

ICC Votable Proposal Submission
Perceptual Intent Reference Medium Color Gamut

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1. Introduction

In generating the color tables for the perceptual intent (AtoB0 and BtoA0) tags, it is necessary to include color re-rendering from the image data medium to the PCS perceptual intent reference medium in the AtoB0 tag, and from the perceptual intent reference medium to the reproduction medium in the BtoA0 tag. ICC.1:2004-04 specifies the reference medium white point, black point, and viewing conditions, but does not specify the color gamut. This omission has been intentional to allow profiling applications some flexibility in the handling of colors, particularly extreme colors.

However, in order to achieve better interoperability between profiles created by different software packages, it is helpful to have a recommended assumption for the PCS perceptual intent reference medium color gamut (PRMG). This is a "fuzzy" gamut in that perceptual intent transforms need not exactly match this gamut in the PCS, but profile creators should consider this gamut to be the target for perceptual intent color re-rendering to the PCS. Likewise, the perceptual intent color re-rendering from the PCS should assume the PRMG as the starting gamut for color re-rendering to the destination medium.

For example, the PCS side gamut produced by a particular AtoB0 tag should be roughly similar in size and shape to the PRMG. AtoB0 tag PCS gamuts may go outside the PRMG, but the probability of colors outside the PRMG being clipped will be larger than for colors within the PRMG. On the other hand, when input side AtoB0 tag PCS gamuts are much smaller in size than the PRMG, desaturated intermediate images will result on the PRM. This may result in desaturated final images when an output side color re-rendering from the PRMG to the actual reproduction medium assumes that the relatively desaturated images, as expressed on the reference medium, are desired.

2. The acceptance of this proposal will result in a:
minor revision of Specification *ICC.1:2004-10*

3. Nature of the proposal

This is a **new technical addition** to the specification(s).

The specification of the perceptual intent reference medium gamut, referring to ISO 12640-3, along with explanatory text is proposed to be added.

Two new optional tags indicating whether the standard perceptual intent reference medium gamut was used in the construction of the AtoB0 and BtoA0 (perceptual intent) tags and/or in the construction of the AtoB2 and BtoA2 (saturation intent) tags are proposed to be added.

4. Votable Proposal

Replace the existing section 6.3.3 with the following (and renumber tables thereafter):

6.3.3 Reference viewing environment and medium for the perceptual rendering intent

6.3.3.1 General

Because perceptual rendering generally involves mapping the colors of a source to be well-suited for a destination medium (i.e., color rendering and/or color re-rendering), it is desirable that the perceptual intent PCS reference medium (PRM) and associated viewing conditions be well-defined. Then, the source profile can perceptually render from the source to the PRM, and the destination profile can perceptually render from the PRM to the destination medium. The PRM, in the PCS, serves as the common intermediate representation. Well-defined viewing conditions are required because they will affect the appearance of color content represented on the PRM.

Perceptual rendering remains a proprietary art, due both to the current state of perceptual rendering algorithms, and also to the fact that viewer and application specific preferences can affect the nature of a desired reproduction (when exact color matching is not the objective). It is not practical or desirable to specify standard perceptual rendering algorithms. Consequently, it is also not practical or desirable to require that perceptual rendering intents match an exact perceptual intent reference medium gamut (PRMG). Gamut mapping could be applied to clip the results of a perceptual rendering algorithm to a specific target gamut, but that would result in a loss of information and invertibility. Therefore, the reference medium white point, black point, and viewing conditions attributes of the PRM are defined precisely, and the PRM gamut is defined to be a fuzzy target that can be used as the aim of perceptual rendering transforms, but does not have to be exactly matched.

6.3.3.2 Perceptual intent reference medium (PRM) characteristics

The reference medium is defined as a hypothetical print on a substrate specified to have a neutral reflectance of 89%. The darkest printable colour on this medium is assumed to have a neutral reflectance of 0,30911%, which is 0,34731% of the substrate reflectance. These shall be assumed to be the white point and black point of the reference medium respectively.

NOTE The reference medium therefore has a linear dynamic range of 287,9:1 and a density range of 2,4593.

6.3.3.3 Perceptual intent reference medium gamut (PRMG)

Perceptual rendering intent and saturation rendering intent transforms may optionally use the reflection color gamut specified in ISO 12640-3, and provided in Table 8, as the PRMG. This color gamut boundary description is intended only as an optional target for perceptual and saturation rendering intents, and these transforms should not clip to it. It is provided to enable improved interoperability of perceptual and saturation transforms. When the PRMG is used as the target color gamut for perceptual and saturation transforms, this should be indicated with the corresponding profile tags as described in 9.2.x1 and in 9.2.x2.

Table 8 – PRMG chroma limits as a function of CIE L* and hue (from ISO 12640-3)

hue [°]	MBP																		MWP		
	3.13	5	10	15	20	25	30	35	40	45	L*						95	100			
0	0	11	26	39	52	64	74	83	91	92	91	87	82	75	67	57	47	37	25	13	0
10	0	10	24	38	50	62	73	82	90	92	91	87	82	75	67	58	48	37	26	13	0
20	0	10	23	37	50	62	73	84	93	94	94	90	85	78	70	60	50	39	27	14	0
30	0	9	22	35	48	61	74	86	98	100	101	96	90	83	75	65	54	42	30	15	0
40	0	8	21	34	47	60	73	83	93	97	101	99	97	90	83	73	61	47	34	17	0
50	0	8	20	32	43	55	66	77	88	95	99	101	100	98	92	85	72	56	40	20	0
60	0	7	17	27	37	47	57	67	76	84	91	96	100	102	103	98	90	72	51	26	0
70	0	6	16	25	34	43	52	60	68	76	83	90	96	100	104	107	109	100	74	37	0
80	0	6	15	23	32	40	48	57	64	71	78	85	91	97	103	107	110	113	110	70	0
90	0	6	14	22	30	39	47	55	62	68	75	82	88	95	101	106	112	117	120	123	0
100	0	6	14	22	30	38	46	54	61	68	74	81	88	94	100	106	109	112	112	92	0
110	0	6	14	22	31	39	47	55	63	69	76	83	89	96	100	103	106	107	102	75	0
120	0	6	15	24	32	41	49	58	66	73	80	87	93	98	101	102	99	91	73	50	0
130	0	6	16	25	35	44	54	63	72	80	87	93	97	101	99	94	86	73	56	34	0
140	0	7	18	28	38	48	57	67	77	86	95	98	101	97	93	85	75	61	44	26	0
150	0	7	19	30	40	51	62	72	83	92	97	99	96	91	85	76	66	52	37	22	0
160	0	7	20	32	44	56	68	80	92	96	99	97	92	87	79	70	59	46	33	19	0
170	0	8	20	32	43	53	64	75	85	91	96	93	89	82	75	65	55	42	30	17	0
180	0	8	20	31	41	52	62	72	81	87	92	90	86	79	71	61	52	40	28	15	0
190	0	8	20	30	40	50	60	68	76	82	87	85	82	76	69	60	50	39	27	14	0
200	0	8	20	30	38	47	56	63	70	76	82	81	77	72	66	58	49	38	27	14	0
210	0	8	20	29	37	46	53	60	66	73	79	80	75	70	64	57	49	38	27	14	0
220	0	8	20	29	37	45	52	59	65	71	76	75	72	68	63	56	48	38	27	14	0
230	0	9	20	29	38	46	53	59	65	70	75	73	71	66	61	54	46	36	26	13	0
240	0	10	22	31	40	48	55	61	67	71	74	70	66	61	56	49	41	32	23	12	0
250	0	11	24	34	43	51	59	65	70	73	71	68	63	58	52	45	38	30	21	11	0
260	0	14	27	38	48	57	64	69	73	73	70	66	61	56	50	43	35	28	20	10	0
270	0	17	32	45	55	65	70	75	75	73	70	66	61	55	49	42	34	27	19	10	0
280	0	21	42	55	68	75	81	80	79	76	72	67	61	55	49	41	34	26	18	9	0
290	0	26	52	68	83	86	89	87	84	80	75	69	63	57	50	42	35	27	18	10	0
300	0	25	69	82	95	94	93	91	88	85	79	73	66	59	52	44	36	28	19	10	0
310	0	21	51	74	91	97	100	98	95	90	84	77	70	63	55	47	39	30	20	10	0
320	0	18	41	62	79	91	102	101	98	95	89	83	76	68	60	51	42	32	22	11	0
330	0	16	35	53	71	82	91	100	104	102	98	91	84	76	67	57	47	36	24	12	0
340	0	14	31	46	61	73	83	92	101	103	99	95	89	80	71	61	50	38	26	13	0
350	0	12	28	42	55	68	77	86	94	96	93	90	85	77	68	58	48	37	25	13	0

Furthermore, as several popular source-to-destination color re-rendering algorithms are defined via transformations of primaries and secondaries, approximate locations for Red, Green, Blue, Cyan, Magenta and Yellow in the PRMG have also been specified. These coordinates are provided in Table 9.

Table 9 – PRMG "primary and secondary" colors

	Red	Yellow	Green	Cyan	Blue	Magenta
L* _{ab}	41	95	60	50	21	42
C* _{ab}	98	123	100	76	95	102
h _{ab}	29	90	140	220	300	340

6.3.3.4 Perceptual intent reference medium viewing conditions

The reference viewing environment shall be based on standard viewing condition P2, as specified for graphic arts and photography in ISO 3664, but extended as follows: It is characterized by an "average" surround, which means that the illumination of the image shall be assumed to be similar to the illumination of the rest of the environment. The surfaces immediately surrounding the image shall be assumed to be a uniform matt grey with

a reflectance of 20%. The reference viewing environment shall also be assumed to have a level of viewing flare of 0,0075 (3/4%) of the luminance of the reference medium in the reference viewing environment (1,06 cd/m2). If the actual viewing environment differs from the reference viewing environment perceptual transforms must compensate for the difference in viewing environments.

NOTE ISO 3664 describes the appropriate illumination level for practical appraisal of prints as 500 lux (P2), which is specified to be typical of the level found in actual home and office viewing environments, This was deemed to be most appropriate for the reference viewing environment.

Add the following to Section 9.2 and re-number 9.2 section paragraphs and document tables:

9.2.x1 perceptualRenderingIntentGamutTag

Tag signature: ‘rig0’ (72696730h)

Allowed tag type: signatureType

There is only one standard reference medium gamut, defined per ISO 12640-3. When the signature is present, the specified gamut is defined to be the reference medium gamut for the PCS side of both the A2B0 and B2A0 tags, if they are present. If this tag is not present the perceptual rendering intent reference gamut is unspecified.

The standard PCS reference medium gamut signatures that shall be used are listed in Table y1:

Table y1 — Perceptual rendering intent gamut

Perceptual rendering intent gamut	Signature	Hex Encoding
Perceptual reference medium gamut	‘prmg’	70726D67h

NOTE 1 Because the perceptual intent is the typical default rendering intent, it is most important to use the PRMG for this rendering intent.

NOTE 2 It is possible that the ICC will define other signature values in the future.

9.2.x2 saturationRenderingIntentGamutTag

Tag signature: ‘rig2’ (72696732h)

Allowed tag type: signatureType

There is only one standard reference medium gamut, defined per ISO 12640-3. When the signature is present, the specified gamut is defined to be the reference medium gamut for the PCS side of both the A2B2 and B2A2 tags, if they are present. If this tag is not present the saturation rendering intent reference gamut is unspecified.

The standard PCS reference medium gamut signatures that shall be used are listed in Table y2:

Table y2— Saturation rendering intent gamut

Saturation rendering intent gamut	Signature	Hex Encoding
Perceptual reference medium gamut	'prmg'	70726D67h

NOTE It is possible that the ICC will define other signature values in the future.

5. Applications and Workflows

The perceptual intent reference medium concept is one of the more fundamental changes of the ICC version 4 major revision. This proposal is intended to further support this concept by providing a color rendering and color re-rendering target gamut.

The PRMG is generally representative of the colors reproducible on reflection media, with the gamuts of most ink-jet, laser, and silver halide printers being contained within the boundary, and of roughly similar shape. Although it is possible that some printers may produce colors that are outside of the gamut, for example using fluorescent inks, having one common rendering target gamut will enable improved interoperability by providing a common PCS reference medium gamut for perceptual transforms. A key characteristic of the reference medium gamut is the shape, which resembles more an average of printer gamuts than for example a monitor gamut. Another essential characteristic of the perceptual intent reference medium gamut is its fuzziness. The idea is to use the reference medium gamut as a fuzzy target for color rendering and color re-rendering algorithms going from a source encoding to the PCS, and as a fuzzy PCS gamut for re-rendering algorithms going from the PCS to an actual medium. Colors that are captured as different signals by an input device and rendered distinctly inside the PRMG are more likely to be reproduced as different colors on printed output if a perceptual rendering intent is used. Colors that are rendered to locations outside the PRMG will more likely be clipped on printed output. As a consequence a more consistent reproduction on a set of output devices will be enabled. As the PRMG is a reflection medium gamut, the extent of the re-rendering will be greater for source or destination media that are non-reflective in nature.

More details about the development of the PRMG can be found in the ISO 12640-3.

6. Revisions

11 February 2005 - minor editorial clarifications in the introduction and 9.2.31; removed unnecessary wording in 6.3.3.3

17 February 2005 - clarification of proposed new tags to use signatures rather than bit codes

22 February 2005 - correction of date on ICC.1 reference