TECHNICAL OPERATING SPECIFICATIONS

For Local Independent Program Submission

September 2011

1. SCOPE AND PURPOSE

This TOS provides standards for producing programs of a consistently high technical quality for delivery to KUED, Salt Lake City. Organizations submitting programs to KUED must have a qualified technician using professional digital measurement equipment evaluate the program to meet these specifications prior to submission. Program submissions not meeting these specifications may be rejected.

This TOS defines the technical specifications of submissions for both high definition and standard definition content as defined in Section 2 of this document.

KUED will only accept:

- **Video acquired in high definition (HD) and submitted in DVC-Pro format.**
- **Video acquired in standard definition (SD) and submitted in DVC-Pro format.**
- **KUED may accept video file transfers under certain conditions. See section 6.**

2. VIDEO

2.1 **Video Image Quality**

2.1.1 This section concerns the video image quality of submitted programs. All programs must be produced with modern digital acquisition and editing systems, with careful attention as early in the process as possible and beginning with the highest quality available, and then maintaining high quality throughout the acquisition and post-production process.

2.1.2 For the purpose of this document, HD and SD upconverted video will be defined as follows:

2.1.2.1 HD program submissions are defined as those programs which have been acquired by cameras which have three sensor chips, each at least a 1/2" diagonal in size with a frame size of 1920 x 1080 and have been edited minimally as 4:2:0 -8 bit video.

2.1.2.2 SD upconverted submissions are defined as those programs created in standard definition and then upconverted to high definition before submission.

2.1.2.43 Video derived from film should be 16mm wide frame or higher quality.

2.1.2.4 Upconverted NTSC video will not be accepted as entire programs. Any submission containing NTSC composite video, such as archival material, must be decoded fully by a digital comb filter decoder.

2.1.3 The image must be free of compression artifacts (such as macroblocking and mosquito noise), aliasing (such as the artifacts associated with scan conversion), frame dropouts, and other artifacts association with conversion and encoding.

2.1.4 Except in the case of use of archival content where no better copies are available, the image must be free of picture impairments associated with legacy analog equipment such as lag, smear, scratches, videotape dropouts, head switching, composite video artifacts.

2.1.5 Only visual content intended to be seen by the viewer is allowed in the active image area. Particular care must be exercised to remove miscellaneous non-image products such as AMOL, closed captions, or Actimates information particularly in images that have letter/pillar-boxed content.

2.1.6 For standard definition submissions, the image must have the high quality image resolution associated with modern (3-chip} cameras and other acquisition devices and must not be derived from a smaller image area. For example, low cost DV cameras that sample less than 480 vertical lines would produce unacceptable images. Cameras must have at least 1/3" diagonal pickup devices with a minimum resolution of 640 x 480 for 4:3 images and 720 x 480 for 16:9 images.

2.2 Video Levels and Gamut

2.2.1 Conversion between Y', $C_{b'}$, $C_{r'}$ to GBR colorspaces can create invalid colors and thus gamut errors. Out of gamut errors generally arise when video computer graphical sequences are authored in Y, Cb, Cr. A waveform monitor which clearly defines gamut limits for HD video should be used to ensure that all video elements within the submission do not generate any out of gamut errors.

2.2.1.1 Objectionable black clipping must not be evident. Black level must be set to 0v on the Y' waveform. Black setup is not allowed in any digital submissions.

2.2.1.2 Peak Y', Cb', Cr' video amplitude each must be no more than 0.7v peak to peak. Since certain combinations Y', Cb', Cr' will create out of gamut colors; close attention should be paid to gamut indicators.

2.2.2 Producers should be aware that the GBR gamut will be hard limited ("legalized") to the 0 to 700 millivolt range when the finished program is broadcast on KUED.

2.3 Video Image

2.3.1 The production aperture of "full-screen" content is defined vertically in lines for each field as shown:

Format	**Field 1**	**Field 2**
480i	23-262	286-525
1080i	21-560	584-1123

2.3.2 When 4:3 content is placed within a 16:9 production aperture (which is termed "pillarbox") (AFD code 1010) the image will fill the following pixels on every line, thus horizontally centering the image. (+/- 5pixels)

Format	**Line Pixels**
1080i 16:9 Pillarbox	241-1680
480i 16:9 Pillarbox	xxx-xxx

2.3.3 When content in a 16:9 production aperture is 4:3 protected (AFD code 1111) then the image will be centered in the middle 75% of the picture aperture thus horizontally centering the critical image.

2.3.4 **The Safe Areas are:**

2.3.4.1 Safe Action is the area within which all significant action must be contained. The area is 93% of the width and height of the production aperture.

Format	Production Aperture	Safe Action Area	4:3 Protected Safe Action Area
480i	720 x 480	670 x 446	–
1080i	1920 x 1080	1786 x 1004	1296 x 972

2.3.4.2 Safe Title Area is the area within which all significant text must be contained. The area is 90% of the width and height of the production aperture.

Format	Production Aperture	Safe Title Area	4:3 Protected Safe Title Area
480i	720 x 480	648 x 432	–
1080i	1920 x 1080	1728 x 972	1296 x 972

2.3.5 Open Captions are limited to 80% of the width and 80% of the height of a 4:3 protected area (when there is a 4:3 protected area).

2.3.6 The aspect ratio of all HD programming shall be 16:9.

2.4 **Field and Frame Rate**

2.4.1 The field rate for both standard definition (480i) and high definition (1080i) formats is 59.94 fields per second (60 multiplied by 1000/1001). The frame rate for both standard definition (480i) and high definition (1080i) formats is 29.97 frames per second (30 multiplied by 1000/1001).

3. AUDIO

Main service audio is defined as the primary service that is intended to serve the majority of the audience. Secondary services include alternate languages and the Descriptive Video Information (DVI).

3.1 **Audio Level**

Refer to the audio level diagram below and ATSC A/85, "Techniques for Establishing and Maintaining Audio Loudness for Digital Television".

3.1.1 For submissions on videotape that include reference tone as required by 6.3.1 and 6.3.3, the operating level and tone frequency must be -20 dBFS at 400 Hz on all channels, with the exception of the LFE channel within 5.1 channel submissions, which shall be -30 dBFS at 80 Hz.

3.1.2 Metering must conform to ITU BS.1770 for loudness and true-peak measurement and must apply to all channels of a 5.1 channel submissions, with the exception of the LFE channel which is not included in the loudness measurement.

3.1.3 The program and every associated container (such as underwriting spots, video offers, etc.) must each have an average loudness of -24 LKFS, ±2 dB, measured for the duration of the container.

3.1.4 Sections of dialog within music programs must also meet the ±2 dB LKFS loudness specification, even if when the duration of dialog is so limited as to not affect the average loudness of the program as a whole.

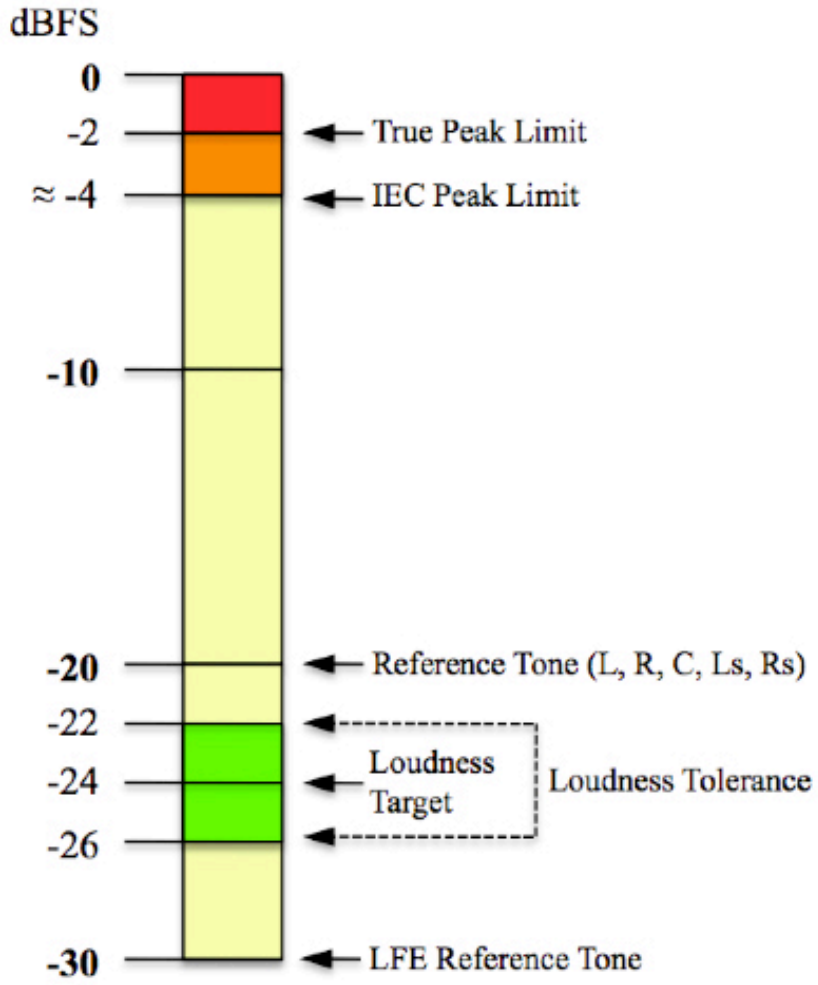
3.1 5 Audio levels between containers (i.e., "boundary problem") must be consistent. Consumer dissatisfaction is apparent when there are instantaneous or abrupt level changes; for example, if the funding credit is much louder than the body of the program.

3.1.6 Programs may have music or effects true-peak levels as high as -2 dBFS during moments of dramatic impact, as long as average dialog levels are maintained as specified in 3.1.3 and 3.1.4. (Producers lacking true-peak measurement tools should be aware that IEC peak measurements often result in readings approximately 2 dB lower than true peak. Producers should also be aware that some legacy downstream station or MSO systems may clip signals at levels higher than -10 dBFS.)

3.1.7 Music and effects levels must be sufficiently below dialog to insure that a wide variety of viewers can understand the dialog upon first viewing, in home listening conditions with high ambient noise, moderate program levels, and a wide variety of audio monitoring systems.

3.1.8 Programs should be monitored for downmix compatibility of the 5.1 submission using appropriate downmix settings of -3 dB in the center channel and -3 dB in the surround channels.

Note: Producers should be aware that programs submitted in 5.1 channel audio will be heard by the majority of consumers as a stereo downmix. This downmix will occur within cable MSO receivers for analog retransmission, and in consumer stereo AC3 decoders.



3.2 **Audio Quality**

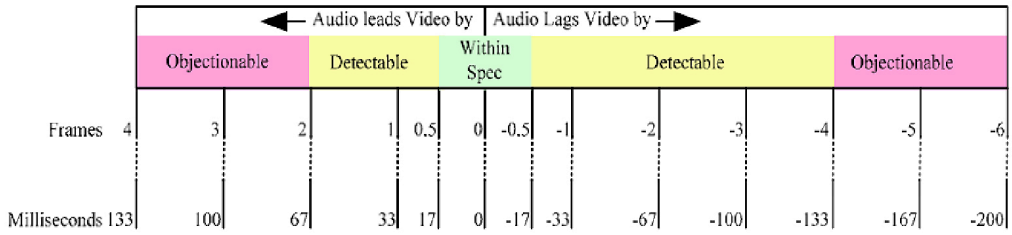
3.2.1 The audio mix must be free of audible clipping and other distortions.

3.2.2 The audio mix must be free of objectionable noise.

3.3 **Audio Phasing & Synchronization**

3.3.1 To insure compatible stereo and mono down-mix, the dialog must be in phase, and the music/effects phase must be within 160 degrees at 400 Hz across channels/tracks within an audio service.

3.3.2 Main service audio must not lead or lag video by more than one-half frame. This specification applies to the program countdown and all program elements.



3.3.3 Audio must be within one frame between services (e.g., between main and descriptive video information, or music between main and alternate language).

3.4 Audio Channel/Track Assignments

3.4.1 Videotape track configuration for SD/HD Stereo submissions

Channel/Track	**Assignment**
1	Left or Left Total or Mono
2	Right or Right Total or Mono
3	DVI or Mono Main
4	Alternate Language or Mono Main

Audio assignments are for the first 4 tracks. 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.

Channel/Track Assignments for SD/HD with 5.1 Audio

Ch 1 Left Front (L)
Ch 2 Right Front (R)
Ch 3 DVI or mono main
Ch 4 Alternative language or mono main
Ch 5 Center (C)
Ch 6 Low Frequency Effects (LFE)
Ch 7 Left Surround (Ls)
Ch 8 Right Surround (Rs)

3.4.4 **Stereo Synthesis**

Stereo synthesizing is not allowed within any content at any time.

3.4.5 **Up-mixing**

When up-mixing two channels (stereo) to multi-channel surround sound (5.1 channel), audio must be properly distributed among the channels. When up-mixing no energy may be directed to the low frequency effects (LFE) channel. Up-mixed audio must be downmix compatible to stereo and mono.

4. Ancillary Information

4.1 Vertical Ancillary Area (VANC)

4.1.1 The vertical ancillary area must be void of all data except:

Line 9, which must contain SMPTE 334 compliant closed caption (CC) data

Line 11, which may contain SMPTE 2016-3 compliant Active Format Description (AFD) data.

4.2 **Time Code**

4.2.1 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	Lines 16 & 18	Lines 16 & 18 (279 & 281)

4.2.2 The recording must 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.

4.3 **Closed Captioning**

4.3.1 For high definition submissions, Closed Caption data must be encoded as specified in CEA-708-C with “608 compatibility bytes”. In particular:

4.3.1.1 The primary language captioning data stream must be carried in the Primary

Synchronous Caption Service (CC1).

4.3.1.2 The optional secondary captioning service must be carried in the Secondary

Synchronous Caption Service CC2

4.3.1.3 The closed captioning data must be encoded on line 9 of the VANC per SMPTE 334M-2000.

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

4.3.2.1 The primary language captioning data stream must be carried in the Primary

Synchronous Caption Service (CC1) on field 1 of line 21.

4.3.2.2 The optional secondary captioning data stream must be carried in the Secondary

Synchronous Caption Service (CC3) on field 2 of line 21.

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

4.4 **Active Format Description (AFD)**

As of the Fall of 2011, KUED is not requiring the insertion of AFD codes. However, this will likely become a requirement in the near future.

4.4.1.1 An AFD code must be placed on line 11 of every field of every frame of each segment including the pre- and post-segment black portions.

4.4.1.2 Only the following 16:9 coded frame AFD codes may be used:

4.4.1.2.1 AFD code 1000 (8) — Full frame 16:9 image

4.4.1.2.2 AFD code 1001 (9) — 4:3 pillarbox image centered in frame

4.4.1.2.3 AFD code 1010 (10) — Full frame 16:9 image – All image area is protected, cropping is not allowed

4.4.1.2.4 AFD code 1111 (15) — 16:9 image with alternate 4:3 center – Visual information outside 4:3 protected area may be cropped with minimum impact for the viewer

5 . **Videotape Submission**

5.1 Formats and Stock

5.1.1 The condition of the tape stock and equipment used for the recording must provide video and audio playback at KUED with no digital hits.

5.1.2 All programs submitted to KUED must be on one of the following formats:

Image Format	Tape Format
SD 4:3	DVC-Pro 25 or 50
SD 16:9	DVC-Pro 25 or 50
HD	DVC-Pro 100

5.2 **Tape Complement and Labeling**

5.2.1 Maximum content length is 120 minutes. Programs exceeding this length must be delivered on multiple tapes with a logical break point and no overlap.

5.2.2 The tape container and label must indicate the following:

- Program title
- Program length
- time code start
- captioning status
- KUED inventory control code (provided by KUED)
- Aspect ratio and resolution
- Producer name and contact information
- Delivery date

5.3 **Leader and trailer specifications**

5.3.1 The recording must begin with 60 seconds of digital SMPTE EG1 color bars and operating level tone on all audio channels.

5.3.2 The recording must continue with a 20 second visual slate noting the information as listed in paragraph 5.2.2.

5.3.3 The recording must continue with a countdown clock beginning precisely 10 seconds before the program. At number "2" of the countdown clock video must drop to black and audio silenced until program start.

5.3.4 After the program concludes the recording should continue with 30 seconds of black and silence.

6. **Program submission by data file**

6.1 KUED will consider program submissions by data file. Any submission must be compatible with KUED's Broadcast Operations Center and video server equipment. No program can be submitted without prior conversation with the KUED Technical Operations. Any necessary transcoding of an incompatible file will be at the Producer's own expense.