Table 3-2 (Continued)

Strongest Dynamic Echo Rejection: 1.8μS in Ensemble A (0.50 Hz)
ATTC Test # 292
Strong Desired Signal Level

	-0.50 dB	-0.20 dB	Threshold	+0.20 dB	+0.50 dB
Main Path to Variable Path Ratio (dB)	8.60	8.90	9.10	9.30	9.60
Bit Error Rate	NO SYNC	NO SYNC	NO SYNC	0.00E+00	NO SYNC
	NO SYNC	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	NO SYNC	NO SYNC	0.00E+00	0.00E+00	0.00E+00

Strongest Dynamic Echo Rejection: 1.8μS in Ensemble A (5 Hz)
ATTC Test # 293
Strong Desired Signal Level

	-0.50 dB	-0.20 dB	Threshold	+0.20 dB	+0.50 dB
Main Path to Variable Path Ratio (dB)	12.00	12.30	12.50	12.70	13.00
Bit Error Rate	NO SYNC	6.10E-08	0.00E+00	0.00E+00	0.00E+00
	NO SYNC	NO SYNC	0.00E+00	0.00E+00	0.00E+00
	NO SYNC	1.10E-07	0.00E+00	0.00E+00	0.00E+00

Note: A report of "NO SYNC" in the BER test results corresponds to the "Sync Loss" alarm having been asserted by the HP3784A BER meter. According to the instruction manual for this instrument, "Sync Loss" indicates that the receiver in the HP instrument has lost reference pattern synchronization. The criteria for sync loss is Error Ratio $\geq \frac{1}{9}$ and sync gain is Error $\leq \frac{1}{100}$.

Our understanding of this is that the "sync loss" indicator exhibits hysteresis between a BER of approximately 10^{-1} and 10^{-2}. When the indication is asserted, the BER is greater than 10^{-2}(>1E-02); *i.e.*, there is more than one error per 100 bits transmitted.

3.2. Measurement of Transient Peak/Average Power Ratio

The measurement of transient peak power was made on the 44-MHz IF signal provided to the ATTC RF Test Bed by the Grand Alliance encoder. As specified in the Test Plan, two independent methods were used - a "generic" measurement technique and a commercial instrument (Boonton 4500)

The data obtained by the generic method are tabulated in Table 3-3 and plotted in Figure 3-1. The peak power at several cumulative levels, specified in the Test Plan, are tabulated for both measurement methods in Table 3-4.

Table 3-3

Peak/Average Power Ratio Measurement
Generic Method

Mean Power Level dBm	-15.12

Gate time	233.57 ms

Power Level (dBm)	Peak level above mean (dB)	Meas. 1	Meas. 2	Meas. 3	Meas. 4	Meas. 5	Average	Percentage
	Reference						10,276,933	100.0000%
-15.12	0.0	4,044,914	4,053,296	4,051,115	4,055,187	4,052,683	4,051,439.00	39.4226%
-14.62	0.5							
-14.12	1.0							
-13.62	1.5							
-13.12	2.0	1,812,285	1,812,344	1,814,156	1,806,858	1,808,639	1,810,856.40	17.6206%
-12.62	2.5	1,262,587	1,264,007	1,268,050	1,266,796	1,262,273	1,264,742.60	12.3066%
-12.12	3.0	835,037	830,366	834,924	836,970	835,677	834,594.80	8.1210%
-11.62	3.5	501,097	499,085	504,044	501,471	501,254	501,390.20	4.8788%
-11.12	4.0	326,189	325,571	324,328	323,085	324,662	324,767.00	3.1602%
-10.62	4.5	161,805	159,978	160,549	159,784	160,020	160,427.20	1.5610%
-10.12	5.0	72,421	71,801	71,335	71,735	70,964	71,651.20	0.6972%
-9.62	5.5	25,214	24,864	25,138	24,761	25,140	25,023.40	0.2435%
-9.12	6.0	7,396	7,184	7,413	7,201	7,295	7,297.80	0.0710%
-8.62	6.5	1,383	1,280	1,185	1,304	1,367	1,303.80	0.0127%
-8.12	7.0	146	132	151	185	127	148.20	0.0014%
-7.62	7.5	10	3	0	8	8	5.80	0.0001%
-7.12	8.0	0	0	0	0	0	0.00	0.0000%

Table 3-4

Peak-to-Average Power

METHOD	Cumulative Distribution Function	Peak-to-Average Power Ratio (dB)
Generic	99.9%	5.9 †
	99.99%	6.6 †
	99.999%	7.1 †
Boonton	99.9%	6.17
	99.99%	6.89
	99.999%	N/A

† determined by interpolation of data points in Table 3-3

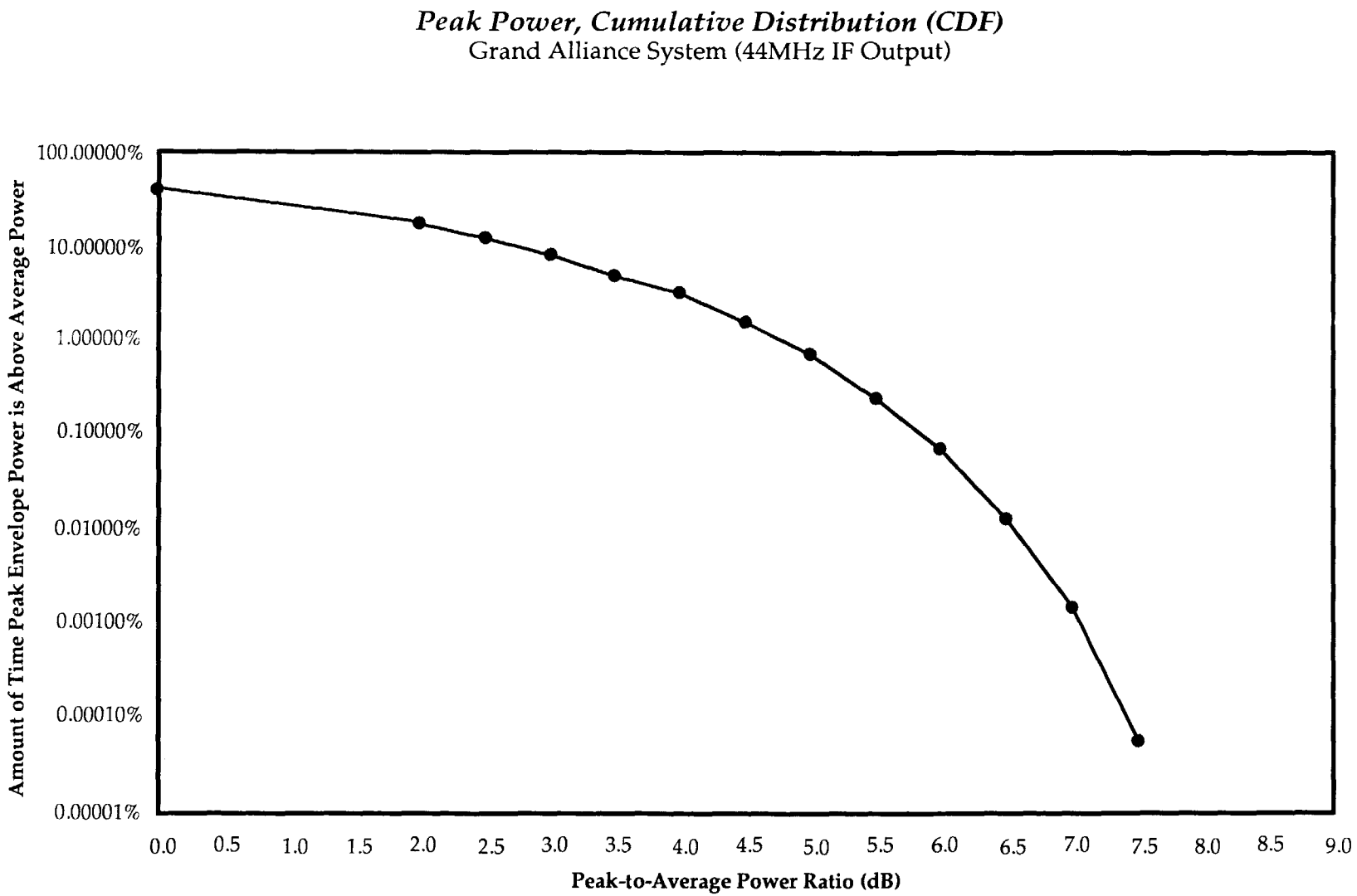
Peak Power, Cumulative Distribution (CDF)
Grand Alliance System (44MHz IF Output)
Amount of Time Peak Envelope Power is Above Average Power
100.00000%
10.00000%
1.00000%
0.10000%
0.01000%
0.00100%
0.00010%
0.00001%
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
Peak-to-Average Power Ratio (dB)

Figure 3-1

3.3. Susceptibility to Noise

The tests reported in this section were conducted by the Task Force on Digital-Specific Testing. Refer to their report in Part II for additional information.

The Test Plan specifies that, for the power calibration procedure, a flat gray field at 50-percent luminance is to be applied as the video modulation for the ATV signal. This procedure was followed in the first round of testing, since the average power was not independent of video modulation for all systems. However, the Grand Alliance affirmed that, for its system, the average power is independent of video modulation. Therefore, it was not necessary to apply a flat field signal for the power calibration procedure.

3.3.1. Random Noise

Table 3-5

Random Noise into ATV

Threshold Characteristics of ATV

ATTC Test #	Description	Subjective Method							BER Method		
		Desired Power		Desired to Undesired Ratio (dB)					Desired Power	Desired to Undesired Ratio (dB)	
		Level	dBm	ACQ	TOV	POU	POR	POF	dBm	ACQ	TOV
	Random Noise										
58	- Video	S	-27.89		15.28	14.41	14.41	14.41	-28.12	OK	15.19
241	- Audio	S	-27.86		14.92	14.54		14.54			

3.3.2. Impulse Noise

Table 3-6

Impulse Noise into ATV

Threshold Characteristics of ATV

		Subjective Method							BER Method		
ATTC Test #	Description	Desired Power		Relative Noise Level (dB)*					Desired Power	Relative Noise Level (dB)*	
		Level	dBm	ACQ	TOV	POU	POR	POF	dBm	ACQ	TOV
	Impulse Noise (Universal AC Motor)										
127	- Video	M	-52.93		-53.31	-50.25	-50.00	-50.00	-53.10	OK	-53.50

*Noise level relative to zero attenuation of noise.

3.4. Susceptibility to Random Noise in the Presence of Static Multipath

The test procedure, specified in *Section I-3.4* of the Test Plan, applies both multipath and random noise impairments to the transmission channel, and determines the difference in the TOV point, compared to that obtained for random noise impairment alone. In the "Calibration" test, ATTC Test #281, only random noise was applied to the channel. The D/U ratio at TOV is reported for that test. For each of the other tests, in which a multipath ensemble is applied in addition to the random noise, only the difference in TOV, with respect to the calibration test (*i.e.*, ensemble TOV minus calibration TOV), is reported.

The Test Plan specifies an acquisition test procedure that must be followed to ensure that the adaptive channel equalizer of the ATV receiver has not "learned" the optimum tap weights for the TOV condition. However, it permits a simplified technique if it can be shown that the system does not hold the tap weights in memory. During the transmission subsystem "bakeoff", the 8-VSB system was proven to have no such memory. The Grand Alliance affirmed that there had been no change to the system in this regard. Therefore, the simplified technique was used for testing of the Grand Alliance system.

Table 3-7

Multipath Impairment into ATV

ATTC Test #	Description	Visual Method				BER Method		
		Desired Power		Desired to Undesired Ratio (dB)		Desired Power	Desired to Undesired Ratio (dB)	
		Level	dBm	ACQ	TOV	dBm	ACQ	TOV
	Random Noise in presence of Ensembles of 5 Multipaths							
281	Random Noise into ATV & Multipath Calibration	S				-27.94	OK	15.16
272	Random Noise into ATV & Multipath Ensemble A	S				-27.93	OK	Δ 3.28
273	Random Noise into ATV & Multipath Ensemble B	S				-27.81	OK	Δ 2.40
274	Random Noise into ATV & Multipath Ensemble C	S				-27.78	OK	Δ 3.18
275	Random Noise into ATV & Multipath Ensemble D	S				-27.82	OK	Δ 2.89
276	Random Noise into ATV & Multipath Ensemble E	S				-27.82	OK	Δ 3.64
277	Random Noise into ATV & Multipath Ensemble F	S				-28.01	OK	Δ 1.20
278	Random Noise into ATV & Multipath Ensemble G	S				-28.01	OK	Δ 1.68

3.5. Susceptibility to Co-channel NTSC in the Presence of Static Multipath

The test procedure, specified in *Section I-3.5* of the Test Plan, applies both multipath impairment and co-channel NTSC interference to the transmission channel, and determines the difference in the TOV point, compared to that obtained for the co-channel interference alone. In the "Calibration" test, ATTC Test #280, only the co-channel NTSC interference was applied to the channel. The D/U ratio at TOV is reported for that test. For each of the other tests, in which a multipath ensemble is applied in addition to the interference, only the difference in TOV, with respect to the calibration test (*i.e.*, ensemble TOV minus calibration TOV), is reported.

The Test Plan specifies an acquisition test procedure that must be followed to ensure that the adaptive channel equalizer of the ATV receiver has not "learned" the optimum tap weights

for the TOV condition. However, it permits a simplified technique if it can be shown that the system does not hold the tap weights in memory. During the transmission subsystem "bakeoff", the 8-VSB system was proven to have no such memory. The Grand Alliance affirmed that there had been no change to the system in this regard. Therefore, the simplified technique was used for testing of the Grand Alliance system.

Table 3-8

Multipath Impairment into ATV

ATTC Test #	Description	Visual Method				BER Method		
		Desired Power		Desired to Undesired Ratio (dB)		Desired Power	Desired to Undesired Ratio (dB)	
		Level	dBm	ACQ	TOV	dBm	ACQ	TOV
	Co-Channel NTSC in presence of Ensembles of 5 Multipaths							
280	Co-Channel NTSC/ATV & Multipath Calibration	W				-67.87	OK	1.60
266	Co-Channel NTSC/ATV & Multipath Ensemble A	W				-67.90	OK	Δ 5.98
267	Co-Channel NTSC/ATV & Multipath Ensemble B	W				-67.87	OK	Δ 5.76
268	Co-Channel NTSC/ATV & Multipath Ensemble C	W				-67.91	OK	Δ 8.98
269	Co-Channel NTSC/ATV & Multipath Ensemble D	W				-67.98	OK	Δ 7.14
270	Co-Channel NTSC/ATV & Multipath Ensemble E	W				-67.81	OK	Δ 5.80
271	Co-Channel NTSC/ATV & Multipath Ensemble F	W				-67.97	OK	Δ 3.91

3.6. Single and Multiple Multipath Test

These tests were conducted in accordance with *Section I-3.6* of the Test Plan. For each of the Strongest Static Echo and Strongest Dynamic Echo Rejection tests (ATTC Tests #285-295), the TOV value reported as the "Main Path to Variable Path Ratio" is the attenuation of the variable path, relative to the reference path, of the HP Ghost Simulator at the TOV point.

The purpose of Test #285 is to confirm that the Grand Alliance system treats an out-of-range (30-μS echo) as random noise. The reference test for this confirmation is Test #284, in which the out-of-range echo is replaced by random noise. Comparison of the two thresholds confirms that the expected result was achieved.

In Test #287, acquisition was not achieved at the TOV level. The echo had to be attenuated an additional 1.4 dB in order for the system to acquire the signal. Per Section I-3.1.4 of the Test Plan, if the system fails to acquire at the BER TOV level, then the lower acquisition (ACQ) level must be considered the "TOV" to be reported.

Anomalous behavior was observed in Test #290, a 0-Hz (i.e., static) test intended to serve as the reference for Tests #291-293 in which the echo was made dynamic. Not only were the visual and BER TOVs different by 0.8 dB, more than the maximum expected difference of 0.5 dB, but the system failed to acquire the signal at the lower visual TOV level. The visual acquisition level was 1.2 dB worse than the BER TOV.

In Test #292, the expert observers noted erratic behavior following their determination of the visual TOV. As they continued to observe the output of the system for several minutes after the official one-minute voting period, they saw the picture go to black several times. This

observed behavior correlates with the results obtained during the BER TOV procedure, in which the system apparently lost acquisition ("NO SYNC") both at the threshold level and at 0.5 dB above threshold. (See the threshold characteristic data for this test in Table 3-1.)

Table 3-9

Multipath Impairment into ATV

ATTC Test #	Description	Visual Method				BER Method		
		Desired Power		Desired to Undesired Ratio (dB)		Desired Power	Desired to Undesired Ratio (dB)	
		Level	dBm	ACQ	TOV	dBm	ACQ	TOV
	Strongest Static Echo Rejection							
284	Random Noise into ATV & Multipath Ensemble C w/o 18µS Echo	S				-27.96	OK	16.99

ATTC Test #	Description	Visual Method				BER Method		
		Desired Power		Main Path to Variable Path Ratio (dB)		Desired Power	Main Path to Variable Path Ratio (dB)	
		Level	dBm	ACQ	TOV	dBm	ACQ	TOV
	Strongest Static Echo Rejection							
285	Strongest Static Echo Rejection: 30µS in Modified Ensemble C	S				-27.91	OK	17.10
286	Strongest Static Echo Rejection: 5.7µS in Ensemble A	S				-27.92	OK	6.90
287	Strongest Static Echo Rejection: 15µS	S				-27.89	5.80	5.80
288	Strongest Static Echo Rejection: 5.7µS	S				-27.89	OK	3.00
289	Strongest Static Echo Rejection: 1.0µS	S				-27.87	OK	1.60
	Strongest Dynamic Echo Rejection							
290	Strongest Dynamic Echo Rejection: 1.8µS in Ensemble A (0 Hz)	S	-27.86	5.40	5.00	-27.89	OK	4.20
291	Strongest Dynamic Echo Rejection: 1.8µS in Ensemble A (0.05 Hz)	S	-27.86	OK	7.85	-27.89	OK	7.60
292	Strongest Dynamic Echo Rejection: 1.8µS in Ensemble A (0.50 Hz)	S	-27.86	OK	9.00[1]	-27.89	OK	9.10
293	Strongest Dynamic Echo Rejection: 1.8µS in Ensemble A (5 Hz)	S	-27.86	OK	12.70	-27.89	OK	12.50
294	Strongest Dynamic Echo Rejection: 1.0µS @ 2 Hz	S				-27.88	OK	4.40
295	Strongest Dynamic Echo Rejection: 1.0µS @ 5 Hz	S				-27.88	OK	6.20

[1] After the one-minute voting period had elapsed at the TOV level, the expert observers saw the picture go to black at least four times over the next several minutes while the interference was maintained at that level. [5/2/95 EO&C]

3.7. Susceptibility to Interference

3.7.1. Introduction

In accordance with the Test Plan, Co-channel, Upper and Lower Adjacent Channel, and Taboo Channel interference tests were conducted for three cases:

1. Grand Alliance as the Undesired signal and NTSC as the Desired signal.

2. NTSC as the Undesired signal and Grand Alliance as the Desired signal.

3. Grand Alliance as both the Undesired signal and the Desired Signal.

The data collected in these tests are presented in a tabular format showing the TOV, POU, and intermediate levels of Undesired signal power. In the tables, the four intermediate ranging levels used for non-expert subjective assessment are designated "TOV+1" through "TOV+4." Documentation of TOV voting, for each test in which the 24 NTSC receivers were used, includes a graph showing the range of thresholds across the 24 sets and indicating the number of sets that exhibited threshold performance at each level of impairment. An example of the NTSC Voting Analysis is included in *Section 14*. The complete set has been archived by ATTC.

Documentation of CCIR3/CCIR4 and POU voting, for each test in which the 24 NTSC receivers were used, includes a receiver-by-receiver tabulation of the voted levels. The complete set appears in *Section 14*.

Following those tests of Co-channel and Lower-Adjacent Channel interference into NTSC, in which ranging levels were found, in accordance with the Video Subjective Test Procedures, videotapes were prepared to support non-expert subjective assessment by ATEL. Further details regarding these videotapes are found in *Section 13*.

3.7.2. Co-channel Interference

Section 3.7.3.1 of the Test Procedures requires that the Grand Alliance specify the precise frequency within Channel 12 at which the ATV RF spectrum is to be centered for the minimum interference condition of ATV-into-NTSC and NTSC-into-ATV interference. For an additional test of NTSC-into-ATV co-channel interference, the Grand Alliance was required to specify the center frequency that would result in worst-case interference. This additional test would provide information as to whether precision offset offers a worthwhile performance gain.

For the case of ATV-into-NTSC co-channel interference, the Grand Alliance claimed no advantage for offset from the exact center frequency of 207.000000 MHz. Therefore, this test was run with no offset.

However, with regard to NTSC-into-ATV co-channel interference, the Grand Alliance provided the following statement to the Test Center:

> Peak system performance can be obtained by proper choices of frequency offsets between the NTSC and ATV channel allocations. The preferred alignment between an NTSC and ATV signal is set up such that the frequency difference between the ATV pilot and the NTSC visual carrier is 70.5 times the segment frequency of the digital

> data. This places the visual carrier near the notch of the comb filter, and ensures that the clock recovery circuitry is not affected by the interfering NTSC visual carrier. . .
>
> This can be achieved by shifting the ATV upconverter local oscillator up (relative to the NTSC nominal) in frequency by 28,615 Hz. Within the RF channel, the NTSC visual carrier is 1.25 MHz from the lower band edge. The ATV pilot is 911,944 Hz lower, or 338,056 Hz from the lower band edge.
>
> As an example, within Channel 12, the ATV pilot will be at 204.338056 MHz, and the NTSC visual carrier will be at 205.25000 MHz.

The Grand Alliance further advised the Test Center that the sensitivity factor for carrier offset in the case of co-channel interference from NTSC into ATV is small relative to the carrier frequency tolerance permitted for NTSC transmitters (±1000 Hz). Therefore, the Test Center proposed (see Doc. SSWP2-1432 in *Section 14*) and SS/WP-2 approved deleting the worst-case interference portion of the test. Instead, the TOV was determined at each of two carrier frequencies, which were 1000 Hz apart, in order to verify that the threshold would be little affected by variation in carrier frequency over the permitted tolerance.

For the primary test of co-channel NTSC-into-ATV interference (ATTC Test #17), the up-conversion frequency was shifted upward by 28,615 Hz, the frequency specified by the Grand Alliance. For the additional test at the delta frequency offset of 1000 Hz (ATTC Test #56), the up-conversion frequency was shifted upward 29,615 Hz. The test results confirm no difference (0.07 dB) in threshold between the two offset frequencies.

For the case of ATV-into-ATV co-channel interference, the Grand Alliance notified the Test Center that the preferred alignment between two ATV signals is such that their pilots are spaced by 1.5 times the segment frequency, and that the resulting frequency offset is 19.403 kHz. The Grand Alliance also reported to the Test Center (and we advised SS/WP-2 via Doc. SSWP2-1432 reproduced in *Section 14*) that, in the case of co-channel ATV-into-ATV interference:

a) Precise carrier offset affects signal acquisition if, and only if, the two training signals of the ATV signals happen to be time coincident (as is the case in testing with only one ATV signal available);

b) The tolerance for each ATV station, beyond which precise carrier offset offers no advantage, is ±5 Hz; and,

c) The true "worst-case" offset is 20 Hz from the specified offset. However, at this worst-case offset, the threshold test is not repeatable since the results become erratic.

Based upon this information, the Test Center proposed and SS/WP-2 approved deleting the worst-case interference portion of the test. Instead, the TOV was determined at each of two carrier frequencies, which were 10 Hz apart, in order to verify that the threshold would be little affected by variation in carrier frequency over the tolerance recommended by the Grand Alliance.

For two of the tests of co-channel ATV-into-ATV interference (ATTC Tests #18 and 237), the up-conversion frequency was shifted upward by 19.403 kHz, the frequency specified by the Grand Alliance. For the corresponding additional tests at the delta

frequency offset of 10 Hz (ATTC Tests #264 and 265), the up-conversion frequency was shifted upward by 19.413 kHz. The test results confirm no difference (0.06 dB and 0.02 dB for Tests #18/264 and 237/265, respectively) in threshold between the two offset frequencies.

The Test Plan also specifies that co-channel ATV-into-ATV interference be tested with the Desired signal delayed with respect to the Undesired signal by each of two delays, nominally 20 µS but different by one-third of the digital symbol period. For two of the tests of co-channel ATV-into-ATV interference (ATTC Tests #18 and 264), the delay between the two ATV signals was 20.00 µS. For the corresponding additional tests at the delta delay of 30 nS (ATTC Tests #237 and 265), the delay between the two ATV signals was 19.97 µS. The test results confirm no difference (0.10 dB and 0.18 dB for Tests #18/237 and 264/265, respectively) in threshold between the two delays.

Table 3-10 presents the data obtained from the co-channel interference tests, at the Moderate and Weak levels of the Desired signal, as required by the Test Plan. Comments of the expert observers and ATTC staff follow the table.

Among the additional data contained in *Section 14* is the NTSC Voting Analysis for the ATV-into-NTSC co-channel interference test at the Weak level. This is an example of the documentation archived for all NTSC threshold-of-visibility tests. In this example, the thresholds for the individual receivers were spread from -100.7 dBm to -104.4 dBm, with the median at -102.74 dBm, the value used in calculating the D/U ratio appearing in Table 3-10.

Some of the levels determined for ATV-into-NTSC upper-adjacent channel interference into video were also used for determining the susceptibility of BTSC audio to such interference. Specifically, these were the video CCIR3 levels, at the weak desired signal level, for the six receivers used in the audio testing. These levels are reported along with the audio test results in *Section 4*.

Table 3-10A

Co-Channel Interference into NTSC

ATTC Test #	Description	Desired Power (nominal)		Desired to Undesired Ratio (dB) (actual)						
		Level	dBm	TOV	CCIR3	TOV+1	TOV+2	TOV+3	TOV+4	POU
16	Co-Channel ATV/NTSC	M	-35	51.27	33.07					
16	Co-Channel ATV/NTSC	W	-55	47.74	33.81[1]	42.01	35.26	30.51	24.80	16.07

[1] At the CCIR 3 level, the expert observers noted that the impairment was mostly noise, as they expected. [4/19/95 EO&C]

Table 3-10B

Co-Channel Interference into ATV

ATTC Test #	Description	Visual Method						BER Method		
		Desired Power		Desired to Undesired Ratio (dB)				Desired Power	Desired to Undesired Ratio (dB)	
		Level	dBm	TOV	POU	POR	POF	dBm	ACQ	TOV
17	Co-Channel NTSC/ATV	M	-53					-53.04	OK	1.40
17	Co-Channel NTSC/ATV	W	-67.86	2.05	1.36[1]	0.61	0.61[2]	-68.10	OK	1.81
56	Co-Channel NTSC/ATV (Δ freq. offset)	W	-68					-68.04	OK	1.88
18	Co-Channel ATV/ATV	M	-53					-52.93	OK	14.78
237	Co-Channel ATV/ATV (ΔDelay)	M	-53					-53.05	OK	14.92
18	Co-Channel ATV/ATV	W	-68					-67.95	OK	15.27
237	Co-Channel ATV/ATV (ΔDelay)	W	-68					-68.05	OK	15.17
264	Co-Channel ATV/ATV (Δ freq. offset)	W	-68					-68.11	OK	15.33
265	Co-Channel ATV/ATV (Δ freq. offset ΔDelay)	W	-68					-68.06	OK	15.15

1 The expert observers noted that the image froze approximately every 3 to 5 seconds, but not necessarily at a fixed period. They saw a blocking pattern in moving objects and breaking up of moving objects. [5/15/95 EO&C #3 Rev. 2]

2 The expert observers noted that the image froze approximately every quarter turn of the main pyramids (in the "Rotating Pyramids" test image), approximately every 1.5 seconds. They saw a blocking pattern in moving objects and breaking up of moving objects. They noted that the lettering in the scrolling text only broke down when the picture froze. [5/15/95 EO&C #4 Rev. 2]

3.7.3. Upper-Adjacent Channel Interference

Testing of interference from an Undesired signal on Channel 13 to a Desired signal on Channel 12 was conducted in accordance with Section I-3.7.3.2 of the Test Procedures. The nominal carrier frequencies for both channels (no offsets) were used for all tests.

Note that the Grand Alliance Test Plan specifies a lower Strong Desired signal level (-25 dBm) than that used in previous rounds of testing (-15 dBm). Nevertheless, in Test #2 (ATV/NTSC) at the Strong level, the point of unusability (at least 12 of 24 sets unusable) could not be achieved at the maximum level of the Undesired signal. In Test #4 (NTSC/ATV) and Test #6 (ATV/ATV) at the Strong level, the TOV could not be achieved at the maximum Undesired signal level.

In Test #2 (ATV/NTSC), at the Strong and Weak Desired signal levels, the expert observers obtained intermediate ranging levels (TOV+1 through TOV+4) as required by the Test Plan. Rating tapes for non-expert subjective assessment were produced, and the subjective testing was conducted by ATEL. A disparity existed between the median CCIR Grade 3 level determined by the expert viewers and the Grade 3 level resulting from the non-expert assessment at ATEL. Subsequent analysis of the results of the expert viewing showed that the "median" receiver that had been used for the ranging and recording was not representative of the performance of the bank of 24 receivers. Furthermore, no recordable receiver could be found that was representative. The results of the ranging and the ATEL results were declared invalid by the Chairman of SS/WP-2 and, therefore, they are not presented in this Record of Test Results. Further information may be found in Document SSWP2-1462, which is reproduced in *Section 14*.

Some of the levels determined for ATV-into-NTSC upper-adjacent channel interference into video were also used for determining the susceptibility of BTSC audio to such interference. Specifically, these were the video CCIR 3 levels for the receivers, and at the Desired signal levels, used in the audio testing. As discussed fully in *Section 4*, the BTSC audio testing conducted per the Grand Alliance Test Plan revealed a previously undocumented susceptibility of BTSC audio, which led to an expansion of the scope of this testing beyond the original Test Plan. This supplemental BTSC audio testing required the finding of additional video CCIR 3 levels. The complete results of the supplemental tests, for both video and audio, are found in *Section 4*. These results show that, at the Weak and Strong Desired signal levels, spectrum planning for upper-adjacent channel interference must be based upon audio impairment.

A tabulation of the data obtained per the original Test Plan for upper-adjacent channel interference is provided in Table 3-11. Following the table are related expert observer comments.

At all three Desired signal levels, on some of the receivers, the expert observers noted that, during only the camera-pan portion of the test image (M14, "Texas Sign Dude"), they observed impairment equivalent to CCIR Grade 3 at a lower level of interference than the level at which they voted the Grade 3 level for each receiver. The impairment observed during the pan took the form of diagonal stripes (beat pattern). (***Note***: It was subsequently confirmed by experiment that the beat pattern is constant, but that it becomes noticeable during motion of the image due to eye-tracking of the motion by the observers.) When the median CCIR 3 level is re-calculated by replacing the "voted" level for each of the affected receivers with the level corresponding to the beat pattern, the beat is shown to be the dominant video impairment for this test condition. At the Weak Desired level, the beat was predominant on 8 receivers, preceding the voted CCIR 3 level for these receivers by 2 to 14.2 dB and degrading the median CCIR 3 level for the 24 receivers by 1 dB. At the Moderate Desired level, the beat was predominant on 13 receivers. It was dominant over the voted CCIR 3 level for these receivers by 9 to 26 dB, and it degraded the median CCIR 3 level by 15.6 dB. At the Strong Desired level, the beat was predominant on 10 receivers, over the voted CCIR 3 level for these receivers by 7.1 to more than 17.9 dB, degrading the median CCIR 3 level for the 24 receivers by 4 dB.

As the results in *Section 4* show, the beat was the dominant effect, video or audio, at both the Moderate and Strong levels.

Experiments conducted between ATTC and the Grand Alliance during the testing period confirmed that the beat occurs between the pilot carrier of the

ATV signal in the undesired upper adjacent channel and the chrominance subcarrier of the desired NTSC signal. It is believed possible to minimize the visibility of this beat by the use of precision offset at an appropriate carrier frequency. Further experiments are planned by ATTC to study this issue, and a supplemental report will be issued at a later date. For further information, see the Analysis of the Color Beat by the ATTC Chief Scientist in *Section 14* (pages I-14-67 through 70) and the Analyses by the Grand Alliance (pages I-15-3 throough 14).

In light of expert observers' comments, and findings of the Upper Adjacent ATV-into-NTSC test in video, SS/WP-2 Chairman Richer asked the Grand Alliance to submit for the record its comments on the source of the "color beat." In addition, having conducted the experiments discussed above, ATTC offered to undertake, and proposed to the Grand Alliance, further tests for the record in order to characterize the video issue and to explore a possible solution to it. The Grand Alliance's responses are pending and will be filed with the Technical Subgroup upon receipt.

Table 3-11A

Upper Adjacent Channel Interference into NTSC

ATTC Test #	Description	Desired Power (nominal)		Desired to Undesired Ratio (dB) (actual)						
		Level	dBm	TOV	CCIR3	TOV+1	TOV+2	TOV+3	TOV+4	POU
2	Upper Adjacent ATV/NTSC	S	-25	0.26	-13.00[1] (P)					<-13.91[2]
2	Upper Adjacent ATV/NTSC	M	-35	-2.09[3]	-13.03 (P)					
2	Upper Adjacent ATV/NTSC	W	-55	-1.95	-16.91[4]					-20.95

(P) - preliminary CCIR level

1 During the camera pan portion of the test image, several receivers showed impairment equivalent to CCIR Grade 3 at a lower level of interference than the voted Grade 3 level. Specifically, the expert observers found that the following receivers had color beat impairments during picture motion at the indicated interference levels:

Receiver A7: +4 dB D/U
Receivers A2, A3, A5, A8, B3, B4, C1, C7, and C8: +3 dB D/U [4/25/95 EO&C]

2 The expert observers commented that ten receivers exceeded the Point of Unusability at the maximum available Undesired power level. These receivers were A1, A3, A7, A8, B1, B3, B5, B6, B8, and C6. Three of these receivers were suffering color loss. Five other receivers were relatively unimpaired. Receiver C3 was judged CCIR Grade 1 ("very annoying"). The impairments are mostly noise and reduction of color. The noise appearance varied on different sets. Some showed white streaks; some showed black streaks; some were more like Gaussian noise. [4/20/95 EO&C]

3 The expert observers noted that, at high levels of interference, the appearance is entirely noiselike. At lower levels, the interference appears as diagonal stripes when the camera is panning and persists through a large range. [4/20/95 EO&C]

4 This test was supplementary to the CCIR3 test run on 4/20/95. The CCIR3 interference levels for three receivers with video outputs were determined to permit the BTSC audio test, which required these levels as a reference point, to be conducted. See table below. [4/21/95 EO&C]

During the camera pan portion of the test image, several receivers show impairment equivalent to CCIR3 at a lower level of interference than the voted CCIR3 level. The picture impairment is less than CCIR3 at other times. See table below. At the voted CCIR3 level for a given receiver, the nature of the impairment varies by receiver, as follows: [4/20/95 EO&C

CCIR3 Level dB D/U	Receiver(s)	Appearance of Impairment
-2.91	A7 B3, B4, C1, C8	Diagonal stripe beat interference *(equivalent to CCIR3 during camera pan).*
-4.91	A7	No color.
-4.91	A2, A3, C7	Diagonal stripe beat during camera pan.
-10.91	B3	Color loss and white noise streaking.
-10.91	B6	White streaking.
-11.91	B5	White streaking.
-12.91	B4	Streaky noise and beat in still portion of image.
-12.91	A3	Color loss.
-12.91	C7, C8	Streaking, breaking up parts of picture, and color loss.
-14.91	B1	White streaking.
-14.91	A5	Picture break-up, color loss, and beat.
-15.91	C1	White streaking, some color loss, and beat.
-16.91*	B8	Noise.
-16.91*	C2	White streaking.
-16.91*	C4	Black streaking.
-17.80	A6	Diagonal striping in color.
-19.80	A6	Line sync loss and diagonal streaking with movement.
-21.80	B7	Noise & horizontal color banding - no horizontal beat.
-22.80	A1	Noise, horizontal color banding & minor line sync loss.

* Median CCIR3 level. At this same level, C7 and C8 are now quite poor - perhaps CCIR Grade 1.5, but receivers other than A3, A5, A7, B3, and C1 [which had lost color] had pictures that could be used. [4/20/95 EO&C]

Table 3-11B

Upper Adjacent Channel Interference into ATV

ATTC Test #	Description	Visual Method				BER Method		
		Desired Power		Desired to Undesired Ratio (dB)		Desired Power	Desired to Undesired Ratio (dB)	
		Level	dBm	ACQ	TOV	dBm	ACQ	TOV
4	Upper Adjacent NTSC/ATV	S	-27.85	NT	<-22.98	-28.05	NT	<-23.18
4	Upper Adjacent NTSC/ATV	M	-52.87	OK	-44.44	-53.04	OK	-44.44
4	Upper Adjacent NTSC/ATV	W	-67.86	OK	-48.54	-68.04	OK	-48.71
6	Upper Adjacent ATV/ATV	S	-28			-28.00	NT	<-17.58
6	Upper Adjacent ATV/ATV	M	-53			-52.89	OK	-39.32
6	Upper Adjacent ATV/ATV	W	-68			-68.06	OK	-43.17

3.7.4. Lower-Adjacent Channel Interference

Testing of interference from an Undesired signal on Channel 11 to a Desired signal on Channel 12 was conducted in accordance with *Section I-3.7.3.2* of the Test Procedures. The nominal carrier frequencies for both channels (no offsets) were used for all tests.

Table 3-12A

Lower Adjacent Channel Interference into NTSC

ATTC Test #	Description	Desired Power (nominal)		Desired to Undesired Ratio (dB) (actual)						
		Level	dBm	TOV	CCIR3	TOV+1	TOV+2	TOV+3	TOV+4	POU
9	Lower Adjacent ATV/NTSC	S	-25	0.23	-10.94[1]					<-13.06[2]
9	Lower Adjacent ATV/NTSC	M	-35	-0.77	-12.04	-10.61	-12.61	-14.36	-16.23	-20.09[3]
9	Lower Adjacent ATV/NTSC	W	-55	-5.92[4]	-15.96[5]	-11.86	-16.11	-20.11	-23.11[4]	-26.09

1 According to the expert observers, when the impairment looks like impulse noise it is more annoying than for other kinds of impairment such as herringbone. When the impairment looks like white impulse noise it is more annoying than when it looks like black impulse noise, for an equal level of impairment. The observers also noted an order of magnitude difference between the impairment level of the best receiver *versus* the worst receiver. [4/24/95 EO&C]

2 The expert observers found that one receiver (A8) was impaired beyond usability; that three receivers (A1, B1, and B6) were very annoying; and that several others (A5, A6, A7, B3, B4, B5, B8, C3, C5, & C8) had some impairment. All the receivers which are unusable or "very annoying" show substantial impairment from impulse noise. [4/25/95 EO&C Rev: 6/7/95]

3 Nine of the twelve receivers judged "unusable" by the expert observers were considered substantially worse than the criteria for "unusable". [4/25/95 EO&C]

4 When the expert observers reviewed the video recording that had been made at their selected ranging levels, they provided the following comments: Sub-TOV appeared noticeably more impaired than TOV at weak power level. The noise was streaky and more random than TOV. The horizontal time base instability seen on the TV screen was not observed on the tape. For impairment level four (TOV+4), in addition to the white impulse noise observed on the original and the tape, color noise on the tape was more noticeable and more impulse-like in nature than on the original. However, overall impairment level was similar. [4/25/95 EO&C Rev: 6/7/95]

5 According to the expert observers, the dominant impairment appears to be impulse noise or herringbone. [4/24/95 EO&C]

Table 3-12B

Lower Adjacent Channel Interference into ATV

ATTC Test #	Description	Visual Method				BER Method		
		Desired Power		Desired to Undesired Ratio (dB)		Desired Power	Desired to Undesired Ratio (dB)	
		Level	dBm	ACQ	TOV	dBm	ACQ	TOV
11	Lower Adjacent NTSC/ATV	S	-27.85	NT	<-22.94[1]	-28.04	NT	<-23.18
11	Lower Adjacent NTSC/ATV	M	-52.86	OK	-44.37	-53.05	OK	-44.46
11	Lower Adjacent NTSC/ATV	W	-67.86	OK	-47.61	-68.04	OK	-47.73
13	Lower Adjacent ATV/ATV	S	-28			-28.02	NT	<-13.35
13	Lower Adjacent ATV/ATV	M	-53			-52.88	NT	<-38.23
13	Lower Adjacent ATV/ATV	W	-68			-67.88	OK	-41.98

1 The expert observers saw some kind of major impairment with no interference introduced. The impairments occurred several times. The source or cause of the impairment was never determined. [5/2/95 EO&C]

3.7.5. UHF Taboo Channel Interference

The results of the taboo tests are tabulated in Tables 3-13A & B. Following the tables are related expert observer comments.

Table 3-13A

Taboo Interference into NTSC

ATTC Test #	Description	Desired Power (nominal)		Desired to Undesired Ratio (dB) (actual)		
		Level	dBm	TOV	CCIR4	CCIR3
20	N-8 Ch. UHF Taboo ATV/NTSC	S	-15	<-3.90[1]	[2]	
20	N-8 Ch. UHF Taboo ATV/NTSC	M	-35	-16.11	<-23.95[3]	
20	N-8 Ch. UHF Taboo ATV/NTSC	W	-55	-31.62		-41.87
248	N-3 Ch. UHF Taboo ATV/NTSC	S	-15	<-1.95[4]	[5]	
248	N-3 Ch. UHF Taboo ATV/NTSC	M	-35	-18.28	<-21.95[6]	
248	N-3 Ch. UHF Taboo ATV/NTSC	W	-55	-29.73		-36.81[7] (P)
28	N-2 Ch. UHF Taboo ATV/NTSC	S	-15	<-1.62[8]	[9]	
28	N-2 Ch UHF Taboo ATV/NTSC	M	-35	-15.00	-21.62[10] (P)	
28	N-2 Ch. UHF Taboo ATV/NTSC	W	-55	-23.73		-30.87[11] (P)
32	N+2 Ch. UHF Taboo ATV/NTSC	S	-15	<-0.57[12]	[13]	
32	N+2 Ch. UHF Taboo ATV/NTSC	M	-35	-17.46	<-20.38[14]	
32	N+2 Ch. UHF Taboo ATV/NTSC	W	-55	-27.93		-37.07[15]
249	N+3 Ch. UHF Taboo ATV/NTSC	S	-15	<-3.39[16]	[17]	
249	N+3 Ch. UHF Taboo ATV/NTSC	M	-35	-19.79	<-22.71[18] (P)	
249	N+3 Ch. UHF Taboo ATV/NTSC	W	-55	-34.13		-42.21[19] (P)
36	N+4 Ch. UHF Taboo ATV/NTSC	S	-15	<-4.80[20]	[21]	
36	N+4 Ch. UHF Taboo ATV/NTSC	M	-35	-18.21	<-24.13[22]	
36	N+4 Ch. UHF Taboo ATV/NTSC	W	-55	-24.96		-30.96[23] (P)
44	N+8 Ch. UHF Taboo ATV/NTSC	S	-15	<-5.11[24]		
44	N+8 Ch. UHF Taboo ATV/NTSC	M	-35	<-25.05[25]	[26]	
44	N+8 Ch. UHF Taboo ATV/NTSC	W	-55	-43.22		<-45.05[27]
48	N+14 Ch. UHF Taboo ATV/NTSC	S	-15	<-2.83[28]	[29]	
48	N+14 Ch. UHF Taboo ATV/NTSC	M	-35	-22.24	<-22.91[30]	
48	N+14 Ch. UHF Taboo ATV/NTSC	W	-55	-29.55		-33.38[31]
52	N+15 Ch. UHF Taboo ATV/NTSC	S	-15	<-1.15[32]	[33]	
52	N+15 Ch. UHF Taboo ATV/NTSC	M	-35	-14.53	-21.20[34]	
52	N+15 Ch. UHF Taboo ATV/NTSC	W	-55	-17.58		-30.58[35]

(P) - preliminary CCIR level

1 Just visible interference (random-noise-like characteristics) on Receivers A1, A2, A7, B3, B5, C1, C2, C6 and C8. [5/5/95 EO&C]

2 No receivers reached CCIR 4 impairment level. [5/5/95 EO&C]

3 The following receivers reached CCIR Grade 4: A8, B1, B5, B8, and C2. The impairment had a random-noise-like character. [5/5/95 EO&C]

4 At maximum Undesired power, impairment (random noise pattern) was just visible on sets A1, A7, B3, and B5. [5/5/95 EO&C]

5 There were no receivers impaired at CCIR Grade 4 at maximum Undesired power level. [5/5/95 EO&C]

6 Receivers A1, B1, B3, B5, B6, B8, C2 and C4 exhibited random noise. These receivers reached or exceeded the CCIR 4 level at the maximum Undesired signal level. [5/5/95 EO&C]

7 The expert observers made the following comments at the median CCIR3 level. Comments related to CCIR impairment levels other than CCIR Grade 3 are estimated values based upon expert observers' judgment and memory of CCIR Level 4 tests performed on the same day:

Two receivers were at CCIR Grade 1. Two receivers were worse than CCIR Grade 1. Four sets were severely impaired at CCIR Grade 2. Four sets were at CCIR Grade 3. The impairment was noise-like with impulse noise aspects when at CCIR 3. When worse than CCIR 3, some sets exhibit streaking in addition to noise. [5/8/95 EO&C]

8 At the maximum Undesired power level, three sets (B3, B5, and C6) were at TOV; and two sets (A1 and A7) were a little worse than TOV. All impairments are random noise-like. [5/8/95 EO&C]

9 At the maximum Undesired power level Receiver A1 was at CCIR Grade 4, Receiver A7 was slightly less impaired than A1, and Receivers B5, B3 and C6 were less impaired than A1. All other receivers did not show any impairments. [5/8/95 EO&C]

10 The expert observers made the following comments at the median CCIR4 level. Comments related to CCIR impairment levels other than CCIR Grade 4 are estimated values based upon expert observers' judgment and memory of CCIR Level 4 tests performed on the same day.

At this level, Receivers A1, B1, and B8 are unusable. Receivers A7, B3, B6 and C2 are "very annoying" (CCIR Grade 1); Receivers A6, A8, B5 and B7 are "annoying" (CCIR Grade 2); Receivers A3, A4, and C4 are "slightly annoying" (CCIR Grade 3); and Receivers B2 and C6 are "perceptible but not annoying" (CCIR Grade 4). Fourteen sets are at or worse than CCIR Grade 4. [5/8/95 EO&C]

11 The expert observers made the following comments at the median CCIR3 level. Comments related to CCIR impairment levels other than CCIR Level 3 are estimated values based upon expert observers' judgment and memory of CCIR Level 3 tests performed on the same day:

Twelve sets are at CCIR 3 or worse. Receivers B1, B5, and B8 are unusable; Receivers C1 and C2 are at CCIR Grade 1; Receivers A7 and B3 are at CCIR Grade 2; Receivers B6, B7, C4, A3, and C5 are at CCIR Grade 3; Receivers A1, A4, A6, B2, C3 and C6 are at CCIR Grade 4; Receivers A2, A5, A8, B4, C7 and C8 are at CCIR Grade 5; [5/8/95 EO&C]

12 At maximum Undesired power level, a very subtle appearance of random noise was noted on receivers A1, A7 and A8 <u>only</u>. [5/9/95 EO&C]

13 At maximum Undesired power level, no receivers achieved the CCIR 4 level of impairment. No impairments were detected on monitor banks A, B, or C of any nature related to this test. [5/9/95 EO&C]

14 At maximum Undesired power level, four receivers (A8, B1, B8 and C2) were worse than CCIR Grade 4. The impairment appears as snow. On Receiver A8, the expert observers estimated the impairment at a CCIR 3 - 3.5 level. The worst receiver (B1) was so impaired as to completely obscure the picture. On Receiver B8, the impairment was estimated to be at a CCIR 2 level. Receiver C2 also had an unusable image. The balance of the receivers showed little or no visible impairment. [5/9/95 EO&C]

15 The expert observers made the following comments at the median CCIR3 level. Comments related to CCIR impairment levels other than CCIR Grade 3 are estimated values based upon expert observers' judgment:

Receivers B1, B3, B5, B8, C1 and C2 are all totally unusable. Receivers A3, A8, B2, B7, C4 and C5 are all "very annoying" (CCIR Grade 1). Receivers A6 and C4 are "annoying" and slightly worse than CCIR Grade 3. Receivers A4, A5, C6 and C8 are "slightly annoying" (CCIR Grade 3). Receivers A1, A2, A7, B4, B6, C3 and C7 all have imperceptible noise in the picture (CCIR Grade 5).

The noise appears as ignition (impulse) noise. [5/15/95 EO&C]

16 At the maximum Undesired power level, slight noise was observed on Receivers A3, A7, and B3. On Receiver A2, very slight noise was observed [5/10/95 EO&C #1 Rev. 1]

17 None of the receivers were impaired at CCIR Grade 4.

Receivers A1, A2, A7 and B3 were slightly impaired. Receiver A3 was very slightly impaired. The impairment was random noise. The remaining receivers did not contain any noticeable impairment. [5/10/95 EO&C #2 Rev. 2]

18 At the maximum Undesired power level, none of the receivers were unusable. Receiver B1 was judged as annoying at CCIR Grade 2. Receiver C2 was more impaired than at CCIR4. Receiver B5 was near CCIR4. Receiver C4 was at the CCIR4 level. Receiver B1 had white noise. Receivers B5, C2 and C4 had mostly random noise. [5/10/95 EO&C #3 Rev. 2]

19 The expert observers made the following comments at the median CCIR3 level. Comments related to CCIR impairment levels other than CCIR Grade 3 are estimated values based upon expert observers' judgment and memory of CCIR3 tests performed on the same day:

Receivers A3, B1, B7, B8 and C2 are unusable. Receivers B5, C1 and C5 are "annoying" (CCIR2). Receivers A5, A8, B2, B3 and C4 are viewable and near CCIR Grade 3. Receivers B4, C7 and C8 are impaired but less than CCIR Grade 3. Receivers A1, A2, A4, A6, A7, B6. C3 and C6 show very slight impairment. [5/10/95 EO&C #4 Rev. 2]

20 At maximum Undesired power level, Receivers A1, A3, A7, B3 and B7 exhibited a slight increase in overall picture noise, slightly past TOV. All other receivers had no detectable impairment. [*5/10/95 EO&C #5 Rev. 1*]

21 At maximum Undesired power level, no receivers were near CCIR Grade 4. All receivers exhibited little or no impairment. [5/10/95 EO&C #6 Rev 1]

22 At maximum Undesired power level, Receivers A3, A4, A6, B1, B2, B3, B5, B7, B8, C2, and C4 (11 monitors) reached or exceeded the CCIR 4 impairment level. Receivers A3 and B7 exhibited a lot of noise, but the picture was sync locked and visible. General impairment was manifested as an increase in picture noise. It was noted, however, that receivers B1, B7 and C2 displayed a beat pattern when the noise impairment began. Most of the remaining monitors exhibited little or no detectable impairment visually. [5/10/95 EO&C #7 Rev. 1]

23 The expert observers made the following comments at the median CCIR3 level:

Receivers A3 and B7 are nearly unusable. Receiver B2 seems to be most similar to the reference (CCIR 3). The remainder of sets had usable pictures. Receivers A4, A6, C4 and C5 are near CCIR3. Receivers A1, A7, A8, B5 and C7 are virtually unaffected. Receivers A6 B1, C2, C5 and C8 show a fixed beat. Receivers B3, B7 and B8 show a wiggly beat. [5/11/95 EO&C #1 Rev. 1]

24 No impairment could be observed. [5/11/95 EO&C #2 Rev. 1]

25 At the maximum Undesired power level, the expert observers made the following comments:

Receiver B1 showed interference which was small but easily detectable. Receivers A1, A3, A6, A5, B6, B5 and C5 showed impairment level equal to Threshold of Visibility (TOV). Receivers A6 and B6 showed wiggly/wormy patterns equivalent to TOV. Receivers C5 showed a diagonal stripe pattern equivalent to TOV. Receiver C2 showed white noise which was well noticeable, perhaps CCIR Grade 3. [5/11/95 EO&C #3 Rev. 1]

26 One receiver (C2) achieved CCIR Grade 4 at the maximum Undesired power level. At that level none of the other sets showed any interference. [5/11/95 EO&C #4 Rev. 1]

27 At the maximum Undesired power level, the expert observers offered the following comments:

None of the sets exhibited CCIR Grade 3 impairment. All were better. Receiver A3 showed wormy/white noise, and Receiver C5 showed diagonal stripes slightly below the CCIR3 level. All other sets showed low levels of interference or no interference at all. Receiver C6 was observed to have a higher noise level than the other sets even without interference from ATV. [5/11/95 EO&C #5 Rev. 1]

28 At the maximum Undesired power level, the expert observers made the following comments:

Receiver B5 showed considerable impairment. The impairment seems to be mainly to the chroma signal (blotchy chroma noise). Receivers A2 and B8 showed almost imperceptible horizontal streaking. The other receivers showed no interference. [5/11/95 EO&C #6 Rev. 1]

29 At the maximum Undesired power level, Receiver B5 exhibited the equivalent of CCIR4 impairment . The comparison between the reference (white noise) and Receiver B5 (chroma noise) was very subjective. None of the other sets showed any impairment at this level. [5/11/95 EO&C #7 Rev. 1]

30 At the maximum Undesired power level, the expert observers made the following comments:

Receiver B5 at this level of impairment is annoying. Receivers A7, B1, C4, C6 and C7 have perceptible interference, but not as visible as the reference monitor. When matching interference to the reference, each receiver (which was selected at CCIR4) exhibited interference visibility prior to achieving the matching CCIR4 level. Receivers A6, B5 and B6 have a herringbone beat pattern (different from reference). Receivers A2 and C5 exhibit streaking white noise. [5/12/95 EO&C #1 Rev. 2]

31 At the maximum Undesired power level, the expert observers made the following comments:

Receivers B5, B6 and C5 were at an "annoying" level. Receivers selected at CCIR 3 were A2, A3, A5, A6, A7, B1, B4, B5, B6, C1, C3 and C5. Receivers A2 and B1 exhibited horizontal streaking chroma noise, a different visual artifact from the grainy noise-like appearance of the reference. Receivers A4, A8, B2, B3, B8, C2 and C4 were unimpaired. [5/12/95 EO&C #2 Rev. 3]

32 At the maximum Undesired power level, only six receivers (A3, A6, B5, B7, B8 and C5) exhibited impairment , with B5 severely impaired. [5/12/95 EO&C #3 Rev. 1]

33 Receiver B8 matched the CCIR4 reference at the maximum Undesired power level. Receiver B5 showed impairment worse than CCIR4 by 11 dB. [5/12/95 EO&C #4 Rev. 2]

34 At the median CCIR4 level, the impairment was visually similar to the reference (random noise-like) for most of the twelve selected receivers. [5/12/95 EO&C #5 Rev. 1]

35 At the median CCIR3 level, the expert observers made the following comments:

Receiver C5 is determined unusable. Receivers B1 and B6 have a beat pattern and are very annoying (CCIR1). Receivers A2, A5, A6 and B5 are very annoying (CCIR1). Receiver C1 is slightly worse than CCIR3. Receivers A1 and B4 are at or equal to CCIR3. Receivers B7 and C7 are slightly better than CCIR3. Receivers A7, B2 and C2 all have slight noise in the picture. Receivers A4, A8, B3, B8 and C4 all have imperceptible noise in pictures (CCIR Level 5). Receiver B1 has a vertical pattern. Receiver B5 has random noise. [5/15/95 EO&C #1 Rev. 2]

Table 3-13B

Taboo Interference into ATV

ATTC Test #	Description	Desired Power		Desired to Undesired Ratio (dB) BER Method	
		Level	dBm	ACQ*	TOV
259	N-3 Ch. UHF Taboo NTSC/ATV	S	-27.92	NT	<-22.07
259	N-3 Ch. UHF Taboo NTSC/ATV	M	-52.91	NT	<-47.06
259	N-3 Ch. UHF Taboo NTSC/ATV	W	-67.93	NT	<-61.79
260	N-3 Ch. UHF Taboo ATV/ATV	S	-27.87	NT	<-20.95
260	N-3 Ch. UHF Taboo ATV/ATV	M	-52.90	NT	<-45.98
260	N-3 Ch. UHF Taboo ATV/ATV	W	-67.85	NT	<-60.61
29	N-2 Ch. UHF Taboo NTSC/ATV	S	-27.90	NT	<-23.19
29	N-2 Ch. UHF Taboo NTSC/ATV	M	-52.90	NT	<-48.23
29	N-2 Ch. UHF Taboo NTSC/ATV	W	-67.93	OK	-62.45
30	N-2 Ch. UHF Taboo ATV/ATV	S	-27.92	NT	<-21.83
30	N-2 Ch. UHF Taboo ATV/ATV	M	-52.91	NT	<-46.80
30	N-2 Ch. UHF Taboo ATV/ATV	W	-67.90	OK	-60.52
33	N+2 Ch. UHF Taboo NTSC/ATV	S	-27.91	NT	<-23.88
33	N+2 Ch. UHF Taboo NTSC/ATV	M	-52.89	NT	<-48.87
33	N+2 Ch. UHF Taboo NTSC/ATV	W	-67.93	OK	-59.86
34	N+2 Ch. UHF Taboo ATV/ATV	S	-27.93	NT	<-22.35
34	N+2 Ch. UHF Taboo ATV/ATV	M	-52.93	NT	<-47.33
34	N+2 Ch. UHF Taboo ATV/ATV	W	-67.91	OK	-59.13
261	N+3 Ch. UHF Taboo NTSC/ATV	S	-27.88	NT	<-23.10
261	N+3 Ch. UHF Taboo NTSC/ATV	M	-52.89	NT	<-48.08
261	N+3 Ch. UHF Taboo NTSC/ATV	W	-67.94	NT	<-62.49
262	N+3 Ch. UHF Taboo ATV/ATV	S	-27.93	NT	<-21.99
262	N+3 Ch. UHF Taboo ATV/ATV	M	-52.92	NT	<-46.98
262	N+3 Ch. UHF Taboo ATV/ATV	W	-67.92	NT	<-61.53

*NT: Not tested when TOV was not found.

3.7.6. Discrete Frequency Interference

The susceptibility of the Grand Alliance system to interference from discrete carrier frequencies was tested in accordance with the Test Plan, Section I-3.7.3.4. The 25 frequencies tested cover the range from approximately 3 MHz below the desired Channel 12 to approximately 3 MHz above the desired channel and are listed in Table 3-14, with the TOV found for each frequency. The thresholds are plotted versus the undesired carrier frequency in Figure 3-2.

Table 3-14

Discrete Frequency Interference into ATV

ATTC Test #	Frequency (MHz)	Desired Power		Desired to Undesired Ratio (dB) BER Method	
		Level	dBm	ACQ	TOV
102	201.0125	W	-67.82	OK	-52.02
103	201.5125	W	-67.80	OK	-51.59
104	202.0125	W	-67.79	OK	-50.34
105	202.5125	W	-67.79	OK	-49.89
106	203.0125	W	-67.78	OK	-47.44
107	203.5125	W	-67.78	OK	-45.09
108	204.0125	W	-68.02	OK	-20.05
109	204.5125	W	-67.78	OK	10.70
110	205.0125	W	-67.78	OK	10.30
111	205.5125	W	-67.78	OK	10.61
112	206.0125	W	-67.78	OK	10.16
113	206.5125	W	-67.78	OK	11.73
114	207.0125	W	-67.78	OK	13.11
115	207.5125	W	-68.02	OK	10.76
116	208.0125	W	-67.78	OK	9.52
117	208.5125	W	-67.78	OK	9.08
118	209.0125	W	-68.02	OK	9.06
119	209.5125	W	-67.78	OK	10.03
120	210.0125	W	-67.80	OK	-16.46
121	210.5125	W	-67.79	OK	-47.42
122	211.0125	W	-67.78	OK	-48.16
123	211.5125	W	-67.79	OK	-50.86
232	212.0125	W	-67.79	OK	-50.33
233	212.5125	W	-67.79	OK	-51.08
234	213.0125	W	-67.79	OK	-51.32

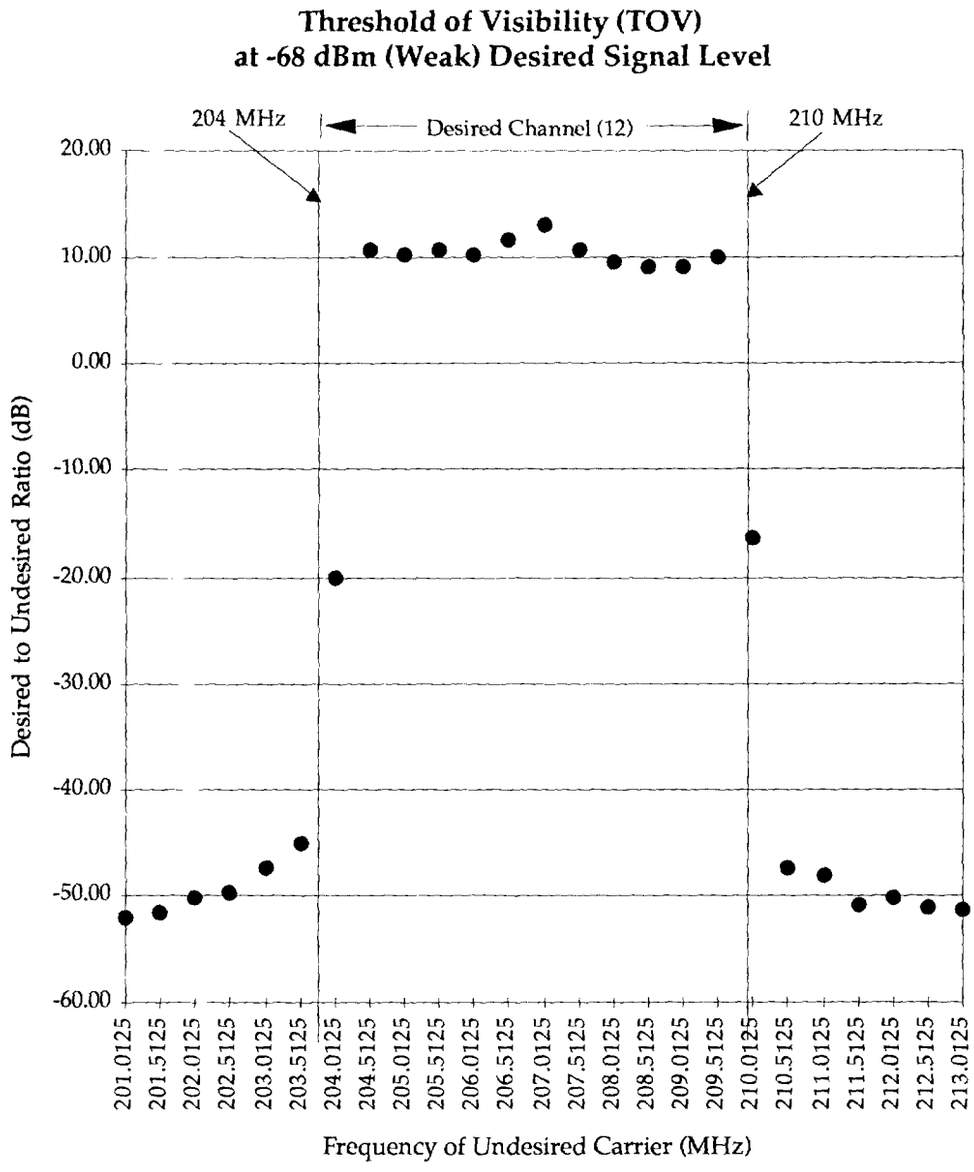
Threshold of Visibility (TOV)
at -68 dBm (Weak) Desired Signal Level
204 MHz
Desired Channel (12)
210 MHz
20.00
10.00
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
Desired to Undesired Ratio (dB)
201.0125
201.5125
202.0125
202.5125
203.0125
203.5125
204.0125
204.5125
205.0125
205.5125
206.0125
206.5125
207.0125
207.5125
208.0125
208.5125
209.0125
209.5125
210.0125
210.5125
211.0125
211.5125
212.0125
212.5125
213.0125
Frequency of Undesired Carrier (MHz)

Figure 3-2

Section 4.

DEGRADATION OF BTSC AUDIO

4.1. Introduction

In the first round of testing, degradation of BTSC audio was tested objectively by measuring, on three representative receivers, any significant increase in total harmonic distortion (THD+N) or decrease in stereo separation due to interference from ATV signals on the co-channel or upper-adjacent channel. No subjective listening was included in the test plan. The level of co-channel interference at which the BTSC audio became impaired was about the same as or greater than the level at which the video was impaired, except for one receiver with one system (CCDC). For upper-adjacent channel interference, the BTSC audio became impaired at about the same level or at a greater interference level than the video. In the ATV System Recommendation to the FCC Advisory Committee, no cause for concern was raised regarding BTSC audio degradation.

The Grand Alliance Test Plan (*Section I-4*) provided for limited testing, by subjective listening, for degradation of BTSC audio in the presence of a co-channel or upper-adjacent channel ATV signal. These tests were carried out on six receivers having baseband audio outputs. The listeners were asked to determine whether any audio impairment heard was "more than slightly annoying" (*i.e.* CCIR Grade 3 or worse) at the video CCIR 3 level determined for each of the receivers during the corresponding ATV-into-NTSC video test. The tests were conducted only at the Weak Desired level of the NTSC signal.

For co-channel interference the test showed that the video was impaired at lower Undesired signal levels than the audio for all six receivers tested. For upper-adjacent channel interference it was found that, for four of the six receivers tested, the audio was impaired at Undesired signal levels below those causing CCIR Grade 3 picture impairment. (These results were documented by Expert Observation and Commentary on April 21, 1995.)

Based upon the results of this limited testing, and the previously undocumented susceptibility of BTSC audio that it revealed, the Chairman of SS/WP-2 authorized supplemental tests during the Grand Alliance testing period. Refer to Doc. SSWP2-1464, reproduced in *Section 14*, which includes a chronology and supplemental audio test plan. These supplemental tests sought the following data:

1. Audio CCIR 3 for the remaining 18 receivers for upper-adjacent channel interference at the Weak Desired level.

2. Audio CCIR 3 and CCIR 4 (including SAP CCIR 4) for upper-adjacent channel interference at Moderate Desired level.

3. Audio CCIR 3 and CCIR 4 (including SAP CCIR 4) for upper-adjacent channel interference at Strong (-25 dBm) Desired level.

4. Audio CCIR 3 (including SAP CCIR 3) for N+14 UHF taboo channel interference at Weak Desired level.

Two other tests were authorized, time permitting. One of these was to be a repeat of Number 3, above, at a -15 dBm Desired level, as was used in the first round of testing (1991-92). The other was a repeat of Number 3 with the ATV signal shifted upward by 0.5 MHz from the normal channel position. These were conducted only as limited experiments by ATTC and Grand Alliance staff, and did not utilize outside expert observers.

4.2. Method

For each test, the video CCIR 3 levels for each receiver were determined first, as starting points for the audio tests. Three sounds were used for each audio test. All selections were taken from the EBU Sound Quality Assessment Material (SQAM) CD.

The following material was used for the BTSC stereo test:

1. Glockenspiel—Cut #35, approx. 30 secs. (stereo)
2. Harpsichord—Cut #40, approx. 20 secs. (stereo)
3. Male Speech—Cut #50, approx. 20 secs. (mono)

The following material was used for SAP testing:

1. Violin—Cut #08, approx. 30 secs. (stereo mixed to mono)
2. Trumpet—Cut #22, approx. 20 secs. (stereo mixed to mono)
3. Male Speech—Cut #50, approx. 20 secs. (mono source)

4.3. Data

The results of all of the BTSC audio tests, original and supplemental, are presented in Tables 4-1 through 4-5. These tables also show the video CCIR3 level for each receiver, including both the voted CCIR3 level and the lower CCIR3 level corresponding to the beat pattern which the expert observers noted on some of the receivers during a portion of the test image, as discussed fully in *Section 3.7.3*. It is important to note that the levels presented in the tables are absolute levels of the Undesired signal—not D/U ratios. Therefore, the largest negative number represents the most critical level. In some cases, the maximum power level of the RF Test Bed was reached before the required data point could be found. In these cases, the "greater than" (">") symbol appears in the data table preceding the maximum Undesired signal level.

As required by the Test Plan, the observers also determined that the presence of audio modulation did not change the visual impairment at the CCIR3 video impairment level.

The results are summarized as follows:

1. For co-channel interference and for N+14 UHF taboo channel interference, the CCIR 3 impairment level for video occurred at a lower interference level than the CCIR 3 impairment level for the audio. Therefore, the spectrum planning is properly based upon <u>video</u> impairment considerations.