ASC NEXT GENERATION CINEMA DISPLAY

CINEMA DISPLAY EVALUATION PLAN & TEST PROTOCOL

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This document was produced by the Next Generation Cinema Display (NGCD) subcommittee of the ASC Technology Committee. The ASC Technology Committee is chaired by Curtis Clark, ASC. The NGCD subcommittee is co-chaired by Michael Karagosian, Eric Rodli, and Steve Schklair.

1 OBJECTIVE

As higher performance cinema projectors and active screens emerge, it is important to identify where value is created from the filmmakers's point-of-view, independent of the technology. The Cinema Display Evaluation Plan and Test Protocol represents the first step towards this goal, defining a method for the visual evaluation of parameters that characterize next generation cinema projection and active screens.

The parameters chosen for this test are ones which have a major impact on image quality, centering on deeper blacks, practical primaries for wider color gamut, effective contrast ratios, and optimal peak white levels for high dynamic range cinema.

Phase One of this work will focus on understanding how different parameter values impact the perception of image quality, establishing a baseline for further testing. The output of this work will be a report, described further in Section 4.7

Phase Two of this work will target an optimized version of the test protocol utilizing licensable content for use by technology providers and other stakeholders worldwide. The Phase Two work may include the influence of frame rate with brighter images, but this will not be included in Phase One. This document is only concerned with Phase One.

2 TERMINOLOGY

2.1 Luminance

Describes the amount of light that is emitted or reflected from the screen. Measured in candela per square meter (cd/m2), sometimes referred to as "nits."

2.2 Brightness

An attribute of visual perception in which a source appears to emit a given amount of light. This is not measureable in the common sense and should not be confused with luminance.

2.3 Peak White

The greatest achievable white luminance as measured from the Small White Patch Test Pattern, Section 5.2.1 Chart #1.

2.4 Display White

The highest achievable modulated white on a projected image or display.

2.5 Dynamic Range

The ratio of maximum to minimum luminance of the projection system or display.

2.6 Sequential Contrast

The ratio of the separately measured whitest white to darkest dark of the projected image or display.

2.7 Simultaneous Contrast

The ratio of the measured whitest white to darkest dark of the projected image or display using the Multipoint Contrast Test Pattern, Section 5.2.1 Chart #29.

2.8 Color Gamut

Defined by white point, color primary locations and the black point. Color gamuts in use today include Rec. 709, DCI P3, and Rec. 2020. In this document, the term "near Rec. 2020" means within a to-be-determined tolerance of the Rec. 2020 color gamut. (A visual representation of a chromaticity diagram gamut is provided in Annex A.)

2.9 Pointer's Gamut

The color gamut of reflected surface colors found in nature, published by Michael R. Pointer in 1980. (http://onlinelibrary.wiley.com/doi/10.1002/col.5080050308/abstract) The Rec. 2020 gamut covers Pointer's gamut. The DCI P3 gamut covers most of Pointer's gamut, but is lacking in cyan. (A visual representation of gamut is provided in Annex A.)

2.10 Display Black

The lowest achievable modulated black on a projected image or display.

2.11 Signal Black

The lowest code value representing a black pixel.

2.12 Mid-Grey Reflectance

An average mid-grey in an exposed scene. (Nominally 18%, as applied in the test charts of Section 5.2).

2.13 Mid-Grey Display Reference Point

The chosen display luminance of a mid-grey reflectance. [In the film system, this was nominally equivalent to a Visual Density of 1.0 as displayed: 4.8 nits for normal cinema (10% of 48 nits center luminance per SMPTE ST431-1); 10 nits for normal video (10% of 100 nits per section 4.3 of ST 2080-1 "Television: Reference White Luminance Level and Chromaticity for HDTV").]

3 OVERVIEW

3.1 Test Premise

The test is designed to examine the visual "value" of performance parameters for a next generation cinema platform. Images will be mastered such that visual characteristics meet the test set of parameters, and then compared for a noticeable difference in quality as perceived by a group of professionals. The test must include motion picture content.

3.2 Test Overview

The test is designed to subjectively determine the comparative creative value of the parameters as set forth in the test matrix. A group of expert creatives will be the test subjects.

A series of test images, including still images, dynamic scenes and adjacent scenes at different parameter levels, will be employed. The image characteristics required by the test matrix will be either "baked in" to the content through the application of limits in post-production, or through adjustment of the characteristics of a capable projector. The preferred method is to apply limits to the content during post-production.

Once produced, the test content image characteristics will be measured and documented. Test patterns will be measured as seen onscreen to establish what viewers actually see.

Preferably, all tests will be conducted in a single facility to eliminate any differential impact on measurements due to environmental factors. The test facility will also be measured for room ambient light level and reflection from the screen.

3.3 Recommended Parameters for Testing

The Study Group recommends the following initial ranges of test parameters, based on a balance of performance and current understanding of manufacturing feasibility, the desire to cover Pointer's gamut, and mindful of the performance of Kodak 2393 Vision Premier film print. The values in the charts below represent an initial hypothesis of visually significant parameters. Higher values for parameters may be included if preliminary testing suggests strong preferences and the projection technology, screen size, and achievable contrast allow it.

Parameters for Test Matrix

Peak Luminance (48 nits current DCI)		
Low	**Medium**	**High**
48	100	200

Contrast (2000:1 current DCI)		
Low	**Medium**	**High**
5000:1	10000:1	20000:1

Color Gamut (P3 current DCI)
P3
Near Rec 2020

Black Luminance Calculation

	Peak Luminance		
	48	100	200
Dynamic Range	**Black (nits)**		
2000	0.024	0.050	0.100
5000	0.0096	0.020	0.040
10000	0.0048	0.010	0.020
20000	0.0024	0.005	0.010

Note: greyed boxes may not be included in test parameters

Functional Parameters

Frame Rate	24fps
Image Resolution	4K (2k If only version available)
Format	2D Only

4 TEST PLAN

4.1 Venue

A theatre or lab with the capability to manage the variables described in Section 4.2, with:

a. Screen size at least 20' wide.
b. White screen-matte ideal (gain = 1.0), but can consider higher gain, "real world" screens.
c. Seating for an adequate number of observers within the range of 1.5 to 3.5 screen heights
d. Uniformity of light onscreen must meet or exceed the Review Room percentages of SMPTE ST431-1 Table 1.

4.2 Room Characterization

a. Ambient Reflection from environment measured off the screen, measured with projector "off" – room lighting controllable so that 1/10,000 to 1/50,000 of peak brightness can be achieved.
b. Room Reflection Ratio - light originating on screen and redirected back to the screen by the room.

4.3 Projector Characterization

a. Measure projector using all of the test content in Section 5.2
b. Set Screen Luminance – controllable from 48 nits to 200 nits peak.
c. Calculate Sequential Contrast controllable in "projected only" image from 2000:1 to 20,000:1.
d. Plot Color Chromaticities (examine projector capable of "near Rec 2020" – the actual gamut of the image content will be managed in the digital file.)

4.4 Content Composition (see Section 5.0)

a. Collect scenes, images, and secure permissions and testing licenses as needed.
b. Motion scenes exercising dark and bright scene cuts with large luminance variation.
c. Colorful scenes examining dark and bright colors.
d. Motion scenes with contrast test patches embedded for measurement.
e. Test images created as needed.

4.5 Content Mastering

a. Master content for each of the test matrix parameters.
b. Measure and record actual test matrix parameters of test patterns.
c. Evaluate performance and note interaction of parameters throughout the color grading process.

4.6 Review

a. Conduct evaluation in an Interactive fashion, where expert viewers assemble and discuss what they see as it is happening.
b. Assess the visual value and diminishing returns with varying parameters.
c. Comparison of images where needed to show a noticeable difference in image quality.

4.7 Report

a. Recommend numbers for luminance and dynamic range, with adequate review as to how the recommendation was reached.
b. Recommend a practical “near Rec 2020” color gamut, with adequate review as to how the recommendation was reached. Variational testing of different primaries may be considered in Phase 2.
c. Summarize viewer preferences and effects on the Phase 2 Test Plan

5 TEST CONTENT

5.1 MOTION PICTURE CONTENT

A suite of motion picture test content is envisioned to test the creative potential of visual performance parameters. The content would be tested with a color grading suite in-line. Ideally, an expert colorist will grade files for a small set of parameters defined in the test plan, eg., 100 nits, 5:000:1 contrast, P3 color gamut, and 200 nits, 10:000:1 contrast, "near Rec 2020" color gamut.

To the extent possible, the test content should have the characteristics described in this section.

5.1.1 Capture Technologies

Film, 35mm and 65mm Kodak Vision 3
Digital (for new material, high quality digital sources preferred such as Red Weapon, Sony F65, ARRI Alexa 65, or Panavision 4K)

5.1.2 Scene Types

Live Action
VFX Intensive
Animation

5.1.3 Technical Aspects

Native 4K resolution preferred (2K resolution if the only version available)
16 bit OpenEXR or TIFF files (ACES encouraged)
10 bit or 16-bit DPX files
2D (only in Phase One)

5.1.4 Visual Attributes

It is desirable that scene content contain the following characteristics:

Large dynamic range in single frame: e.g. inside dark room with bright daylight outside window
Very dark scene with low-level detail
Bright outdoor scene with highlight detail
Rapidly changing scenes, bright to dark with detail
Low contrast scene: e.g. gray cat in gray fog
Skin tones: e.g. beauty shots
Bright saturated colors with possibility of extending beyond P3 gamut
Dark saturated colors

5.1.5 Creative & Business Considerations

Viewers include trained image evaluators, including respected and recognized cinematographers, colorists, directors, and representatives of the major studios.

5.1.6 Representative Examples of Content for Viewing

Visual Characteristics	Title	Source	Technical	Creative/Business
Bright Whites	Oblivion	Sony F65	4K DI	Dist: Universal Dir: Joseph Kosinski DP: Claudio Miranda
Dark Scenes	Se7en	Film		Dist: New Line DP: David Ficher DP: Darius Khondji
Daytime snow with dark horses & stage coach Interior cabin at night with furs, leathers & wood details	The Hateful Eight	65mm Vision 3	Ultra 70mm Panavision prints available	Dist. Weinstein Dir. Tarantino DP. Robert Richardson
Night exchange on bridge Interior hangar with view to runway	Bridge of Spies	35mm Vision 3	4K DI	Dist. Fox/Prod. Amblin & SKG Dir. Spielberg DP. Janusz Kaminski
Heavy VFX and Color combinations	Captain America/ Guardians of tbe Galaxy	Alexa & VFX	2K DI	Dist. Disney/Prod. Marvel Dir. Russo Bros/James Gunn DP. Trent Opaloch/Ben Davis
Wide variety of colors	Kung Fu Panda 3	Animation	2D & 3D?	Dist. Fox/Prod. Dreamworks Exec. Jeffrey Katzenberg
Wide color gamut possibility:	Alice Through the Looking Glass	Alexa, F65	2K DI	Dist. Disney/Prod Tim Burton Dir. James Bobin DP Stuart Dryburgh
Dark saturated colors: Night scene, gold evening dress, cyan highlights	Mission: Impossible-Rogue Nation	Alexa 65 & 35mm		Dist: Paramount/Prod. Bad Robot Dir. Chris McQuarrie DP. Robert Elswit
Bright outdoor scenes. Vivid blues, golds	Mad Max: Fury Road	Alexa	2K DI	Dist. Warner Bros Dir. George Miller DP. John Seale
Ultra realism? Daytime walk across the wire	The Walk	Red Epic Dragon	6K digital source 3D?	Dist. Sony Dir. Robert Zemeckis DP. Darius Wolski
Soft contrast, rapidly changing light, high contrast detail	The Revenant	Alexa 65, AlexaM	4K DI	Dist. Fox Dir. Alexandro Inarritu DP. Emmanuel Lubezki
Beauty shots, skin tones, subtle color rendition	Fifty Shades of Grey	Alexa	2K	Dist. Universal Dir. Sam Taylor-Johnson DP. Seamus McGarvey
HFR (phase 2)	Academy NGCT	Alexa, F65	2K & 4K	AMPAS Test

5.2 TEST PATTERNS

The purpose of the test pattern suite is to characterize by measurement the projector or display used in testing. This includes the evaluation of color and luminance linearity, color fidelity performance, and contrast. This custom test suite is designed for three-component RGB testing and is not intended to evaluate spatial processing.

A 'small' patch size refers to a small circle less than 3 degrees of visual angle, as seen by the measurement meter, covering at least the 1 degree measurement circle of most meters.

5.2.1 Test Chart List and Descriptions

Chart Number	Description
#1	Peak white, small patch
#2 - #14	Grey series / small patches
#15	Full Frame Black (Signal Black)
#15 -#21	R,G,B,Y,C,M / full signal colors, small patches
#22 - #28	Dark Colors R,G,B,Y,C,M / 5% of signal colors, small patches
#29	Multipoint Contrast: black and white
#30	Ring Contrast: black and white
#31-37	Shadow Contrast Series

Charts #1-#21 will be consistent with those described in Annex A of SMPTE RP431-2 Reference Projector. Grey and Black Measurements should include chromaticity.

Charts #22 - #28, Dark Colors, will be similar to #15-#21 but at a level of output luminance that is 5% of the peak luminance of the color.

Chart #29, Multipoint Contrast, is intended to replace the use of ANSI Contrast charts. It includes a series of black and white dots throughout the frame that are the measurement points. The test charts may be used to calculate uniformity and the overall simultaneous contrast in a frame.

Chart #30, Ring Contrast, consists of a ring of peak white on black, and should produce a consistent and measurable flare luminance at the center of the frame. The ring is 132 pixels wide having a radius of 1040 pixels, in a 4K frame. (1040 pixels radius x 132 pixels will produce 1% of the frame brightness at the center if the flare is high.)

Charts #31-#37, Shadow Contrast Series, are similar to the Multipoint Contrast Chart but with partial greys down to 0.01 % peak luminance in place of a white patch (e.g. 18%, 10%, 5%, 2%, 1%, 0.5%, 0.01%).

5.2.2 Measurement Setup and Process

The measurement device should be aligned with the center of the screen and should be capable of dark readings. (i.e. a photometer or spectroradiometer.

6 CONTRIBUTORS

This document was prepared by the NGCD Study Group, a subgroup of the ASC Technology Subcommittee on Next Generation Cinema Display, whose members are:

Matt Cowan
Jim Houston
Michael Karagosian
Loren Nielsen
Eric Rodli

7 ANNEX A

7.1 Color Gamuts

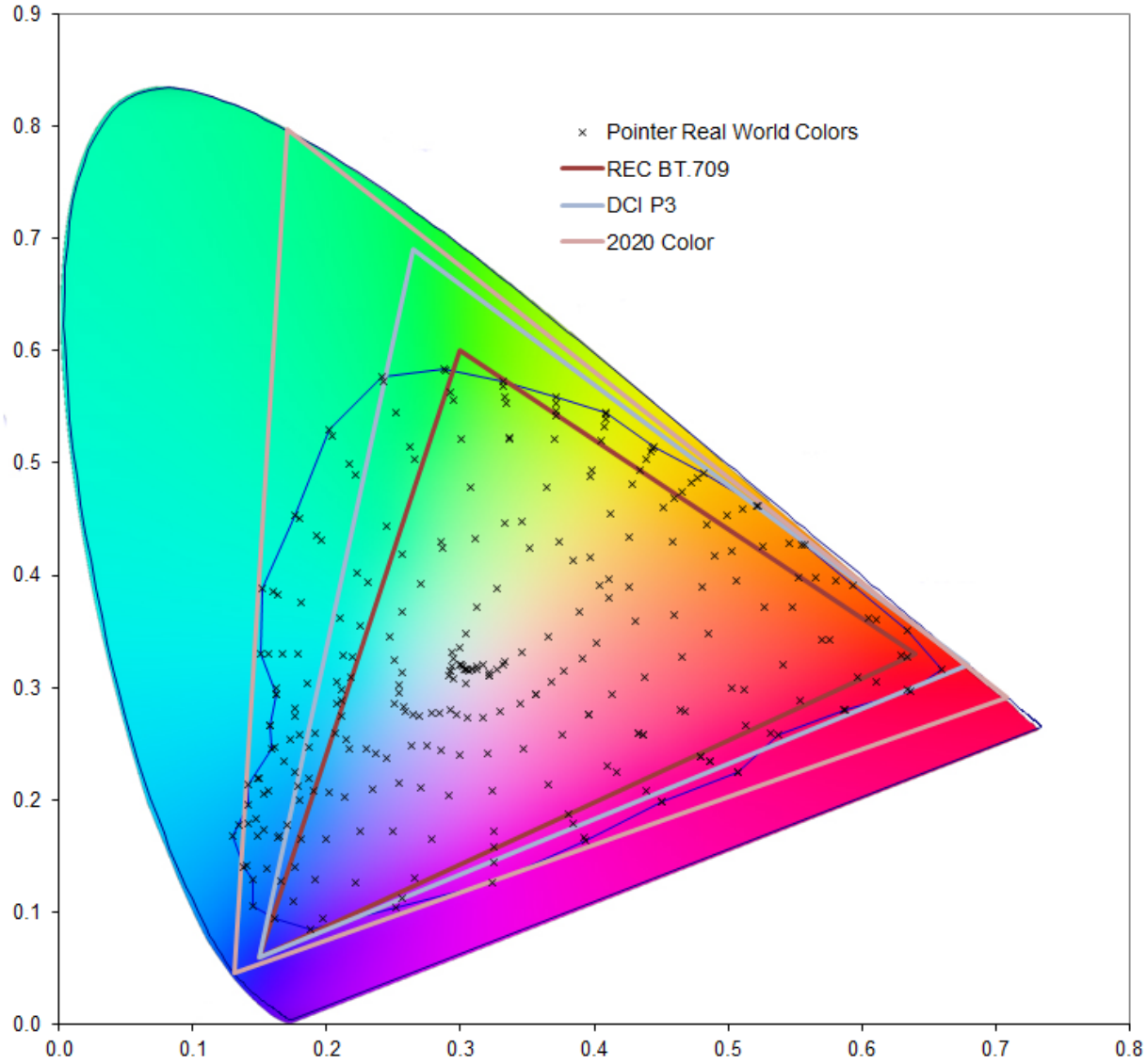

Figure 1: Color Gamuts of current "standards", and the Pointer Real World surface colors.

Source: Matt Cowan, ETC