Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	
Advanced Television Systems and Their Impact on the Existing Television Broadcast Service	
Review of Technical and and Operational Requirements: Part 73-E, Television Broadcast Stations	MM Docket No. 87-268
Reevaluation of the UHF Television Channel and Distance Separation Requirements of Part 73 of the Commission's Rules	

To: The Commission

COMMENTS OF ATSC

The United States Advanced Television Systems Committee ("ATSC") submits these Comments on the Notice of Inquiry ("NOI") released by the Commission on August 20, 1987. Our primary purpose is to bring to the attention of the Commission the ATSC's plans for testing and evaluating advanced television systems, and for coordinating and developing voluntary technical standards in this area. We believe that the ATSC can provide valuable assistance to the Commission in assessing the issues raised and achieving the goals described in the NOI, and we offer the ATSC as a resource for the Commission's use. We also suggest that decisions on certain issues raised in the Commission's inquiry -- for example, the amount of spectrum space that may be required

for the terrestrial transmission of a satisfactory HDTV signal -- should await the availability of additional data which the ATSC is now working assiduously to develop.

Our Comments do not address the specific questions posed in the NOI, or the merits of any particular spectrum allocation plan. These matters are left to individual ATSC members who may wish to comment on them.

I. Background Of The ATSC

In late 1982, the Joint Committee on Inter-Society Coordination ("JCIC") established the ATSC to coordinate and develop voluntary national technical standards for advanced television systems. The JCIC members -- the Electronic Industries Association (EIA), the Institute of Electrical and Electronics Engineers (IEEE), the National Association of Broadcasters (NAB), the National Cable Television Association (NCTA), and the Society of Motion Picture and Television Engineers (SMPTE) -- are Charter Members of the ATSC.

ATSC's 52 member and observer organizations represent all facets of the United States television industry. The membership is composed of television networks, terrestrial and satellite broadcasters, cable television operators, consumer and professional television equipment manufacturers, learned

institutions and, through the Motion Picture Association of America ("MPAA"), the major U.S. motion picture producers. A list of these organizations is attached as Exhibit 1.

The ATSC is also charged with making recommendations for presentation to the United States Department of State for its use in developing United States positions on various standards issues as those issues are considered from time to time by the International Radio Consultative Committee ("CCIR") and other international organizations.

The work of ATSC is divided among three Technology Groups having terms of reference as follows:

> Improved NTSC. The Technology Group on Improved NTSC is addressing ongoing and evolutionary improvements to the present NTSC system that involve no incompatible changes to the present radiated signal standards. Any such improvements would retain the present 525-line scanning standard and 4:3 aspect ratio. Examples include improvements in home receivers, studio cameras, plant distribution and processing systems.
>
> Enhanced 525-Line Systems. The Technology Group on Enhanced 525-Line Systems is considering voluntary national standards involving improvements through changes in the production, transmission and reception of the presently utilized 525-line signal format. Improvements may be gained by employing wider signal bandwidth for chrominance and luminance signals as well as separate transmission of these signal components. As appropriate, multiple-channel sound, potential extensibility of the system, and conditional access through addressing, scrambling and encryption are being considered.

High Definition Television. The Technology Group on High Definition Television ("HDTV") is considering voluntary national standards for high definition television systems. These systems are characterized by an improvement in both horizontal and vertical resolution of approximately 2 to 1, a wide aspect ratio of at least 5:3, and multiple-channel high fidelity sound. Improvements may be achieved using even wider chrominance and luminance bandwidths than enhanced or composite systems, and through the separate transmission of chrominance and luminance signal components.

II. ATSC Activities To Date

A. Improved NTSC

The Technology Group on Improved NTSC ("T1") has studied various concepts which have been put forward for improving the current NTSC system in a compatible manner. T1 has not, at this point, documented any of the concepts in the form of a recommended standard because:

a) the concepts can be implemented by television broadcasters or television receiver manufacturers in a manner that would not require standards activities, or

b) insufficient information has been proffered, presumably for proprietary reasons, to support standards activities, or

c) there is lack of agreement that any of the specific concepts require standards activities at this time.

T1 is, however, currently studying the possibility of eliminating set-up from the NTSC specification and the possibility of adding digital stereo sound to the NTSC specification. It has also discussed the possibility of fully documenting the NTSC

system. Such activity would take on considerable importance should the Commission decide to amend the mandatory NTSC transmission standard and make it voluntary in nature.

B. Enhanced 525-Line Systems

The Technology Group on Enhanced 525-Line Systems ("T2") has issued a report containing detailed descriptions of the audio, video, data and control signal format characteristics of the "B-MAC" system. The characteristics include the methods of scrambling, encryption key distribution, and data multiplex. The ATSC has developed a paper on "Multiplexed Analog Component Television Broadcast System Parameter Specifications," which is a publicly available document (ATSC Report T2/62, April 1987).

T2 recently established a Specialist Group to study possible methods for distributing enhanced 525-line signals in cable systems. Pursuant to a decision of the ATSC Executive Committee, the work of T1 and T2 has been temporarily combined to improve the operating efficiency of the organization.

C. High Definition Television

The ATSC Technology Group on High Definition Television ("T3") has been actively engaged in standardization work in connection with high definition television production and transmission systems.

1. HDTV Production

In March 1985, T3 adopted a recommended position for the United States' participation in deliberations of the CCIR. That recommendation, attached hereto as Exhibit 2, was approved by the ATSC Executive Committee and transmitted to the U.S. Department of State in April 1985. Following the approval of the U.S. CCIR National Committee, the recommended position was adopted as the United States position. T3 reaffirmed that position in May 1987 by approving the document attached hereto as Exhibit 3, a further recommendation regarding the United States position in the CCIR.

In September 1987, T3 approved a document specifying the 1125/60 high definition television production system as a proposed ATSC voluntary technical standard. The document, attached hereto as Exhibit 4, is currently under ballot by the full ATSC Committee.

2. HDTV Transmission

T3, The Technology Group on HDTV, appointed a Specialist Group on HDTV Transmission and Distribution in September 1986. The goal of the Specialist Group is to "study and provide recommendations to ATSC regarding a single standard or family of standards for delivery of high definition television to the consumer." In order to achieve this goal, the Specialist Group

outlined the following objectives:

1. Analyze and test the relevant characteristics of spectrum potentially available for the transmission of HDTV signals.

2. Gather information about systems capable of delivering HDTV pictures to the consumer.

3. Define "compatibility" as it applies to delivery systems.

4. Develop test plans and criteria for evaluating system performance including, but not limited to, compatibility, spectrum efficiency, propagation characteristics, interference (potential to cause or be affected by), system complexity. Subjective assessment tests will also be included in the evaluation of system performance.

5. Conduct tests of proposed systems.

6. Analyze technical feasibility and economic tradeoffs of system implementation, using the criteria developed in item 4 above.

The Specialist Group also recommended "that field tests be undertaken expediently by this Group to measure the propagation characteristics of signal bands for broadcast HDTV suitable for development of channel models and suitable for evaluation of transmission systems."

The Technology Group on HDTV and the ATSC Executive Committee endorsed the plans of the Specialist Group and requested that the testing program begin immediately.[1]

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[1] The ATSC's Technology Group on HDTV is also proceeding with standardization work in the field of cable television transmission. That work is not detailed here, however, in light of the focus of the Commission's current inquiry on terrestrial transmission.

III. ATSC Plans For Testing and Evaluating HDTV Transmission Systems

As part of its ongoing standards development work, the ATSC has established a program for testing and evaluating transmission systems for the terrestrial broadcasting of HDTV in the United States. This program consists of three phases:

Phase I - Signal Propagation Tests

Phase II - Evaluation of Proposed HDTV Transmission Systems

Phase III - Subjective Assessment of Proposed HDTV Transmission Systems

Only after all three phases are completed can a fair and broad-based comparison be made of the proposed HDTV transmission systems.

A. Phase I - Signal Propagation Tests to Evaluate Spectrum Characteristics

Based on current knowledge, the spectrum bandwidth required to broadcast high definition television, as that term is generally understood, is expected to require somewhat more than the 6 MHz bandwidth presently allocated to broadcasters using the current NTSC transmission standard. An analysis of relevant spectrum bandwidth considerations is attached as Exhibit 5. In considering the use of potentially available channels, various combinations of 12 MHz channels will be tested to determine the

appropriate propagation characteristics as they pertain to high definition television signals. Possible 12 MHz channels could be formed by using:

(a) One VHF and one UHF channel,

(b) Two contiguous UHF channels,

(c) Two non-contiguous UHF channels, or

(d) One 12 MHz channel in the 12 GHz band.

This phase of the test program has already begun. A description providing greater detail of the first steps of the program is attached as Exhibit 6. During these first tests, the information gathered will be used to define the further steps to be taken, which will include other spectrum arrangements of the types listed above. The influence of different field conditions -- such as topography, weather conditions and urban environments -- must be determined. For this reason, the tests will be conducted at a number of appropriate geographic locations.

B. Phase II - Evaluation of Proposed HDTV Transmission Systems

A number of alternative and innovative systems have been proposed for HDTV transmission, with RF bandwidths ranging from 6 MHz to 12 MHz. These various systems have been developed to different levels, ranging from computer simulations to developed hardware. As each of these systems is fully developed and appropriate hardware made available, it will be intensively

evaluated, first under laboratory conditions and then under actual field conditions.

In the laboratory, tests of the systems will be conducted under controlled and reproducible conditions using RF simulators designed to duplicate actual conditions as determined by the earlier propagation characteristic tests and studies. System proponents will be asked to supply the hardware to be tested -- along with full disclosure of the technical characteristics of the system -- and technical experts to assist in the measurements of their respective systems.

Each system will then be tested under field conditions of transmission and reception to determine the reliability and ruggedness of the system in an operational environment. The spectrum used for these transmission tests will be chosen from those identified as most appropriate in Phase I.

Many organizations have indicated their willingness and desire to assist the ATSC in carrying out the work described. For example, the NASA Lewis Research Center in Cleveland, Ohio has indicated its willingness to make its facilities and staff available to the ATSC; the Electronic Industries Association (EIA) has offered to conduct various tests; the National Association of Broadcasters (NAB) has offered to make available its new Broadcast Technology Center.

The work in Phase II will be aimed at providing an objective basis for assessing the comparative technical merits of each HDTV terrestrial broadcasting system under consideration. The standardization process will then move to its final phase, subjective evaluation by the ultimate judge, the viewer.

C. Phase III - Subjective Assessment of Proposed HDTV Transmission Systems

In the course of the detailed technical investigation and evaluation of the proposed transmission systems, and because the different systems are based on different assumptions for the appropriate compromises, it is inevitable that each system will exhibit some artifacts in the display. However, the practical assessment of their acceptability can come only from the viewer.

Accordingly, this subjective assessment phase is of major importance. The first step in this phase is to examine the several techniques of subjective assessment now in use, world-wide, and to select particular methodologies which are most appropriate for the display of high definition television and for developing comparative quality assessments of a number of different transmission systems. This study has already been initiated.

This work will involve the careful selection of test viewers with normal visual acuity and normal color vision from several

different categories of viewers. The conditions for the viewing tests must be carefully and realistically defined using program material which has been broadcast using each of the HDTV transmission systems under study. Various considerations for this phase of the test and evaluation program are attached as Exhibit 7.

The results of Phase III should finally provide a fair and broad-based comparative assessment of the actual operating characteristics of each of the proposed transmission systems.

IV. CONCLUSION

The ATSC was formed five years ago with the express purpose of coordinating and developing voluntary national technical standards for advanced television systems. During the intervening period, the ATSC has been quite actively fulfilling its obligations as expressed in its Charter. The ATSC is now recognized here and internationally as the preeminent advanced television systems standards organization in the United States. It represents all facets of the television industry in the United States and has an organization in place actively involved in carrying out its designated tasks. Accordingly, we urge the Commission to use the ATSC as one of the resources available to it. For the reasons set forth above, we also urge the Commission to await the development of additional data before making final

decisions regarding bandwidth requirements for HDTV transmission. With the ATSC's help, we believe that such data can be developed on a timetable that is reasonably expeditious under the circumstances and consistent with a Commission policy designed to promote the orderly development of HDTV in this country.

Respectfully submitted,

UNITED STATES ADVANCED

TELEVISION SYSTEMS COMMITTEE

By: 

E. William Henry
Chairman

Robert Hopkins
Executive Director

November 18, 1987

ATSC MEMBERSHIP Exhibit 1

ATSC CHARTER MEMBERS

National Association of Broadcasters (NAB)
Electronic Industries Association (EIA)
Institute of Electrical and Electronics Engineers (IEEE)
National Cable Television Association (NCTA)
Society of Motion Picture and Television Engineers (SMPTE)

ATSC MEMBERS

American Television and Communications Corporation
Ampex Corporation
Association of Maximum Service Telecasters
AT&T Bell Laboratories
Baylor University
Bell Communications Research
Capital Cities/American Broadcasting Company
CBS Broadcast Group
David Sarnoff Research Center
Dolby Laboratories, Inc.
Faroudja Laboratories
GE/RCA Consumer Electronics Business
General Instrument Corporation, Jerrold Division
Hitachi Denshi America, Ltd.
Hoechst Celanese Corporation
Home Box Office, Inc.
INTV
Jansky Telecommunications, Inc.
Matsushita Electric Corporation of America
McDonnell Douglas Corporation
Mitsubishi Electric Sales America, Inc.
Motion Picture Association of America (MPAA)
National Broadcasting Company
New York Institute of Technology
North American Philips Corporation
Northern Telecom
Panasonic Broadcast Systems Company
Panavision Electronics
Public Broadcasting Service
Satcorp, Inc.
Satellite Television Corporation
Scientific Atlanta
Sony Communications Products Company
Sony Corporation of America
Tektronix, Inc.
Toshiba America, Inc.
Tribune Broadcasting Company
VISNEWS
Westinghouse Broadcasting Company, Inc.
Zenith Electronics Corporation

ATSC OBSERVERS

Eastman Kodak Company
ESPN
Hazeltine Corporation
INTELSAT
M/A-COM Development Corporation
Malarkey-Taylor Associates
Weston E. Vivian Associates

Exhibit 2

1985 ATSC RECOMMENDATION TO U.S. STATE DEPARTMENT

Doc. T3/83
19 Mar. 1985
(revision 1)

PROPOSAL FOR A NEW RECOMMENDATION

Worldwide HDTV Studio Standard

The CCIR

CONSIDERING

(a) that a worldwide HDTV Studio Standard is desired

(b) that the HDTV Studio Standard (Draft Recommendation, Annex to CCIR Report 801-1, Geneva, September 1983) should provide pictures with approximately twice the horizontal and vertical spatial resolution of studio sources using existing standards, and a larger aspect ratio of at least 5:3

(c) that the parameter values specified in Recommendation 601 should be taken into account

(d) that conversion to existing 625/50 and 525/60 standards should be provided with good quality

(e) that the transfer to and from film should be provided with acceptable quality

(f) that state of the art television camera technology and the constraints of channel noise and bandwidth (e.g., in video tape recorders, in the cost of semiconductor memory, and in the bit rate of digital channels) should be taken into account

(g) that there exists a broad range of applications for HDTV

RECOMMENDS

1. that there be an HDTV Studio Standard for program exchange purposes

2. that the standard shall be based upon a temporal rate of 60 Hz, an aspect ratio of 5.33:3 (precisely 16:9) and separate luminance and two color-difference component signals

3. that the HDTV Studio Standard be 1125-lines, 60 fields/s, 2:1 interlace

4. that work continue on a 60 Hz 1:1 progressive scan system

5. that work continue to define parameter values not listed in this document, e.g., colorimetry, gamma, adherence to the principles of constant luminance, etc.

HDTV STUDIO STANDARD

Parameter	HDTV Studio Standard
Aspect ratio	5.33:3 (precisely 16:9)
Total scan lines	1125
Total line period	29.63 µs
Active scan lines	1035
Active line period	25.86 µs
Horizontal blanking period	3.77 µs
Scanning format	2:1 interlace
Temporal rate	60 fields/s
Luminance video bandwidth	27 MHz
Luminance horizontal resolution	785 TVL/ph
Color-difference format	C_R and C_B simultaneous
Color-difference bandwidths	13.5 MHz maximum
Member of coding family (per Rec 601)	22:11:11
Luminance sampling frequency	74.25 MHz (22/4 x 13.5 MHz)
Color-difference sampling frequency	37.125 MHz (11/2 x 6.75 MHz)
Luminance samples per total line	2200
Luminance samples per active line	1920
Luminance samples in hor. blanking	280

Exhibit 3

1987 ATSC RECOMMENDATION TO U.S. STATE DEPARTMENT

Documents
CCIR Study Groups
Period 1986-1990

Doc. 11/6-
May 1987
Original: English

UNITED STATES OF AMERICA

HDTV STUDIO AND PROGRAM EXCHANGE SYSTEM PARAMETERS

A USA contribution to the XVI Plenary Assembly recommended adoption of the HDTV studio and program exchange standard forwarded to the Assembly by the Chairman of Study Group 11 as the world standard.

The position of the USA has not changed. In the USA, an HDTV system adhering to the recommendation annexed to Report 801-1 is finding rapid acceptance among the production industry in the production of programming for television and for the cinema. Further, the SMPTE is proceeding rapidly to document this system for proposal as a U.S. national standard (ANSI Standard).

At this time, the technology is not available to make a compromise standard at a higher field rate such as 100 Hz practical and the performance of systems with a field rate of 50 Hz has been found to be lower than for equivalent systems with a field rate of 60 Hz, both in full field flicker and in motion portrayal. Therefore, it is not possible for the USA to envisage an HDTV studio and program exchange system with a field rate other than 60 Hz.

Attached to the present document is the SMPTE draft standard for the 1125/60 HDTV system. As stated previously, all the parameters contained in the annex to Report 801-1 are firm and approved. These are:

Number of scanning lines:	1125
Number of active lines:	1035
Field rate:	60.00 Hz
Scanning method:	2:1 interlace
Aspect ratio:	Horizontal 16 to vertical 9
Samples per active line:	1920 for luminance 960 for color difference

Most of the other parameters in the SMPTE draft, while already quite firm, are not yet completely frozen.

DRAFT

SIGNAL PARAMETERS OF THE 1125/60 HIGH DEFINITION TELEVISION PRODUCTION SYSTEM

1. Scope

This document defines the characteristics of the video signals associated with the 1125/60 High Definition Television production system.

It defines the scanning and image analysis characteristics of this system. The characteristics of both digital and analog representations of the video signal and synchronizing waveform are also defined.

Separate documents describe the interfaces to be used to interconnect equipment operating according to this standard:

Document [ ] Standard for a Three Channel Parallel High Definition Video Interface

2. Scanning Parameters

The video signals represent a scanned raster with the following characteristics:

Total scan lines per frame	1125
Active lines per frame	1035
Scanning Format	Interlaced 2:1
Aspect Ratio	16:9
Field repetition rate	60.00 fields per second
Line repetition rate and tolerance	33750 lines per second ±10 ppm

3. Reference Reproducer

Colorimetric analysis and signal amplitude transfer function are defined in terms of a reference reproducer with the following characteristics:

Chromaticity of reproducing primaries:	G: x = 0.210	y = 0.710
	R: x = 0.670	y = 0.330
	B: x = 0.150	y = 0.060
Chromaticity for equal primary signals:	Illuminant D_{65}: x = 0.313	y = 0.329
Electro-optical transfer characteristic:	$L = ((V + 0.1115)/1.1115)^{(1/0.45)}$	for $V \geq 0.0913$
	$L = V/4.0$	for $V < 0.0913$

where L = light output from reproducing primary
V = video signal driving the reproducing primary
(Ref. ARD Document Pflichtenheft Nr. 8/4, §4.1.8)

4. Reference Clock

Signal durations and timings are specified both in microseconds, and in reference clock sample counts. The reference clock frequency, F_R, and its period, T_R, are as follows:

Reference clock frequency:	F_R = 74.25 MHz
Reference clock period	T_R = 13.468nsec

5. Video Signal Definitions

The video signals shall be appropriate to drive the reference reproducer. Picture sources shall incorporate colorimetric analysis of source images, and signal processing, to achieve this end.

The image is represented by three parallel, time-coincident video signals. Each incorporates a synchronizing waveform.

The signals shall be either of the following sets:

Color Set	Color Difference Set
G - "green"	Y - "luminance"
R - "red"	P_R - "red color difference"
B - "blue"	P_B - "blue color difference"

where [G R B] are the signals appropriate to directly drive the primaries of the reference reproducer, and [Y P_R P_B] can be derived from [G R B] through a linear matrix.

More specifically, P_R is amplitude-scaled (R-Y), according to:

$$P_R = \frac{(R-Y)}{1.442}$$

and P_B is amplitude-scaled (B-Y), according to:

$$P_B = \frac{(B-Y)}{1.846}$$

The transformation between the two sets is defined as:

$$\begin{bmatrix} G \\ R \\ B \end{bmatrix} = \begin{bmatrix} 1.000 & -0.607 & -0.220 \\ 1.000 & 1.442 & 0.000 \\ 1.000 & 0.000 & 1.846 \end{bmatrix} \begin{bmatrix} Y \\ P_R \\ P_B \end{bmatrix}$$

$$\begin{bmatrix} Y \\ P_R \\ P_B \end{bmatrix} = \begin{bmatrix} 0.644 & 0.279 & 0.077 \\ -0.447 & 0.500 & -0.053 \\ -0.349 & -0.151 & 0.500 \end{bmatrix} \begin{bmatrix} G \\ R \\ B \end{bmatrix}$$

6. Video and Synchronizing Signal Waveforms

The combined video and synchronizing signal shall be as shown in figure 1.

6.1 Timing

The durations of the various portions of the video and sync waveforms are defined as follows:

		time specification (μs)	sample count specification (T)
a	Front porch	0.59	44
b	H sync pulse	0.59	44
c	H blanking	3.77	280
d	clamp period	1.19	88
e	V sync pulse	11.85	880
f	Line period	29.63	2200
g	Active line	25.86	1920

6.2 Bandwidth

The Color Set [G R B] comprises three equal-bandwidth signals, whose nominal bandwidth is 30 MHz.

The Color Difference Set [Y P_R P_B] comprises a luminance signal Y whose nominal bandwidth is 30 MHz, and color difference signals P_R and P_B whose nominal bandwidth is 30 MHz in analog representations, and 15 MHz in digital representations.

6.3 Analog Representation

The video signals are represented in analog form as follows:

		Y,G,R,B Signals
Reference Black Level	(mV)	0
Reference White level	(mV)	700
Synchronizing level	(mV)	±300
		P_R,P_B signals
Reference zero signal level	(mV)	0
Reference peak levels	(mV)	±350
Synchronizing level	(mV)	±300

6.4 Digital Representation

The video signals are represented in digital form as follows:

		Y,G,R,B signals	P_R,P_B signals
Quantization	(bits)	[ ]	[ ]
Coding law		[ ]	[ ]
Sampling frequency	(MHz)	74.25	37.125
Samples per active line		1920	960

The sampling structure is line, field and frame repetitive.

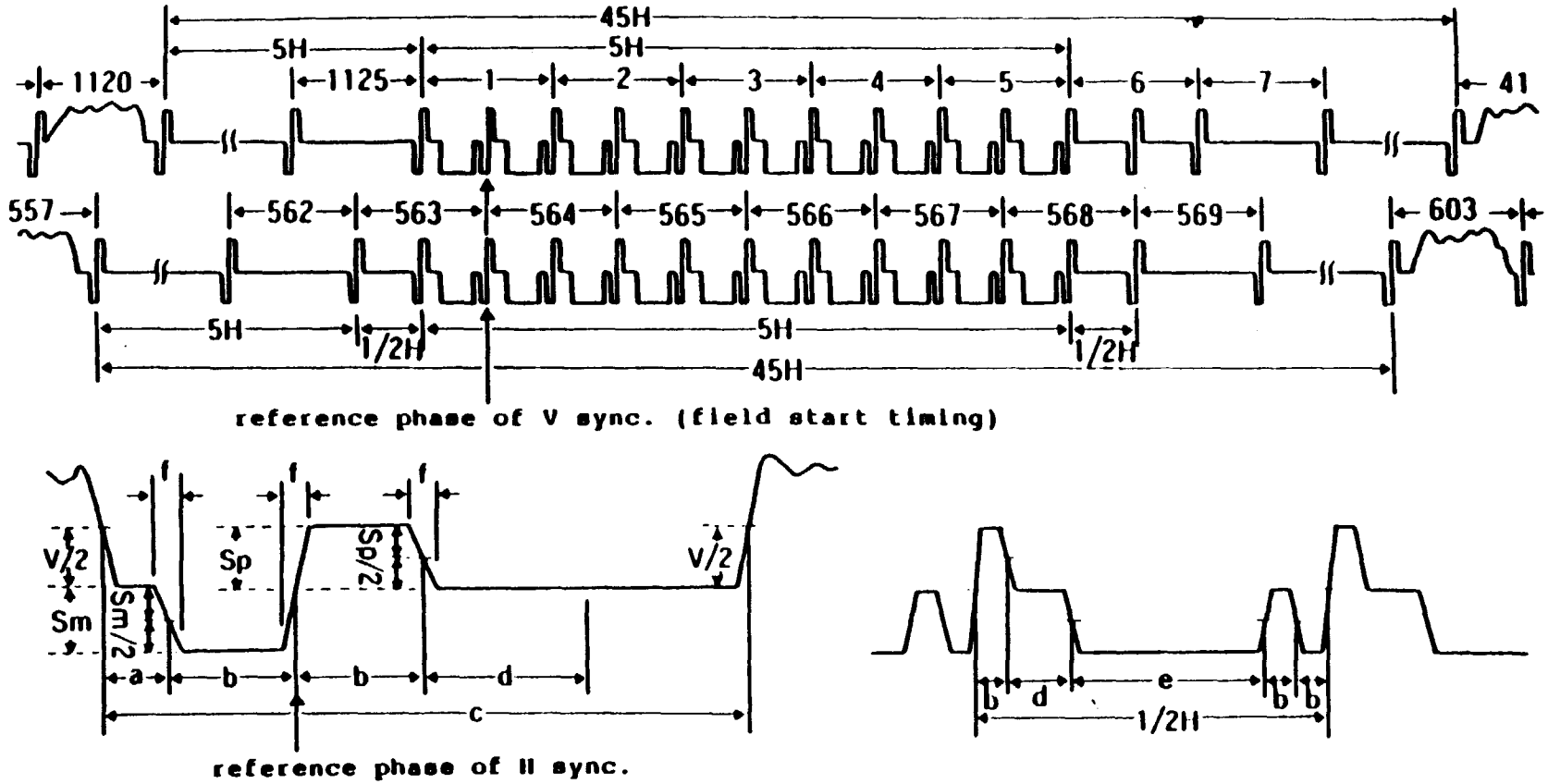

Figure 1 Synchronizing Signal Waveform and Timing

Exhibit 4

Doc. T3/142
4 Sep. 1987

United States Advanced Television Systems Committee

Draft ATSC Standard

SIGNAL PARAMETERS OF THE 1125/60 HIGH DEFINITION TELEVISION PRODUCTION SYSTEM

This document was prepared at the request of the ATSC by the Society of Motion Picture and Television Engineers, a charter member of the ATSC. SMPTE document DOC N15.040, 11 AUG 1987

1. Scope

This document defines the basic characteristics of the video signals associated with origination equipment operating in the 1125/60 High Definition Television production system.

As this document deals with basic system characteristics, all parameters are untoleranced. Tolerances will be developed in detailed system specification documents as appropriate.

2. Scanning Parameters

The video signals represent a scanned raster with the following characteristics:

Total scan lines per frame	1125
Active lines per frame	1035
Scanning Format	Interlaced 2:1
Aspect Ratio	16:9
Field repetition rate	60.00 Hz
Line repetition rate (derived)	33750 Hz

3. System Colorimetry

The system is intended to create a metameric reproduction (visual color match) of the original scene under conditions of equal color temperature and luminance between the original scene and its reproduction.

Camera and monitor design will accommodate this intent within the constraints imposed by the choice of reference primaries (see Appendix 1).

Colorimetric analysis and signal amplitude transfer function are defined as follows:

Chromaticity of reference primaries:	G:	x = 0.310 y = 0.595
	B:	x = 0.155 y = 0.070
	R:	x = 0.630 y = 0.340
Chromaticity for equal primary signals:	Illuminant D_{65}:	x = 0.3127 y = 0.3291