Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Amendment of Part 97 of the Commission's Rules	)	WT Docket No. 05-235
To Implement WRC-03 Regulations Applicable to	)	
Requirements for Operator Licensing in the	)	
Amateur Radio Service	)	
	)	

Reply To Comments of Mr. Paul K. Boomer on My Blanket Reply To Comments Of Those Seeking Retention Of Test Element 1 For Any License Class Examination

Submitted on 11 September 2005 by:

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General

This Reply to Comments is made in regards to Mr. Paul K. Boomer's 8 September 2005 Reply To Comments concerning his criticism in regards to a basic advantage in receiving bandwidth favoring common narrowband receiving bandwidths used in amateur radio telegraphy over common bandwidths used with amateur radio single-sideband suppressed-carrier AM voice. This will show that the advantage does exist for reception of radiotelegraphy and my value in decibels is correct but that Mr. Boomer's numbers and formulas are not fully referenced and tend towards the egregious in this particular argument.

Claude Elwood Shannon's *A Mathematical Theory Of Communications* seminal paper, originally published in the Bell System Technical Journal of July and October, 1948, is included as a separate attachment.

Discussion

1. My Original Text in Regard to *the Noise-Immune Weak-Signal Hypothesis* (Item 2)

The following is verbatim from my 5 September 2005 Reply To Comments:

"CW [radiotelegraphy] *gets through when nothing else will."* That *morse myth* may have been born

in pre-World-War-Two days in reference to early amateur radio when there was little choice in modes among amateurs other than manual radiotelegraphy and amplitude-modulated voice. In a comparison of bandwidth effects, manual radiotelegraphy offers only a 3.5 db random noise improvement over single-sideband voice.[1] With equal bandwidth receiver filters and equal-rate mode throughput, phase-shift or frequency-shift keying has about a 3 db power improvement over on-off carrier keying for noise immunity.[2]

--- End of first paragraph of original text in Item 2

I apologize to the Commission and Mr. Boomer in regards to my error on original text footnote 1. The formula used for deriving the 3.5 db power advantage of radiotelegraphy over SSB voice is commonly called the *Nyquist Noise Formula* not C. E. Shannon's famous paper of 1948 as indicated in footnote 1 reproduced below. The standard pure-resistive load Root-Mean-Square noise voltage formula used for my value was taken from *Electronic Designers' Handbook*[3] equation 7.2 on Page 7-5:

$$E_n = \sqrt{4\ k\ T\ \Delta f\ R}$$

Where:

E_n = RMS value of thermal noise within bandwidth Δf across R

k = Boltzmann's constant of $1.38 \cdot 10^{-23}$ joules/° Kelvin

T = Temperature of R in °K, R purely resistive in Ohms

Δf = Bandwidth in Hertz containing the thermal noise

Noise is the limiting factor as to lowest possible signal level in a radio circuit to maintain a given signal-to-noise ratio. Random noise occurs in any resistive conductor above Absolute Zero.

Given a comparison of only two bandwidths (500 Hz and 2500 Hz) **with all other factors equal,** the difference is the square-root of 5 or 2.23607 (to five decimal fractions). Converted to **power** decibels

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[1] Based on a 500 Hz bandwidth receiver bandpass filter for manual radiotelegraphy and a 2.5 KHz bandwidth receiver bandpass filter for SSB voice. According to *Shannon's Law*, the random noise improvement is in indirect square-root proportionality of bandwidth or, in this case, the square-root of 5.0. In the power decibel formula of 10 x Log_{10} (bandwidth) that would be about 3.5 db.

[2] That presumes an elementary phase-lock-loop (PLL) detection system to demodulate the mode data from either phase-shift or frequency-shift keying of binary data, that demodulation compared to conventional beat-frequency-oscillator (BFO) heterodyning commonly used with manual radiotelegraphy reception. A greater improvement in noise immunity is possible using error-correction coding of binary data to eliminate single bit errors or detecting double bit errors.

[3] *Electronic Designers' Handbook* by Robert W. Landee, Donovan C. Davis, Albert P. Albrecht, McGraw-Hill Book Company, 1957. Nyquist's thermal noise formula has been reproduced in many and varied text books on electronics since 1957.

that results in 3.5 db. If that were converted to voltage or current decibels it would be 7.0 db. There is no error in that initial condition or its numeric calculation. The remainder of Mr. Boomer's criticism is quibbling.

2. The Alleged *3 db Advantage* of Radiotelegraph Operators over Radiotelephone Operators

Mr. Boomer makes an absolute statement without reference, saying: "*Morse code operators can reliably receive messages with a pre-detection carrier-plus-noise-to-noise (C/N) ratio of 3 db.*" Apparently that is some sort of common assumption by radiotelegraph operators but no reference is made for this absolute value. It may exist but such an alleged fundamental principle should be as a result of actual scientific testing with the full details of the test subjects given as to experience and pre-experiment rates of reception accuracy.

I will concede that the ear-mind can resolve a repetitive signal in a low ratio of signal-plus-noise to noise situation. However, the efficacy of such signal discrimination is, from this Commenter's observation highly variable, so much so as to not be quantifiable.

3. Quibbling Over Exact Numbers Under Variable Circumstances

My original Reply To Comments used a singular condition of comparison of two bandwidths, all other factors remaining identical. That was considered **basic** for discussion since, under highly variable circumstances such as are possible in emergency communications, there is **no guarantee** that the other end of the radio circuit is optimized for radiotelegraphy reception.

Mr. Boomer attempts a rigorous mathematical discussion of low-signal-level reception of radiotelegraphy signals versus only one other mode, single-sideband suppressed-carrier amplitude modulation of voice (common on amateur radio HF bands). He has barely scratched the surface of possible means of reception available to radio amateurs and not mentioned a variety of methods of post-reception signal processing or of error-correcting codes used with data modes nor touched on PSK31. He has avoided any mention of amateur radio band mode use above 30 MHz operation.

There are several possibilities for augmenting reception of nearly every mode available to radio amateurs through peripheral equipment. Forward-error-correction coding of data used with phase-shift keying offers better low-signal operation, at higher rates than is common in radiotelegraphy, and without needing specific manual radiotelegraphic skills.

The BFO or Beat Frequency Oscillator has long been used in radiotelegraphy reception, yielding the familiar *beep* sound of the radiotelegraphy dots and dashes. That oscillator circuit in a receiver deliberately mixes the incoming, amplified signal with a local stable continuous-wave frequency slightly different from the incoming frequency. The difference or *heterodyne* is adjusted by the receiving operator to be an audio frequency signal or the tone of the beep sound.[4] This has a subtle

[4] Identical action is done in more modern, common SSB receivers which use *product detectors* and *carrier-reinsertion oscillators*, the reinsertion oscillator acting as the old BFO for radiotelegraphy reception. For

difference in improving the repetitive versus random ratio perceived by the ear-mind of the receiving operator. If that BFO is switched **off** the ear-mind can perceive only a **slight** difference in signal-plus-noise to noise...if any at all.[5] If, in a real emergency situation, the only working receiver does not have a BFO or SSB demodulating system capable of simulating the BFO action, the alleged advantage of radiotelegraphy discrimination over voice signals will not be there.

So far, all the proponents of keeping radiotelegraphy skill in amateur radio seem to think that all other radio amateurs are equipped for optimum radiotelegraphy reception. There is **no guarantee in any emergency communications condition** that such is possible. Emergencies do not come pre-defined with *rules* such as is found in amateur radio contact contests.

4. Radiotelegraphy Skill Is A Life-Saving Advantage In Emergencies

Mr. Boomer's last paragraph in his Reply To Comments is as follows: *"It is a fact that Morse code communications can provide critical connectivity with substantially weaker signals than SSB voice, a life-saving advantage in emergencies."* While that was once true at sea, it is no longer.[6] **In any emergency condition there is no guarantee that the receiver at the other end of a radio circuit is either optimized for radiotelegraphy reception or even has a radiotelegraphy operator present!** Real emergencies happen with great variation of conditions, sometimes said to *vary from bad to worse.*[7]

The majority of United States amateur radio operations are done from fixed land-based locations in a residence. A minority of operations are done from handheld, walking-mobile or vehicle-mobile variable locations. Emergency areas such as the landfall location of hurricane Katrina on 28 to 29 August, 2005, causing extensive destruction of residences and the infrastructure (including primary electric power generation) in Louisiana and Mississippi Gulf coast region are all within Line-Of-Sight of survived, much-less-devastated land areas. Line-Of-Sight (LOS) distances are approximately 25

SSB reception the carrier reinsertion takes the place of the missing (actually suppressed) carrier frequency of the SSB signal.

[5] It is an interesting experiment to challenge any radiotelegraph operator on very low-signal reception with **no BFO** (or carrier reinsertion oscillator) on a receiver. This Commenter has done this and found that even experienced radiotelegraph operators suddenly **lose** their ability to perceive radiotelegraph signals better than radiotelephone signals.

[6] The early days of radio prior to World War One saw an enthusiastic adoption of early radio to seaborne life, radio providing something never before achieved at sea: Instant communications over the horizon. After the terrible disaster of the Titanic sinking the 500 KHz radiotelegraph-mode International Maritime Distress and Safety frequency was established and used on up to the end of the previous millennium. The open ocean can be described as sparsely populated radio territory and great distances at sea need powerful radio transmitters and sensitive receivers. The letters S-O-S, even the rhythmic pulses of radiotelegraph signals became well-known to the public after several early at-sea rescues were effected through 500 KHz calls for help. That all changed with the maritime world's adoption of the Inmarsat-relayed GMDSS or Global Marine Distress and Safety System was made internationally at the end of the previous millennium. GMDSS uses data modes, is relatively simple to operate by a ship's bridge officers, no radiotelegraphy skill specialty required.

[7] One of many common folk-sayings in our society.

statute miles on flat land: such distances are communicable with a variety of radios from MF to beyond UHF bands using available radio equipment, amateur to professional/commercial.[8] It should be pointed out that the majority of residences in the New Orleans, LA, city area were flooded in the aftermath of hurricane Katrina and their electrical power cut off. Flooding disabled many personal vehicles that might have been used for vehicle mobile communications for any radio service.

Very few VHF-and-above amateur radios are equipped for optimum radiotelegraph reception; most are operated using frequency-modulated voice. While radiotelegraphy might be effected using frequency-shift-keying (or phase-shift-keying), such is a rarity in amateur radio operation above 30 MHz. Below 30 MHz United States radio amateurs have ready-manufactured transceivers and radio equipment which do have reasonably-optimized radiotelegraphy reception capability.[9] However, very few of those ready-manufactured HF transceivers are capable of operating **away from allocated amateur radio bands.** Since real emergencies have no *rules*, such an emergency may not allow any amateur radio contact whatsoever. Further, no licensed amateur radio operators may survive in a real emergency locale; such equipment may have to be operated by licensed or unlicenced individuals not required to know radiotelegraphy.[10]

Given that there are over 700 thousand amateur radio licensees in the Commission's license database[11], it is doubtful that low-power, weak-signal radio contacts are necessary in real emergency situations, those situations typically well within a 50-mile wide distance, any azimuth.[12] Radiotelegraphy skill is not seen as advantageous in emergency operations; had it been so, then other radio services directly involved in emergency operations would have retained it for their emergency communications. In particular, maritime radio with its storied 500 KHz *SOS* distress calls. They have not.

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[8] The United States military often uses NVIS or Near-Vertical-Incidence-Skywave (pronounced *nevis*) on HF to VHF for radio circuit distances up to 300 statute miles. Radio amateurs sometimes colloquially refer to NVIS propagation as *cloud-burning* and with some scorn.

[9] The common narrowband filter available to such HF transceivers is 500 Hz bandwidth, hence its use in the original text of this Commenter's Reply in comparing thermal noise using different bandwidths.

[10] Real emergencies involving life-endangerment may happen and unlicenced individuals such as medical specialists may have to assist those in the emergency location. In such instances, any need to know radiotelegraphy skill or radiotelegraph procedure is egregious. I personally doubt if the Commission would prosecute any Technician class licensee from operating HF radios (beyond their regulations) in a real emergency involving life danger.

[11] 721,351 individual licensees (exclusive of *club* licenses) according to www.hamdata.com of 9 September, 2005.

[12] In several real emergencies of the 1990s and 2000s in the United States, only the southwest and northwest wildfires and forest fires exceeded this 50 mile arbitrary dimension. Flooding of the tributaries to and northern part of the Mississippi river exceeded 50 miles but there was half that distance on either side that remained open to land-based radio operations. There is no poll or other data to indicate how many licensed radio amateurs are active in operations; in all probability there are at least half of them active. Given a Unites States total land area of 3.5 million square miles and 350 thousand active radio amateurs, there would be an average of 1 active radio amateur for every 10 square mile area.

Any mode of communications may be valuable in any real emergency situation. The Commission does not mandate any radio amateur to operate exclusively in radiotelegraphy mode. Telegraphy skills may be acquired by anyone outside of United States amateur radio license testing; the license test is solely for the Commission's determination in granting an amateur radio license.

SUMMARY

Mr. Boomer has quibbled about low-signal sensitivity levels and used un-referenced data supposedly showing some alleged additional radiotelegraph operator signal-to-noise discrimination over single-sideband suppressed-carrier amplitude modulation of voice. He has not done any comparisons to other modes allocated to United States radio amateurs. Mr. Boomer has not shown any valid case for supporting his contention that amateur radio radiotelegraphy skill testing for a license is either essential or necessary to effect any emergency communications by amateur radio. Real emergencies in real locations do not have pre-defined rules or limits by which to judge the efficacy of any particular mode over another. Any mode may be used for emergency communications. Any statement saying that the manual radiotelegraphy test for an amateur radio license in order to effect emergency communications is fallacious. The Commission yields all amateur radio licensees their **option** in operating any allocated mode, any allocated band or channel, any license class. **Option is not a failure.**

A Thank You

I wish to thank the Commission for permitting a private citizen of the United States, one who holds no amateur radio license, to comment on regulations governing the obtaining of a United States amateur radio license grant.

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Veteran, United States Army 1952 to 1960 (Signal Corps), Honorable Discharge 1960
General Radiotelephone (Commercial) Radio Operator license from a First Class Radiotelephone Radio Operator License first obtained in March, 1956, and kept renewed.
Former contributor to and then Associate Editor of *Ham Radio* magazine prior to 1990.

Separate file attached through the ECFS, *A Mathematical Theory of Communications* by Claude E. Shannon, Bell System Technical Journal, July and October 1948, a copy obtained via Internet: http://ch.bell-labs.com/ch/ms/what/shannonday/shannon1948.pdf