



HQV BENCHMARK DVD

TESTING & SCORING GUIDE

This manual provides details on how to use the Benchmark DVD and develop a composite score for the display under test. There is a scorecard at the rear of this manual with which to summarize your results.

Version 1.4



www.hqv.com



INTRODUCTION

Congratulations! You hold in your hands the HQV Benchmark DVD, a most powerful evaluation tool. It's designed to put your TV, monitor, DVD player, or video scaler through a grueling video obstacle course, one that will reveal much about the quality of video signal processing in these components.

While it's true that the transition from analog to digital television is well underway, a great deal of video that we watch is still delivered and played back in analog composite (NTSC), S-video (Y/C), and component (YPbPr) video formats. The picture scanning system is interlaced in all three.

The video clips and test patterns on this DVD have been specifically designed to evaluate a variety of interlaced video signal processing tasks including decoding, de-interlacing, motion correction, noise reduction, film cadence detection, and detail enhancement. The ultimate quality of the images you watch is limited by any and all of these steps. (It's a rare signal processor that can handle all of these tasks well!)

Ten test patterns are provided for a thorough workout, including color bars, two "jaggies" patterns, a waving flag, a static, detailed image; a saturated color image to check for noise reduction, a roller coaster sequence for motion adaptive noise reduction, a test for film detail, a series of tests for film and animation cadences, and a title crawl that mixes film and video elements.

For each test, you'll find a brief description of what picture artifacts to look for and how to score the resulting images. Now, turn on your DVD player, get out your pencil, put on your judge's hat, and start scoring!

BEFORE YOU BEGIN

IMPORTANT: If you are evaluating a display device, be sure to put the DVD player in "interlaced" output mode. Otherwise you will be actually evaluating the video processing in the DVD player. On the other hand, if you are evaluating the video processing of the DVD player itself, be sure to put it into progressive mode.

The most convenient way to cycle through the tests is to go to the main menu and select "Play All Tests, Manual Advance." Each test will loop upon itself until you press the "Enter" button on the remote. At that point, it will jump to the next test. If you ever want to go back to an individual test, go back to the main menu and choose "Select Single tests." The "intro" and "understanding" programs also provide a good background on the tests.

Remember, this disc is intended to be a thorough test of real world scenarios, and the scores should vary widely depending upon the quality of the video processor. This method allows you to clearly and objectively separate the high performance units from the mediocre ones and determine if you are getting what you about to pay for.

TEST: COLOR BAR/VERTICAL DETAIL

Significance

The color bar pattern will show if the color hue and saturation controls are set properly and provide a means to evaluate the vertical resolution of the device.

Procedure

Before you begin testing, you may want to use this color bar pattern to double check the color fidelity of the image. This may be done by viewing this pattern through a blue filter. When color saturation is accurate, the white, blue, green, and red bars will have the same luminance level (dark). When color hue is accurate, the cyan and magenta bars will have the same luminance level (light).

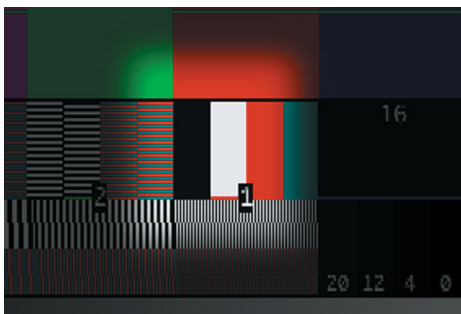
Now you are ready to test the vertical resolution. You will see varying degrees of detail in the alternating black-and-white bar pattern at marker "1". The more detail you see, the higher the quality of static de-interlacing that is being employed.

If these bar patterns flicker or are soft or missing you are not seeing the full vertical resolution possible in the source.

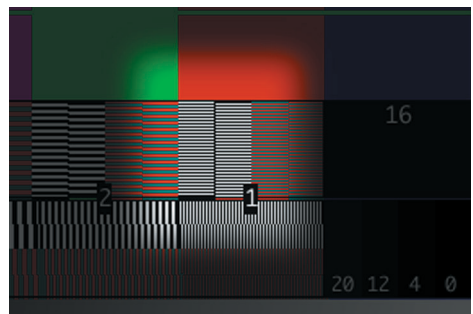
Simple de-interlacers will not preserve the full vertical resolution of still images. A stable image with image detail at "1" and correctly shaded colors gets a passing grade.

Scoring

- 10 IMAGE DETAIL IS SEEN AT MARKER "1", NO FLICKER IS OBSERVED
- 5 MINOR FLICKERING IS SEEN AT MARKER "1"
- 0 NO IMAGE DETAIL IS SEEN AT MARKER "1"



Score of 0



Score of 10

TEST: JAGGIES PATTERN 1

Significance

Interlaced video creates images with scan line artifacts. When video is de-interlaced for display, some of these artifacts may not be completely eliminated. As a result, diagonal lines may appear to have stepped edges. We call these artifacts 'jaggies' as they resemble a jagged edge.

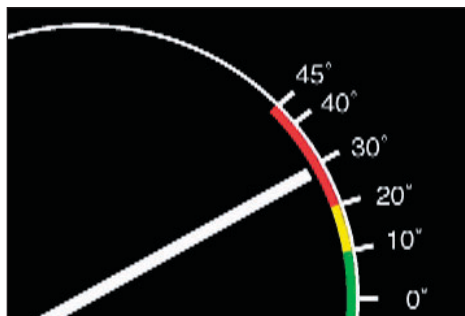
Both 480i standard definition and 1080i high definition video program formats are interlaced and thus produce images with these artifacts. (480p and 720p program formats do not.) They can be corrected with a good quality video processor. A technique called motion adaptive de-interlacing with directional interpolation is often employed to process these types of signals.

Procedure

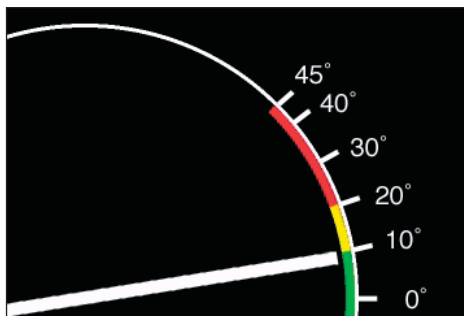
The slowly rotating line will appear smooth or jagged, depending on its angle. As the line passes through a 45-degree angle and then approaches 0 degrees (horizontal), you may see a jagged edge appear. The point at which you first notice this jagged edge shows just how well the processor is working – the closer the bar gets to 0 degrees without any noticeable 'jaggies', the better the motion adaptive de-interlacing. Motion adaptive de-interlacers are supposed to treat still areas differently from moving areas. The still "logo" portion of the image should be highly detailed and free of jaggies if the processor is truly motion adaptive.

Scoring

- 5 JAGGIES ARE NOT SEEN UNTIL THE BAR ENTERS THE GREEN AREA (< 10 DEGREES) AND THE LOGO IS FREE OF JAGGIES.
- 3 JAGGIES ARE NOT SEEN UNTIL THE BAR ENTERS THE YELLOW AREA (< 20 DEGREES) AND THE LOGO IS FREE OF JAGGIES.
- 0 JAGGIES ARE VISIBLE AS THE BAR ENTERS THE RED AREA (< 45 DEGREES) OR THE LOGO HAS JAGGIES.



Score of 0



Score of 5

TEST: JAGGIES PATTERN 2

Significance

Motion adaptive de-interlacing is just one step in cleaning up scan line artifacts. The video signal processor should also employ directional filtering to catch rapidly moving shapes that may change direction, speed, and angle.

Procedure

In the second jaggies test, you'll see a cluster of three equally spaced white bars of the same thickness, rapidly moving up and down between a 5-degree and 35-degree angle. If all three bars appear to have jagged edges at all times, the video processor does not use directional filtering to smooth the images. If all three bars are smooth throughout the test, the video processing earns a passing grade.

Scoring

- 5 ALL THREE BARS HAVE SMOOTH EDGES AT ALL TIMES
- 3 THE TOP TWO BARS HAVE SMOOTH EDGES, BUT THE BOTTOM BAR DOES NOT
- 1 ONLY THE TOP BAR HAS SMOOTH EDGES
- 0 NONE OF THE BARS HAVE SMOOTH EDGES



Score of 0



Score of 5

TEST: WAVING FLAG

Significance

Moving bars are a good way to evaluate the quality of motion adaptive de-interlacing and directional filtering, but the ideal test is to use a real-world object with rapidly moving lines at multiple, continuously shifting angles. The flag of the United States of America, with its 13 red and white stripes, is perfectly suited to this test.

Procedure

As the flag slowly furls and unfurls in the wind, the 13 bars create a natural jaggies test, much like our Jaggies #2 pattern. The cleaner the edges of the red and white bars appear, the higher the quality of motion adaptive de-interlacing in use. Some lower-cost processors intentionally blur the image to mask scan line artifacts they can't clean up, so pay attention also to background sharpness in this test!

Scoring

- 10 JAGGED EDGES ARE NOT SEEN IN THE RED AND WHITE BARS, AND THE FLAG EXHIBITS FINE DETAIL
- 5 SOME JAGGED EDGES ARE SEEN, AND/OR THE BACKGROUND APPEARS SOFT
- 0 JAGGED EDGES ARE QUITE APPARENT ALONG EDGES OF THE BARS



Score of 0



Score of 10

TEST: PICTURE DETAIL

Significance

Even though high definition television is growing in popularity, the majority of TV programs are still delivered as standard definition television. An HDTV set will use some sort of image processing to scale up this SDTV content and convert it to 'pseudo' HDTV. However, many of these processors employ low-quality detail enhancement circuitry that degrades the converted images with "ringing" artifacts. These appear as artificially enhanced edges around objects, and often resemble faint white outlines.

Procedure

Turn on any detail enhancement option on your TV or monitor to the nominal setting ("Medium" or "On"). In this scene of a bridge with foreground auto traffic, check the level of detail in the bricks of the bridge, the statue, the stairs and the blades of grass in the lawn. If any of these areas appear too smooth or even blurred, your TV's or monitor's image detail processing is inadequate.

An effective image detail processor will preserve and reveal fine textures in the bricks, grass, and steps. The bricks next to the highlight arrow should be nearly as detailed as those on the left side of the bridge. Also, there should be no noise visible in the sky as a result of any image detail processing.

Scoring

- 10 THE STATUE, GRASS, STAIRS AND BRIDGE EXHIBIT FINE DETAIL, RESULTING IN A CRISP, REALISTIC IMAGE
- 5 FINE IMAGE DETAILS ARE SEEN, BUT EDGES SEEM EXCESSIVELY SHARPENED OR A FAINT WHITE OUTLINE RINGING APPEARS AROUND OBJECTS IN THE SCENE
- 0 THE OVERALL IMAGE APPEARS SOFT OR INTERLACED SCAN LINE ARTIFACTS ("JAGGIES") ARE OBSERVED IN THE STAIRS



Score of 0



Score of 10

TEST: NOISE REDUCTION

Significance

In the NTSC analog video system, noise can be created or inadvertently added to a program through capture, duplication and editing. This noise is especially evident when large areas of solid colors are present. Two problematic color shades are saturated blues, saturated reds, and shades of either color. Even digital video programs can suffer from noise, whether present in the actual content or introduced as a result of digital compression.

For this test, the scenes presented have been duplicated numerous times to introduce noise. A quality video processor will apply multiple axes of noise reduction to minimize these artifacts.*

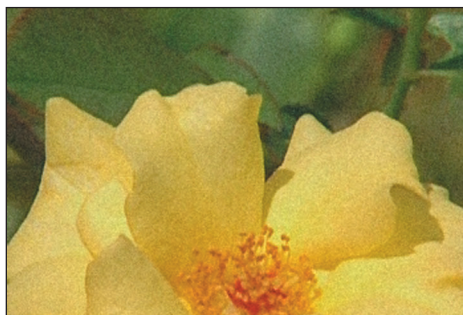
Procedure

Turn on any noise reduction controls on the device under test to the nominal setting ("Medium" or "On"). High quality noise reduction processing will minimize solid color noise while preserving image detail. You may need to turn the controls on and off to see the effect.

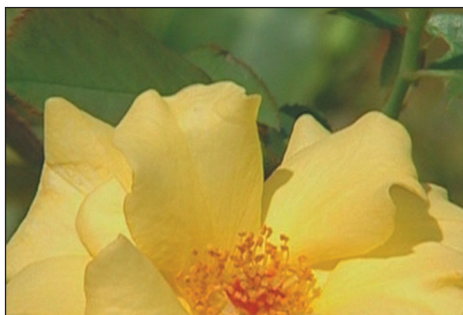
Scoring

- 10 THE LEVEL OF NOISE IS NOTICEABLY REDUCED WITHOUT LOSS OF IMAGE DETAIL
- 5 THE LEVEL OF NOISE IS REDUCED SOMEWHAT WHEN NOISE REDUCTION IS TURNED ON, OR IMAGE DETAIL IS REDUCED
- 0 THERE IS NO APPARENT REDUCTION IN NOISE AND/OR IMAGE DETAIL IS SIGNIFICANTLY REDUCED, OR THE TV OR MONITOR HAS NO NOISE REDUCTION FEATURE

* NOTE: If you are performing this test on a plasma TV or monitor, be advised that many of these products create a picture artifact that resembles random noise. It is known as false contouring and results from insufficient bit depth when sampling the incoming video signal. Artificial boundaries around objects of all sizes (i.e. false contours) may appear as noise on the screen, particularly in scenes with low luminance levels.



Score of 0



Score of 10

TEST: MOTION ADAPTIVE NOISE REDUCTION

Significance

Inferior noise reduction circuitry often confuses motion with random noise. As a result, too much noise reduction will be applied, resulting in image smearing or ghosting behind moving objects. Quality image processing will reduce noise without creating motion artifacts.

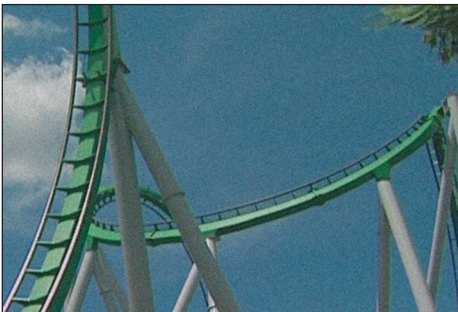
Procedure

Turn on any noise reduction controls on your TV or monitor to the nominal setting ("Medium" or "On"). Watch the clip of the roller coaster carefully to see if any noise appears in the deep blue sky or any smearing or blurring is apparent as the coaster moves through the scene.*

Scoring

- 10 THE SKY EXHIBITS LITTLE OR NO NOISE, IMAGE DETAIL IS SHARP AND CRISP, AND NO MOTION TRAILS OR SMEARING ARTIFACTS ARE OBSERVED
- 5 SOME NOISE IS EVIDENT IN THE SKY AND/OR THE IMAGE APPEARS SOFT; THE ROLLER COASTER APPEARS TO BE SLIGHTLY BLURRED
- 0 NOISE IS CLEARLY PRESENT IN THE SKY AND/OR MOTION TRAILS ARE VISIBLE BEHIND THE ROLLER COASTER AS THEY MOVE THROUGH THE SCENE

* NOTE: If you are performing this test on an LCD flat panel TV, you may see blurred motion even when a high-quality video processor is used. This is due to the inability of the TVs' liquid crystals to switch quickly enough and keep up with fast motion and is a common imaging problem with all sizes of flat panel LCD TVs.



Score of 0



Score of 10

TEST: 3:2 DETECTION

Significance

Although video programs are transmitted to your TV using one of two picture refresh rates - 30 frames per second, interlaced (30i) and 60 frames per second, progressive scan (60p) – the original program content may have vastly different refresh rates. For example, motion picture film is shot, edited, and screened with a picture refresh rate of 24 frames per second, progressive scan (24p).

To convert such programs for television, a conversion process is used to find a common mathematical relationship between the original program and the broadcast format in use. One common technique is called 3:2 pulldown. During this technique, one additional film frame is repeated in every fifth field of video – hence, the term “3:2”. A complete film-to-video sequence actually has a 2:3:2:3 pattern.

A quality video processing circuit will detect the extra frame and remove it to result in a smooth presentation of motion. However, the 3:2 sequences can be corrupted during digital editing, insertion of video effects and titles, digital compositing, and intercutting with animated sequences (which often have very different cadences).

Electronic editing is the most common source of discontinuities in the 3:2 sequence. If all edits started on the first, odd-numbered field of video (often called the ‘A’ frame), then the job of the 3:2 circuitry in your TV would be quite simple. However, when edits do not start on the ‘A’ frame, your 3:2 processor can lose count and must recapture the sequence.

Procedure

For this test, your TV’s progressive scan image or 3:2 cadence processor must be set in “Automatic” mode, not “Film Mode”. As you watch the test image, pay attention to detail in the rows of seats in the racetrack grandstand. In addition to smooth motion and image detail, observe how quickly the TV’s image processor picks up the 3:2 pattern.

No more than 5 frames (about .2 seconds) should pass before this happens, which is about the time it takes the racecar to reach the “HOMESTEAD” billboard on the wall along the track. If you see a strong moiré interference pattern in the grandstand, it is evidence that the processor has not correctly detected the image cadence.

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TEST: 3:2 DETECTION (CONTINUED)

Scoring

- 10 OVERALL SHARPNESS IS GOOD, NO MOIRÉ PATTERN IS SEEN, AND THE TV LOCKS INTO FILM MODE ALMOST INSTANTLY (NO MORE THAN 5 FRAMES OR ABOUT .2 SECONDS)
- 5 THE IMAGE LOOKS DETAILED AND MOTION IS SMOOTH, BUT MOIRÉ IS SEEN IN THE GRANDSTAND FOR UP TO ONE HALF SECOND (ABOUT 15 FRAMES) AS THE TV SWITCHES INTO FILM MODE
- 0 THE TV TAKES TOO LONG TO LOCK INTO FILM MODE OR DROPS IN AND OUT OF FILM MODE, AND A STRONG MOIRÉ PATTERN IS SEEN IN THE GRANDSTAND



Score of 0



Score of 10

TEST: FILM CADENCE

Significance

As mentioned in the previous section, program content for television is often created using different picture refresh rates and cadences. Here are some of the more common frame rates and cadences:

- Documentaries shot on high speed film use 30 frames per second frame rates resulting in a 2:2 cadence
- Professional DV camcorders and the new HDV models can capture video at a 24 fps rate for a film 'look', but employ a special cadence (either 2:2:2:4 or 2:3:3:2) for more efficient digital compression
- To allow more time for commercials, theatrical films shown on television are often sped-up or edited to remove 1 out of every 13 video fields after 3:2 pull-down has been applied, resulting in a cadence of 3:2:3:2:2.
- Animation is often rendered at 12fps. Two pull-down cadences can be used to convert this to the 30 fps broadcast standard. Doubling every frame, and then applying 3:2 pull-down to the resultant fields will generate a 5:5 cadence. Applying 3:2 pull-down to the frames (rather than the fields) will generate a 6:4 cadence.
- The Japanese 'Anime' format is often rendered at 8 fps. To convert this to 30 fps, each frame of animation is repeated three times, and then 3:2 conversion is performed for an effective cadence of 8:7.

Different film cadences may appear to strobe on TV sets, which is considered normal. You may see this strobing effect in movie theaters as well, but it usually isn't as apparent as on an interlaced display. If the video processor can't detect and lock onto all of these different sequences, the result will be half resolution images.

Procedure

The ability of a processor to detect and correct for a given film-to-video cadence affects image detail and may introduce scan line artifacts ("jaggies") as the video processor defaults to video mode. Observe the lines in the coffee cups and watch to see if they appear to jump or flicker, a sign of incorrect cadence detection resulting in half-resolution images. The text in the newspaper may also exhibit moiré and interlaced scan line artifacts.

Scoring (5 points for each cadence)

- 5 THE INDIVIDUAL TEST CADENCE IS PRESENTED SMOOTHLY WITH NO FLICKERING OR JAGGIES IN THE COFFEE CUPS, NO MOIRÉ IN THE NEWSPAPER, AND NO LOSS OF RESOLUTION
- 0 ANY OF THE ABOVE ARTIFACTS APPEAR DURING ANY INDIVIDUAL TEST CADENCES



Score of 0



Score of 5

TEST: MIXED 3:2 FILM WITH ADDED VIDEO TITLES

Significance

Filmed content edited electronically for video can introduce additional problems for a video processor. 30 fps video elements, such as title crawls and scene transitions, may confuse the processor as it tries to detect and hold a 3:2 sequence, preserving the smooth motion of 24 fps film.

A worst-case scenario is when a movie is transferred to video for broadcast or distribution on DVD and an entirely new electronic end title sequence is created. The best video processors will be able to distinguish between film and video content, converting different parts of the image of a per-pixel basis.

Procedure

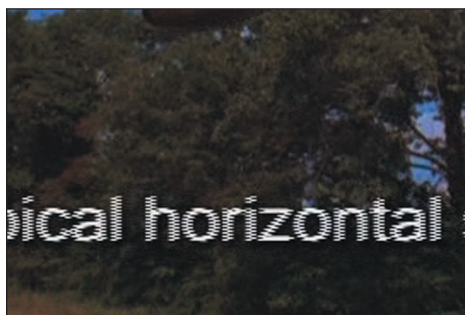
Look closely at the various filmed scenes to see if image detail is preserved while electronic titles crawl across and up the screen. Are diagonal lines smooth, or jagged? Is the title crawl text smooth and crisp, or does it appear soft and degraded?

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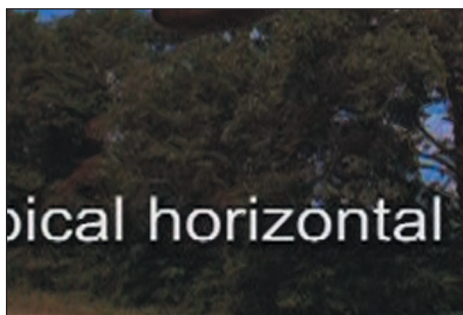
TEST: MIXED 3:2 FILM WITH ADDED VIDEO TITLES (CONTINUED)

Scoring - Horizontal Text Crawl

- 10 THE TEXT IS CRISP, THE CRAWL IS SMOOTH, AND THE BACKGROUND IMAGE EXHIBITS EXCELLENT DETAIL WITHOUT SCAN LINE ARTIFACTS ("JAGGIES")
- 5 THE CRAWLING TEXT IS SMOOTH AND CRISP, BUT THE BACKGROUND IMAGES HAVE NOTICEABLE SCAN LINE ARTIFACTS
- 0 THE CRAWLING TEXT EXHIBITS NOTICEABLE TEARING OR COMBING



Score of 0



Score of 10

Scoring - Vertical Text Scroll

- 10 THE CREDIT SEQUENCE TEXT MOVES SMOOTHLY UP THE SCREEN, THE TEXT IS SHARP AND CRISP, AND THE BACKGROUND IMAGE EXHIBITS EXCELLENT DETAIL WITHOUT SCAN LINE ARTIFACTS ("JAGGIES")
- 5 THE SCROLLING TEXT IS SMOOTH AND CRISP, BUT THE BACKGROUND IMAGES HAVE NOTICEABLE SCAN LINE ARTIFACTS
- 0 THE SCROLLING TEXT EXHIBITS NOTICEABLE TEARING OR COMBING



Score of 0



Score of 10

SCORE	TEST	SCORING DESCRIPTION
	Color Bar/ Vertical Detail	10 IMAGE DETAIL IS SEEN AT MARKER "1", NO FLICKER IS OBSERVED 5 MINOR FLICKERING IS SEEN AT MARKER "1" 0 NO IMAGE DETAIL IS SEEN AT MARKER "1"
	Jaggies Pattern 1	5 JAGGIES ARE NOT SEEN UNTIL THE BAR ENTERS THE GREEN AREA (< 10 DEGREES) AND THE LOGO IS FREE OF JAGGIES. 3 JAGGIES ARE NOT SEEN UNTIL THE BAR ENTERS THE YELLOW AREA (< 20 DEGREES) AND THE LOGO IS FREE OF JAGGIES. 0 JAGGIES ARE VISIBLE AS THE BAR ENTERS THE RED AREA (< 45 DEGREES) OR THE LOGO HAS JAGGIES.
	Jaggies Pattern 2	5 ALL THREE BARS HAVE SMOOTH EDGES AT ALL TIMES 3 THE TOP TWO BARS HAVE SMOOTH EDGES, BUT THE BOTTOM BAR DOES NOT 1 ONLY THE TOP BAR HAS SMOOTH EDGES 0 NONE OF THE BARS HAVE SMOOTH EDGES
	Flag	10 JAGGED EDGES ARE NOT SEEN IN THE RED AND WHITE BARS, AND THE FLAG EXHIBITS FINE DETAIL 5 SOME JAGGED EDGES ARE SEEN, AND/OR THE BACKGROUND APPEARS SOFT 0 JAGGED EDGES ARE QUITE APPARENT ALONG EDGES OF THE BARS
	Picture Detail	10 THE STATUE, GRASS, STAIRS AND BRIDGE EXHIBIT FINE DETAIL, RESULTING IN A CRISP, REALISTIC IMAGE 5 FINE IMAGE DETAILS ARE SEEN, BUT EDGES SEEM EXCESSIVELY SHARPENED OR A FAINT WHITE OUTLINE RINGING APPEARS AROUND OBJECTS IN THE SCENE 0 THE OVERALL IMAGE APPEARS SOFT OR INTERLACED SCAN LINE ARTIFACTS ("JAGGIES") ARE OBSERVED IN THE STAIRS
	Noise Reduction	10 THE LEVEL OF NOISE IS NOTICEABLY REDUCED WITHOUT LOSS OF IMAGE DETAIL 5 THE LEVEL OF NOISE IS REDUCED SOMEWHAT WHEN NOISE REDUCTION IS TURNED ON, OR IMAGE DETAIL IS REDUCED 0 THERE IS NO APPARENT REDUCTION IN NOISE AND/OR IMAGE DETAIL IS SIGNIFICANTLY REDUCED, OR THE TV OR MONITOR HAS NO NOISE REDUCTION FEATURE
	Motion Adaptive Noise Reduction	10 THE SKY EXHIBITS LITTLE OR NO NOISE, IMAGE DETAIL IS SHARP AND CRISP, AND NO MOTION TRAILS OR SMEARING ARTIFACTS ARE OBSERVED 5 SOME NOISE IS EVIDENT IN THE SKY AND/OR THE IMAGE APPEARS SOFT; THE ROLLER COASTER APPEARS TO BE SLIGHTLY BLURRED 0 NOISE IS CLEARLY PRESENT IN THE SKY AND/OR MOTION TRAILS ARE VISIBLE BEHIND THE ROLLER COASTER AS THEY MOVE THROUGH THE SCENE
	3:2 Detection	10 OVERALL SHARPNESS IS GOOD, NO MOIRÉ PATTERN IS SEEN, AND THE TV LOCKS INTO FILM MODE ALMOST INSTANTLY (NO MORE THAN 5 FRAMES OR ABOUT .2 SECONDS) 5 THE IMAGE LOOKS DETAILED AND MOTION IS SMOOTH, BUT MOIRÉ IS SEEN IN THE GRANDSTAND FOR UP TO ONE HALF SECOND (ABOUT 15 FRAMES) AS THE TV SWITCHES INTO FILM MODE 0 THE TV TAKES TOO LONG TO LOCK INTO FILM MODE OR DROPS IN AND OUT OF FILM MODE, AND A STRONG MOIRÉ PATTERN IS SEEN IN THE GRANDSTAND
	Film Cadence ← TOTAL OF ALL EIGHT CADENCES	5 THE INDIVIDUAL TEST CADENCE IS PRESENTED SMOOTHLY WITH NO FLICKERING OR JAGGIES IN THE COFFEE CUPS, NO MOIRÉ IN THE NEWSPAPER, AND NO LOSS OF RESOLUTION 0 ANY OF THE ABOVE ARTIFACTS APPEAR DURING ANY INDIVIDUAL TEST CADENCES (5 POINTS / SUCCESSFUL CADENCE) 2:2 : _____ 2:2:2:4 : _____ 2:3:3:2 : _____ 3:2:3:2:2 : _____ 5:5 : _____ 6:4 : _____ 8:7 : _____ 3:2 : _____
	Mixed 3:2 Film Mixed With Added Video Titles • Horizontal Text Crawl	10 THE TEXT IS CRISP, THE CRAWL IS SMOOTH, AND THE BACKGROUND IMAGE EXHIBITS EXCELLENT DETAIL WITHOUT SCAN LINE ARTIFACTS ("JAGGIES") 5 THE CRAWLING TEXT IS SMOOTH AND CRISP, BUT THE BACKGROUND IMAGES HAVE NOTICEABLE SCAN LINE ARTIFACTS 0 THE CRAWLING TEXT EXHIBITS NOTICEABLE TEARING OR COMBING
	Mixed 3:2 Film Mixed With Added Video Titles • Vertical Text Crawl	10 THE CREDIT SEQUENCE TEXT MOVES SMOOTHLY UP THE SCREEN, THE TEXT IS SHARP AND CRISP, AND THE BACKGROUND IMAGE EXHIBITS EXCELLENT DETAIL WITHOUT SCAN LINE ARTIFACTS ("JAGGIES") 5 THE SCROLLING TEXT IS SMOOTH AND CRISP, BUT THE BACKGROUND IMAGES HAVE NOTICEABLE SCAN LINE ARTIFACTS 0 THE SCROLLING TEXT EXHIBITS NOTICEABLE TEARING OR COMBING
	TOTAL (MAXIMUM SCORE: 130)	

