AIPA TECHNICAL OPERATING STANDARDS

1. GENERAL

AIPA hereby summarizes for you TECHNICAL OPERATING STANDARDS for producing programs to technical quality for delivery to PBS stations. Program submissions not meeting these specifications may be rejected by PBS, requiring corrective action and delay in processing. All programs must be judged to meet these specifications prior to submission by a qualified technician using professional digital measurement equipment. For questions related to program submissions and this please contact our Executive Creative Director, Terry Balagia.

These TECHNICAL OPERATING SPECIFICATIONS should be used for any new recording whether for use in PBS programming or other applications. Please understand that PBS is not the only distribution channel we have available. If, for instance, an existing library of recordings is available that does not fully meet PBS broadcast requirement, other very useful and appreciated manners of educational distribution are available and would be of great service.

2. VIDEO

2.1 Video Image Quality

2.1.1 All programs must be produced with modern component-digital acquisition and editing systems, with careful attention to technical detail throughout the acquisition and post-production process. Use professional digital cameras, VTRs, editing and monitoring equipment. Leave picture monitors in the "underscan" mode at all times.

2.1.2 For standard definition, the image must have the high quality image resolution associated with modern 3-chip cameras and must not be derived from a smaller image area (such as the widescreen mode in some low cost DV cameras, which samples less than 480 vertical lines) except for special effects. The CCD chips must have at least a 1/3” diagonal with a minimum resolution of 640 x 480. For high definition, the camera must use three CCD chips, each with at least a 1/2” diagonal and a minimum resolution of 1280 x 720. For either standard or high definition under certain circumstances such as breaking news or other unscripted or unplanned events, less than full broadcast quality equipment may be used. However, efforts must be made to minimize the deficiencies inherent in lower quality image acquisition. Do not use the "widescreen mode" on inexpensive DV cameras that simply scale a 360 line raster up to 480 lines. The resulting low resolution and aliasing is unacceptable.

2.1.3 Programs submitted as "Digital Widescreen" must be principally content that was originally created in a minimum frame size of 720 x 480. When producing a "Widescreen" program, acquire primarily widescreen content, and do not upconvert the smaller 360 lines of a 4:3 image. The resulting low

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resolution is unacceptable. Any upconversions should use high-end equipment and avoid the poor quality of many non linear editor scaling algorithms.

2.1.4 Programs submitted as "High Definition" must be principally content that was originally created in a minimum frame size of 1280 x 720. When producing a HDTV program, acquire primarily HDTV content. Occasional up-convers scaling algorithms. 2.1.5 2.1.6.

2.1.5 The image must be free of aliasing such as the artifacts associated with low cost scan conversion. Use a high quality aspect ratio converter for any letterbox functions.

2.1.6 Compression artifacts must not be obvious when viewed on a professional standard-definition monitor for 4:3 shows, and when viewed on an HDTV monitor for widescreen shows. Use compression equal to, or better than, a single generation of DV compression. If possible, use DV50 or IMX compression.

2.1.7 Except in the case of clear archival justification, the image must be free of picture impairments associated with legacy analog equipment: lag, smear, scratches, dropouts, head switching, etc.

2.2 Video Level

2.2.1 Video levels must be measured with direct digital waveform monitoring equipment calibrated to represent video levels on the final submission. Connect a professional digital waveform monitor to the editing system digital output. Connect the picture monitor output of the waveform monitor to the GBR input of the edit room color monitor, and configure it to flash alarms when levels are exceeded.

2.2.2 The luminance level in black areas of the program must fall as low as 0%, but not below 0%. Objectionable black clipping must not be evident. Black setup is not allowed in any digital submissions. When measured as derived composite signal, the black level must not fall below 7.5 IRE units. Make sure operators understand that neither component analog nor component digital signals have "setup". If it appears to have setup something is set or adjusted wrong. Adjust cameras and editor input settings for proper black levels without clipping. Apply level (color) correction as needed to make levels consistent. Consider use of a "legalizer" in the final release process.

2.2.3 The luminance level in white areas of the program must reach as high as 100%, but not above 100%. Objectionable white clipping must not be evident. When measured as derived composite signal, the white level must not exceed 100 IRE units.

2.2.4 Derived standard definition NTSC peak chrominance plus luminance gamut must not exceed 120 IRE when measured with a flat filter on a digital waveform monitor. Component digital derived GBR values must remain within the legal gamut of 0-700 millivolts.

2.3 Color Gamut

The allowable color gamut (range of values) for GBR signals in NTSC is 0-700 millivolts for Green, Blue, and Red. Serial digital 601 signals provide an Y C_b C_r component signal that can contain invalid colors

when it is converted to GBR. Signals outside the GBR gamut range may lead to clipping, crosstalk or other distractions in encoders and other processing devices designed to operate within the legal gamut. All G,B or R signals should lie inside the range -10 millivolts and 720 millivolts after an IRE filter has been applied. The resulting composite luminance signal should lie inside the range of -1 to 103 IRE. A diamond arrow or equivalent display should be used to detect illegal gamut levels. Programs with GBR Upper Gamut levels above 735 millivolts; and GBR Lower Gamut below -50 millivolts will be rejected and returned to the program producer for correction. GBR gamut will be "legalized" to the -10 to 720 millivolt range when the final PBS package is created for distribution.

2.4 Video Blanking

2.4.1 Horizontal Blanking must not exceed the limits specified, per SMPTE standard:

Format	Maximum
480i (170M)	11.0 µsec
1080i (240M)	3.94 µsec

2.4.2 Full-screen content should fill the raster in each field as shown.

Format	Field 1	Field 2
480i	23-262	22-261 (285-524)
1080i	21-560	21-560 (584-1123)

**This field 2 blanking represents common practice. In contrast, SMPTE RP202-2000 recommends lines 23-262*

2.4.3 The "letterboxing" of 16:9 content in a 4:3 raster is ideally performed as follows to allow subsequent inter-cutting of various letterbox programs with consistent blanking:

	Field 1	Field 2
480i 16:9 Letterbox	53-232	52-231 (315-494)

Monitor video throughout the edit process with the picture monitor in underscan, watching for excessive horizontal or vertical blanking. Regularly check

2.5 Field and Frame Rate

The field rate for both standard and high definition is59.94 fields per second. The frame rate for both standard and high definition is 29.97 frames per second.

3. AUDIO

3.1 Audio Level

Digital metering must be set to meet the ballistic specifications for VU (IEC 60268-17) and Peak (IEC 60268-10, 10ms Attack, 1.7 sec. Decay). This metering, in conjunction with the dialnorm reading, will allow a producer to adhere to the audio requirements within the TECHNICAL OPERATING SPECIFICATIONS.

3.1.1 The operating level for reference tone and legacy analog system calibration is -20 dBFS per SMPTE RP155. Make sure audio metering is calibrated to the SMPTE standard of -20 dB full scale digital for the "operating" level. This is not common practice in semi-pro audio, where levels are often pushed closer to full scale digital. For example, Final Cut Pro has meters and default tone settings corresponding to -12 dB full scale, requiring an adjustment of the tone each time it is used, and making the meters marginally useful. External meters may be required to solve limitations of editing software.

3.1.2 Programs are to have average loudness levels that fall between -28 dBFS and -20 dBFS during the majority of a program as measured on a digital meter calibrated to the RMS/VU ballistic. Average loudness should not go above -17 dBFS at any point during the program. Use an audio limiter if needed, to insure level peaks do not exceed -10 dBFS for SD programs and do not exceed -3 dBFS for HD or Widescreen programs.

3.1.3 Programs are permitted to have audio levels that regularly peak near but not above the following limits using a digital peak meter:
SD: -10 dBFS
HD: -3 dBFS.

Procure equipment that can measure dialnorm (such as the Dolby LM100) and provide adequate training. Mix to the standard dialog level of -24±2 dB. Use digital metering set to meet the ballistic specifications for VU (IEC 60268-17) and Peak (IEC 60268-10, 10ms Attack, 1.7 sec. Decay). This metering, in conjunction with the dialnorm reading, will allow a producer to adhere to the audio requirements within the TECHNICAL OPERATING SPECIFICATIONS. 3.1.4 Make sure the final mix is performed by a skilled technician who is unbiased by prior work. Make sure this audio technician is trained to understand the effect of mixing fatigue which often results in music and effects levels being set too high. After hearing a program countless times, the technician's judgment can become impaired. The final mix must compensate for the phenomena of mix-engineer fatigue, caused by long periods of repetitive listening

3.1.4 Programs must be mixed using dialog level Lea metering or subsequent ATSC standard method. They must have dialog levels with a value of -24 dBFS ±2 dB. Programs may have peak music or effects levels up to the level limits specified in 3.1.3 during moments of dramatic impact, as long as dialog levels are maintained as specified.

3.1.5 Producers must maintain music and effects levels sufficiently below dialog to insure that a wide variety of viewers can understand the dialog upon first viewing, in home conditions with high ambient noise and moderate program levels.

3.2 Audio Quality

3.2.1 The audio mix must be free of audible clipping and other distortions. Provide phase scopes (X-Y for two-channel, or more elaborate scopes for multi-channel) and associated training to all audio technicians.

3.2.2 The audio mix must be free of obvious noise. When doing the final evaluation, listen with headphones comparing the audio timing of all program audio channels, not just program audio.

3.2.3 To prevent lip sync problems, insure that an audio delay accompanies every video frame synchronizer and digital effects device. Watch for creeping lip sync issues throughout the production and dubbing process. At this point in the production process there is no reason to have anything but zero error in the timing of audio and video. Be aware that LCD and Plasma displays have latency in video processing - in some models as much as four frames. Use of these displays for checking lip-sync must be accompanied by an audio delay adjusted to equal the display latency

3.3 Audio Phasing & Synchronization

3.3.1 Audio timing and phase must remain consistent across all channels and tracks. 3.3.2 Audio/video synchronization (lip sync) must appear to be correct during the program itself. During the program countdown, or by any in-service measurement technique adopted in the future, audio cannot lead or lag video by more than one half frame.
See Figure 1.

3.4 Audio Channel/Track Assignments

3.4.1 Normal Configuration.

Chnl/Track	Assignment
1	Left or Mono
2	Right or Mono
3	Descriptive Video or Mono
4	Secondary Language or Mono

Audio assignments are for the first 4 tracks of a server or VTR. Servers or VTRs with more than 4 tracks shall not have audio on tracks higher than track 4.

3.4.2 Programs may be encoded without special notice using Dolby Pro-Logic with Lt/Rt replacing the normal stereo audio on channels/tracks 1 & 2.

3.4.3 Dolby E encoding is not permitted on standard definition programs. High definition programs may be encoded using Dolby E in place of DVI/Second Language on tracks 3 & 4, using the following track assignments. The producer must insure that the encoded Dolby signal is recorded on tape one frame advanced from the recorded video. This is accomplished by delaying video and audio Tracks 1 and 2 by two frames. The delay shall be accomplished with methods external to the VTR. Thus, all audio signals will be in sync with video when played back through a normal Dolby E decode on an HDCam VTR in its default configuration.

Dolby E 5.1 Surround Configuration

Chnl/Track	Assignment
1	Left Stereo, Mono, or Left Total
2	Right Stereo, Mono, or Right Total
3	Dolby E (see next table)
4	Dolby E (see next table)

Channel/Track 3 and 4 Dolby E Assignments

Ch 1	Left Front
Ch 2	Right Front
Ch 3	Center
Ch 4	Low Frequency Effects
Ch 5	Left Surround
Ch 6	Right Surround
Ch 7	DVI (Mono or Left),Stereo Left, Mono
Ch 8	SAP, DVS (Right) Stereo Right, Mono

4. Ancillary Information

4.1 Time Code

4.1.1 Drop-Frame time-code per SMPTE 12M must be present on the longitudinal track with identical VITC recorded as follows:

Format	Field 1	Field 2
480i	16 & 18	16 & 18 (279 & 281)

Note: The above is NOT the Sony Digital BetaCam default for VITC location. The HDW-2000 VTRs (HD Cam) record VITC on line 9 of the HANC and LTC on line 10 of the HANC, and both assignments are fixed. 4.1.2 The recording should begin with timecode starting at 00:58:30:00, with 01:00:00:00 being the start of program material. The timecode must increment without interruption from the beginning of the tape until 30 seconds after the final program segment.

4.2 Closed Captioning

4.2.1 For standard definition submissions, Closed Captioning data must be encoded as specified in CEA-608-C. In particular:

4.2.1.1 The primary language captioning data stream must be carried in the Primary Synchronous Caption Service (CC1) on field 1 of line 21.

4.2.1.2 The optional secondary captioning data stream must be carried in the Secondary Synchronous Caption Service (CC3) on field 2 of line 21.

4.2.1.3 Line 21 waveform timing specifications must be in compliance with CEA-608-C Table 2 (“Line 21 Waveform Timing”)

4.2.1.4 The analog equivalent of the Data Bit High shall be 50±2 IRE (357±14 mV)

4.2.1.5 The analog equivalent of the Data Bit Low shall be between 0 and 2 IRE (0 and 14 mV) 4.2.2 For High Definition submissions, CEA-708-C captions with "608 compatibility bytes" must be carried in the ancillary data space (ANC) per SMPTE 334M-2000. The captioning ANC data must be present on line 9.

5. VIDEOTAPE SUBMISSION

5.1 Formats & Stock

5.1.1 The condition of the tape stock and equipment used for the recording must provide video and audio playback at AIPA with no digital “hits” that exceed error correction. (The Digital BetaCam playback should show no “yellow” or “red” error rate indication throughout the recording.)

5.1.2 All programs must be submitted on one or more of the following formats. Other digital videotape formats may be accepted with prior approval but will incur a dubbing charge.

480i 16 & 18 16 & 18 (279 & 281)	Tape Format
SD 4:3	SDigital BETACAM
SD 16:9	Digital BETACAM
HD	HDCAM (1080i)

Please contact Terry Balagia, the Executive Creative Director of the American Institute of Performing Arts, with any questions about these TECHNICAL OPERATING SPECIFICATIONS. All proposals to AIPA will incorporate these TECHNICAL OPERATING SPECIFICATIONS by reference.