappeared (it still is used with rain-scatter on the microwaves) and the majority of amateurs use crystal-controlled NBFM transceivers with filters wider than 12 kHz, thus loosing several dB's in communications efficiency.

It must be noted that the application of the recommendation is not limited to frequencies above 30 MHz. It equally well applies to the 29 MHz band, although it appears that NBFM on that band is often received with filters narrower than 12 kHz.

Three years later, at the 1972 Scheveningen conference, a more detailed standard, largely based upon the first was adapted, but this time VFO control appeared to be out of fashion and the standard dealt with "Fixed channel FM stations". The audio response was specified more in detail as *300-3000 Hz with a 12 dB/octave fall off outside this band and 6 dB/octave pre-emphasis*.

It appears sensible to combine those two recommendations into a single one at a future conference.

A.1.b. NBFM Repeaters (Recommendation FM.2.)

At the 1972 Conference in Scheveningen a recommendation was worded for the then appearing NBFM repeaters. Initially the recommendation only was meant for the 145 MHz band, but later the 435 MHz band was added. The recommendation -of course- was based upon the standing recommendation for the audio channel parameters (FM.1.). But in addition the antenna polarisation was recommended as being *vertical* which was a logical choice for a system meant to be used by mobile stations. Note that, although no recommendation on antenna polarisation existed at the time, consensus existed on the use of horizontal polarisation for all VHF and UHF activities and that still is the case for all non-channelised activities on VHF/UHF.

In order to make the planning of repeaters using the same channel easier a *maximum ERP of 15 Watts* was recommended. As, however, the antenna height above the surroundings was not specified this ERP limit is not sufficient for the planning, but no additions have been made to this recommendation.

The major flaw of the recommendation is the lack of any explicit specification of the receiver bandwidth. Had the receiver parameters been defined compatible with the transmitter definition (some people think this is implicit) some difficulties in a few countries with the introduction of a 12.5 kHz channel spacing system would never have been arisen.

A.2. DIGITAL TRANSMISSION

A.2.1 Data-transmission (Recommendations D.1.1. and D.1.2.)

At the 1975 Conference in Warsaw standards for RTTY/AMTOR were adopted (Recommendation D.1.1.), based upon the practice in the amateur bands. At that time on the VHF/UHF bands NBFM was becoming widely used and the recommendation took that into account. Although the text speaks of "bandwidth efficiency" that efficiency was not yet

deemed too important at VHF-UHF.

On the HF bands FSK/PSK is almost exclusively used and those methods were recommended for VHF and higher frequencies as well. FSK for speeds below 300 bit/s and PSK for higher signalling rates (which were not used at HF). In addition FM/AFSK was recommended although only for 300 and 1200 bit/s. The latter standard was not so much determined by considerations of bandwidth and communications efficiency, but almost exclusively by the ease of using telephone line modems connected to the audio in-and output of TX and RX.

In practice initially 45 or 50 bit/s RTTY was used with 170 Hz or 850 Hz shift and with FM/AFSK the space frequency was set at 1275 Hz, the mark frequency 170 or 850 Hz higher.

On VHF/UHF, however, RTTY activities declined and most stations began to use 300 or 1200 bit/s "packet-radio" via an NBFM channel.

In 1987, therefore, a more general recommendation (D.1.2.) was adopted where AMTOR/RTTY and PACKET applications were dealt with. The essentials of D.1.1. were not changed. Although many amateurs today use higher speed packet data transmission systems, it appears that the note of the recommendation stating that FM/AFSK should not be used >1200 bit/s is often neglected . It appears that the interest for experimentation with high speed data transmission is rather low.

The FM/AFSK recommended modulation methods were intended to use the "radio-channel" between two stations just like a telephone channel, whereby the radio-channel in general has a much better group-delay characteristic. The bandwidth efficiency is very low.

A.2.2. Digital telephony (Recommendation D.2.)

Although analog transmission of telephony in public networks is generally replaced by transmission of digitalised speech , amateurs have not experimented much in this field. This may change once more "intelligent" coding/decoding systems/chips will become available. In order to stimulate experiment the 1984 conference in Cefalu recommended to start those experiments using Continuously Variable Slope Delta Modulation. This was at that time a relatively efficient coding schema and several companies distributed codec-chips. A signalling speed of 16 kbit/s over a ± 10 kHz shifted FSK channel seems a good compromise between bandwidth, quality and communications efficiency.

A.3. AMATEUR (wide band) TELEVISION

A.3.1. Vestigial Sideband AM (Recommendation V.1.1.)

After some initial experiments with fast-scan TV transmission in the 145 MHz band around 1955/60 the wider 435 MHz band seemed ideal for fast-scan broadcast quality ATV experiments. Although in several Region 1 countries the parameters were set by the national administration, IARU Region 1 at its 1969 Conference in Brussels recommended "CCIR-2, following the Gerber standard". At a later conference (Warsaw 1975) it was recommended to use "vestigial sideband techniques in the 435 MHz band" and at the same time "medium band ATV or SATV" was brought forward in order to "conserve bandwidth" in the 435 MHz band. This aspect was important as in several countries in Region 1 amateurs could only use part of the 430-440 MHz band. The 1987 Noordwijkerhout conference recommended that Vestigial Sideband ATV in the 435 MHz band should use the 434-440 MHz segment with the carrier frequency either below 434.5 or above 438.5 MHz. This, in fact, determined the maximum allowed bandwidth of the modulated signal.

A.3.2. Medium bandwidth ATV (Recommendation V.1.2.)

As in several countries only 6 MHz of the 435 MHz band is allocated, the "normal" ATV transmission is not possible. As an alternative the relatively narrow-band system proposed by DC6MR has been recommended as an alternative.

A.3.3. FM-ATV (Recommendation V.2.)

For ATV experiments above 1 GHz a recommendation was adopted at the 1991 Torremolinos Conference. The recommendation was based upon the emerging standards for satellite TV transmitters, but as in many of the microwave amateur bands the available spectrum was limited, a *channel bandwidth of 18 MHz (-60 dB)* was recommended. Although the standard was adopted without much discussion, at the 1996 Tel Aviv conference it was decided that it was not possible to adhere to the given bandwidth limitation when complying with all other parts of the recommendation. This was due to the recommended audio sub-carriers at 5.5 or 6 MHz . At the Lillehammer 1999 Conference the standard was amended in the shared microwave bands. Although the level of the spectrum outside the main spectral lobe is not yet ideal, the standard is now more realistic.

A.4. FACSIMILE (Recommendation V.3)

At the 1978 Conference in Miscolc-Tapolca a standard for facsimile was adopted, based upon wide-spread practice on HF and VHF . Frequency modulation with a "shift" of 800 Hz is the basic modulation method, but above 144.5 MHz a compound modulation (FM/AFM with the audio FM between 1500 and 2300 Hz) is permitted. The implication is that with (preferred) FM the channel bandwidth required is in the order of 1 kHz but that for the same type of transmission some 12 kHz bandwidth is used for FM/AFM on 145 MHz. The 1978 standard is not complete, but no

society has since proposed additions. In practice "slow-scan" ATV transmissions use the same basic standard.

B. REPORTING

B.1. SIGNAL REPORTING (Recommendation R.1; R.2)

Although from the beginning of amateur radio signal reports have been essential, no formal standard for the reports exists. But the "Readability, Strength, Tone" system with R,S and T values between 1 and 9 is in widespread use. Several handbooks gave and give in words indications how the values are to be understood.

The readability and tone reports are in principle "subjective" but the strength report can be objective as a simple measurement of the received signal in voltage or power is possible. Such reports are in particular at the VHF and higher frequencies useful for more precise evaluation of propagation, antenna properties and receiver sensitivities.

At the IARU Region 1 Conference in Hungary 1978 the need for a harmonised standard for the "S-meter scale" was expressed and a proposal was accepted for publication in society journals. The essential recommendation was *1 S-point is 6 dB*. At the Brighton Conference in 1981 the recommendation was formally adopted as a standard for amateur radio equipment manufacturers.

At the 1990 Torremolinos conference an amendment was adopted which reconfirmed the -93 dBm reference level for frequencies above 144 MHz, but no statement was issued for the bands between 30 and 144 MHz.

Although not explicitly stated the implication of the recommendation is that on VHF and higher frequencies the S-meter will deviate on the thermal noise only (S2 in 3 kHz bandwidth, S3 in 12 kHz bandwidth). Although the recommendation is not too complex it seems to be rather difficult to implement by commercial manufacturers.

Another matter is the "tone" report. This is a subjective measure. It was important in the "old days" when rather primitive oscillators were used in the TX. Modern transmitters, even on the millimeter bands, have in most cases a very good oscillator, resulting in a "pure tone" and a T9 report is generally given. On VHF and higher, however, the characteristics of the propagation medium can significantly "modulate" the signal (doppler shift, spreading) and a T9 report is not possible. Definitions of tone reports below 9 are rather vague. At the Region 1 conference 1999 in Lillehammer a recommendation (R.2) has been accepted to use special letters for signal tone reports when the influence of the propagation is detectable. Such reports can support propagation studies.

C. ANTENNA POLARISATION (Recommendation P.1.)

At several conferences the antenna polarisation has been discussed. Interestingly enough the use of horizontal polarisation, almost exclusively used for non-channelised amateur traffic on VHF and higher frequencies has never been formally recommended. Part of recommendation FM.2. recommends vertical polarisation for NBFM repeaters

At the Lausanne conference in 1953 (this is really the oldest technical recommendation of Region 1) the helical antenna thread direction was laid down. Why that was done at the time is unclear, but 30 years later (Cefalu 1984) the EME community felt a need for the definition of circular polarisation for EME contacts. 12 years later, however, it was recommended to use for EME above 3 GHz linear polarisation for the time being.

As using circular polarisation appears to have advantages for repeater stations the matter may come up again at future conferences.

D. BEACONS (Recommendation B.1)

Although any type of beacon (including the TX of repeaters) can be used as a propagation indicator and/or receiver quality reference, some standards for the beacon parameters are useful. In particular the frequency spacing and tolerance are of importance for the planning of the Region 1 beacon coordinator. The frequency tolerances have been tightened at recent conferences due to the requirements for a more efficient "packing" in the rather narrow exclusive beacon segments. The recommendation, however, leaves room for "specialities".