



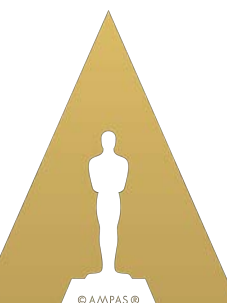
\ ACADEMY COLOR ENCODING SYSTEM \

# Output Device Transforms Virtual Working Group

Bill Mandel & Thad Beier

Academy Science and Technology Council

\ ACEScentral.com \

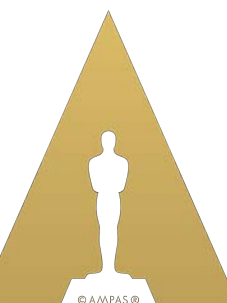




\ ACADEMY COLOR ENCODING SYSTEM \

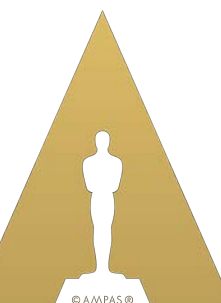
ACESCentral Virtual Working Groups are intended to enable and encourage the broadest possible participation by the community. As with any healthy and productive community, setting expectations for good citizenship from the start is important, e.g., be nice, consider the Virtual Working Group as a public forum, don't publicly disparage anyone or speak on behalf of the Virtual Working Group (unless you are the Group Lead), etc.

Please see [https://aces.mp/vwg\\_rules](https://aces.mp/vwg_rules) for the full Virtual Working Group Participation Guidelines.

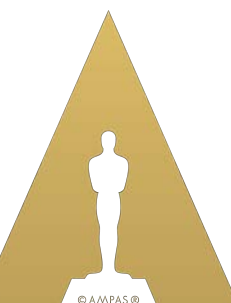


# Agenda

- Overview of Virtual Working Group Process
- Analysis of current ACES 1.0 Output Device Transforms
- Straw-man ODT enhancement proposal
- Open work items
- Time frame
- Action Items



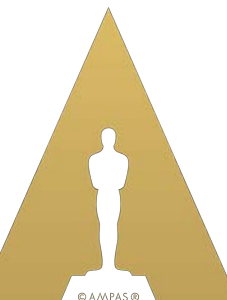
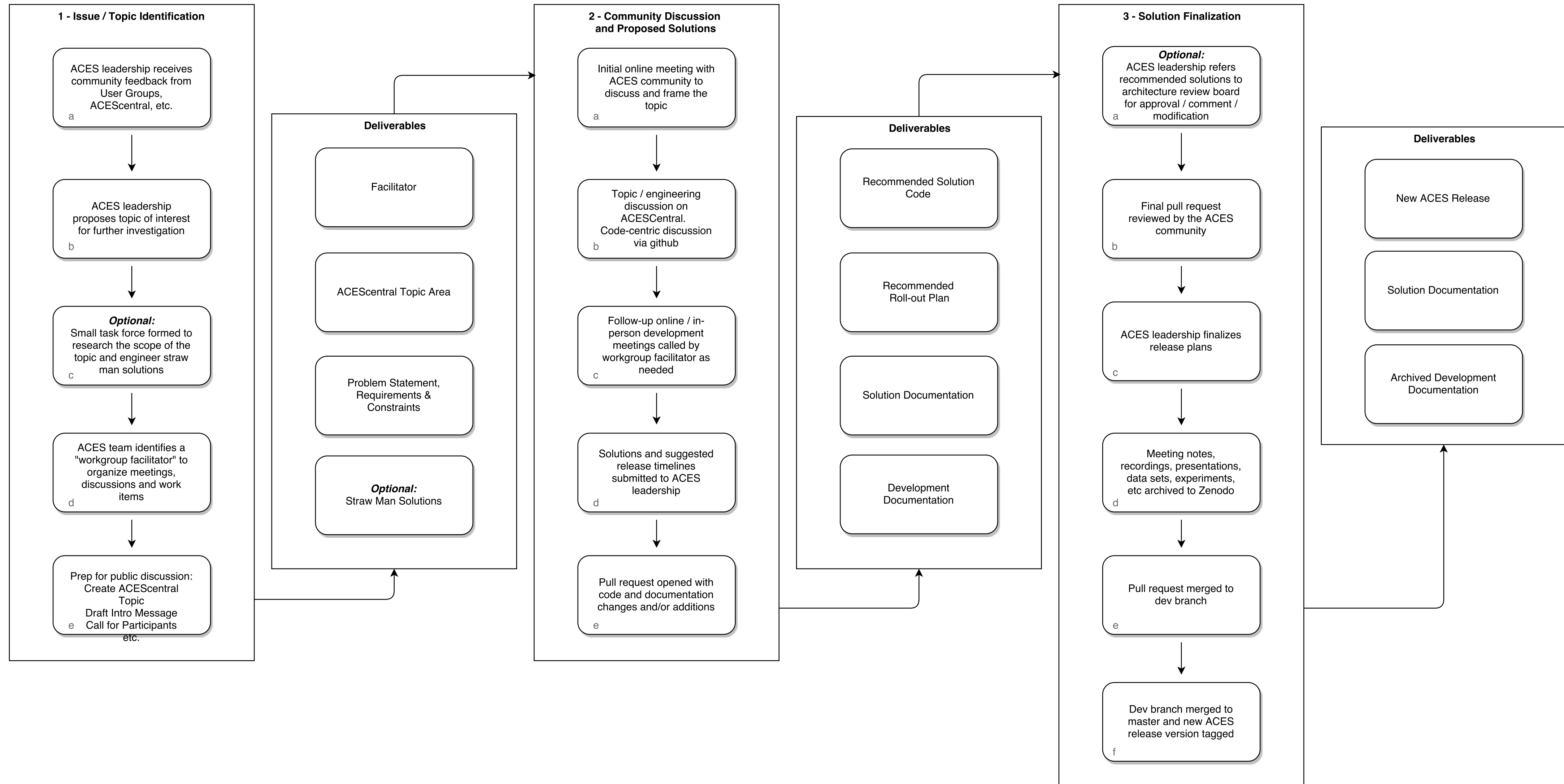
# Virtual Working Group Process



# Virtual Working Group Process – Workflow

## Workflow for ACES Development

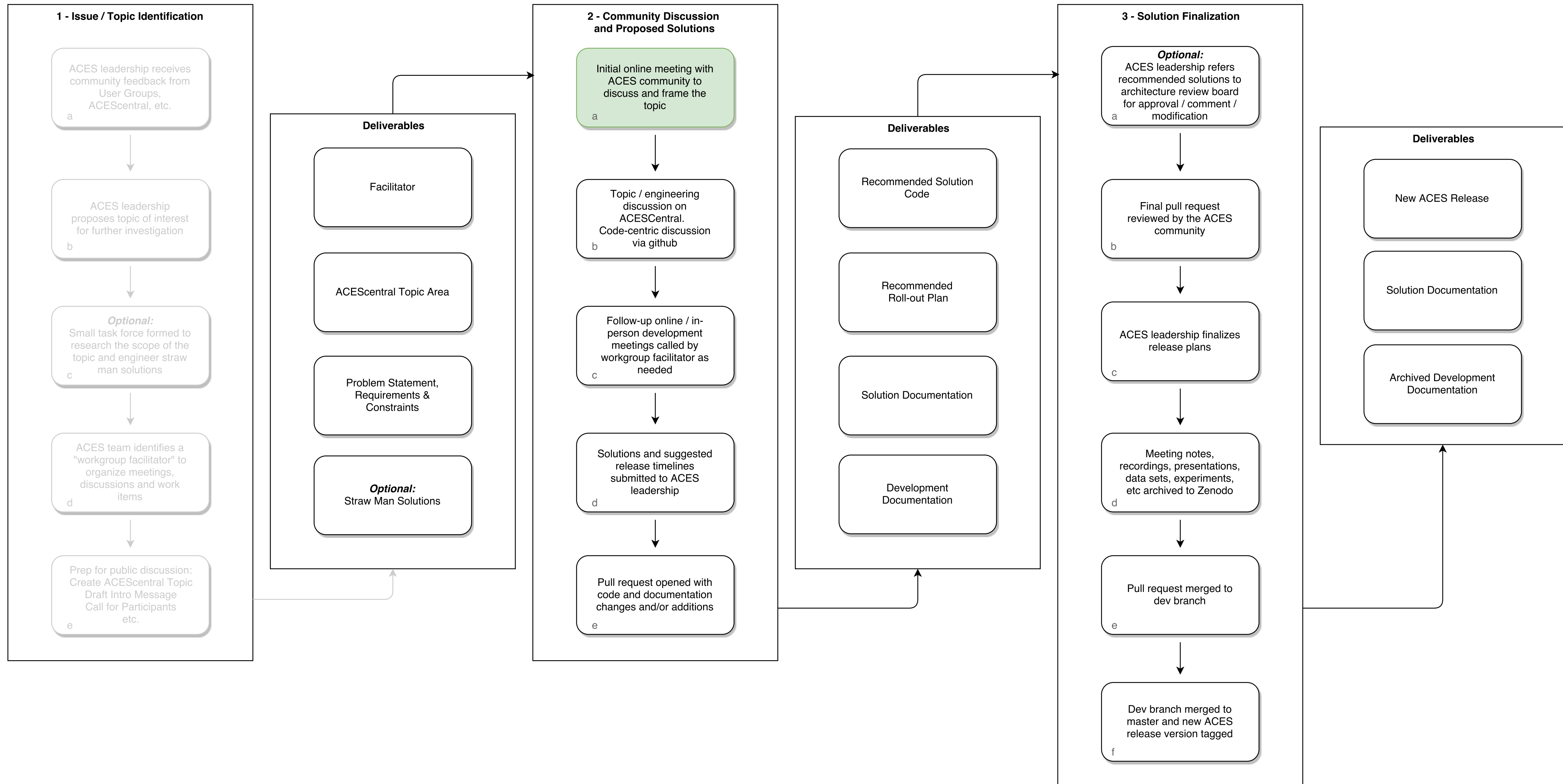
v1.0  
10/17/2017



# Virtual Working Group Process – Workflow

## ACES ODT Development

v1.0  
10/17/2017





# Virtual Working Group Process – ACEScentral.com

The image shows two overlapping browser windows from ACEScentral.com. The background window displays a forum page for 'VIRTUAL WORKING GROUP - ODT' with a table of topics. The foreground window shows a detailed announcement for an 'ACESnext - ODT Virtual Working Group Online Meeting - 10.19.2017' by Alex Forsythe.

**Background Window: Virtual Working Group - ODT**

Navigation: DISCUSSIONS - DESIGN/ENHANCEMENTS TO ACES > VIRTUAL WORKING GROUP - ODT > LATEST TOP

Topic	Users	Replies	Views
<b>About the Virtual Working Group - ODT category</b> This sub-category is intended to contain all discussion pertaining to the ODT Virtual Working Group. All discussions in this sub-category are forward-looking and developmental in nature and should not be considered docu... <a href="#">read more</a>		1	
<b>ACESnext - ODT Virtual Working Group Online Meeting - 10.19.2017</b>		0	15

**There are no more Virtual Working Group – ODT topics.**

**Foreground Window: ACESnext - ODT Virtual Working Group Online Meeting - 10.19.2017**

Discussions - Design/Enh... Virtual Working Group - ...

**Alex Forsythe** Alexander\_Forsythe ACES Team 1 3d

ACES Community,

The ACES leadership team invites members of the ACES community to participate in an on-line meeting, hosted on [ACEScentral.com](#), to review the ACES 1.0 Output Device Transforms (ODTs) and set a course for enhancements. Over the past several months, a small group has been evaluating the ACES 1.0 ODTs and exploring ways to improve them. The group has identified a number of possible enhancements that they feel would better serve ACES-based productions, and developed a strawman solution to share with the broader ACES community.

As members of this community, your input, participation and help is critical to developing future versions of ACES. Please join us for this discussion on October 19, 2017 at 11 AM (PDT).

Corresponding dates and times for other time zones are included in the invite link. Please RSVP by clicking on the link below if you'd like to participate.

[RSVP here if you plan to participate](#) 19

Thanks  
ACES Leadership

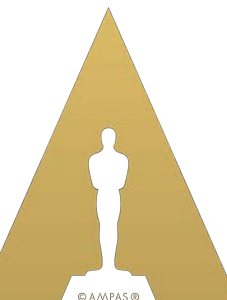
Welcome to ACES Central! Looks like you're enjoying the discussion, but you're not signed up for an account.

When you create an account, we remember exactly what you've read, so you always come right back where you left off. You also get notifications, here and via email, whenever new posts are made. And you can like posts to share the love.

[Sign Up](#)  [Remind me tomorrow](#) [no thanks](#)

**Suggested Topics**

Topic	Category	Replies	Views	Activity
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# Virtual Working Group Process – Github

The image displays two overlapping screenshots of a GitHub pull request page. The left screenshot shows the code diff for a pull request titled "Improve linearization of LogC data for exposure indices above 1600... #98". The right screenshot shows the pull request details, including comments, a "Merge pull request" button, and a "Set up continuous integration" notification.

**Left Screenshot: Code Diff**

Repository: `ampas / aces-dev`

Pull Request Title: `Improve linearization of LogC data for exposure indices above 1600... #98`

Author: `JGoldstone` wants to merge 1 commit into `ampas:master` from `JGoldstone:master`

Changes from all commits: `+2,561 -2,561`

Files changed: 492

Diff Summary:

- 2 files changed: `transforms/ctl/idt/vendorSupplied/arri/alexa/idt_maker_script.csh`
- 17 files changed: `transforms/ctl/idt/vendorSupplied/arri/alexa/v3/EI1000/IDT.ARRI.Alexa-v3-logC-EI1000.ct1`
- 10 files changed: `.../idt/vendorSupplied/arri/alexa/v3/EI1000/IDT.ARRI.Alexa-v3-raw-EI1000-CCT11000-ND1pt3.ct1`

Code Diff (Line 2):

```
... <ACEstransformID>IDT.ARRI.Alexa-v3-raw-EI1000-CCT11000-ND1pt3.a1.v1</ACEstransformID>
+// <ACEstransformID>IDT.ARRI.Alexa-v3-raw-EI1000-CCT11000-ND1pt3.a1.v2</ACEstransformID>
```

Code Diff (Line 8):

```
-// Written by v3_IDT_maker.py v0.08 on Friday 19 December 2014
+// Written by v3_IDT_maker.py v0.09 on Thursday 22 December 2016
```

Code Diff (Line 10):

```
const float EI = 1000.0;
```

**Right Screenshot: Pull Request Details**

Repository: `ampas / aces-dev`

Pull Request Title: `Improve linearization of LogC data for exposure indices above 1600... #98`

Author: `JGoldstone` wants to merge 1 commit into `ampas:master` from `JGoldstone:master`

Changes from all commits: `+2,561 -2,561`

Files changed: 492

Comments:

- `JGoldstone` commented on Feb 18: "...and for EI 1600 when the normalized LogC value was above 0.8."
- `KeiSolaar` referenced this pull request in `colour-science/colour` on Mar 9: "Implement relevant changes regarding "ALEXA Log C" IDTs. #308"
- `scottdyer` commented on Mar 10 (edited): "Approved into dev branch in commit `908fd85`"

Buttons:

- `Open`
- `Conversation` (1)
- `Commits` (1)
- `Files changed` (492)
- `Unified`
- `Split`
- `View`
- `Show comments`
- `Write`
- `Preview`
- `Cancel`
- `Add single comment`
- `Start a review`
- `Merge pull request`
- `Set up continuous integration to automatically test your code`
- `Explore GitHub Marketplace`

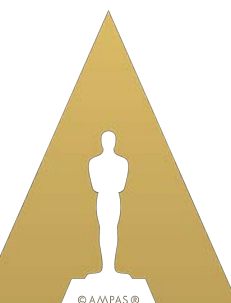
Notifications:

- `Unsubscribe`
- `2 participants`
- `Lock conversation`



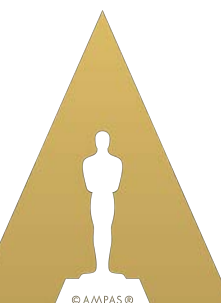


# Analysis of ACES 1.0 Output Device Transforms



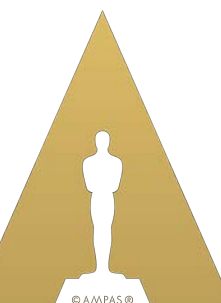
# Analysis of ACES 1.0 Output Device Transforms – Problem Statements

- The Output Device Transforms supported in ACES 1.0 are limited to those published by the Academy. Documented means to support alternate devices, viewing environments, device dynamic range capabilities, and encodings are needed.
- ACES 1.0 does not contain sufficient end-user or engineering documentation related to the design and usage of Output Device Transforms.
- In some cases, the ACES 1.0 Output Device Transforms are contributing to the existence of image artifacts.



# Analysis of ACES 1.0 Output Device Transforms – Issues

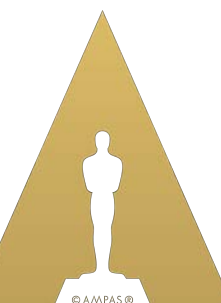
- Lack of algorithm consistency between Output Device Transforms (ODTs)
- No consistent methodologies established for ...
  - supporting alternate dynamic ranges
  - application of surround compensation
  - white point compression algorithm for handle D60 simulation
  - PQ (ST-2084) = 0





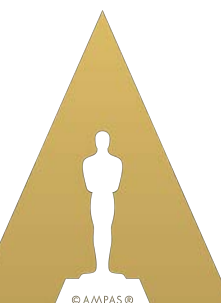
# Analysis of ACES 1.0 Output Device Transforms – Issues

- Lack of sufficient documentation
  - End-user documentation (What ODT do I use when ...)
  - ODT Specification (What is an ODT?)
  - Engineering documentation (Design considerations. What are the ODT's trying to accomplish? How?)
- Unexplained constants in code

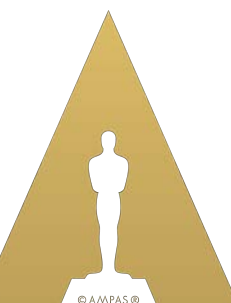


# Analysis of ACES 1.0 Output Device Transforms – Issues

- Image artifacts due to gamut clipping
- Complex tone scale splines with first derivative variations
- No support for the Hybrid Log-Gamma (HLG) Encoding



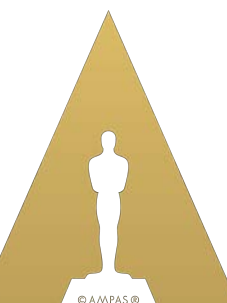
# Straw-man ODT enhancement proposal





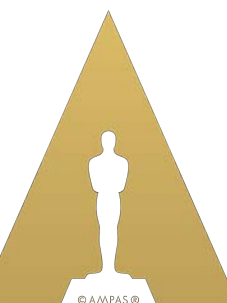
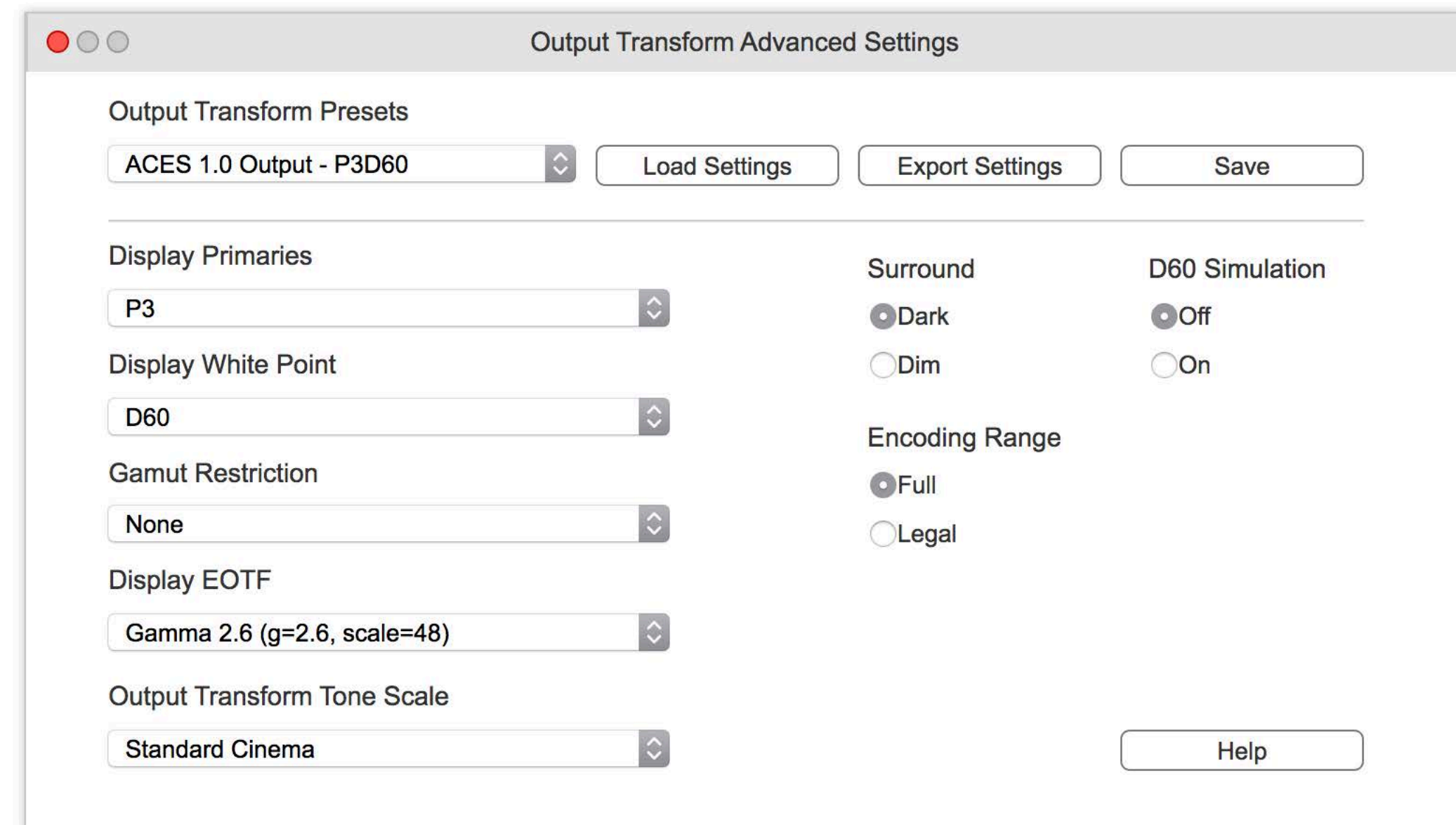
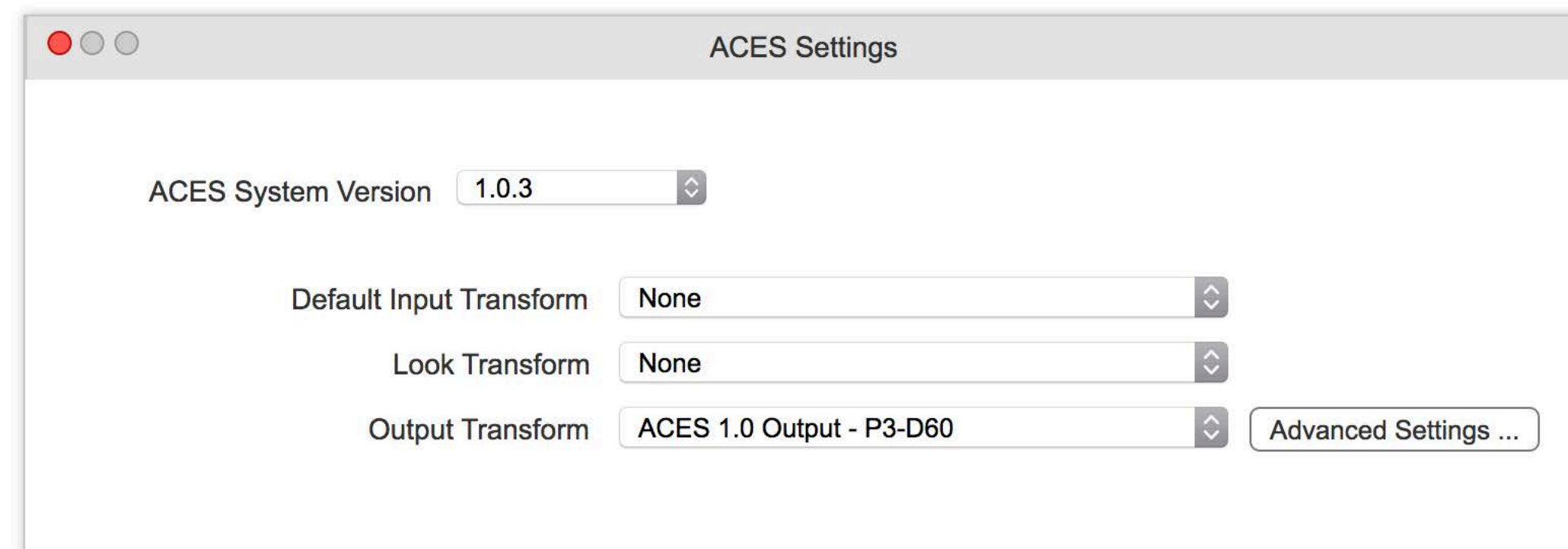
# Straw-man proposal – Parametric output transform

- Address ODT inconsistencies using a single parametric ODT algorithm
- Proposed ODT parameters include:
  - Display Primaries – CIE chromaticity coordinates of R, G, and B (includes XYZ)
  - Display White Point – CIE chromaticity coordinates of R=G=B
  - Display EOTF – Presets and custom based on various EOTF Models
  - Gamut Restriction Primaries – e.g. encode as Rec.2020 but limit colors to P3
  - ODT Tone Scale – Presets and custom based on display min Y, max Y, and preferred reproduction Y of ACES=0.18
  - Display Environment Surround – Dim or Dark
  - D60 Simulation Mode – On or Off
  - Encoding Range – Full or Legal




# Straw-man proposal – Parametric output transform

- Interactive wireframe available at [http://ip110x.axshare.com/aces\\_settings.html](http://ip110x.axshare.com/aces_settings.html)



# Straw-man proposal – End-user documentation

- First working draft at <https://aces.mp/odt-end-user-doc>



**Technical Bulletin**  
**TB-2017-00x**  
**ACES Output Transform User Guide**

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

August 18, 2017

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 transform to 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.

TB-2017-00x

ACES Output Transform User Guide

**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.

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ACES Output Transform User Guide

**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.a1.0.3` 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.P3DCI.48nits.a1.0.3` 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 than 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.a1.0.3` transform. (Figure 1a, 1b, 1c, 1d, 1e) For instance, neutral ACES values processed through `ODT.Academy.P3DCI.48nits.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 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 1d) Although not noted in the name of this ODT, it 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).

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ACES Output Transform User Guide

**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.

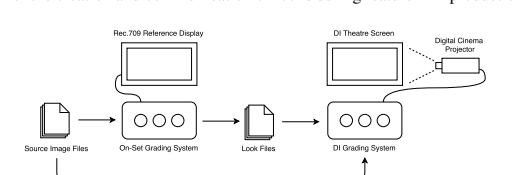
**3.1 Feature Film – On-Set to Digital Intermediate**

**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

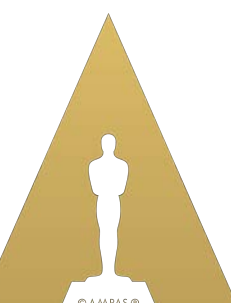
**Table 17 – Summary of suggested ODTs**

**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

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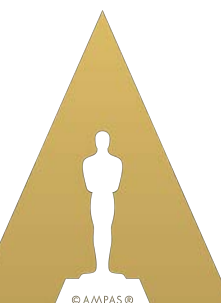


# Time frame

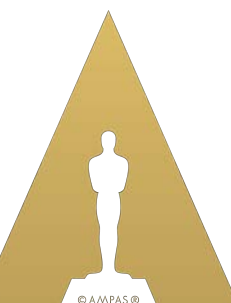


# Time frame

- First virtual working group meeting – 10.19.2017
- ACES Central discussion of straw man proposal – 10.19.2017–11.22.2017
- Alternate proposals due – 11.20.2017
- Second virtual working group meeting – 11.22.2017
- ACES Central discussion of all proposals – 11.22.2017– 01.17.2017
- Final recommendations to ACES leadership – 1.17.2017

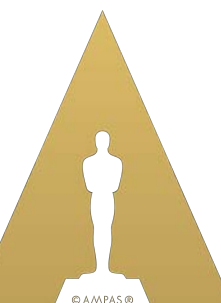


# Action Items



# Action Items

- Review and provide comments on ACEScentral for the following :
  - The ACES development process
  - The ACES 1.0 ODT problem statements
  - The ACES 1.0 ODT issues
  - The parametric ODT proposals
  - The end-user documentation
- Provide alternate proposals
- Provide any feedback on this meeting process ... email [aces@oscars.org](mailto:aces@oscars.org)



Thank you for your participation ...

