INTERNATIONAL ELECTROTECHNICAL COMMISSION

COLOUR MANAGEMENT IN MULTIMEDIA SYSTEMS
- Part 2: Colour Management,
Part 2.1: DEFAULT RGB COLOUR SPACE - sRGB

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International Standard IEC 61966 has been prepared by project team 61966: Colour measurement and management in multimedia systems and equipment, of IEC technical committee TC100: Audio, Video and Multimedia Systems and Equipment.

The text of this standard is based on

FDIS	Report on voting
XXX/FDIS	XXX/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

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1 GENERAL

1.1 Introduction

The method of digitisation in this part are designed to complement the current colour management strategies by enabling a method of handling colour in the operating systems, device drivers and the Internet that utilises a simple and robust device independent colour definition. This will provide good quality and backward compatibility with minimum transmission and system overhead. Based on a calibrated colourimetric RGB colour space well suited to cathode ray tube (CRT) displays, flat panel displays, television, scanners, digital cameras, and printing systems, such a space can be supported with minimum cost to software and hardware vendors. The intent is to promote its adoption by showing the benefits of supporting a standard colour space, and the suitability of this standard colour space, sRGB.

Recently the International Colour Consortium has proposed breakthrough solutions to problems in communicating colour in open systems. Yet the ICC profile format does not provide a complete solution for all situations.

Currently, the ICC has one means of tracking and ensuring that a colour is correctly mapped from the input to the output colour space. This is done by attaching a profile for the input colour space to the image in question. This is appropriate for high end users. However, there are a broad range of users that do not require this level of flexibility and control in an embedded profile mechanism. Instead it is possible to create a single, standard default colour space definition that can be processed as an implicit ICC sRGB profile. Additionally, most existing file formats do not, and may never, support colour profile embedding, and finally, there are a broad range of uses that actually discourage people from appending any extra data to their files. A common standard RGB colour space addresses these issues and is useful and necessary. This approach maintains the advantage of a clear relationship with ICC colour management systems while minimising software processes and support requirements.

Application developers and users who do not want the overhead of embedding profiles with documents or images should convert them to a common colour space for storage. Currently there is a plethora of RGB CRT-based colour spaces attempting to fill this void with little guidance or attempts at standardisation. There is a need to merge the many standard and non-standard RGB display spaces into a single standard RGB colour space. This standard dramatically improves the colour fidelity in the desktop environment by meeting this need. For example, if operating system vendors provide support for a this standard RGB colour space, the input and output device vendors that support this standard colour space could easily and confidently communicate colour without further colour management overhead in the most common situations. The three major factors of this RGB space are the colourimetric RGB definition, the simple exponent value of 2.2, and the well-defined viewing conditions, along with a number of secondary details necessary to enable the clear and unambiguous communication of colour.

The dichotomy between the device dependent (e.g. amounts of ink expressed in CMYK or digitised video voltages expressed in RGB) and device independent colour spaces (such as CIELAB or CIEXYZ) has created a performance burden on applications that have attempted to avoid device colour spaces. This is primarily due to the complexity of the colour transforms they need to perform to return the colours to device dependent colour spaces. This situation is worsened by a reliability gap between the complexity and variety of the transforms, making it hard to ensure that the system is properly configured.

This standard addresses these concerns, serves the needs of PC and Web based colour imaging systems is based on the average performance of personal computer displays. This solution is supported by the following observations:

- Most computer displays are similar in their key colour characteristics — the phosphor chromaticities (primaries) and transfer function
- RGB spaces are native to displays, scanners and digital cameras, which are the devices with the highest performance constraints
- RGB spaces can be made device independent in a straightforward way. They can also describe colour gamuts that are large enough for all but a small number of applications.

This combination of factors makes a colourimetric RGB space well suited for wide adoption since it can both describe the colours in an unambiguous way and be the native space for actual hardware devices. This, many readers will recognise, describes in a roundabout way what has been the practice in colour television for some 45 years. This proven methodology provides excellent performance where it is needed the most, the rapid display of images in CRT displays.

There are two parts to the proposed standard described in this standard: the encoding transformations and the reference conditions. The encoding transformations provide all of the necessary information to encode an image for optimum display in the reference conditions. If actual conditions differ from reference conditions, additional rendering transformations may be required.

1.2 Scope

The IEC 61966 standards are a series of methods and parameters for colour measurements and management for use in multimedia systems and equipment applicable to the assessment of colour reproduction.

This part of IEC 61966 is applicable to the encoding and communication of RGB colours used in computer systems and similar applications by defining encoding transformations for use in defined reference conditions. The encoding transformations are the default RGB colour definition when no other colour space information is available or appropriate.

If actual conditions differ from the reference conditions, additional rendering transformations could be required. Such additional rendering transformations are beyond the scope of this standard.

1.3 Normative References

The following normative documents contain provisions, which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards

IEC 60050(845): 1987, *International Electrotechnical Vocabulary (IEV) - Chapter 845: Lighting*

CIE 15.2: 1986, Colourimetry (2nd Ed.)

CIE 122: 1996, *The relationship between digital and colourimetric data for computer-controlled CRT displays*

ITU-R BT.709-2: 1995, *Parameter Values for the HDTV Standards for Production and International Programme Exchange*

ISO 3664: 1975, *Photography – Illumination conditions for viewing colour transparencies and their reproduction*

ISO 9358:1994, Optics and optical instruments -- Veiling glare of image forming systems -- Definitions and methods of measurement

1.4 Definitions

For the purpose of this International Standard, the following definitions apply. Definitions of illuminance, luminance, tristimulus, and other relating lighting terms are defined in reference IEC 60050(845) International Electrotechnical Vocabulary (IEV) - Chapter 845 Lighting. Veiling glare is defined in reference ISO 9358:1994.

1.4.1
ambient illuminance level

The illuminance level due to lighting in the viewing environment not from the display measured normal from the display faceplate at a typical viewing distance.

1.4.2
ambient white point

The coordicate poitn in the CIE 1931 XYZ colour space defined by CIE 15.2 due to lighting in the viewing environment, not from the display measured normal from the display faceplate relative to a perfect reflecting diffuser.

1.4.3
display illuminant white point

The point in the xy chromaticity diagram defined by CIE 15. when the red, green and blue channels are at 100% as measured normal from the display faceplate relative to a perfect reflecting diffuser.

1.4.4
display background

The environment of the colour element extending typically for about ten degrees from the edge of the proximal field in all, or most directions. When the proximal field is the same colour as the background, the latter is regarded as extending from the edge of the colour element considered.

1.4.5
display model offset
The display model offset measured consistently with CIE 122, representing the black offset level of the display grid voltage.

1.4.6
display gun/phosphor gamma
The transfer characteristic relating the input signal data and the output luminance as represented by an exponential function. This transfer characteristic represents the intrinsic

characteristics of the CRT display grid voltage and electron beam current acting on the display phosphors.

1.4.7
display luminance level

The luminance level of the display measured consistently with CIE 122.

1.4.8 display surround

The field outside the background, filling the field of vision.

1.4.9 display proximal field

The immediate environment of the colour element considered, extending typically for about two degrees from the edge of the colour element considered in all or most directions.

1.4.10
World Wide Web

The universe of network-accessible information, the embodiment of human knowledge. The Web has a body of software, and a set of protocols and conventions. Through the use hypertext and multimedia techniques, the web is easy for anyone to roam, browse, and contribute to.

2 REFERENCE CONDITIONS

2.1 Reference Display Conditions

1. Display luminance level	80 cd/m2
2. Display white point	x = 0,3127, y = 0,3291 (D65)
3. Display model Offset (R,G and B)	0,055
4. Display Gun/Phosphor Gamma (R, G, and B)	2,4

The CIE chromaticities for the red, green, and blue ITU-R BT.709-2 reference primaries, and for CIE Standard Illuminant D65, are given in table 1.

Table 1 CIE chromaticities for ITU-R BT.709 reference primaries and CIE standard illuminant

	Red	Green	Blue	D65
x	0,6400	0,3000	0,1500	0,3127
y	0,3300	0,6000	0,0600	0,3291
z	0,0300	0,1000	0,7900	0,3583

The reference display characterisation is based on the CIE 122display characterisation standard. Relative to this standard methodology, the reference display is characterised by the equation below.

$$V_{sRGB} = \left[\left(V'_{sRGB} + 0{,}055 \right) \big/ 1{,}055 \right]^{2{,}4} \qquad (1)$$

2.2 Reference Viewing Conditions

Specifications for the reference viewing environments are based on ISO 3664 and are defined as follows:

1. Reference Background	for the background as part of the display screen, the background is 20% of the reference display luminance level
2. Reference Surround	20% reflectance of the reference ambient illuminance level
3. Reference Proximal Field	20% of the reflectance of the reference display luminance level
4. Reference Ambient Illuminance Level	64 lx
5. Reference Ambient White Point	x = 0,3457, y = 0,3585 (D50)
6. Reference Veiling glare	1,0%

2.3 Reference Observer Conditions

The reference observer is the CIE 1931 two-degree standard observer from CIE 15.2.

3 ENCODING CHARACTERISTICS

3.1 Introduction

The encoding transformations between 1931 CIEXYZ values and 8 bit RGB values provide unambiguous methods to represent optimum image colourimetry when viewed on the reference display in the reference viewing conditions by the reference observer. The 1931 CIEXYZ values are scaled from 0.0 to 1.0, not 0.0 to 100.0. These non-linear sR'G'B' values represent the appearance of the image as displayed on the reference monitor in reference viewing environment. The sRGB tristimulus values are linear combinations of the 1931 CIE XYZ values as measured on the faceplate of the display, which assumes the absence of any significant veiling glare. Recommended treatments for both veiling glare and viewing conditions are provided in Annexes G and H.

3.2 Transformation from RGB values to 1931 CIE XYZ values

The relationship is defined as follows:

$$
\begin{aligned}
R'_{sRGB} &= R_{8bit} \div 255{,}0 \\
G'_{sRGB} &= G_{8bit} \div 255{,}0 \\
B'_{sRGB} &= B_{8bit} \div 255{,}0
\end{aligned}
\qquad (2)
$$

If $R'_{sRGB}, G'_{sRGB}, B'_{sRGB} \leq 0{,}03928$

$$
\begin{aligned}
R_{sRGB} &= R'_{sRGB} \div 12{,}92 \\
G_{sRGB} &= G'_{sRGB} \div 12{,}92 \\
B_{sRGB} &= B'_{sRGB} \div 12{,}92
\end{aligned}
\qquad (3)
$$

else $R'_{sRGB}, G'_{sRGB}, B'_{sRGB} > 0{,}03928$

$$R_{sRGB} = \left[\left(R'_{sRGB} + 0{,}055 \right) / 1{,}055 \right]^{2{,}4}$$
$$G_{sRGB} = \left[\left(R'_{sRGB} + 0{,}055 \right) / 1{,}055 \right]^{2{,}4} \qquad (4)$$
$$B_{sRGB} = \left[\left(R'_{sRGB} + 0{,}055 \right) / 1{,}055 \right]^{2{,}4}$$

and

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} 0{,}4124 & 0{,}3576 & 0{,}1805 \\ 0{,}2126 & 0{,}7152 & 0{,}0722 \\ 0{,}0193 & 0{,}1192 & 0{,}9505 \end{bmatrix} \begin{bmatrix} R_{sRGB} \\ G_{sRGB} \\ B_{sRGB} \end{bmatrix} \qquad (5).$$

The above equations closely fit a simple power function with an exponent of 2,2. This maintains consistency with the legacy of desktop and video images.

3.3 Transformation from 1931 CIE XYZ values to RGB values

The sRGB tristimulus values can be computed using the following relationship:

$$\begin{bmatrix} R_{sRGB} \\ G_{sRGB} \\ B_{sRGB} \end{bmatrix} = \begin{bmatrix} 3{,}2410 & -1{,}5374 & -0{,}4986 \\ -0{,}9692 & 1{,}8760 & 0{,}0416 \\ 0{,}0556 & -0{,}2040 & 1{,}0570 \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \end{bmatrix} \qquad (6)$$

In the RGB encoding process, negative sRGB tristimulus values, and sRGB tristimulus values greater than 1,00 are not retained. When encoding software cannot support this extended range, the luminance dynamic range and colour gamut of RGB is limited to the tristimulus values between 0,0 and 1,0 by simple clipping.

The sRGB tristimulus values are transformed to non-linear sR'G'B' values as follows:

If $R_{sRGB}, G_{sRGB}, B_{sRGB} \leq 0{,}00304$

$$R'_{sRGB} = 12{,}92 \times R_{sRGB}$$
$$G'_{sRGB} = 12{,}92 \times G_{sRGB} \qquad (7)$$
$$B'_{sRGB} = 12{,}92 \times B_{sRGB}$$

else $R_{sRGB}, G_{sRGB}, B_{sRGB} > 0{,}00304$

$$R'_{sRGB} = 1{,}055 \times R_{sRGB}^{(1{,}0/2{,}4)} - 0{,}055$$
$$G'_{sRGB} = 1{,}055 \times G_{sRGB}^{(1{,}0/2{,}4)} - 0{,}055 \qquad (8)$$
$$B'_{sRGB} = 1{,}055 \times B_{sRGB}^{(1{,}0/2{,}4)} - 0{,}055$$

The non-linear sR'G'B' values are converted to digital code values. This conversion scales the above sR'G'B' values by using the equation below where WDC represents the white digital count and KDC represents the black digital count.

$$\begin{aligned} R_{8bit} &= \left((WDC - KDC) \times R'_{sRGB} \right) + KDC \\ G_{8bit} &= \left((WDC - KDC) \times G'_{sRGB} \right) + KDC \\ B_{8bit} &= \left((WDC - KDC) \times B'_{sRGB} \right) + KDC \end{aligned} \quad (9)$$

This standard specified a black digital count of 0 and a white digital count of 255 for 24-bit (8-bits/channel) encoding. The resulting RGB values are formed according to the following equations:

$$\begin{aligned} R_{8bit} &= \left((255{,}0 - 0{,}0) \times R'_{sRGB} \right) + 0{,}0 \\ G_{8bit} &= \left((255{,}0 - 0{,}0) \times G'_{sRGB} \right) + 0{,}0 \\ B_{8bit} &= \left((255{,}0 - 0{,}0) \times B'_{sRGB} \right) + 0{,}0 \end{aligned} \quad (10)$$

This is simplified as shown below:

$$\begin{aligned} R_{8bit} &= 255{,}0 \times R'_{sRGB} \\ G_{8bit} &= 255{,}0 \times G'_{sRGB} \\ B_{8bit} &= 255{,}0 \times B'_{sRGB} \end{aligned} \quad (11)$$

ANNEX A
(informative)
Ambiguity in the Definition of the Term "Gamma"

Historically, both the photographic and television industries claim integral use of the term "gamma" for different effects. Hurter and Driffield first used the term in the 1890's in describing the straight-line portion of the density vs. log exposure curves that describe photographic sensitometry. The photographic sensitometry field has used several interrelated terms to describe similar effects, including; gamma, slope, gradient, and contrast. Both Languimier in the 1910's and Oliver in the 1940's defined "gamma" for the television industry (and thus the computer graphics industry) as the exponential value in both simple and complex power functions that describe the relationship between gun voltage and intensity (or luminance). In fact, even within the television industry, there are multiple, conflicting definitions of "gamma." These include differences in describing physical aspects (such as gun "gamma" and phosphor "gamma"). These also include differences in equations for the same physical aspect (there are currently at least three commonly used equations in the computer graphics industry to describe the relationship between gun voltage and intensity, all of which provide significantly different results). After significant insightful feedback from many industries, this standard has chosen to explicitly avoid the use of the term "gamma." Furthermore, it appears that the usefulness as an unambiguous, constructive standard terminology is impossible and its continued use is detrimental to cross standard and unambiguous communication.

Annex B
(informative)
sRGB and ITU-R BT.709-2 Compatibility

The compatibility between this standard and the ITU-R BT.709-2 was a primary consideration in development of this standard. Unfortunately, ITU-R BT.709-2 can be somewhat confusing. This annex is an attempt to clarify and reduce this confusion.

In April 1990 unanimous worldwide agreement on a calibrated non-linear RGB space for HDTV production and program exchange in ITU-R BT.709-2 was obtained. This recommendation specifies the encoding of real world scene tristimulus values into a reference display RGB colour space assuming a dark viewing condition. The ITU specification is rather vague on defining the reference display. This standard provides a clear and well-defined reference display for ITU-R BT.709-2 for a dim viewing environment.

ITU-R BT.709-2 specifically describes the encoding transfer function for a video camera that when viewed on a "standard" display will produce excellent image quality. The implicit target of this encoding is a standard video display whose transfer function is *not* explicitly delineated. Instead a typical display setup is assumed. This paper attempts to explicitly describe a standard display characterisation that is compatible with ITU-R BT.709-2.

This is illustrated in figures 1-3 below. Figure 1 is directly derived from ITU-R BT.709-2. This standard provides mathematical methods to transform from tristimulus values of the scene using a video camera into a reference display device space.

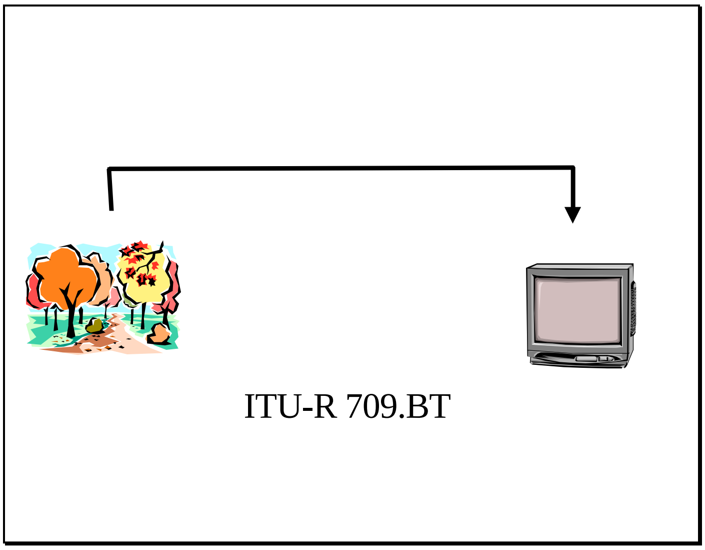

Figure 1

Figure 2 expands the implicit step of these methods and shows the transformation between the original scene tristimulus values into the target display tristimulus values. Since these two viewing conditions are different, an implicit compensation is made to account for these differences (i.e. veiling glare, surround and ambient illuminance). In order to provide an independent display reference colour space, the reference display, viewing conditions and observer implicit in the encoding transforms must be extracted from this confounded compensation. This is precisely the goal of this standard.

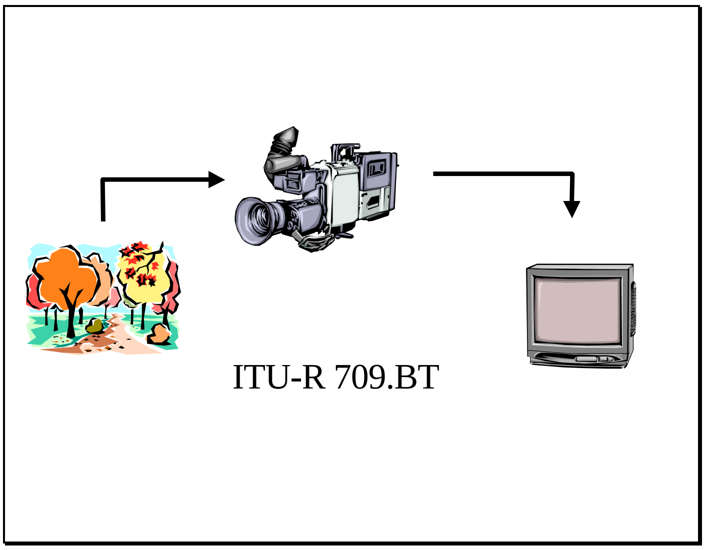

Figure 2

Figure 3 illustrates both the sRGB colour space and the extraction of the reference display specifications (with its viewing conditions) implicit within ITU-R BT.709-2. By building on this system, the sRGB colour space provides a display definition that can be used independently from ITU-R BT.709-2 while maintaining compatibility.

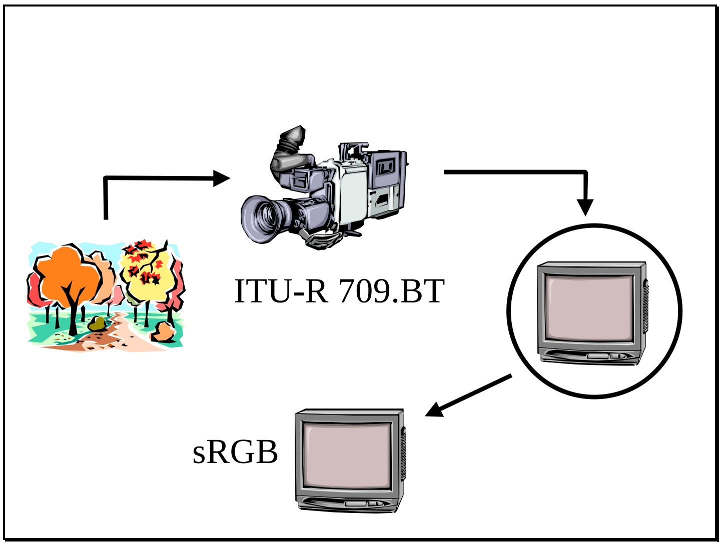

Figure 3

This sRGB recommendation essentially defines the second part of this transformation between the reference RGB display space and the display CIEXYZ tristimulus values in a dim viewing environment.

Annex C
(informative)
Usage Guidelines

C.1 Definition of a Colour Space

For colour to be reproduced in a predictable manner across different devices and materials, it has to be described in a way that is independent of the specific behaviour of the mechanisms and materials used to produce it. For instance, colour displays and colour printers use very different mechanisms for producing colour. To address this issue, current methods require that colour be described using device independent colour co-ordinates, which are translated into device dependent colour co-ordinates for each device.

C.2 Definition of Colour Management:

Traditionally, operating systems have supported colour by declaring support for a particular colour space, RGB in most cases. However, since RGB varies between devices, colour was not reliably reproduced across different devices.

The high-end publishing market could not meet its needs with the traditional means of colour support, so the various OS's added support for using International Colour Consortium (ICC) profiles to characterise device dependent colours in a device independent way. They use the profiles of the input device that created an image and the output device that displayed the image and create a transform that moves the image from the input device's colour space to the output device's colour space. This resulted in very accurate colour. However, it also involved the overhead of transporting the input device's profile with the image and running the image through the transform.

This standard provides an additional means of managing colour that is optimised to meet the needs of most users without the overhead of carrying an ICC profile with the image: the addition to the OS and the Internet of support for a Standard Colour Space. Since the image is in a known colour space and the profile for that colour space would ship with the OS and display application, this enables the end users to enjoy the benefits of colour management without the overhead of larger files. While it may be argued that profiles could buy slightly higher colour accuracy, the benefits of using a standard colour space far out-weigh the drawbacks for a wide range of users. The migration of devices to natively support the standard colour space will further enhance the speed and quality of the user experience.

It is recommended to use the colour space, sRGB, that is consistent with but is a more tightly defined derivative of ITU-R BT.709-2 as the standard colour space for the OS's and the Internet. In April of 1990 this space obtained unanimous worldwide agreement as the calibrated non-linear RGB space for HDTV production and program exchange.

C.3 Specifying Colour of Page Elements

Complex documents are often composed of multiple page elements of graphics, text and images. These elements may be in different colour spaces. It is recommended that all page elements be assumed to be in the sRGB colour space unless embedded ICC profiles (or other explicit methods) indicate otherwise. The relationship between sRGB and ICC profiles is shown in table 2 below.

Table 2 Relationship between sRGB and ICC Profiles

ICC and sRGB	ICC Source Profile	No ICC Source Profile
ICC Destination Profile	ICC Source ICC Destination	sRGB Source ICC Destination
No ICC Destination Profile	ICC Source sRGB Destination	sRGB Source sRGB Destination

C.4 Standard Colour Space in Practice

Once page elements are converted to sRGB, the display application should interpret the colour space correctly and use the OS colour management to image the page. Table 3 below summarises how the display application handles colour management in each of the possible scenarios.

Table 3 How a Display Application Handles Colour Management

	Page Element Colours (sRGB)	Page with no Colour Space information	Re-purpose Data outside of Display application environment
Embedded Profile in Image	Colour Space for Image determined by embedded profile.	Colour Space for Image determined by embedded profile.	Colour Space for Image determined by embedded profile.
Image file specifies sRGB	Colour Space for Image is sRGB	Colour Space for Image is sRGB	Colour Space for Image is sRGB
Image has no Colour space information.	Colour Space for Image is sRGB	Colour Space for image is sRGB.	Colour Space for image is sRGB.
Text	Colour Space for text is sRGB	Colour Space for text is sRGB.	Colour Space for text is sRGB.
Graphics	Colour Space for Graphics is sRGB	Colour Space for graphics is sRGB.	Colour Space for graphics is sRGB.

C.5 Display Application Scenarios

The following cases describe what an end-user sees in the various scenarios:

C5.1 Image not in sRGB, does not have an embedded ICC profile, and no display/output device ICC profile

This is the behaviour before colour management systems were added. Even though the image is assumed to be in sRGB colour space, it is imaged (displayed, printed etc.) without translation to the device colour space since the output profile is not available. The quality varies tremendously since output device characteristics differ greatly.

C5.2 Image not in sRGB, does not have an embedded ICC profile, and system has a display/output device ICC profile

Since the image has no ICC profile, it is assumed to be in the sRGB colour space. In this scenario, the resulting image will be consistent across devices; however it could be different from the original image.

C5.3 Image in sRGB, and no display/output device ICC profile

In this scenario, the image has been run through a transform that consists of the input device ICC profile, and the sRGB ICC profile, or it was created using devices that conform to sRGB. However, since the system has no ICC profile for the output device, it will simply assume the image is in the device's colour space. If all the images rendered on the output device are in sRGB, then they will at least be consistent with respect to each other on a given display/output device.

C5.4 Image in sRGB, and system has a display/output device ICC profile

In this scenario, the image has been run through a transform that consists of the input device ICC profile, and the sRGB ICC profile, or it was created using devices that conform to sRGB. Because the system has an ICC profile for the output device, the image can be converted to the output device's colour space and imaged. The resulting image will be consistent across devices, and will be very close to the original in appearance.

C5.5 Image in sRGB, and display/output device is sRGB compliant

In this scenario, the image has been run through a transform that consists of the input device ICC profile, and the sRGB ICC profile, or it was created using devices that conform to sRGB. As the output device has been designed to conform to sRGB, and is associated with that ICC profile, a transform is not necessary for this case. The OS realises that no transformation is required and simply images the image directly on the output device. This case is ideal since there is no colour transformation at output time, and the image is more compact since there is no ICC profile embedded in it. The resulting image will be consistent across devices, and will be very close to the original in appearance.

C5.6 Image not in sRGB, has an embedded ICC profile, and no display/output device ICC profile

The decision to save the image in a device specific colour space and embed an ICC profile should result in equal or higher quality than saving the image in sRGB. Since the device specific colour space will not display correctly on an unknown output device, it will be transformed into sRGB, using the embedded ICC profile as the source profile and sRGB as the destination profile.

C5.7 Image not in sRGB, has an embedded ICC profile, and system has a display/output device ICC profile

This is the standard colour management scenario. The two ICC profiles are combined to produce a transform that will map the colours of the image into the output device's colour space. The resulting image will be consistent across devices, and will be very close to the original in appearance.

C.6 Authoring Scenarios

The following scenarios describe how to get an image into the sRGB colour space when creating it.

C6.1 Image created on a device that has no ICC profiles and is not sRGB compliant

Display the image on a display that is sRGB compliant or that has an ICC profile. Edit the image until it looks good on the display. For displays that are not sRGB compliant but have ICC profiles, depending on the capabilities of the application, either use the application to save the image as sRGB or embed the display's profile into the image, and use a tool to create a transform with the display's profile and the sRGB profile and run the image through the transform. If the image file format supports it, specify the image is in sRGB.

C6.2 Image created on a device that has ICC profiles and is not sRGB compliant

Use a tool to create a transform with device's profile and the sRGB profile. Then run the image through the transform, specify the image is in sRGB if the image file format supports it.

C6.3 Image created on a device that is sRGB compliant

Specify the image is in sRGB if the image file format supports this.

C.7 Palette Issues

There are several different scenarios to consider when dealing with palletised images and displays.

C7.1 Image does not have a colour table (> 8bpp), and client graphics subsystem is not palletised

The image is run through a colour management transform as described in the previous section, and the resulting 24bpp image is displayed on the display.

C7.2 Image has a colour table (8bpp) and client display is not palletised

The colour table accompanying the image is run through a colour management transform, and the resulting colour table is used with the image for display. The displayed image is very close to original image.

C7.3 Image does not have a colour table (>8bpp) and client display is palletised.

The software displaying the image (e.g. display application) should use the default palette that is defined in sRGB space, convert it into device colour space by running it through a colour management transform, and use this palette to display the image. The resulting image gets dithered into the closest possible colours on the display. The assumption is that the display profile is created with the default palette selected.

C7.4 Image has a colour table (8bpp) and was created using the default palette and client display is palletised

The software displaying the image should follow the same steps as above. The resulting image is very close to the original image and unintentional dithering is eliminated. If the original image only had colours in the default palette, the final image doesn't have any dithering.

C7.5 Image has a colour table (8bpp) and was created using an arbitrary palette and client display is palletised

If the client display only has a palletised profile and can only display the image by discarding this profiled palette and replacing it with an uncalibrated palette, it is not recommended to colour manage this scenario. If the client display is able to treat the image as if it was a truecolour (unpalettised) image, it should proceed as for case 3 above.

Note that cases 3 and 4 assume an industry standard default palette defined in sRGB colour space that will be used by authoring and display software to handle 8bpp images.

Annex F
(informative)
Typical Viewing Conditions

While office desktop would theoretically use the viewing conditions which represent the actual or typical office viewing environment, if this is done with 24 bit images a significant loss in the quality of shadow detail results. This is due to the typical viewing veiling glare of approximately 5 percent into a 24 bit image as opposed to the reference viewing veiling glare of 1 percent. This is somewhat compensated for by the apparent visual darkening effect of the lighter surround. It is therefore recommended to use the reference viewing environment for most situations including when one's viewing environment is consistent with the typical viewing environment and not the reference viewing environment.

1.	Typical Ambient Illuminance Level	200 lx
2.	Typical Ambient White Point	x = 0,3457, y = 0,3585 (D50)
3.	Typical Viewing Veiling glare	5,0%

The *typical ambient illuminance level* is intended to be representative of a typical office viewing environment. Note that the illuminance is at least an order of magnitude lower than average outdoor levels.

The chromaticities of the *typical ambient white* are those of CIE D_{50}.

Typical Viewing veiling glare is specified to be 5% of the maximum white-luminance level.

Annex G
(informative)
Recommended Treatment for Viewing Conditions

Colour appearance on a CRT display is significantly affected by the ambient lighting, since the human visual system changes its sensitivity according to the viewing conditions. At its meeting held in Kyoto in May 1997, CIE Technical Committee TC 1-34 agreed to adopt as the simple version the colour appearance model CIECAM97S. While the inclusion of the year 97 in the designation is intended to indicate the interim nature of the model, this same caveat is providing for the CIELAB and CIELUV colour spaces which are ubiquitous in colour reproduction work today and should not be discourage the use of this model. Still it is due to the newness of this recommendation that this model is a recommendation and not a requirement for compliance with this standard. In order to use this standard in viewing conditions that are not compliant with the reference conditions, it is therefore strongly recommended that the CIECAM97S colour appearance model be used to transform into and out of the reference viewing conditions.

Unfortunately, the CIECAM97S colour appearance model does not account for two important aspects of viewing conditions; veiling glare and black mapping.

The recommended veiling glare compensation is shown below. Equation 12 should be applied after equation 5 to provide input into the CIECAM97S model.

$$\begin{aligned} X_{CRT} &= X_{xRGB} + VG \times X_{ambient} \\ Y_{CRT} &= Y_{xRGB} + VG \times Y_{ambient} \\ Z_{CRT} &= Z_{xRGB} + VG \times Z_{ambient} \end{aligned} \qquad (12)$$

Equation 13 should be applied before equation 6 and after the CIECAM97S model.

$$\begin{aligned} X_{sRGB} &= X_{CRT} - VG \times X_{ambient} \\ Y_{sRGB} &= Y_{CRT} - VG \times Y_{ambient} \\ Z_{sRGB} &= Z_{CRT} - VG \times Z_{ambient} \end{aligned} \qquad (13)$$

Finally, it is strongly recommended to rescale the lightness dimension of the CIECAM97S model from 0 to 100 when using this standard. This allows the black colours as measured off the display faceplate to appropriately represent a visual black. Several experts have recommended this rescaling (Johnson 1996, Fairchild 1997) and it is common practice is the colour reproduction industry.

Note that is problematic to implement only veiling glare and not a viewing condition model and rescaling since this is NOT compliant with either CIE colour measurement or colour appearance recommendations. Instead it represents an intermediate physical measurement that does not represent colour appearance, but are dependent upon viewing conditions that colour appearance models describe.

Annex H
(informative)
Bibliography

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