Date: 2-8-07

Technical Requirements for

Production

This is the first 2007 revision of the CBS/Paramount technical requirements. These requirements have always been based on two things, the needs of our network and ancillary market customers, and the things we've learned from our mistakes. If you find any errors or omissions, or if you have any comments or suggestions, please contact:

John Sprung, Director of Technology
CBS/Paramount Network Television
4024 Radford Avenue, R&E Bldg. Rm. 310
Studio City, CA, 91604-2190

Office 818 655-7423, Fax 818 655-8252,

John.Sprung@CBSParamount.com.

The goal is to make it easy to find the information you need. These are the Production requirements, there is a separate document for Post. The table of contents includes quick answers wherever possible, but please read the full text, and use them only as reminders.

Anti-piracy measures are not discussed in this widely distributed document. They are handled separately, on a need to know basis.

Table of Contents:

Date: 2-8-07

1. Frame Rate:

All normal speed film must be shot at 24.000 or 23.976 frames per second. All normal speed HD shooting must be 1080p/24, either 24.000 or 23.976 frames per second. All post is done in 1080p/24. Conversions from 30 frames or 60 fields are unacceptable in the PAL/SECAM markets. A little over half our money comes from foreign sales.

There is one very rare exception. If you have a PAL or SECAM monitor in the shot, you can use 25 fps to eliminate the roll bar. Anything shot that way will be played 4% slow at 24 fps, which is acceptable.

An interesting new technology for constructing in-between frames was demonstrated at the 2007 HPA Tech Retreat, but it's a few years away from being a finished product. So, for the foreseeable future, the fact remains that we can't fix this one in post.

Of course you can use whatever frame rate you want for fast or slow motion. Whatever rate you shoot, it will be seen at 24 fps.

2. Shutter angle/exposure time:

Film cameras typically spend about half their time with the shutter closed, pulling down the film, and the other half with the shutter open, exposing the film. Most can be set to smaller shutter angles, reducing the exposure time. Electronic cameras also let you select the length of exposure.

Anything that moves in the frame during exposure gets blurred. How much blur depends on the length of exposure. This motion blur is a good thing, not a bad thing. Without it, there is no illusion of motion. Without it, we see a rapid sequence of still pictures skipping by, the "Private Ryan" effect.

At this time there is no way to fake motion blur, though the in-between frame technology may also solve this some day. Think long and hard before using exposure times substantially under 18 milliseconds or shutter angles under 160 degrees. It's a decision that can't be changed later.

Some HD cameras allow you to use shutter angles much larger than is physically possible with film, 330 degrees or more. That lets you make smooth fast pans and moves that would skip severely on film.

3. Crushed blacks, blown out whites, extreme colors:

Tape to tape color correction can easily make things look extremely dark, extremely bright, extremely red, or whatever look you want. But it doesn't work the other way. If you shoot with most of the image close to the extremes, some of it gets pushed all the way out of the system's dynamic range, and the information is lost. Try to get it back in timing, and all you get is noise and milky fog. For HD cameras, shoot with clipping and enhancement off, and a low gamma curve.

Whether you're shooting film or tape, think long and hard about working close to the edges of what the system can handle. Think about where you might want to go with the look of the show, and where the director, producers, studio, and network may want to take it. Note well that they may change their minds after they see it cut together. Mull this over before you shoot something in a way that ties their hands. Weigh carefully the consequences of their disappointment.

4. Shooting Formats:

Some shows will shoot on film and some will shoot on 1080p/24 tape. Most film shows will shoot 35mm/3 perf. Which format your show shoots depends on the budget and the look you want. All shows will post on 1080p/24 tape. HDCam SR 4:4:4 is the preferred tape format, especially for composite special effects. D-5 and original HDCam are also acceptable.

In rare cases, MOW's that have a theatrical release will use 35mm Academy centering and four perf pulldown. For composite special effects, 35mm/4 perf can be used for pin registered telecine. There is no problem with mixing 3 perf and 4 perf, except on cut negative shows.

The big problem with first generation HD cameras is that the actual image area is tiny, between the size of super-8 and regular 16, and the maximum aperture is limited by the optical block to no wider than f/1.45. As a result, the depth of field is always large, whether you want it that way or not. Lens design and manufacturing tolerances are extremely critical. Resolution is limited by diffraction at stops deeper than f/8 for 2/3” chips, and f/4 for 1/3” chips. You can work around diffraction by using neutral density, but the depth of field problem can only be completely solved by making a larger CCD or CMOS sensor.

Panavision has done that with the large chip/single chip Genesis camera, and now so has Arriflex with the D-20. There are other competitors, but they're farther from having practical cameras.

The chips in these cameras are the same size as 35mm film, so all the familiar 35 film lenses work with them, giving you the same field of view and depth of field as on film. Shoulder, toe, and dynamic range are also close enough to intercut with film. Diffraction isn’t a consideration until f/22. We have used the Genesis in the 2006-7 season, with fine results. This is a major advance in camera technology which should be considered by all single camera tape shows as soon as the prices come within reason for TV. For sitcoms, the depth of field of small chip/three chip cameras is an advantage, so they have no reason to change.

5. Resolution and High Definition Monitoring:

For shows that shoot on HD tape, it is important to bear in mind that 1080p cameras and tape are capable of substantially higher resolution than can be displayed on even the best CRT (picture tube) monitors. Just as film shooters can only see the full resolution of their work by projecting a workprint, the full resolution of HD can only be seen by mapping its pixels one to one onto a chip based front projection system such as DLP or DILA.

In particular, 1080p and 720p may seem to match quite well on a CRT. In projection, they don't.

6. High Definition Main and Special Purpose Cameras:

For shows that shoot on HD tape, everything that is intended to directly represent objective reality must be shot 1080p. Upconversions from 720p are not adequate. But there are exceptions. If a special look is required for a scene, you can do whatever it takes to get what you want, so long as at the end of the day we have it on 1080p/24 tape.

For example, if the characters in your story are being held hostage, and one of them dares to shoot some video with a cell phone, you can shoot that material with a cell phone.

If you need the undercranked look of an old time silent comedy, you could upconvert from a 720p Varicam, or shoot with a hand crank film camera, or whatever else you want to try.

For slow motion, there are a few options. The new big chip cameras give you a choice of frame rates. Older HD cameras can do a reduced resolution slow motion effect by shooting at 50i or 60i, and converting each field to a frame in post. For a very slight slow motion, you can shoot 30p at full resolution. There is also the 720p Panasonic Varicam. It gives you better resolution than upconverting fields, and a wider choice of frame rates. But it requires a conversion process at the video facility, using Panasonic's proprietary box. Think of it as the Arri 2C of HD.

If you need to shoot in a confined space where the 1080p "A" camera won't fit, use the best camera you can get that will fit where you need it. Iconix makes a 1/3" camera that'll fit in a large coffee cup. (Bear in mind that 1/3" chips are diffraction limited at stops deeper than f/4.)

The reason for insisting on full 1080p resolution for most of our work is that consumers will have higher resolution displays than today's HDTV fairly early in the life of the product we're making now. They'll be able to see the difference that we can only see in projection at a video house today. Particularly in the more quality-critical foreign markets, that can make or break a sale. There is, though, a long established precedent of acceptance for special shots.

We're still distributing "I Love Lucy" from over 50 years ago. Lucy was shot and finished on film. Other hit shows from that golden age were shot live, and they all looked about as good on the air. But today those other shows exist only as hot kinescopes. Given the value of what we do, we don't want to make the mistake of using anything less than the best available format.

7. Aspect Ratios:

The vast majority of shows have full screen 1.33:1 NTSC as their primary market, but must also deliver for 1.78:1 HDTV simulcast. On these shows, compose for a 1.33 center extraction from within a 1.78 frame. Protect the entire 1.78 frame. Crew and movable equipment such as boom microphones should always be kept out. Anything that you can't keep out of 1.78 in production will be fixed in post, which costs money. That should only happen when it'll cost less to fix in post than in production.

Film camera viewfinders and video taps have an overview area that doesn't appear on the negative. One purpose of the overview area is to help you position things as close as possible and still keep them out. Some HD cameras have optical viewfinders with overview, but there is no overview area in the electronic image from any HD camera. Everything you see goes on the air. Protect the entire 1.78 TV transmitted frame, 100%, not just the safe action area.

One tape must serve both frames, using center extraction. There is no budget for pan and scan. When the networks go to single tape delivery, it'll be impossible to air a pan and scan. CBS has informed us that they may go to single tape delivery next year.

If a letterbox NTSC first run is authorized in writing by the network, all work should be done in flat 1.78. Ancillary markets may do a pan-and-scan later if they get 1.33 orders that justify the expense.

8. Alignment Charts (Film shows only):

The best way to make sure that what the telecine operator puts on tape matches the composition you saw in the viewfinder is to shoot an alignment chart. Setting up to a chart corrects out the cumulative small errors in the camera pulldown, the mirror shutter, the marking and seating of the ground glass, the telecine transport, etc. Each camera body needs its own chart, and it's best to shoot a new chart if you pull and replace the ground glass.

Shoot the charts carefully. A sloppy chart can do more harm than good. For instance, if the chart is tilted back so the top appears narrower than the bottom, the telecine operator will have to split the difference every day, and probably do it a little differently each time.

Please note on the first camera report where to find these setup charts, and whether they represent the safe action or TV transmitted area.

Ground glass markings are up to the Director of Photography and the Operators. The only requirement is that they be consistent with the telecine extraction areas. All shows should use markings that indicate a secondary 1.78 frame having common top and bottom with the primary 1.33 composition, which is centered in the 1.78 frame.

9. Time code:

There is no practical dropping algorithm for 24 fps, so all 24 frame code is non-drop. To avoid having changing offsets, all code on the set should be non-drop.

On film shows, run-stop generation is preferable to time-of-day, because it eliminates duplicate codes. On tape shows, jamming everything to time of day makes it easier to find and sync things.

10. "Point zero zero" vs. "Point nine something":

Before color TV, frame rates were always whole numbers. Film was 24.00 frames per second, TV was 30.00 frames or 60.00 fields per second. In 1953, to fix a last-minute problem in the NTSC color standard, TV was slowed down by a tenth of a percent to 29.97 frames or 59.94 fields per second. Most HD and film cameras have the option to run at either 24.000 or 23.976 frames per second.

In order to sync any two recording devices, be they film cameras, sound recorders, or tape cameras, both must be on the same side of the "point what?" fence. Therefore, everything on the set must either run at "point zero zero" rates, or everything must run at "point nine something" rates.

Though it is possible to fix a sound "point what" error in post, it requires a transfer step to re-sample the audio. That costs time and money, and delays dailies.

11. Pre-Roll:

Time code must run for 7 seconds between camera and sound start and sticks. Whenever a recording machine stops and starts again, there's a gap in time code. Playback machines get confused when they have to roll through that code jump. So, to check sync using the sticks, there has to be a handle ahead of the sticks. Seven seconds is a safe minimum.

12. Sound:

On film shows, sound must necessarily be recorded on a separate machine. Tape camcorders can be used with a separate sound recorder, or with a hard wire sound feed to the camera, or both.

It's preferable to record sound on the HD tape whenever it's not inconvenient for production, because it saves the syncing step for dailies. For steadicam shots and dolly moves, it's better to work without the wire. For HD cameras that record picture to an offboard deck, there's no reason not to make good use of the audio tracks on the HD tape.

Always slate sync takes with sticks. Conventional slates are fine, even though most people have digital slates. This is necessary to establish sync if the machines drift. The camera and sound code generators should be jammed together at the beginning of the day and immediately after lunch, to minimize drift. Sometimes they may drift more than a frame in an hour, sometimes less than a frame in a day. If they seem to be perfect day after day, that's just Murphy setting you up.

There are many ways to record separate sound. The classic Nagra still works, there's DAT, DA-88, DEVA, and DVD RAM with Broadcast Wave Poly files. All are acceptable to Paramount provided that the video and sound post facilities you're using are equipped for them.

Digital sound should be sampled at 48.048 kHz if the camera is running at 24.000 fps and audio time code is 30.00 fps. It should be sampled at 48.000 kHz if the camera is at 23.976 fps, and audio code is 29.97 fps. The depth should be 24 bits per sample. Head tones and levels should be set where the post facilities want them.