FCC regulations on separation distances, maximum antenna heights and radiated powers. The degrading effects of interference sometimes may be reduced by using a directional antenna and the capabilities of a receiver to discriminate between desired and undesired signals. A similar situation is expected to hold for ATV reception.

2. Purpose

The purpose of developing this model is to obtain a tool by means of which RF receiver interference and noise impairment thresholds, such as those measured by the Advanced Television Test Center (ATTC) for the several ATV systems, can be translated into expected geographic service and interference areas. The model will be a useful tool for exploring the trade-off between the coverage area of new ATV stations and the degree of interference protection afforded to the present NTSC television service. This trade-off is centered on establishing minimum ATV-NTSC cochannel separation distances. Existing spectrum assignment models are able to explore the relationship between the ATV-NTSC cochannel separation distance and the number of NTSC allotments that could be assigned a simulcast channel.

The programs which implement the model will be capable of providing output values in convenient formats for any reasonable range of input parameters, such as desired-to-undesired ratios, transmitter power, HAAT, spacing, broadcast band, propagation characteristics and receiving characteristics.

Some of the parameter values for an ATV service will not be known until after completion of the subjective tests in Canada and until after FCC rule-making. Tentative values must be assigned carefully to these criteria so that an equitable and fair comparison of ATV transmission systems is possible and so that allotment planning is based upon valid estimates of coverage and interference.

Each Proponent and interested party was asked to designate an individual:

- To serve on SG-11 to specify a model
- To verify that the resultant model will fairly represent the capabilities and advantages of the proposed ATV Systems
- To monitor the development and testing of the Model

The initial charge to SG-11 was:

> *To specify and to develop a computer model that may be used to calculate the service and interference contours and their areas for an ATV transmission and receiving system; and to propose a software system which will implement the model and which will serve as a tool to evaluate and compare ATV transmission and receiving systems by using data assembled by ATTC/ATEL to predict and plot ATV service and interference contours.*

The charge was extended:

> *To define comparable service area as the interference-limited service area of present stations; and to develop a methodology for calculating the interference-limited service areas of stations as a tool for evaluating proposed allotment plans.*

3. Allotment Plan Principles

Three reasonable objectives for an ATV simulcast service, are:

(1) That all, or nearly all, present NTSC allotments be paired with an allotted ATV simulcast channel

(2) That an ATV simulcast station have a service area that is comparable to the service area of the NTSC station to which it is paired

(3) That reception of existing NTSC stations not be significantly impacted by interference from new ATV stations

The most critical parameter of an ATV allotment plan is the separation distance between a new ATV transmitter and an existing cochannel NTSC transmitter. If this cochannel separation parameter is set to the largest distance that will permit nearly 100% of existing NTSC allotments to be paired with simulcast channels, then an ATV transmitter power level which would support an ATV coverage area comparable to the existing NTSC coverage area would create a certain level of additional interference within the NTSC service area. Should that level of interference be deemed objectionable, then either the ATV transmitter power must be reduced with a corresponding reduction in ATV coverage area or the cochannel separation distance must be increased with a corresponding decrease in the number of ATV allotments.

WP-3 has recommended ATV spectrum allotment and assignment planning principles to the Planning Subcommittee. They are useful

for comparing how proposed ATV transmission systems would implement broadcast service areas within a nationwide spectrum allotment plan. They also could be applied to any existing station or allotment to compare coverage areas.

The principles can serve as a guide for recommending limits on the separation distances, antenna heights and permissible powers of cochannel ATV stations. Two of the principles, which address the above objectives, are particularly relevant to the work of SG-11.

(1) That ATV assignments should provide a service area comparable to the calculated interference-limited service area of the NTSC station with which it is paired. The interference-limited service area is that region to which reception is limited by calculated interference from TV stations.

(2) That an ATV station should not cause any greater interference penetration into the service area of existing NTSC stations or other ATV stations than is permitted for NTSC.

The Fourth Interim Report stated that the degree of interference to NTSC permitted will be comparable to that caused by NTSC-to-NTSC cochannel interference at typical cochannel spacings. WP-3 has suggested for the initial purpose of comparing ATV systems that the measure of NTSC-NTSC cochannel interference should be taken at the minimum separation and the maximum height and power permitted by the FCC rules, except that 1200 ft was suggested for VHF. SG-11 now recommends that comparisons be made at three separations corresponding to minimum, typical of the congested northeast, and typical of uncongested areas.

4. Comparable Coverage

The principle of *Comparable Coverage* relates to the pairing of an ATV simulcast channel with an existing NTSC allotment. The calculation of coverage area is an important factor for evaluating alternative ATV transmission systems. SG-11 has developed a methodology and a model that will be useful for calculating and comparing service areas that may be limited by interference. The model could be used to calculate interference-limited service areas for both ATV and NTSC stations. The model will treat multiple interferences. For instance, the model could compute the boundary of the region within the NTSC Grade-B service area to which coverage is limited due to calculated interference from other NTSC stations. A realistic example of interfering stations might include one or two cochannel and one or two adjacent channel stations. One could then compare that region to the similarly calculated service area of a paired ATV channel assignment.

5. Comparable Interference

The above principle of comparable coverage depends upon establishing a criterion for comparing the effects of ATV and NTSC interference into NTSC. NTSC reception is already subject to much cochannel and adjacent channel interference. Establishing what undesired ATV or NTSC signal levels may be present in a receiver without causing unacceptable degradation of a desired signal is a complex issue involving many factors -- subjective and political, as well as technical. The ACATS, using the results of the video subjective tests, is to recommend a criterion for permitted ATV

interference into NTSC that is comparable to existing levels of NTSC interference into NTSC.

One objective for the model is to calculate the maximum radiated power that should be used by a new ATV cochannel station so that the new ATV station would not introduce more than a permitted level of interference into the service areas of existing NTSC stations. The methodology behind the model is useful for developing and evaluating recommended limits on the minimum separation distances, maximum antenna heights and maximum permissible powers of ATV stations.

6. Parameters

The model incorporates many parameters to characterize the significant factors of television transmission and reception. The parameters fall into several classes:

ATV System Parameters	eg:	Carrier-to-noise ratio Desired-to-undesired ratios
Allotment Plan Parameters	eg:	Minimum spacings Antenna height Radiated power
Propagation Factors	eg:	FCC curves Signal fade over time
Receiving System Planning Factors	eg:	Antenna gain Receiver noise figure

In the implementation of the Advanced Television Service, values will be assigned to each parameter. Some parameter values will be determined in the ATTC by objective measurement or by the ATEL subjective evaluation; some parameter values will come from a spectrum allotment plan; some parameter values will be based upon engineer-

ing judgements about state-of-the-art of transmitter, antenna and receiver manufacturing.

7. System Design Tool

A user of the model will be able to interactively vary the values of one or more parameters and to immediately calculate the effect of that change upon coverage and interference. The model will permit experimentation with and evaluation of different criteria proposed for comparing levels of interference.

B. Methodology

1. Introduction

Methodologies were developed for:

(1) Calculating signal strength contours and interference threshold D/U ratio contours.

(2) Calculating the interference-limited service areas of ATV and NTSC stations.

(3) Developing and evaluating recommended limits on the minimum separation distances, maximum antenna heights and maximum permissible powers of ATV stations.

The relevant theory, propagation factors, formulas, parameters, and algorithms used in performing calculations are discussed in a forthcoming technical report.

2. Concepts and Definitions

ATV Noise-Limited Service Area (NLSA) - An ATV service will be an interference-limited service. Nevertheless it is useful as a reference to determine what the coverage of an ATV station would be in the case that reception is limited only by

noise. Given an interference criterion and ATV-NTSC cochannel separation distance, one can calculate the maximum power that may be radiated by a cochannel ATV transmitter at a given antenna height. Given also, the value of the Carrier-to-Noise-Ratio (CNR) for an acceptable ATV picture quality, the ATV noise-limited service area may be calculated.

Interference-Limited Service Area (ILSA) - The Interference-Limited Service Area of an ATV or NTSC station is defined as that portion of the ATV NLSA or the NTSC Grade-B service area respectively in which reception is calculated to not be limited by any interference from TV stations beyond an acceptable level.

For this purpose, an acceptable, or permitted, level of an undesired signal is a signal strength that is less than or equal to the signal strength of the desired signal by a specified D/U ratio measured in dB. That is, the strength of the desired signal must exceed the strength of the undesired signal plus the D/U ratio as measured at the receiver terminals. In this sense, the D/U ratio may be viewed as the threshold for the onset of unacceptable interference from that signal. D/U ratios compare signal strengths which are measured or derived according to criteria of location and time availability for the desired and undesired signals. For instance, the desired signal may be determined according to a 50/90 rule and the undesired signal strength may be determined according to a 50/10 rule; that is, the desired signal is

available at 50% of locations for 90% of the time and the undesired signal is available at 50% of locations for 10% of the time. A larger D/U ratio signifies a more stringent interference criterion. The model is to have individual D/U ratio parameters for each type of interference. The types of interference considered include cochannel, adjacent channels and taboo channels for all combinations of ATV and NTSC signals as the desired and undesired stations. For instance, a frequently used value of D/U for NTSC-to-NTSC cochannel interference is 28 dB for normal frequency offset and 22 dB for precise frequency offset of carriers. These values should not be confused with the Threshold of Visibility (TOV) or the Point of Unusability (POU) measured by ATTC. ATEL will determine subjective quality ratings between these two points from which the point of acceptable interference will be chosen by PS/WP-3.

Typical Interferers - For the initial calculations and for both ATV and NTSC we will assume that the desired station is located on a line between one ATV and one NTSC cochannel interferer and is at the reference separation distances from them. Future calculations could add second cochannels and two adjacent channels.

Minimum Separation Distances - Separation distance is a model parameter. It is expected that different minimum spacings between ATV and NTSC stations will be required for

the three allocation zones is not expected to be necessary. It may be desirable to provide a separate allocation zone with higher minimum spacings for the Gulf region and southern California.

Reference NTSC Cochannel Separation Distances - It is recommended that comparisons of the coverage of ATV systems be made at three cochannel separation distances selected as follows: the minimum separation permitted under the present FCC rules (Column A), separations typical of the congested northeast (Column B), and separations typical of uncongested areas (Column C).

		A	B	C	
VHF:	NTSC-NTSC:	275	290	305	km
	NTSC-ATV:	160	180	200	km
UHF:	NTSC-NTSC:	250	270	290	km
	NTSC-ATV:	160	180	200	km

Permitted NTSC Penetration Into NTSC - For the purpose of comparing ATV systems, the following parameter values should be used for the NTSC service. The receiving parameter values are the NTSC receiving planning factors with the addition of a 6 dB F/B ratio for the receiving antenna, which is considered typical in fringe reception areas. The transmitter parameter values are the maximums permitted under the FCC rules for Zone I with the exception of an antenna height at UHF of 1200 ft, which was considered to be more typical than the 2000 ft permitted under the rules. The criterion for permitted interference is specified as a percent of the NTSC Grade-B contour area penetrated at or

below a given D/U ratio of the desired NTSC signal to the undesired NTSC signal. The D/U level to be used will be determined by PS/WP-3 from the ATEL subjective ratings. This will be calculated using the NTSC-NTSC cochannel separation distances given above and the following antenna heights and powers:

The NTSC/NTSC cochannel interference boundary D/U ratio is usually taken as 28 dB.

RECOMMENDED NTSC MODEL TRANSMITTER FACILITIES				
			Grade B Contour	
Channels	ERP (dBk)	HAAT (m)	Distance (km)	Field Strength (dBu)
2-6	20	305	104.0	47
7-13	25	305	95.7	56
14-69	37	366	89.7	64

Permitted ATV Penetration Into NTSC - The criterion will be specified to the model as a percent of the NTSC Grade-B contour area penetrated at or below a given D/U ratio of the desired NTSC signal to the undesired ATV signal. The level of ATV cochannel interference into NTSC that could be considered subjectively equivalent to any given level of NTSC cochannel interference into NTSC will be determined from the ATEL subjective test results.

WP-3 is to recommend a criterion for a permitted level of ATV interference penetration into NTSC. One suggestion is to begin with a criterion for permitted NTSC/NTSC cochannel interference and then determine an ATV signal power which produces an equivalent level of ATV interference as determined subjectively by trained observers. Another suggestion, which applies only to noise-like interference from digital ATV systems, is to permit ATV cochannel interference to degrade the received CNR for an acceptable picture quality at a certain distance from the desired transmitter by a specified amount (e.g., lower the CNR by no more than 2 dB).

Maximum Permissible ATV Power And Height - Any ATV service is expected to be an interference-limited service. That is, the amount of interference that a new ATV station will be permitted to generate within the Grade-B service area of a cochannel NTSC station at a given transmitter separation and antenna height will limit the maximum permissible radiated power. From the criterion for permitted ATV interference into NTSC, one can determine, by following the methodology outlined below, the maximum power that may be radiated by an ATV transmitter with a given antenna height and a given cochannel transmitter spacing.

Coverage Versus Cochannel Separation - From the permitted power and the minimum required CNR at the input to the ATV receiver, the noise limited service area can be calculated. A performance curve of noise-limited coverage area versus separation distance can be drawn.

Comparable ATV and NTSC Interference - For the present, there is no recommendation of a D/U ratio or other measure of ATV cochannel interference into NTSC that is comparable to a D/U of 28 dB for NTSC-NTSC cochannel interference. PS/WP-3 will select D/U ratios based upon the subjective ratings determined by ATEL.

Measured ATV Interference Ratios - The plan is to use interference ratios measured by ATTC and ATEL for each type of Interference (Cochannel, adjacent, or taboo) from ATV into ATV or NTSC and from NTSC into ATV. ATTC will determine a Desired-to-Undesired (D/U) signal ratio for TOV and POU. Data will be measured for up to three levels of desired signal power which have been established in terms of a reference noise power which is the same for all ATV systems. ATEL will determine subjective quality ratings between these two points from which the point of acceptable interference will be chosen by PS/WP-3; one possibility is when the interfering signal is "perceptible but not annoying".

Reference NTSC/NTSC Interference Ratios - For each type of adjacent channel or taboo channel interference from NTSC into NTSC, the reference D/U ratios will be taken from an FCC study of receiver performance reported by Hector Davis: "A Study of UHF Television Receiver Interference Immunities"; FCC OET TM/1 8-87 or from ATEL data as decided by PS/WP-3.

3. Outline of Methodology

The method of determining ATV and NTSC Interference-Limited Service Areas is outlined below. The methodology employs a series of models and calculations as follows:

Signal Transmission and Reception
- Models of NTSC and ATV Transmitter Power and Antenna
- Signal Propagation based upon FCC Curves
- Receiving System Planning Factors for NTSC and ATV

NTSC Interference-Limited Service Area
- Calculation of NTSC service areas without Interference
- Model NTSC with NTSC Interference: Cochannel, Adjacent, Taboo
- Calculation of Multiple Interferences
- Calculation of NTSC-ILSA-1

Maximum Cochannel ATV Power and Height
- Model of NTSC with ATV Interference
- Calculation of NTSC-ILSA-2 with ATV Cochannel
- Compare NTSC-ILSA-1 and NTSC-ILSA-2
- Determine Maximum Permitted ATV Power
- Calculate for a range of HAAT

ATV Interference-Limited Service Area
- Model of ATV Service Area Without Interference
- Model of ATV with NTSC Interference
- Model of ATV with ATV Interference
- Calculation of Multiple Interferences
- Calculation of ATV-ILSA

C. Scope of Model

PURPOSE - The purpose of the model is to investigate the transmission, receiving, and propagation characteristics of proposed Advanced Television Systems relative to service area and interference from and into other TV broadcasts. The interferences modeled include all combinations of ATV or NTSC cochannel, adjacent channel and taboo channel interference to ATV and NTSC desired stations. It is beyond the scope of the present task to develop tools for an engineering study of any specific station or geographic location.

SIGNAL PROPAGATION - The received signal strength is a statistical function of distance, time, frequency, elevation and terrain variables. The propagation function F(L%,T%) accounts for the variation of received signals due to location and fading over time where L and T represent percentages of locations and time. For instance, at a given distance from a transmitter, F(50,90)

represents a signal strength which is met or exceeded at the best 50% of locations for 90% of the time.

MODEL COMPONENTS - A model run is composed of a Desired Station and 0-10 Undesired Stations located in a plane area. Distances are measured in kilometers, and locations are relative to a polar coordinate system. When calculating contours for a station, every point in the model area may be considered as the location of a receiving site for that station. The receiving system assumed to have a directional antenna, at a nominal height of 10 m, which is oriented with the direction of maximum gain towards the station under consideration. Given a function (e.g. Signal Strength, D/U, CNR) which varies over the model area, contours and their areas may be calculated and plotted. There are two kinds of model runs:

FUNCTION-1: CONTOUR CALCULATION (Normal mode) - *Given* the parameters of a desired station and one or more interfering stations, then *calculate* and plot the service and interference threshold contours, *calculate* the area of each service contour, *calculate* the area and penetration of each interference contour, and *calculate* the area within each service area that is outside of all interference contours.

FUNCTION-2: COCHANNEL ERP CALCULATION - Given a separation distance and the parameter values of a desired station and an undesired cochannel station; given also an interference D/U ratio considered acceptable and a percentage of the reference contour area of the desired station penetrated by interference from the undesired cochannel; then for each of a given range of values for HAAT of the undesired cochannel, calculate the maximum cochannel ERP which is calculated to generate a permissible amount of cochannel interference. The parameters and results will be prepared for Function-1 in order to calculate and plot the reference and interference contours for each station and to calculate for each station:

Area enclosed by the reference contour
(Grade-B or Noise Limited Service Contour)
Penetration distance of interference along axis of stations
Interference area and percent of reference area
Interference-Limited area and percent of reference area
Interference Penetration (% of radial distance)

CONTOURS AND CALCULATIONS - The model shall have the capability to calculate, display and plot multiple contours, individual points, and other information. For each individual station, applicable items should be individually selectable. The calculations shall use ATV or NTSC planning factors appropriate to the type of signal received.

For NTSC Stations Calculate and Plot:
- City Grade Contour
- Grade A Service Contour
- Grade B Service Contour

For ATV Stations Calculate and Plot:
- Strong Signal Contour
- Moderate Signal Contour
- Weak Signal Contour
- Noise Limited Service Contour
- Interpolate Between the Signal Levels

For Any Station Calculate and/or Plot:
- Threshold Contours of Interference from Other Stations
- Interference Limited Contour
- Circles at km Distances
- Circles at Distances to Radiation Horizon at k*Earth Radius
- Contour of Field Strength Values: F(L%,T%)
- Contours of CNR Values
- Angular Radials

For Station Centered Contours, Calculate and Display:
- Area of Reference Grade-B or Noise Limited Contour
- Interference Limited Contour Area
  - Percent of Reference Area
- Areas of Other Contours

For Interference Threshold Contours, Calculate and Display:
- Interference Areas and as Percent of Reference Area
- Distance to Contours on Line to Interfering Station
  - Penetration Distance of Interference Contours
  - Percent of Reference Contour Distance Penetrated

Calculate and Display Points
- Coordinates of Contour Intersections
- Intersections of Contours With Lines Between Stations
- Specified Points (R,θ)

Calculate and Display For Receivers at Points:
- Value of Signal Strength
- Value of Total ATV Digital Signal Power
- Value of CNR
- Value of D/U Ratio
- Weak Desired Signal Power
- Moderate Desired Signal Power
- Strong Desired Signal Power
- Field Strength to Available Signal Power Conversion Factor

IX. FUTURE WORK

During the next reporting period, Specialist Group 3, which is assigned the responsibility of analyzing the impact of ATV on broadcast support services spectrum and non-broadcast spectrum uses, will continue to (a) consider the proponent systems in terms of their particular ATV signal's impact on microwave and other types of contribution and distribution circuits as the necessary information becomes available, (b) continue discussions with manufacturers of contribution and distribution equipment regarding issues associated with the transmission of ATV signals on their systems, (c) continue to pursue alternative spectrum that might be made available for broadcast auxiliary services on at least an interim basis, and (d) continue to keep the Working Party, Planning Subcommittee, and full Advisory Committee informed of its concerns about the availability of adequate spectrum to support initial ATV systems. Specialist Group 4, dealing with the possibility of accommodating ATV in the spectrum above 1 GHz, will remain temporarily inactive for the reasons noted earlier.

In the next reporting period, the work of (1) Specialist Groups 6 and 7, which deal on a combined basis with spectrum analysis and taboo issues, (2) Specialist Group 10, which deals with planning factors, and (3) Specialist Group 11, which deals with service and interference modeling, will begin to converge. The work of Specialist Group 11 is the pacing (critical path) activity. As reported above, a contract has been let for preparing the required computer program, and completion is anticipated in the

Spring of this year. Initial test calculations will be made for NTSC systems and reports of ATV coverage, and accommodation statistics will be prepared as the test data become available. In addition to the laboratory test data, these calculations will make use of the planning factors being developed in Specialist Group 10. The results of the calculations will be provided through this Working Party to the Systems Subcommittee Working Party Four as elements to be factored into that Working Party's determination of what system it will propose that the Advisory Committee recommend for implementation. Finally, a suggested Table of Allotments and Assignments will be prepared based upon these data and the accompanying analysis.

ATTACHMENT

Advanced Television Committee
Planning Subcommittee WP-3
Spectrum Utilization Working Group
Attendance (Alpha by Name)

Name	Affiliation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Aileen Amarandos	Latham & Watkins							x	x																																				
Harvey Arnold	North Carolina Public TV																																x	x	x	x			x				x		x
Stan Baron	NBC																																							x					
Paul Beeman	Viacom Networks								x	x	x	x																																	
Krishma Bhatnagar	COMSAT																															x													
Martin Billips	NPR																																												
Christina Black	George Washington University		x	x	x		x	x	x	x																																			
William H. Borman	Motorola	x	x		x	x	x	x			x	x	x		x		x	x				x							x	x										x	x				
Kenneth Brown	Capital Cities/ABC										x																																		
Karen Brown	GAO/IMTEC																									x																			
Frank Bugg	PBS				x	x	x	x		x	x				x																														
William Byrnes	Haley, Bader & Potts																					x								e															
Karen Christansen	NPR			x		x																																							
Richard Citta	Zenith																																								x				
Lynn Claudy	NAB																x	x					x	x	x	x		x		x	x	x		x			x		x		x	x			x
Jennifer Clayborne	GAO														x																														
David Cohen	NTIA		x					x	x																																				
Jules Cohen	Jules Cohen & Associates/MST			x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x		x		x	x	x		x	x	x	x	x	x	x		x	x
Ed Cohen	NAB																						x																						
Ted Coltman	Corp. for Public Broadcasting			x	x	x	x	x		x	x	x		x	x	x	x				x		x		x	x			x	x						x				x					
Steve Crowley	du Triel, Lundin & Rackley																																											x	x
Ben Crutchfield	ATTC										x								x																										
Aldo G. Cugnini	Philips Labs																										x																		
Kathy Dale	Televisa			x																																									
Pat Daley	Bellcore																																	x											
Allen Davidson	Motorola																					x					x																		
Hector Davis	FCC Laboratory																																	x											
Gregory DePriest	MST	x	x		x	x	x	x	x			x	x	x	x	x									x		x																		
Robert DeSantis	ATTC																								x																				
Bob Denny	Jules Cohen & Associates/MST	x	x	x	x	x	x	x	x	x	x																																		
Joe Donahue	Thompson C.E.																															x													
Linda Dubroof	FCC																								x																				
Ken Dunmore	Economists Inc.													x																															
A. James Ebel	Network Affiliate			x	x																																								

Advanced Television Committee
Planning Subcommittee WP-3
Spectrum Utilization Working Group
Attendance (Alpha by Name)

Name	Affiliation	Mtg: 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Bob Eckert	FCC									x		x	x	x	x		x					x	x		x	x		x		x	x	x	x		x	x	x	x	x		x		x	x	x	x
Chris Ehrenbard	HBO				x	x	x									x																														
James G. Ennis	Fletcher, Heald & Hildreth	x						x	x		x								x								x	x						x				x								
John Ernandez	PBS																																													x
Peter Fannon	ATTC															x																														
Lex Felker	Wiley, Rein & Fielding																									x																				
Kevin Fisher	Smith & Powstenko																																		x	x	x	x	x	x	x	x			x	
Barry Fleishman	Anderson, Baker, Kill & Olick								x																																					
Pieter Fockeus	Zenith																																								x					
Bruce Franca	FCC						x	x				x													x									x										x		
Tom Friel	EIA/CEG																	x																												
Joe Gianguinto	Group W	x	x	x	x	x		x	x	x		x		x	x		x	x	x	x		x	x	x	x	x	x	x	x		x															
James Gibson	David Sarnoff Research Center																											x		x										x	x	x	x	x		x
W.E. Glenn	NYIT															x																														
Ronald Gnidziejko	NBC															x																														
Gordon Godfrey	FCC																																		x	x	x			x	x	x		x	x	x
Anne Goodwin	Fletcher, Heald & Hildreth														x					x																										
Rick G. Gould	Telecom Systems																		x																											
David Gump	HDTV Data Corp.																					x		x		x																				
David Hack	CRS/SPR Library of Congress	x	x	x	x	x	x		x	x		x		x																																
Ann Hagemann	HDTV International													x													x																			
David L. Hanna	GTE Telops			x																																										
George Hanover	EIA			x		x		x	x		x		x	x								x		x									x									x					
Gina Harrison	FCC																																											x		
William Hassinger	FCC MMB				x					x				x																																
Dale Hatfield *	Hatfield Associates	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x		x	x	x		x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x		x	x
Howard Head	A.D. Ring & Associates								x	x	x	x		x																																
John G.N. Henderson	David Sarnoff Research Center																															x														
Rich Hindman	House Subcommittee on Telecom.					x																																								
Judson Hoffman	Panasonic Technologies			x	x		x	x	x				x	x				x																												
Randy Hoffner	NBC																								x	x				x																
Robert Hopkins	ATSC														x		x																x										x			
John Huffman	HDTV Washington Resources																							x	x	x																				
Richard Iredale	Del Ray Group													x																																

Advanced Television Committee
Planning Subcommittee WP-3
Spectrum Utilization Working Group
Attendance (Alpha by Name)

Name	Affiliation	Mtg: 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Chuck Jackson	NERA																																x													
Don Jansky	Jansky Barmat Telecom, Inc./CBS	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x		x	x	x	x	x		x	x	x		x	x	x	x	x	x	x	x		x	x	x	x	x		x
Frank Jazzo	Fletcher, Heald & Hildreth			x	x	x	x	x				x	x	x				x		x	x	x	x	x		x	x		x	x		x	x		x	x									
Mark W. Johnson	CBS								x																																					
Wayne Johnson	Philips Labs													x																																
Krish Jonnalagadda	David Sarnoff Research Center	x																																				x								
Ralph Justus	NAB		x	x		x	x	x			x	x		x	x	x		x	x		x	x	x	x				x		x			x													
Tom Keller	NAB				x	x					x																								x											
Dick Klensch	David Sarnoff Research Center																									x	x	x	x	x	x	x	x	x	x	x	x		x		x		x			
Bud Klueck	Fletcher, Heald & Hildreth															x	x																													
Benn Kobb	Federal Communications Tech News							x	x																			x															x			
Jeff Krauss	General Instrument Consultant																																	x	x	x	x		x	x	x	x	x	x	x	x
Keiichi Kubota	NHK																											x	x											x	x					
James Kutzner	PBS																																x	x	x	x	x	x	x	x	x	x	x	x		
Ray LaForge	FCC																x										x	x																		
Ken Lager	A-Vision																					x																								
Frank Lang	David Sarnoff Research Center															x																														
Bernard J. Lechner	Consultant													x																											x					
John C. Lee	CABSC																					x																								
Louis Libin	NBC	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x		x	x		x	x	x	x		x	x
Marty Liebman	FCC PRB			x																																										
Lawrence Lockwood	TeleResources		x	x																																										
Wayne C. Luplow	Zenith														x																															
Louise Lynch	PBS		x	x																																										
Paul Marrangoni	FCC OET																											x																		
Robert McFarlane	Philips Labs														x													x																		
James McNally	FCC MMB/EPB		x																																											
Martin Meaney	NBC	x	x	x	x	x	x	x	x		x	x	x	x	x		x						x																								
Charles Mellone	NTIA/DOC						x																																							
Saeed Mirzad	Pacific Bell	x		x																																										
Tom Mock	EIA/CEG				x											x		x							x																					
Max Muterspaugh	Thompson C.E.															x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
Sheau Ng	David Sarnoff Research Center																											x																		
Celia Nogales	Pacific Telesis																	x																												

Advanced Television Committee
Planning Subcommittee WP-3
Spectrum Utilization Working Group
Attendance (Alpha by Name)

Name	Affiliation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Robert A. O'Connor	Jansky Barmat Telecom, Inc./CBS			x	x	x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Randy Oster	U S WEST Advanced Technologies													x	x										x	x		x	x			x					x									
Stuart Overby	Motorola	x	x	x	x		x	x	x	x	x		x																																	
Robert A. Peloso	Panasonic ATVL																																						x	x	x	x	x	x	x	
Thomas Pfaff	Medill News Service																							x																						
Larry Phillips	Panasonic ATVL																																				x	x								
William F. Pohts	Consulting Engineer	x																																												
Jelena G. Polic	Annenberg, Univ. of Penn.																																					x	x							
Alison Purcell	HBO							x																																						
Harley Radin	Direct Broadcast Satellite Corp.		x					x	x	x	x										x																		x	x			x			
Tom Ramstack	FCC Week Publication																							x																						
Robert Rast	General Instrument																																		x				x							
Ed Reinhardt	SBCA				x						x		x	x																																
Charles Rhodes	ATTC		x			x				x				x		x		x	x			x	x								x								x							
Cinda Rishell	CRS																									x																				
Jayne Roads	Hughes Aircraft																				x	x	x																							
Andrew Russell	Corp. for Public Broadcasting																														x	x	x	x						x						
Joe Russo	ABC-TV																						x			x	x		x	x	x	x														
Jouke Rypkema	Zenith	x	x	x		x	x	x			x	x	x	x		x	x	x	x	x	x			x	x		x	x	x	x	x		x	x	x	x	x	x	x	x				x	x	x
Burnett Sama	NBC																																	x	x	x	x		x	x	x	x	x	x	x	x
Carl Scarpa	Hitachi																																									x	x	x	x	x
Tim Schnacke	Fletcher, Heald & Hildreth																																				x									
Herb Schubarth	Gannett								x																																					
Ed Schultz	Bell Atlantic																							x																						
Steve Selwyn	FCC	x	x	x	x	x	x		x	x	x						x																													
Wayne Shore	COMSAT												x																																	
Richard E. Shrum	Department of State														x																															
David Siddall	FCC						x	x							x			x																												
Ken Skinner	NAPC																																					x	x	x	x					
Rodney Small	FCC			x	x		x		x	x																																				
John J. Smith	Anadigics																																													x
Richard Solomon	MIT Media Lab					x																																								
Allan Stalker	Group W		x	x		x		x		x	x	x	x	x																																
Tom Stanley	FCC						x																																							

Advanced Television Committee
Planning Subcommittee WP-3
Spectrum Utilization Working Group
Attendance (Alpha by Name)

Name	Affiliation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Alan Stillwell	FCC																																		x	x	x		x		x			x		x
Rupert Stow	RSA																																													x
Larrie Sutliff	Bellcore	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x		x	x	x	x	x	x	x	x		x	x
Peter Tannenwald	Arent,Fox,Kintner,Plotkin & Kahn	x	x			x	x					x																x	x	x	x	x	x			x										
Victor Tawil	MST								x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x		x	x	x		x			x	x					x			
Eb Tingley	EIA											x																																		
Tony Uyttendaele	Capital Cities/ABC				x	x	x	x	x	x		x		x	x	x	x	x	x	x													x	x	x		x					x	x		x	
Ted Wagner	David Sarnoff Research Center						x	x	x						x					x																										
Don Walker	Motorola		x	x	x		x		x	x		x	x	x			x	x	x	x	x	x	x		x	x	x		x				x										x	x		
John Watson	Group W						x																					x				x	x	x			x									
Barbara Wellbery	PBS				x																																									
Howard Whitcomb	Tandy Electronics																																										x			
Steve Wildman	Economists Inc.													x																																
Dick Wiley	Wiley, Rein & Fielding	x																																												
Chuck Wilk	Corp. for Public Broadcasting																																												x	
Ed Williams	ATTC	x			x					x				x	x	x				x	x			x		x	x	x	x	x	x		x	x		x	x	x		x			x		x	x
David Workman	FCC									x																																				
Atsushi Yamakita	PBS																																							x	x	x		x	x	x
Kei Yamashita	Hitachi																x																													
William Zou	PBS																																							x						
Totals: 156 Indiv. & 80 Entities Participating		20	24	31	30	28	30	31	31	26	25	25	20	33	25	22	21	21	17	14	15	21	17	22	18	23	20	28	17	18	20	16	25	19	23	17	26	19	19	24	26	20	24	17	19	23

1st Meeting	12/16/87	11th Meeting	6/2/88	21st Meeting	3/23/89	31st Meeting	5/1/90	41st Meeting	9/13/91
2nd Meeting	1/12/88	12th Meeting	6/27/88	22nd Meeting	5/22/89	32nd Meeting	6/20/90	42nd Meeting	10/15/91
3rd Meeting	1/28/88	13th Meeting	8/3/88	23rd Meeting	7/5/89	33rd Meeting	9/11/90	43rd Meeting	11/20/91
4th Meeting	2/11/88	14th Meeting	9/8/88	24th Meeting	9/7/89	34th Meeting	10/30/90	44th Meeting	12/18/91
5th Meeting	2/23/88	15th Meeting	10/19/88	25th Meeting	10/5/89	35th Meeting	12/5/90	45th Meeting	1/13/92
6th Meeting	3/8/88	16th Meeting	11/22/88	26th Meeting	11/7/89	36th Meeting	1/16/91		
7th Meeting	3/22/88	17th Meeting	12/21/88	27th Meeting	12/8/89	37th Meeting	2/12/91	* Chairman	
8th Meeting	4/5/88	18th Meeting	1/11/89	28th Meeting	1/10/90	38th Meeting	4/8/91		
9th Meeting	4/19/88	19th Meeting	1/24/89	29th Meeting	2/7/90	39th Meeting	6/19/91		
10th Meeting	5/10/88	20th Meeting	2/17/89	30th Meeting	3/13/90	40th Meeting	7/16/91		

Advanced Television Committee
Planning Subcommittee WP-3
Spectrum Utilization Working Group
Attendance (By Affiliation)

Name	Affiliation	Mtg: 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ken Lager	A-Vision																					x																									
Howard Head	A.D. Ring & Associates								x	x	x	x		x																																
Joe Russo	ABC-TV																						x			x	x		x	x	x	x														
Robert Hopkins	ATSC														x		x																x										x			
Ben Crutchfield	ATTC										x								x																											
Robert DeSantis	ATTC																									x																				
Peter Fannon	ATTC															x																														
Charles Rhodes	ATTC		x			x				x				x		x		x	x			x	x								x								x							
Ed Williams	ATTC	x			x					x				x	x	x				x	x			x		x	x	x	x	x	x		x	x		x	x	x		x			x		x	x
John I. Smith	Anadigics																																													x
Barry Fleishman	Anderson, Baker, Kill & Olick								x																																					
Jelena G. Polic	Annenberg, Univ. of Penn.																																					x	x							
Peter Tannenwald	Arent,Fox,Kintner,Plotkin & Kahn	x	x			x	x					x																x	x	x	x	x	x				x									
Ed Schultz	Bell Atlantic																							x																						
Pat Daley	Bellcore																																		x											
Lorrie Sutliff	Bellcore	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x		x	x	x	x	x	x	x	x		x	x
John C. Lee	CABSC																					x																								
Mark W. Johnson	CBS								x																																					
Krishma Bhatnagar	COMSAT																																x													
Wayne Shore	COMSAT												x																																	
Cinda Rishell	CRS																									x																				
David Hack	CRS/SPR Library of Congress	x	x	x	x	x	x		x	x		x		x																																
Kenneth Brown	Capital Cities/ABC										x																																			
Tony Uyttendaele	Capital Cities/ABC				x	x	x	x	x	x		x		x	x	x	x	x	x	x													x	x	x		x					x	x		x	
Bernard J. Lechner	Consultant													x																											x					
William F. Pohts	Consulting Engineer	x																																												
Ted Coltman	Corp. for Public Broadcasting			x	x	x	x	x		x	x	x		x	x	x	x				x			x		x	x			x	x					x				x						
Andrew Russell	Corp. for Public Broadcasting																														x	x	x	x						x						
Chuck Wilk	Corp. for Public Broadcasting																																												x	
James Gibson	David Sarnoff Research Center																											x		x										x	x	x	x	x		x
John G.M. Henderson	David Sarnoff Research Center																															x														
Krish Jonnalagadda	David Sarnoff Research Center	x																																				x								
Dick Klensch	David Sarnoff Research Center																									x	x	x	x	x	x	x	x	x	x	x	x		x		x		x			
Frank Lang	David Sarnoff Research Center															x																														