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ACES Output Transform User Guide

The Academy of Motion Picture Arts and Sciences Science and Technology Council Academy Color Encoding System (ACES) Project Committee

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Summary: The Academy Color Encoding System (ACES) includes a variety of Output Transforms intended to support a wide range of display devices. These devices include standard dynamic range digital cinema projectors, broadcast monitors, computer desktop displays, and high dynamic range displays. Each of these devices may be configured differently and requires an ACES output transforms be used based on the specifics of the configuration. This document is intended to be practical guide help end-users determine the proper ACES output transform to be used based on their devices, configurations, and workflows.

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Related Academy Documents

Document Name	Description

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Introduction

ACES 1.0 includes thirteen Output Transforms that can be broadly characterized as applying to four different display types used in various configurations. (Table 1) The display types include digital cinema projectors typically used in digital intermediate, motion picture mastering, and theatrical exhibition, standard dynamic range (SDR) broadcast displays used in editorial and on-set preview applications, high dynamic range (HDR) broadcast displays used in mastering an exhibition of HDR content, and computer desktop monitors such as those typically used in the creation of computer generated visual effects (VFX).

Output Transform (Short Name)	Display Type
ACES 1.0 Output - P3-DCI	Digital Cinema Projector (SDR)
ACES 1.0 Output - P3-D60	Digital Cinema Projector (SDR)
ACES 1.0 Output - DCDM	Digital Cinema Projector (SDR)
ACES 1.0 Output - DCDM (P3 gamut clip)	Digital Cinema Projector (SDR)
ACES 1.0 Output - Rec.709	SDR Broadcast Monitor
ACES 1.0 Output - Rec.709 (D60 sim.)	SDR Broadcast Monitor
ACES 1.0 Output - Rec.2020	SDR Broadcast Monitor
ACES 1.0 Output - P3-D60 ST2084 (1000 nits)	HDR Broadcast Monitor
ACES 1.0 Output - P3-D60 ST2084 (2000 nits)	HDR Broadcast Monitor
ACES 1.0 Output - P3-D60 ST2084 (4000 nits)	HDR Broadcast Monitor
ACES 1.0 Output - Rec.2020 ST2084 (1000 nits)	HDR Broadcast Monitor
ACES 1.0 Output - sRGB	Desktop Computer Display
ACES 1.0 Output - sRGB (D60 sim.)	Desktop Computer Display

 Table 1 – ACES 1.0 Output Transforms and Display Types

The output device to be used with any particular device depends on the detailed configuration of that device. This document is intended to be practical guide help end-users determine the proper ACES output transform to be used the configuration, workflow, and intended usage. This document is intended to cover a series of common use cases. There may be valid uses of the ACES output transforms that fall outside of the scope of this document.

1 References

The following standards, specifications, articles, presentations, and texts are referenced in this text:

SMPTE ST 2065-1:2012, Academy Color Encoding Specification (ACES)

SMPTE ST 2084:2014, Dynamic Range Electro-Optical Transfer Function of Mastering Reference Displays

ITU-R Rec. BT.1886, Reference electro-optical transfer function for flat panel displays used in HDTV studio production

ITU-R Rec. BT.2020, Parameter values for ultra-high definition television systems for production and international programme exchange

ITU-R Rec. BT.2100, Image parameter values for high dynamic range television for use in production and international programme exchange

2 Output Transform Applications

2.1 Theatrical Digital Intermediate (P3-DCI Calibrated Projector)

2.1.1 Summary

It is common in the digital intermediate process (DI) to color correct motion pictures and episodic television shows while displaying the images using a DCI compliant digital cinema projector. DCI compliant digital cinema projectors have a simplified setup using a projector configuration file (PCF) that contains all the relevant projector settings and can often be loaded at the press of a button. The most common PCF used in motion picture and television production is the "DCI-P3" PCF. Using this PCF, the projector will be configured such that equal red, green, and blue projector code values will produce the chromaticity x=0.3140 y=0.3510 on the screen. With the projector configured in this manner it is recommended that the ACES 1.0 ODT with the transformID ODT.Academy.P3DCI_48nits.al.0.3 be used.

2.1.2 Projector Setup

Parameter	Setting
PCF	DCI-P3 (RGB 4:4:4 Full Range, P3 Primaries, DCI white point, 48 nit max Luminance)
Viewing Environment	Dark
Bit Depth	12-bit

Table 2 – P3-DCI Projector Setup

2.1.3 Best ODT for application

Simple Name	TransformID
ACES 1.0 Output - P3-DCI	ODT.Academy.P3DCI_48nits.a1.0.3

Table 3 – P3-DCI Best ODT

2.1.4 Notes

Using the "DCI-P3" PCF, the projector will be configured such that equal red, green, and blue display code values will produce the chromaticity x=0.3140 y=0.3510 on the screen. However, the ODT.Academy.P3 DCI_48nits.al.0.3 transform is configured such that neutral ACES source file values (ACES R=G=B) will produce non-equal projector code values. The chromaticity of produced on screen by those non-equal projector code values will be x=0.32168 y=0.33767 (aka D60).

It's important to note that the image on projection screen may look distinctly less green then some workflows that utilize a projector setup with the "DCI-P3" PCF. This will also be reflected on the color corrector scopes when neutral ACES values sent through the ODT.Academy.P3DCI_48nits.al.0.3 transform. (Figure 1a, 1b, 1c, 1d, 1e) For instance, neutral ACES values processed through ODT.Academy.P3DCI_48nits.al.0.3 transform. (Figure 1a, 0.3 will not have equal levels on the waveform, nor will they land in the middle of the vector scope. This behavior was intentional. The image may also have a distinctly magenta cast on a computer monitor such as the one used for the color corrector user interface if that monitor is calibrated to a D65 white point. (Figure 1f) Although not noted in the name of this ODT, the mimics the behavior found in other ODTs included in ACES 1.0 and labeled "D60 sim". Due to this "D60 sim" behavior the maximum output screen luminance of neutral ACES values will be slightly less than the maximum luminance produced by projector code values red = 1, green = 1, blue = 1 (e.g. 48 nits).

When using the correct projector setup and corresponding ODT, the image on the projector screen will match nearly exactly in Application 2.1 and Application 2.2.







Figure 1 - ODT. Academy. P3DCI_48nits.a1.0.3 Scope Screenshots

2.1.5 **Test Values**

Table 4 contains test values can be used to confirm the proper monitor setup and ODT combination. Each of the 9 ACES RGB input values should yield the RGB noted display RGB code values (normalized 0-1, full range) when processed through the ODT.Academy.P3DCI_48nits.al.0.3. When driving a properly setup display with the noted display RGB code values, the light from the display should measure with the noted CIE xyY colorimetry.

If the display RGB code values do not match those in the table when using the corresponding input ACES RGB code values, it is likely the wrong ODT is being used. If the proper display RGB code values are being produced by the ODT, but he measured display colorimetry doesn't match the display xyY code values noted, it is likely the display setup is incorrect.

Patch	ACES RGB			Display RGB			Display xyY		
N1	1.8233	1.8233	1.8233	0.9243	0.8651	0.9013	0.3217	0.3377	34.4858
N2	0.2753	0.2753	0.2753	0.5383	0.5038	0.5249	0.3217	0.3377	8.4552
N3	0.0898	0.0898	0.0898	0.2804	0.2625	0.2734	0.3217	0.3377	1.5514
R	0.4689	0.1193	0.0417	0.8046	0.2227	0.1795	0.6413	0.3307	6.4488
G	0.339	0.8068	0.0936	0.4335	0.8036	0.2434	0.3046	0.624	20.8422
В	0.2162	0.133	0.8711	0.1707	0.1503	0.8215	0.1562	0.0692	2.3365
С	0.5187	0.9138	1.0432	0.4332	0.8028	0.8406	0.2269	0.3404	22.8164
М	0.58	0.2096	0.9086	0.808	0.2134	0.8294	0.333	0.1596	8.4349
Y	0.8237	0.9378	0.0855	0.8654	0.8096	0.2487	0.4338	0.5187	26.9923

Table 4 - ODT.Academy.P3DCI_48nits.a1.0.3 Test Values

2.2 Theatrical Digital Intermediate (P3-D60 Calibrated Projector)

2.2.1 Summary

It is common in the digital intermediate process (DI) to color correct motion pictures and episodic television shows while displaying the images using a DCI compliant digital cinema projector. DCI compliant digital cinema projectors have a simplified setup using a projector configuration file (PCF) that contains all the relevant projector settings and can often be loaded at the press of a button. The recommended PCF to be used with digital cinema projectors and ACES-based workflows is the "P3-D60" PCF (add link). Using this PCF, the projector will be configured such that equal red, green, and blue projector code values will produce the chromaticity x=0.32168 = 0.33767 (aka D60). With the projector configured in this manner it is recommended that ACES ODT with the transformID ODT.Academy.P3D60_48nits.al.0.3 be used.

2.2.2 Projector Setup

Parameter	Setting
PCF	P3D60(RGB 4:4:4 Full Range, P3 Primaries, D60 white point, 48 nit max Luminance)
Viewing Environment	Dark
Bit Depth	12-bit

Table 5 – P3-DCI Projector Setup

2.2.3 Best ODT for application

Simple Name	TransformID
ACES 1.0 Output - P3-D60	ODT.Academy.P3D60_48nits.a1.0.3

Table 6 – P3-DCI Best ODT

2.2.4 Notes

The "P3-D60" PCF is not typically included by the manufacturer by default in most digital cinema projectors. It must be downloaded and installed in the projector using the appropriate projector configuration software (e.g. DCP Librarian). Once the PCF is installed and activated neutral ACES values sent through the the OD T.Academy.P3D60_48nits.al.0.3 transform will produce equal red, green and blue projector code values, will have equal levels on the waveform, will land in the middle of the vector scope, will appear neutral on a D65 calibrated computer monitor, and will produce the chromaticity x=0.32168 y=0.33767 (aka D60) on the projection screen. (Figure 2a, 2b, 2c, 2d, 2e)

Often the resulting projector code values are saved into a file and converted using specialized tools (e.g. Clipster) into DCDMs and/or a DPC for distribution. It is important to note that many conversion tools assume that equal red, green, and blue projector code values are intended to produce a chromaticity of x=0.3140 y=0.3510 on the screen. Converting the projector code values from ODT.Academy.P3D60_48nits.a1 . 0.3 using such tools will result in incorrect DCDM and/or DCP files. The tools must explicitly be capable of converting projector code values where equal red, green, and blue projector code values are intended to produce a chromaticity x=0.32168 y=0.33767 (aka D60) on the screen.

When using the correct projector setup and corresponding ODT, the image on the projector screen will match nearly exactly in Application 2.1 and Application 2.2.





2.2.5 Test Values

Table 7 contains test values can be used to confirm the proper monitor setup and ODT combination. Each of the 9 ACES RGB input values should yield the RGB noted display RGB code values (normalized 0-1, full range) when processed through the ODT.Academy.P3D60_48nits.al.0.3. When driving a properly setup display with the noted display RGB code values, the light from the display should measure with the noted CIE xyY colorimetry.

If the display RGB code values do not match those in the table when using the corresponding input ACES RGB code values, it is likely the wrong ODT is being used. If the proper display RGB code values are being produced by the ODT, but he measured display colorimetry doesn't match the display xyY code values noted, it is likely the display setup is incorrect.

Patch	ACES RGB			D	isplay RG	B	Display xyY		
N1	1.8233	1.8233	1.8233	0.9056	0.9056	0.9056	0.3217	0.3377	37.0944
N2	0.2753	0.2753	0.2753	0.5209	0.5209	0.5209	0.3217	0.3377	8.8075
N3	0.0898	0.0898	0.0898	0.2714	0.2714	0.2714	0.3217	0.3377	1.6161
R	0.4689	0.1193	0.0417	0.7786	0.2302	0.1781	0.6413	0.3307	6.7175
G	0.339	0.8068	0.0936	0.4184	0.8322	0.2411	0.3042	0.6246	21.7918
В	0.2162	0.133	0.8711	0.1647	0.1553	0.816	0.1562	0.0692	2.4372
С	0.5187	0.9138	1.0432	0.4174	0.8317	0.8371	0.2263	0.3398	23.8751
Μ	0.58	0.2096	0.9086	0.7819	0.2206	0.8243	0.3325	0.1593	8.7918
Y	0.8237	0.9378	0.0855	0.8392	0.8399	0.2459	0.4336	0.5192	28.3358

Table 7 - ODT. Academy. P3D60_48nits.a1.0.3 Test Values

2.3 Theatrical On-Set Preview (Rec.709 SDR Reference Monitor)

2.3.1 Summary

In theatrical workflows it is often desirable to preview the final look of the image on set as it is expected to appear during final color grading and mastering. Using ACES based workflows it is likely the default chromaticity of neutrals will be $x=0.32168 \ y=0.33767$ (aka D60) on the DI projection screen regardless of the projector's calibration white point. In order to properly preview this on-set it is recommended a Rec.709 SDR reference monitor with a calibration white point of CIE $x=0.3127 \ y=0.3290$ (aka D65) be used in conjunction with the ACES Output Transform ODT.Academy.Rec709_D60sim_100nits_dim.al.0.3.

2.3.2 Display Setup

Parameter	Setting
Max Luminance	100 nits
Display White Point	D65
Primaries	Rec.709
EOTF	BT.1886
Viewing Environment	dim
Signal	RGB 4:4:4 (Full range or Legal Range)
Bit Depth	10 or 12-bit

 Table 8 – Rec.709 Display Setup

2.3.3 Best ODT for application

Simple Name	TransformID
ACES 1.0 Output - Rec.709 (D60 sim.)	ODT.Academy.Rec709_D60sim_100nits_dim.a1.0.3

Table 9 – Best Theatrical On-Set Preview ODT

2.3.4 Notes

Using a Rec.709 SDR reference monitor with a calibration white point of D65 in in conjunction with the ACES Output Transform ODT.Academy.Rec709_D60sim_100nits_dim.a1.0.3 will cause

Using a Rec.709 SDR reference monitor with a calibration white point of D65 will cause equal red, green, and blue display code values to produce the chromaticity x=0.3127 y=0.3290 on the display screen. However, the ODT.Academy.Rec709_D60sim_100nits_dim.a1.0.3 transform is configured such that neutral ACES source file values (ACES R=G=B) will produce non-equal display code values. The chromaticity of produced on screen by those non-equal projector code values will be x=0.32168 y=0.33767 (aka D60). This is intentional and designed such that the image appearance on the on-set Rec.709 SDR reference monitor will mimic that of the final image displayed in DI mastering.

It's important to note that the image on projection screen may look less blue then some video based workflows. This will also be reflected on the color corrector scopes when neutral ACES values sent through the ODT.A cademy.Rec709_D60sim_100nits_dim.a1.0.3 transform. (Figure 3a, 3b, 3c, 3d, 3e) For instance, neutral ACES values processed through ODT.Academy.Rec709_D60sim_100nits_dim.a1.0.3 will not have equal levels on the waveform, nor will they land in the middle of the vector scope. This behavior was intentional. The image may also have a slightly warm cast on a computer monitor such as the one used

for the color corrector user interface if that monitor is calibrated to a D65 white point when compared to images generated using some traditional video workflows. (Figure 1f) In the ACES system, the behavior of mimicking the default DI look in the on-set environment is known as "D60 sim". Due to this "D60 sim" behavior the maximum output screen luminance of neutral ACES values will be slightly less than the maximum luminance produced by display code values red = 1, green = 1, blue = 1 (e.g. 100 nits).

When using the correct Rec.709 reference display setup and corresponding ODT, the image on the projector screen will have a similar appearance to that of Application 2.1 and Application 2.2. However, the images will not measure exactly the same due the fact the Rec.709 reference display's max luminance is 100 nits vs 48 nits in DI, and the ODT.Academy.Rec709_D60sim_100nits_dim.a1.0.3 compensates for a dim viewing environment.



(e) vectorscope

(f) Projector code values as displayed on a D65 calibrated computer monitor

Figure 3 - ODT.Academy.Rec709_100nits_dim.a1.0.3 Scope Screenshots

2.3.5 Test Values

Table 9 contains test values can be used to confirm the proper monitor setup and ODT combination. Each of the 9 ACES RGB input values should yield the RGB noted display RGB code values (normalized 0-1, full range) when processed through the ODT.Academy.Rec709_D60sim_100nits_dim.a1.0.3. When driving a properly setup display with the noted display RGB code values, the light from the display should measure with the noted CIE xyY colorimetry.

If the display RGB code values do not match those in the table when using the corresponding input ACES RGB code values, it is likely the wrong ODT is being used. If the proper display RGB code values are being produced by the ODT, but he measured display colorimetry doesn't match the display xyY code values noted, it is likely the display setup is incorrect.

Patch	ACES RGB		Display RGB			Display xyY			
N1	1.8233	1.8233	1.8233	0.9003	0.8812	0.8512	0.3217	0.3377	74.2273
N2	0.2753	0.2753	0.2753	0.5002	0.4896	0.4729	0.3217	0.3377	18.1096
N3	0.0898	0.0898	0.0898	0.2501	0.2448	0.2365	0.3217	0.3377	3.4311
R	0.4689	0.1193	0.0417	0.8181	0.1449	0.1341	0.6193	0.3312	13.8831
G	0.339	0.8068	0.0936	0.2181	0.8126	0.1111	0.3063	0.5895	44.0469
В	0.2162	0.133	0.8711	0.1642	0.1522	0.7881	0.1587	0.0733	5.1345
С	0.5187	0.9138	1.0432	0.2268	0.8131	0.7857	0.233	0.3397	48.1745
Μ	0.58	0.2096	0.9086	0.8219	0.1478	0.7874	0.3322	0.1655	18.078
Y	0.8237	0.9378	0.0855	0.8289	0.8122	0.0999	0.422	0.5004	56.9904

Table 10 - ODT.Academy.P3D60_48nits.a1.0.3 Test Values

2.4 Theatrical On-Set Preview (iPad)

2.4.1 Summary

- 2.4.2 Best ODT for application
- 2.4.3 Notes
- 2.4.4 Test Values

2.5 Broadcast Television Mastering (Rec.709 SDR Reference Monitor)

2.5.1 Summary

Mastering of episodic television shows and other broadcast content often takes place while viewing images on a standard dynamic range (SDR) Rec.709 Reference Monitor. The display is typically configured such that equal red, green, and blue display code values will produce the chromaticity CIE x=0.3127 y=0.3290 (aka D65) on the screen. With the display configured in this manner, where the intention is to master content for broadcast, it is recommended that the ACES 1.0 ODT with the transformID ODT.Academy.Rec709_100nits_dim.al.0.3 be used.

2.5.2 Display Setup

Parameter	Setting
Max Luminance	100 nits
Display White Point	D65
Primaries	Rec.709
EOTF	BT.1886
Viewing Environment	dim
Signal	RGB 4:4:4 (Full range or Legal Range)
Bit Depth	10 or 12-bit

Table 11 – Rec.709 Display Setup

2.5.3 Best ODT for application

Simple Name	TransformID
ACES 1.0 Output - Rec.709	ODT.Academy.Rec709_100nits_dim.al.0.3

Table 12 – Broadcast Television Mastering ODT

2.5.4 Notes

ODT.Academy.Rec709_100nits_dim.al.0.3 is intended to be used with a broadcast display that configured such that equal red, green, and blue display code values produce a chromaticity CIE x=0.3127 y=0.3290 (aka D65) on the screen and the content is intended to be viewed in a typical home viewing environment. The output transform is configured such that neutral ACES source file values (ACES R=G=B) will produce equal projector code values. In this application, the resulting content will inter-cut with content produced using other video workflows. Care should be taken to configure choose the proper output range as the ODT supports both full and legal range.

It's important to note that the image on display screen should be similar in color balance to content produced with other video workflows. The color corrector scopes should reflect this white balance similarity by producing equal red, green and blue display code values for neutral ACES source file values. The scopes may however appear different in range to some video workflows. In ACES based workflows dynamic range of the source content is maintained by manipulating the content prior to the output transforms. The shape of the output transform tone scale may be reflected in the display code values being monitored on the color corrector scopes. This is common with other video workflows where a look-up table (LUT) is used.





2.5.5 Test Values

Table 13 contains test values can be used to confirm the proper monitor setup and ODT combination. Each of the 9 ACES RGB input values should yield the RGB noted display RGB code values (normalized 0-1, full range) when processed through the ODT.Academy.Rec709_100nits_dim.a1.0.3. When driving a properly setup display with the noted display RGB code values, the light from the display should measure with the noted CIE xyY colorimetry.

If the display RGB code values do not match those in the table when using the corresponding input ACES RGB code values, it is likely the wrong ODT is being used. If the proper display RGB code values are being produced by the ODT, but he measured display colorimetry doesn't match the display xyY code values noted, it is likely the display setup is incorrect.

Patch	ACES RGB		ACES RGB Display RGB		Display xyY				
N1	1.8233	1.8233	1.8233	0.9000	0.9000	0.9000	0.3127	0.3290	77.6573
N2	0.2753	0.2753	0.2753	0.5000	0.5000	0.5000	0.3127	0.3290	18.9465
N3	0.0898	0.0898	0.0898	0.2500	0.2500	0.2500	0.3127	0.3290	3.5897
R	0.4689	0.1193	0.0417	0.8275	0.1525	0.1498	0.6155	0.3303	14.3569
G	0.3390	0.8068	0.0936	0.1500	0.8300	0.1500	0.3005	0.5889	46.0295
В	0.2162	0.1330	0.8711	0.1500	0.1500	0.8300	0.1566	0.0709	5.5935
С	0.5187	0.9138	1.0432	0.1500	0.8300	0.8300	0.2265	0.3287	50.5696
Μ	0.5800	0.2096	0.9086	0.8300	0.1500	0.8300	0.3207	0.1589	18.9661
Y	0.8237	0.9378	0.0855	0.8300	0.8300	0.1500	0.4164	0.5005	59.4021

Table 13 - ODT. Academy. Rec709_100nits_dim.a1.0.3 Test Values

2.6 Broadcast Television On-Set Preview (Rec.709 SDR Reference Monitor)

2.6.1 Summary

It has become common to preview of episodic television production on-set using a standard dynamic range (SDR) Rec.709 Reference Monitor. The display is typically configured such that equal red, green, and blue display code values will produce the chromaticity CIE x=0.3127 y=0.3290 (aka D65) on the screen. With the display configured in this manner, where the intention is to master content for broadcast, it is recommended that the ACES 1.0 ODT with the transformID ODT.Academy.Rec709_100nits_dim.al.0.3 be used.

2.6.2 Display Setup

Parameter	Setting
Max Luminance	100 nits
Display White Point	D65
Primaries	Rec.709
EOTF	BT.1886
Viewing Environment	dim
Signal	RGB 4:4:4 (Full range or Legal Range)
Bit Depth	10 or 12-bit

Table 14 – Rec.709 Display Setup

2.6.3 Best ODT for application

Simple Name	TransformID
ACES 1.0 Output - Rec.709	ODT.Academy.Rec709_100nits_dim.a1.0.3

 Table 15 – Broadcast Television Mastering ODT

2.6.4 Notes

ODT.Academy.Rec709_100nits_dim.al.0.3 is intended to be used with a broadcast display that configured such that equal red, green, and blue display code values produce a chromaticity CIE x=0.3127 y=0.3290 (aka D65) on the screen and the content is intended to be viewed in a typical home viewing environment. The output transform is configured such that neutral ACES source file values (ACES R=G=B) will produce equal projector code values. In this application, the image resulting on the display will mimick the content as it will appear in broadcast television mastering. Care should be taken to configure choose the proper output range as the ODT supports both full and legal range.

It's important to note that the image on display screen should be similar in color balance to content produced with other video workflows. The color corrector scopes should reflect this white balance similarity by producing equal red, green and blue display code values for neutral ACES source file values. The scopes may however appear different in range to some video workflows. In ACES based workflows dynamic range of the source content is maintained by manipulating the content prior to the output transforms. The shape of the output transform tone scale may be reflected in the display code values being monitored on the color corrector scopes. This is common with other video workflows where a look-up table (LUT) is used.





2.6.5 Test Values

Table 16 contains test values can be used to confirm the proper monitor setup and ODT combination. Each of the 9 ACES RGB input values should yield the RGB noted display RGB code values (normalized 0-1, full range) when processed through the ODT.Academy.Rec709_100nits_dim.a1.0.3. When driving a properly setup display with the noted display RGB code values, the light from the display should measure with the noted CIE xyY colorimetry.

If the display RGB code values do not match those in the table when using the corresponding input ACES RGB code values, it is likely the wrong ODT is being used. If the proper display RGB code values are being produced by the ODT, but he measured display colorimetry doesn't match the display xyY code values noted, it is likely the display setup is incorrect.

Patch	ACES RGB		ACES RGB Display RGB		Display xyY				
N1	1.8233	1.8233	1.8233	0.9000	0.9000	0.9000	0.3127	0.3290	77.6573
N2	0.2753	0.2753	0.2753	0.5000	0.5000	0.5000	0.3127	0.3290	18.9465
N3	0.0898	0.0898	0.0898	0.2500	0.2500	0.2500	0.3127	0.3290	3.5897
R	0.4689	0.1193	0.0417	0.8275	0.1525	0.1498	0.6155	0.3303	14.3569
G	0.3390	0.8068	0.0936	0.1500	0.8300	0.1500	0.3005	0.5889	46.0295
В	0.2162	0.1330	0.8711	0.1500	0.1500	0.8300	0.1566	0.0709	5.5935
С	0.5187	0.9138	1.0432	0.1500	0.8300	0.8300	0.2265	0.3287	50.5696
Μ	0.5800	0.2096	0.9086	0.8300	0.1500	0.8300	0.3207	0.1589	18.9661
Y	0.8237	0.9378	0.0855	0.8300	0.8300	0.1500	0.4164	0.5005	59.4021

Table 16 - ODT. Academy. Rec709_100nits_dim.a1.0.3 Test Values

2.7 Broadcast Television On-Set Preview (iPad)

2.7.1 Summary

- 2.7.2 Best ODT for application
- 2.7.3 Notes
- 2.7.4 Test Values

2.8 High Dynamic Range On-Set Preview (Rec.2020 HDR Reference Monitor)

2.8.1 Summary

- 2.8.2 Best ODT for application
- 2.8.3 Notes
- 2.8.4 Test Values

2.9 Computer Visual Effects (VFX) Generation (Desktop Computer Monitor)

2.9.1 Summary

- 2.9.2 Best ODT for application
- 2.9.3 Notes
- 2.9.4 Test Values

2.10 HDR10 Deliverable Generation (HDR 1000 nit Rec.2020 ST-2084)

2.10.1 Summary

- 2.10.2 Best ODT for application
- 2.10.3 Notes
- 2.10.4 Test Values

2.11 Dolby Vision Master (4000 nit Dolby Pulsar PQ Master)

2.11.1 Summary

- 2.11.2 Best ODT for application
- 2.11.3 Notes
- 2.11.4 Test Values

3 Recommended Workflows

This section is intended to outline the recommended usage of ACES Output Transforms as they apply to common workflows applicable to feature motion picture and episodic television production.

3.1 Feature Film – On-Set to Digital Intermediate

3.1.1 Summary

It is common in the production of digital feature films to monitor the output of the camera on-set to check for framing, exposure, and often to create looks. Looks are often created on-set or near-set using an on-set grading system with the result being a series of ASC-CDL values that are passed to digital intermediate (DI) mastering facility as a starting point for final grading. In order to insure looks are set and communicated from on-set to the DI master facility as intended, it's important that the correct Output Transforms be used in each location. The following is a recommendation for the usage of Output transforms for a common on-set to digital intermediate workflow.

3.1.2 Workflow

The complete workflow from camera to post is beyond the scope of this document, but Figure 6 shows a typical workflow for the creation and communication of looks during feature film production.



Figure 6 – Feature Film On-Set to DI Workflow

In this on-set to digital intermediate workflow a Rec.709 reference display is connected to the on-set grading system and a digital cinema projector is connected to the DI grading system. In this workflow it is suggested that the on-set grading system be configured according to the Output Transform Application specified in Section 2.3. The DI grading system should be configured according to the Output Transform Application specified in Section 2.2, or alternatively Section 2.1. The recommendations are summarized in Table 17.

System	Display	Suggested ODT
On-set Grading	Rec.709 Reference Monitor	ODT.Academy.Rec709_D60sim_100nits_dim.a1.0.3
DI Grading	P3 Digital Cinema Projector	ODT.Academy.P3D60_48nits.a1.0.3 or ODT.Academy.P3DCI_48nits.a1.0.3

Table 17 – Summary of suggested ODTs

3.1.3 Discussion

In the On-Set to Digital Intermediate workflow, using the suggested ODT will provide a white point match between the two environments. The displays will not match to the degree there are colors in the content that would take advantage of the P3 color space in DI since those colors could not be reproduced on-set with the Rec.709 monitor. It's important to recognize that the colorimetry will not measure as matching due the

the surround environment differences associated with the DI grading and On-set ODTs. The On-set ODT is designed for a dim surround environment where the DI grading ODT is designed for a dark surround environment. If viewed in their correct respective environments using the suggested ODTs should provide a visual match since the ODTs compensate for perceptual differences imposed by the viewing environments.