Attachment B to ARINC
Reply Comments – Docket
ET 04-37, June 22, 2004

Radio Noise and Aeronautical HF Communications

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ARINC, in its normal day-to-day operations, uses the HF frequency bands to their greatest efficiency. This means that when propagation is known to be poor, or when atmospheric conditions are known to be high, ARINC routes its radio traffic to frequencies that are more conducive to higher levels of communications quality. Therefore, the times in which noise on a particular frequency band is high, ARINC avoids those frequencies.

It should be noted that the NTIA study utilized for its noise calculations (page 6-5 of the NTIA Phase I Study) a noise value derived from a location in Kansas City, KS, and a residential condition. ARINC's receiver locations are not in Kansas, and they are not located in residential neighborhoods. The receive sites are all located in quite rural areas, with one site near Half Moon Bay, CA. ARINC recalculated the expected noise floor using the same noise program as NTIA, ITS' NOISEDAT, only using Half Moon Bay as the location, and quite rural noise values. the printout of the program is attached. The overall noise values for each time period was utilized, with an average of the noise over time and seasons for one year compiled. For 4 MHz, the noise level for these parameters was calculated to be -156.67 dB/Hz. Converting to a noise bandwidth of 2.8 kHz gives a noise power of –122.20 dBW. This value is lower than the NTIA value by 10.9 dB which means that the expected noise floor for our HMB site is nearly 10.9 dB lower than the NTIA expects. This also means that the projected signal to interference ratio calculated by NTIA is now 10.9 dB worse.

At this point it should be noted that this method of determining an expected noise floor, and consequently a signal-to-noise ratio, for a single sideband (SSB) signal can be misleading. The combination of the power bandwidth of the noise calculation and the apparent bandwidth of the human ear contribute to this confusion. Though the method for establishing a signal-to-noise ratio employed by NTIA works well for detection of other modes of communication such as FM and various digital modulations, SSB demodulation is different. SSB demodulation is not demodulation at all, but rather frequency translation. With SSB "demodulation" each RF frequency is simply translated to a base band frequency (i.e., audio signals). At this point the human ear "detects" the "composite signal", extracting the intelligent speech. The human ear is a wonderful and marvelous device, performing instantaneously a Fast Fourier Transform (FFT) function and, through the used of the brain, translates the FFT information over time into intelligent speech. Because the human ear can detect frequency changes down to 10 Hz, an argument can easily be made that the bandwidth of the human ear is also 10 Hz (or less). By applying this bandwidth to the expected noise floor calculated above, a more realistic noise floor would be only 10 dB [$\Delta = 10 * \log_{10}(10\ \text{Hz}) = 10$ dB] above the noise level calculated by the program. This translates to noise levels of -156.67 dBW, -173.18 dBW, and -184.47 dBW for 4, 15, and 25 MHz respectively, corresponding to -126.67 dBm, -143.18 dBm, and -154.47 dBm for 4, 15 and 25 MHz respectively.

This correlates quite well with the normal operating conditions that ARINC typically works within. In many cases, especially when atmospheric noises are at a minimum, the HF communications systems are operated at or near the noise floor of the receiver itself. While this would not be acceptable for so-called "toll quality" voice such as that for which designers of cellular systems strive in order for mobile communications to work well for the general public, ARINC employs trained radio operators who are skilled in handling traffic under such conditions. What all this means is, great care must be taken in comparing the background noise levels to the noise(s) attributed to BPL signals. If the noises are not evaluated properly, i.e. bandwidth to bandwidth, an unrealistic signal-to-noise ratio will be arrived at and degradation in in-situ signal-to-noise ratios will be experienced.

Conclusions:

1) Naturally occurring noise is a reality of communications at the HF frequencies and is already accounted for in the ARINC operations. Many of the signals received from aircraft are normally near the noise level or the particular frequency being used and no increase in the ambient noise can be tolerated without a direct decrease in the received signal-to-noise ratio.

2) The parameters used by NTIA to determine normal background noise floors may be adequate for many modes of wireless communications but do not reflect the operating conditions to which ARINC is exposed. If the residential noise levels, levels which are much higher than the quite rural areas in which ARINC's operations are located, are used to calculate the expected change in signal-to-noise ratio, an unrealistic acceptance level will be attained.

3) The methods used by NTIA to determine a particular normal ambient noise floor for a particular bandwidth do not apply to SSB communications. They give an unrealistically higher level of noise than is realized in practical applications of HF communications. If these unrealistically higher levels of noise floors are utilized in determining acceptable noise limits from Access BPL systems, then considerable interference will be experienced by HF frequency users such as ARINC.

Noise Calculations at Half Moon Bay Using NOISEDAT.EXE

Input Variables: Half Moon Bay, CA Receiver Site
Quite Rural Noise

LAT = 37.39, LONG = -122.41, hmb
WINTER, FMHZ = 4.000, QUIET RURAL NOISE

	---MEDIAN NOISE VALUES IN DBW--				STATISTICAL VALUES IN DB ATMOSPHERIC NOISE				
TIME BLOCK	ATMO	GAL	MANMADE	OVERALL	DL	DU	SL	SM	SU
0000-0400	-152.2	-165.8	-167.6	-151.7	6.2	7.8	2.2	3.5	2.4
0400-0800	-153.5	-165.8	-167.6	-153.1	8.9	10.1	2.8	3.5	2.3
0800-1200	-182.3	-165.8	-167.6	-164.9	7.1	8.7	3.0	4.6	3.5
1200-1600	-178.5	-165.8	-167.6	-164.7	7.0	8.6	3.0	5.3	3.7
1600-2000	-160.3	-165.8	-167.6	-159.0	9.7	10.9	3.2	4.1	2.8
2000-2400	-151.6	-165.8	-167.6	-151.2	7.1	8.6	2.7	3.9	2.7

LAT = 37.39, LONG = -122.41, hmb
SPRING, FMHZ = 4.000, QUIET RURAL NOISE

	---MEDIAN NOISE VALUES IN DBW--				STATISTICAL VALUES IN DB ATMOSPHERIC NOISE				
TIME BLOCK	ATMO	GAL	MANMADE	OVERALL	DL	DU	SL	SM	SU
0000-0400	-147.3	-165.8	-167.6	-147.1	7.6	7.8	2.4	3.5	2.1
0400-0800	-159.1	-165.8	-167.6	-158.4	11.5	12.1	2.8	3.1	2.8
0800-1200	-180.3	-165.8	-167.6	-164.7	7.7	10.5	3.5	3.9	4.3
1200-1600	-179.0	-165.8	-167.6	-165.4	9.2	13.5	4.6	5.0	5.5
1600-2000	-158.0	-165.8	-167.6	-157.8	12.3	14.2	3.4	3.6	3.8
2000-2400	-148.8	-165.8	-167.6	-148.5	6.9	7.0	2.0	3.7	2.0

LAT = 37.39, LONG = -122.41, hmb
SUMMER, FMHZ = 4.000, QUIET RURAL NOISE

	---MEDIAN NOISE VALUES IN DBW--				STATISTICAL VALUES IN DB ATMOSPHERIC NOISE				
TIME BLOCK	ATMO	GAL	MANMADE	OVERALL	DL	DU	SL	SM	SU
0000-0400	-149.5	-165.8	-167.6	-149.2	7.1	7.1	2.3	4.5	2.1
0400-0800	-158.1	-165.8	-167.6	-157.4	10.9	11.5	3.2	3.8	3.0
0800-1200	-185.2	-165.8	-167.6	-164.9	7.9	11.5	3.5	5.0	4.2
1200-1600	-170.5	-165.8	-167.6	-168.6	10.9	15.5	4.6	6.5	5.8
1600-2000	-153.2	-165.8	-167.6	-153.1	12.4	13.7	3.6	4.3	3.9
2000-2400	-146.4	-165.8	-167.6	-146.2	5.5	5.3	1.7	4.3	1.5

LAT = 37.39, LONG = -122.41, hmb
AUTUMN, FMHZ = 4.000, QUIET RURAL NOISE

	---MEDIAN NOISE VALUES IN DBW--				STATISTICAL VALUES IN DB

TIME BLOCK	ATMO	GAL	MANMADE	OVERALL	ATMOSPHERIC NOISE DL	DU	SL	SM	SU
0000-0400	-148.9	-165.8	-167.6	-148.6	7.7	8.1	2.3	3.1	2.1
0400-0800	-154.8	-165.8	-167.6	-154.4	10.7	11.3	2.7	3.9	2.8
0800-1200	-179.6	-165.8	-167.6	-164.6	7.6	10.6	3.1	4.2	4.6
1200-1600	-177.9	-165.8	-167.6	-164.3	8.4	12.0	3.7	5.0	4.8
1600-2000	-153.9	-165.8	-167.6	-153.7	10.8	12.0	3.1	3.5	3.1
2000-2400	-148.9	-165.8	-167.6	-148.6	7.0	7.3	2.0	3.6	2.2

LAT = 37.39, LONG = -122.41, hmb
WINTER, FMHZ = 15.000, QUIET RURAL NOISE

	---MEDIAN NOISE VALUES IN DBW--				STATISTICAL VALUES IN DB ATMOSPHERIC NOISE				
TIME BLOCK	ATMO	GAL	MANMADE	OVERALL	DL	DU	SL	SM	SU
0000-0400	-188.8	-179.1	-184.0	-179.0	3.2	4.2	1.7	4.2	2.7
0400-0800	-182.2	-179.1	-184.0	-177.4	4.1	5.3	1.7	3.2	2.9
0800-1200	-173.6	-179.1	-184.0	-171.8	5.5	7.2	2.1	5.5	3.6
1200-1600	-166.8	-179.1	-184.0	-166.3	5.6	7.5	1.9	5.7	4.1
1600-2000	-174.4	-179.1	-184.0	-172.3	5.2	6.6	1.9	3.8	3.7
2000-2400	-178.8	-179.1	-184.0	-175.7	4.2	5.1	2.1	3.8	3.0

LAT = 37.39, LONG = -122.41, hmb
SPRING, FMHZ = 15.000, QUIET RURAL NOISE

	---MEDIAN NOISE VALUES IN DBW--				STATISTICAL VALUES IN DB ATMOSPHERIC NOISE				
TIME BLOCK	ATMO	GAL	MANMADE	OVERALL	DL	DU	SL	SM	SU
0000-0400	-179.8	-179.1	-184.0	-176.2	4.3	5.2	1.9	4.0	2.6
0400-0800	-177.8	-179.1	-184.0	-174.6	5.5	6.3	2.0	3.8	2.5
0800-1200	-175.3	-179.1	-184.0	-172.9	5.5	7.5	1.8	4.6	3.0
1200-1600	-172.1	-179.1	-184.0	-170.9	6.1	8.7	1.9	4.9	3.1
1600-2000	-168.6	-179.1	-184.0	-168.0	6.3	7.7	2.0	4.0	2.4
2000-2400	-175.5	-179.1	-184.0	-173.3	4.5	5.4	1.8	3.7	2.4

LAT = 37.39, LONG = -122.41, hmb
SUMMER, FMHZ = 15.000, QUIET RURAL NOISE

	---MEDIAN NOISE VALUES IN DBW--				STATISTICAL VALUES IN DB ATMOSPHERIC NOISE				
TIME BLOCK	ATMO	GAL	MANMADE	OVERALL	DL	DU	SL	SM	SU
0000-0400	-179.6	-179.1	-184.0	-176.3	3.9	4.7	1.4	4.0	1.9
0400-0800	-177.3	-179.1	-184.0	-174.6	5.0	5.5	1.5	3.2	1.9
0800-1200	-179.2	-179.1	-184.0	-175.3	4.9	6.8	1.7	4.8	2.5
1200-1600	-172.7	-179.1	-184.0	-171.4	5.6	8.4	1.9	4.4	3.0
1600-2000	-167.4	-179.1	-184.0	-166.8	5.8	7.1	1.8	5.9	2.2
2000-2400	-172.7	-179.1	-184.0	-171.2	4.0	4.7	1.5	3.0	1.7

LAT = 37.39, LONG = -122.41, hmb

AUTUMN, FMHZ = 15.000, QUIET RURAL NOISE

TIME BLOCK	ATMO	GAL	MANMADE	OVERALL	DL	DU	SL	SM	SU
	---MEDIAN NOISE VALUES IN DBW--				STATISTICAL VALUES IN DB ATMOSPHERIC NOISE				
0000-0400	-185.5	-179.1	-184.0	-178.5	4.1	4.5	1.8	4.0	2.0
0400-0800	-183.3	-179.1	-184.0	-177.7	5.0	5.5	2.1	4.5	2.2
0800-1200	-175.6	-179.1	-184.0	-173.0	5.9	7.0	2.2	5.3	2.7
1200-1600	-171.1	-179.1	-184.0	-170.0	6.0	7.4	2.4	5.3	2.5
1600-2000	-169.4	-179.1	-184.0	-168.5	5.2	6.3	2.0	4.1	2.3
2000-2400	-176.9	-179.1	-184.0	-174.5	4.0	4.9	1.5	4.0	2.3

LAT = 37.39, LONG = -122.41, hmb
WINTER, FMHZ = 25.000, QUIET RURAL NOISE

TIME BLOCK	ATMO	GAL	MANMADE	OVERALL	DL	DU	SL	SM	SU
	---MEDIAN NOISE VALUES IN DBW--				STATISTICAL VALUES IN DB ATMOSPHERIC NOISE				
0000-0400	-218.9	-184.2	-190.4	-184.7	2.6	3.6	1.6	4.2	3.2
0400-0800	-211.0	-184.2	-190.4	-184.7	2.8	4.2	1.8	3.2	3.7
0800-1200	-204.2	-184.2	-190.4	-184.7	4.0	6.0	1.8	5.5	4.2
1200-1600	-193.4	-184.2	-190.4	-183.9	4.1	6.7	1.7	5.7	4.8
1600-2000	-196.1	-184.2	-190.4	-184.4	3.5	5.4	1.8	3.8	4.4
2000-2400	-205.2	-184.2	-190.4	-184.7	3.1	4.1	1.7	3.8	3.3

LAT = 37.39, LONG = -122.41, hmb
SPRING, FMHZ = 25.000, QUIET RURAL NOISE

TIME BLOCK	ATMO	GAL	MANMADE	OVERALL	DL	DU	SL	SM	SU
	---MEDIAN NOISE VALUES IN DBW--				STATISTICAL VALUES IN DB ATMOSPHERIC NOISE				
0000-0400	-206.5	-184.2	-190.4	-184.7	3.4	4.9	1.7	4.0	3.0
0400-0800	-208.7	-184.2	-190.4	-184.7	3.3	4.9	2.0	3.8	3.2
0800-1200	-205.1	-184.2	-190.4	-184.7	4.8	6.9	2.0	4.6	3.2
1200-1600	-199.5	-184.2	-190.4	-184.5	5.5	7.5	1.6	4.9	2.7
1600-2000	-196.1	-184.2	-190.4	-184.3	4.4	6.1	1.9	4.0	2.5
2000-2400	-200.1	-184.2	-190.4	-184.6	3.8	5.5	2.0	3.7	2.8

LAT = 37.39, LONG = -122.41, hmb
SUMMER, FMHZ = 25.000, QUIET RURAL NOISE

TIME BLOCK	ATMO	GAL	MANMADE	OVERALL	DL	DU	SL	SM	SU
	---MEDIAN NOISE VALUES IN DBW--				STATISTICAL VALUES IN DB ATMOSPHERIC NOISE				
0000-0400	-205.3	-184.2	-190.4	-184.7	3.4	4.7	1.3	4.0	2.2
0400-0800	-204.2	-184.2	-190.4	-184.7	3.2	4.5	1.4	3.2	2.2
0800-1200	-208.1	-184.2	-190.4	-184.7	4.6	6.5	1.6	4.8	2.3
1200-1600	-197.1	-184.2	-190.4	-184.4	5.2	6.8	1.6	4.4	2.2
1600-2000	-193.2	-184.2	-190.4	-184.0	4.4	5.7	1.6	5.9	2.2
2000-2400	-197.5	-184.2	-190.4	-184.5	4.0	5.5	1.5	3.0	2.3

LAT = 37.39, LONG = -122.41, hmb
AUTUMN, FMHZ = 25.000, QUIET RURAL NOISE

	---MEDIAN NOISE VALUES IN DBW--				STATISTICAL VALUES IN DB ATMOSPHERIC NOISE				
TIME BLOCK	ATMO	GAL	MANMADE	OVERALL	DL	DU	SL	SM	SU
0000-0400	-214.9	-184.2	-190.4	-184.7	3.0	3.5	1.6	4.0	2.1
0400-0800	-208.4	-184.2	-190.4	-184.7	3.6	4.5	2.2	4.5	2.6
0800-1200	-201.8	-184.2	-190.4	-184.6	4.7	6.4	2.6	5.3	2.3
1200-1600	-194.5	-184.2	-190.4	-184.1	5.2	6.5	2.3	5.3	1.9
1600-2000	-188.5	-184.2	-190.4	-182.8	3.9	5.6	1.8	4.1	2.5
2000-2400	-202.1	-184.2	-190.4	-184.7	2.9	4.4	1.4	4.0	2.5

LAT = 37.39, LONG = -122.41, hmb
WINTER, FMHZ = 30.000, QUIET RURAL NOISE

	---MEDIAN NOISE VALUES IN DBW--				STATISTICAL VALUES IN DB ATMOSPHERIC NOISE				
TIME BLOCK	ATMO	GAL	MANMADE	OVERALL	DL	DU	SL	SM	SU
0000-0400	-230.5	-186.0	-31.7	-31.7	2.6	3.6	1.6	4.2	3.2
0400-0800	-223.9	-186.0	-31.7	-31.7	2.8	4.2	1.8	3.2	3.7
0800-1200	-224.6	-186.0	-31.7	-31.7	4.0	6.0	1.8	5.5	4.2
1200-1600	-214.5	-186.0	-31.7	-31.7	4.1	6.7	1.7	5.7	4.8
1600-2000	-208.8	-186.0	-31.7	-31.7	3.5	5.4	1.8	3.8	4.4
2000-2400	-217.7	-186.0	-31.7	-31.7	3.1	4.1	1.7	3.8	3.3

LAT = 37.39, LONG = -122.41, hmb
SPRING, FMHZ = 30.000, QUIET RURAL NOISE

	---MEDIAN NOISE VALUES IN DBW--				STATISTICAL VALUES IN DB ATMOSPHERIC NOISE				
TIME BLOCK	ATMO	GAL	MANMADE	OVERALL	DL	DU	SL	SM	SU
0000-0400	-217.8	-186.0	-31.7	-31.7	3.4	4.9	1.7	4.0	3.0
0400-0800	-223.8	-186.0	-31.7	-31.7	3.3	4.9	2.0	3.8	3.2
0800-1200	-224.6	-186.0	-31.7	-31.7	4.8	6.9	2.0	4.6	3.2
1200-1600	-219.4	-186.0	-31.7	-31.7	5.5	7.5	1.6	4.9	2.7
1600-2000	-212.9	-186.0	-31.7	-31.7	4.4	6.1	1.9	4.0	2.5
2000-2400	-212.0	-186.0	-31.7	-31.7	3.8	5.5	2.0	3.7	2.8

LAT = 37.39, LONG = -122.41, hmb
SUMMER, FMHZ = 30.000, QUIET RURAL NOISE

	---MEDIAN NOISE VALUES IN DBW--				STATISTICAL VALUES IN DB ATMOSPHERIC NOISE				
TIME BLOCK	ATMO	GAL	MANMADE	OVERALL	DL	DU	SL	SM	SU
0000-0400	-216.0	-186.0	-31.7	-31.7	3.4	4.7	1.3	4.0	2.2
0400-0800	-216.9	-186.0	-31.7	-31.7	3.2	4.5	1.4	3.2	2.2
0800-1200	-226.0	-186.0	-31.7	-31.7	4.6	6.5	1.6	4.8	2.3

1200-1600	-214.3	-186.0	-31.7	-31.7	5.2	6.8	1.6	4.4	2.2
1600-2000	-209.0	-186.0	-31.7	-31.7	4.4	5.7	1.6	5.9	2.2
2000-2400	-209.9	-186.0	-31.7	-31.7	4.0	5.5	1.5	3.0	2.3

LAT = 37.39, LONG = -122.41, hmb
AUTUMN, FMHZ = 30.000, QUIET RURAL NOISE

	---MEDIAN NOISE VALUES IN DBW--				STATISTICAL VALUES IN DB ATMOSPHERIC NOISE				
TIME BLOCK	ATMO	GAL	MANMADE	OVERALL	DL	DU	SL	SM	SU
0000-0400	-226.5	-186.0	-31.7	-31.7	3.0	3.5	1.6	4.0	2.1
0400-0800	-218.8	-186.0	-31.7	-31.7	3.6	4.5	2.2	4.5	2.6
0800-1200	-219.0	-186.0	-31.7	-31.7	4.7	6.4	2.6	5.3	2.3
1200-1600	-212.0	-186.0	-31.7	-31.7	5.2	6.5	2.3	5.3	1.9
1600-2000	-200.3	-186.0	-31.7	-31.7	3.9	5.6	1.8	4.1	2.5
2000-2400	-214.0	-186.0	-31.7	-31.7	2.9	4.4	1.4	4.0	2.5