MM 87-268

April 1, 1991

ORIGINAL FILE

APPENDICES TO THE

FOURTH INTERIM REPORT

OF THE

FCC ADVISORY COMMITTEE ON

ADVANCED TELEVISION SERVICE

Volume III

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SSWP2-0601
REV 29 JAN 91

ATV Test Procedures Manual

Field Tests

0. Introduction

0.1 The objective of the advanced television field testing program is defined by Working Party 2 of the Systems Subcommittee of the Advisory Committee on Advanced Television Systems:

> The primary goal of the field testing program is to verify the performance and operability of the selected ATV system(s) under real world conditions. In addition, this testing phase should be used to point out system flaws that are not uncovered through laboratory testing. The intent of the field testing is not to provide comparative data. The large number of uncontrolled variables inherent in field testing would indicate that quantitative analysis and decision-making in this environment would be subject to strong criticism of poor science and might lead to invalid conclusions.

In addition to the foregoing, an important objective of the Field Test Program is a comparison of impairments to NTSC and ATV under actual field conditions. When a specific system (or systems) has been selected for field testing, some modifications of the procedures herein (e.g., bit error rate test) may be necessary to stress particular features of the system.

These test procedures do not include satellite, microwave, or other distribution media as signal sources for over the air or cable testing. While these tests are desirable, it is assumed that they will be carried out at a later time.

0.2 Preceding Testing Programs

0.2.1 The Advanced Television Test Center (ATTC) is scheduled to conduct the following single interferer series of tests:

- Random Noise
- Impulse Noise
- Multipath
- Airplane Flutter
- Various Interference Conditions
  - ATV to NTSC
  - NTSC to ATV
  - ATV to ATV *
  - Cochannel
  - Adjacent Channel
  - Discrete Frequencies
  - UHF Taboo Channels

* In the ATV to ATV tests at ATTC, the undesired input is to be simulated by using the same input as for the desired signal but time shifted, frequency offset and level adjusted. Prior to the FCC decision, the ATV system tentatively selected for terrestrial broadcasting may be laboratory tested for ATV to ATV interference using uncorrelated program sources for the desired and undesired inputs.

0.2.2 CableLabs is scheduled to conduct the following tests:

- Carrier to Noise
- Second and Third Order Intermodulation Distortion
- Microreflections
- Effect of High Level Sweep
- Hum and Low Frequency Noise
- Incidental Carrier Phase Modulation
- Intermodulation Distortion in Fiber Optic Systems

0.2.3 The following tests with lay observers are scheduled to be conducted in Canada:

- Subjective Quality
- Impairment Rating

0.3 SS/WP-2 Field Test Task Force

0.3.1 The Field Test Task Force through this Field Test Plan completes the testing plans of the Advisory Committee on Advanced Television Systems. Described is the necessary preparation and the intended procedures for testing NTSC systems and proposed ATV systems.

1. Selection of Testing Sites.

1.1 Transmitting Location(s) and Frequencies.

The test transmission sites will be selected considering a number of criteria. An important criterion is the availability of a transmit location at a low or no cost. Among the available sites, a site (or sites) will be chosen that is expected to produce the transmission environment of interest. Worst case conditions are not being sought. Instead, conditions are being sought that represent impairments that occur in television broadcasting.

1.1.1 Analyze television channel usage in the selected test area and determine which VHF and which UHF channels can be employed without unacceptable interference to existing stations.

1.1.2 Apply to the Federal Communications Commission for authority to use the selected television channels.

1.2 Identification of Receiving Locations.

The receive locations will be chosen using the following conventional selection methods.

1.2.1 Assemble USGS 7-1/2 minute topographical quadrangle maps for the area of each test site with particular attention directed to locations satisfying the conditions specified in 1.2.2.

1.2.2 Analyze the topography and general area conditions and identify sectors of each area where the following conditions are likely to be encountered:

Uniform Terrain
Irregular Terrain
Residential Development
Commercial Development
Cleared Farm Land
Forested Areas
Areas subject to Multipath Impairments, including Airplane Flutter
Areas subject to Interference.

1.2.3 Select radial arcs that provide a variety of conditions across the areas selected in Section 1.2.2.

1.2.4 Develop grid with one mile spacing in the principal city and other areas of central business districts and surrounding residential areas if appropriate.

1.2.5 Extend radial lines within the arcs identified in Section 1.2.3.

1.2.5.1 Omit the area covered by the grid in Section 1.2.4.

1.2.5.2 Identify at least three radials within each arc for a total of nine to fifteen radials.

1.2.5.3 Identify one mile intervals on the radials.

1.3 General

1.3.1 The NTSC power level to be employed in the test procedure will be as close to normally used broadcast levels as the equipment available will permit consistent with restrictions that might be imposed to avoid interference to operating stations. ATV power level relative to NTSC will have been determined by a procedure described in PS/WP-3 Document 0140, 11 September 1990. That relative level, measured by the method developed at the ATTC, will be used throughout the field test. To simulate performance near the fringe of the service area, NTSC and ATV power, held at the appropriate ratio, may be reduced for a limited number of test observations. **

1.3.2 Determine field strengths expected within the proposed observation areas. Determine field strengths by the ITS terrain specific method and by the FCC prediction method expected within the proposed observation areas.

** The requirement of conducting NTSC reference tests on the same channel as the ATV tests inherently prohibits field testing on a channel that has certain interference characteristics of interest. In addition to the specified test procedures, it may be desirable to test/demonstrate the selected ATV system(s) on a channel that cannot be utilized for NTSC transmission, but could be used for the ATV system under test. An example would be a channel that does not meet the minimum co-channel or adjacent channel separation for NTSC, but would meet the requirements for the ATV system under test.

1.3.3 Develop a computer program to record the results of the test. This program shall include space for the following information:

Date and Time
Receiving Site Identification Code
Receiving Site Coordinates
Receiving Site Address (if applicable)
Receiving Site Location Description
Receiving Site Non-variable Physical Conditions
Receiving Site Seasonal Physical Conditions
NTSC Test Point Field Strength and Range
NTSC Picture Impairment Ratings of n observers
NTSC Picture Impairments Description of n observers
NTSC Additional Impairments Comments
ATV Test Point Field Strength and Range
ATV BER Measurements
ATV Picture Impairment Ratings of n observers
ATV Picture Impairment Description of n observers
ATV Video Dropouts
ATV Audio Dropouts
ATV Additional Impairment Comments

1.4 Install test transmission system(s).
Installation(s) complement and installation procedures will be determined by available site(s) facilities, manpower, new equipment and by the nature of the selected ATV system(s).

1.5 Assemble mobile test receive vehicle(s).
Installation(s) complement and installation procedures will be determined by available vehicle(s), manpower, new equipment and by the nature of the selected ATV system(s).

1.6 The qualifications of the observers should include experience with ATV systems.

2. Conduct NTSC reference tests at each receive test site.

2.1 Select receive test sites.

2.1.1 Visit each receive test site and determine the best location closest to the position previously identified on the maps. Visually inspect the site taking into account overhead obstructions of 30 feet or less over a 100 foot linear path. Choose a clear path.

2.1.2 Locate and mark each receive site on the maps and identify each with a unique code.

2.1.3 Prepare a written description of each site location and vehicle path position and direction with sufficient detail for a third person to return to the exact location. Identify each description with its identification code.

2.1.4 Photograph and/or videotape a panorama of the location of the test receive sites with the vehicle in place. These will provide a visual record to aid in returning to the exact location.

2.2 Perform NTSC VHF and UHF tests.

2.2.1 Place test vehicle at each receive site location and erect mast to 30 feet.

2.2.2 Calibrate the field strength meter.

2.2.3 Move the test vehicle over the 100 foot run and record the field strength.

2.2.4 Return test vehicle to the test point of the 100 foot run and record the field strength. This same location will be a point of observation for ATV testing.

2.2.5 Selected the line in the vertical blanking interval (VBI) containing the Pseudo Noise (PN) code, digitize the I and Q outputs of the receiver and store this information in the computer.

2.2.6 Record on videotape video and audio test signals.

2.2.7 Rate the picture impairments on a five point scale:

(5) Imperceptible
(4) Perceptible, but not annoying
(3) Somewhat annoying
(2) Severely annoying
(1) Unusable

2.2.8 Describe the nature of the video and audio impairments in the computer record.

2.2.9 Photograph the picture monitor and RF spectrum analyzer during a still test display.

2.2.10 Record the waveform monitor output with test signals displayed.

2.2.11 Note any comments necessary to further identify signal impairments.

2.2.12 In the event the NTSC picture impairment grade is (1) or (2), relocate the test vehicle within the 100 foot run to achieve at least a grade of (3) and repeat the foregoing tests and observations.

2.2.13 Note any site location variables such as, but not limited to, presence of foliage and any seasonal variations.

2.2.14 Videotape on industrial or consumer format, the testing process as a record of the proceedings.

2.2.15 At the time of the ATV testing, steps 2.2.4 through 2.2.11 are to be repeated.

3. ATV Tests.

3.1 Test locations will include all those identified in Section 2.1.1.

3.2 ATV Test Procedures.

3.2.1 Return the test vehicle to the test receive sites.
3.2.2 Note any changes at the test receive sites that may have occurred.
3.2.3 Position the vehicle at the point used for the NTSC test. (The 100 foot run will not be performed, the relative field strengths variations are the same with ATV as with NTSC.)
3.2.4 Measure the field strength.

3.2.4.1 The method for measuring the ATV signal will depend on the characteristics of the system under test.

3.2.6 Conduct Bit Error Rate (BER) measurements where applicable.
3.2.7 Record the audio signals.
3.2.8 Rate the picture impairments on a five point scale:
(5) Imperceptible
(4) Perceptible, but not annoying
(3) Somewhat annoying
(2) Severely annoying
(1) Unusable

3.2.9 Describe the nature of the video and audio impairments.
3.2.10 Note the number of video and audio dropouts in a single sequence of test pictures.
3.2.11 Photograph the picture monitor and RF spectrum analyzer during a still test display. Repeat with the receiving antenna oriented at the 90°, 180° and 270° positions from maximum signal direction.
3.2.12 Record the waveform monitor output with test signals displayed.
3.2.13 Note any comments necessary to further identify signal impairments, including an identification of possible causes and, if applicable, the need to return to the site for further analysis.
3.2.14 Note any site location variables such as, but not limited to, presence of foliage and any seasonal variations.

3.2.15 Videotape on industrial or consumer format, the testing process and ATV monitor testing as a record of the proceedings.

4. Test Result Analysis.

4.1 Field Strength.

4.1.1 Provide a probability analysis of the NTSC field strengths for the grid areas.
4.1.2 Plot the NTSC field strengths versus distance for each radial.
4.1.3 Produce a comparison plot of NTSC measured field strength versus predicted field strength.

4.2 Channel Characterization.

4.2.1 Prepare a probability analysis of multipath in terms of both magnitude and displacement of both the NTSC and ATV signals.
4.2.2 Prepare narrative description of other channel impairments noting differences between NTSC and ATV performances.

4.3 Picture Impairment.

4.3.1 Plot picture impairment ratings versus field strength of both NTSC and ATV signals.

5. Cable Tests.

5.1 Introduction

5.1.1 Selection of Testing Sites

5.1.1.1 The cable tests will take place in the same communities as the terrestrial transmission tests. The site selection must take into account both the requirements for terrestrial tests and availability of cable systems for the cable tests.

5.1.1.2 The cable system(s) required for the test is at least 30 TV channels with spectrum available for the addition at least one, and preferably three ATV signals. Additionally, the systems should have both AM fiber and AML microwave links, and FM super trunks.

5.1.2 Receiving Locations

5.1.2.1 The most optimal locations for cable tests will be the same locations as the terrestrial tests. That would allow the complete series of tests (cable and terrestrial) to be conducted at one location. The test locations should primarily be near the ends of distribution lines scattered throughout the cable systems. They should represent various depths in the trunk system and, for reference, some locations at or near the bridger outputs. If insufficient common locations are located it will be necessary to supplement the terrestrial locations with cable only locations. Some of the test points should be fed via fiber, AML and FM super trunk.

5.1.3. General

5.1.3.1 Two sources of ATV signal will be used for the cable tests: originated at the headend and received via terrestrial broadcast. This will provide information on the quality of signals that can be carried on the system from two normal cable system signal sources. The head end signal quality from the two sources will be noted. Where possible, the terrestrial transmitter supplying the signals to the cable headend should be located some miles (across the city) from the cable receive site to simulate typical receive distances and quality.

5.1.3.2 The ATV signal carried on the cable system will be inserted between two NTSC channels. The NTSC channels will be used to test for adjacent channel interference into both the visual and aural portions of the signal. The ATV signals from the various sources will be sequentially switched onto the ATV test channel while the expert viewers are observing the ATV signal quality. That will help ensure that the cable channel characteristics are the same for both sources. The same test channel will be used to determine system operating characteristics and NTSC quality.

5.1.3.3 The observations will be made by expert observers located in the test vehicle(s). No non-expert observers will be used in the field tests.

5.1.3.4 A computer programme will be developed similar to the terrestrial programme to record the cable tests results. This programme will record the following information:

Date and Time
Receiving Site Identification Code
Receiving Site Address
Number of Trunk Amplifiers
Number of Line Extenders
NTSC Test Channel Signal Level
NTSC Picture Impairments Ratings of n Observers
NTSC Picture Impairments of n Observers
NTSC Additional Impairments Comments

For the two ATV test sources:

ATV Channel Signal Levels
ATV BER Measurements of Data Channel
ATV Picture Impairments Ratings of n Observers
ATV Picture Impairments Description of n Observers
ATV Additional Impairments Comments
ATV Interference into Adjacent Channel Video and Audio

5.1.4 Install test transmission system(s)

5.1.4.1 Installation(s) complement and installation procedures will be determined by available site(s) and facilities, manpower, new equipment and by the nature of the selected ATV system(s).

5.1.5 Assemble mobile receive vehicle(s).

5.1.5.1 Installation(s) complement and procedures will be determined by available vehicle(s), manpower, new equipment and by the nature of the selected ATV system(s).

5.1.6 Observer Qualifications

5.1.6.1 The qualifications of the observers should include experience with ATV systems.

5.2. Conduct NTSC reference tests at each receive site.

5.2.1 Select receive site

5.2.1.1 Visit each proposed test site to determine that a cable tap is readily available and tap output levels are within normal range. Ensure that the cable system is operating properly and the quality of signals is acceptable. Use a characterized standard length drop (eg. 100') for all tests.

5.2.2 Perform NTSC tests just prior to the ATV tests

5.2.2.1 Modulate the test channel with NTSC programming material.

5.2.2.2 Select the line in the vertical blanking interval containing the pseudo noise (PN) code (inserted at the origination site and headend if possible), digitize the I and Q output of the professional demodulator and store this information in the computer per the terrestrial field test plan.

5.2.2.3 Measure and record the channel carrier-to-noise and composite triple beat ratios and frequency response.

5.2.2.4 Record on videotape the video and audio test signals.

5.2.2.5 Rate the picture impairments on the five point scale.

5.2.2.6 Describe the nature of the video and audio impairments.

5.2.2.7 Record the RF spectrum analyzer display during a specified still test display.

5.2.2.8 Record the waveform monitor output with test signals displayed.

5.2.2.9 Note any comments necessary to further identify signal impairments.

5.2.2.10 Describer the nature in ATV interference into upper and lower adjacent NTSC channels.

5.2.2.11 Videotape the testing process as a record of the proceedings.

5.3. ATV Tests

5.3.1 ATV test are performed at the same location on the same channel immediately after the NTSC tests. The signal sources are switched sequentially to perform the tests.

5.3.2 For the two ATV test signal sources:

5.3.2.1 Measure the signal.

5.3.2.2 Characterize the ATV channel from the modulator input to the receiver output

5.3.2.3 Determine the bit error rate of the data channel.

5.3.2.4 Record the audio signals.

5.3.2.5 Rate the pictures on the five point scale.

5.3.2.6 Describe the nature of the video and audio impairments.

5.3.2.8 Photograph the picture monitor during a specified still display.

5.3.2.9 Record the RF spectrum analyzer display during a specified still test display.

5.3.2.10 Record the waveform monitor output with the test signals displayed.

5.3.2.11 Note any comments necessary to further identify signal impairments including an identification of possible causes and, if applicable, the need for return to the site for further analysis.

5.3.2.12 Videotape the testing process and ATV monitor testing as a record of the proceedings.

5.4 Test Result Analysis

5.4.1 Plot picture impairment ratings versus C/N, CTR, and frequency response for both NTSC and ATV signals.

6. Summary and Report.

6.1 Prepare Field Test Results and Analysis Report

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December 4, 1990

Mr. Mark Richer
Chairman, SS/WP-2
PBS
1320 Braddock Place
Alexandria, Virginia 22314

Dear Mark:

On behalf of the Field Test Task Force, we are delivering today the field test procedure formatted in conformance with other test procedures. The draft being submitted was approved by the Task Force yesterday, and thanks to the efforts of Jim Kutzner, is now ready for submission to SS/WP-2. However, I have been charged by the Task Force to provide this transmittal letter referencing some concerns we have and describing some additional work we believe to be necessary.

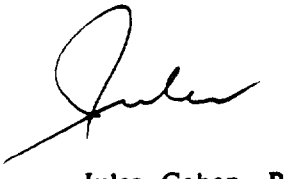
The procedure provided is far from the ideal for field testing of what we hope will be the North American standard for terrestrial broadcasting of an Advanced Television System --- a standard as enduring as the NTSC that it replaces. What we have done in the Task Force is develop a procedure consistent with the time restraints (and likely cost restraints) of the schedule decreed by the Commission and the Advisory Committee. A more logical procedure, from an engineering viewpoint, is to extend the field testing for a period likely to spread over two years. During that time, several experimental transmissions would be initiated and prototype receivers placed in a relatively large number of receiving locations. The system would be given a real "shakedown" and modifications made to correct weaknesses found.

Adherence to the present schedule may not even afford the time needed to carry out this limited test procedure provided. If ATTC testing of the last system is to be completed in April, 1992, followed by subjective testing in Canada, an analysis by PS/WP-3 to determine permissible power level and accommodation characteristics for the systems, analysis by SS/WP-4 of both test data and spectrum studies, followed by selection of the system (or systems) for field test, how much time can be available prior to mid-August for the test procedure? Since the Advisory Committee deadline for a report to the Commission is September 30, 1992, SS/WP-4 will surely have to have in hand by mid-August all relevant data so that its draft report can meet the schedule.

Without detailed knowledge of the particular ATV system to be field tested, a determination of the most meaningful tests is difficult. Some tests of a specialized nature are performed more logically in the laboratory rather than the field. In the certification process being undertaken by SS/WP-1, theoretical analyses will lead to proposals for system specific tests. However, the field testing may reveal other areas that should be tested also. Furthermore, problems encountered in the field may dictate the need to return to certain locations for additional testing using different program material, other equipment in the test vehicle and, perhaps, experts from the proponent's laboratory, or elsewhere, better able to analyze the cause, and suggest the cure for problems found.

An omission recognized by the Task Force, and one that is to be remedied with the help of cable interests, is a section on cable testing of the ATV system(s) selected for field testing. Until a transmission site is selected, specific procedures cannot be determined, but the intention of the Task Force is that cable transmission tests will be conducted in connection with the terrestrial transmission tests.

Sincerely yours,



Jules Cohen, P.E.
Chairman, Field Test Task Force

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