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Standard Practice for Specifying and Matching Color Using the Colorcurve System¹

This standard is issued under the fixed designation E 1541; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

The COLORCURVE® System² provides a systematic array of color samples whose arrangement has a simple relationship to the international CIE 1964 system, described in Test Method E 308 and used widely in industry to specify color and color differences from instrumental measurements. The system is based on four main elements: (1) aim points displayed on CIE (CIELAB) a^* , b^* planes at constant L^* ; (2) atlases containing physical representations of those aim points; (3) tables of spectral and colorimetric data for those aim points; and (4) computational methods and computer software that furnish Colorcurve notations and reflectances when CIE data are entered, or tristimulus values and reflectance data when Colorcurve notations are entered. The tristimulus data can be used in color formulation software to formulate specimens with minimum metamerism to the atlas samples.

The Master Atlas consists of 1231 atlas samples approximating the computed aim points and the corresponding data tables. A separate Gray and Pastel Atlas contains 956 additional samples, for a total of 2187 unique samples.

1. Scope

1.1 This practice provides a means for specifying the colors of objects in terms of the Colorcurve system. Both computational and visual methods are included. This practice is applicable to inked, painted, dyed, or mass-colored surfaces viewed by an observer with normal color vision.

1.2 This practice includes a method for producing a color specimen to match a Colorcurve sample.

1.3 This practice does not cover the preparation of specimens. If specimen preparation is required in conjunction with this practice, a mutually agreed upon procedure shall be established.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

D 1729 Practice for Visual Appraisal of Color and Color

¹ This practice is under the jurisdiction of ASTM Committee E-12 on Color and Appearance and is the direct responsibility of Subcommittee E12.07 on Color Order Systems US Tag ISO TC 187.

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² Colorcurve® is a registered U.S. trademark used by ASTM under the authorization of Colorcurve Systems, Inc. Aspects of Colorcurve technology are covered by U.S. Patent 5 012 482.

Differences of Diffusely-Illuminated Opaque Materials³

E 284 Terminology of Appearance³

E 308 Practice for Computing the Colors of Objects by Using the CIE System³

E 1164 Practice for Obtaining Spectrophotometric Data for Object-Color Evaluation³

3. Terminology

3.1 Definitions of appearance terms in Terminology E 284 are applicable to this practice.

3.2 Definitions:

3.2.1 *chromaticness, n*—the attribute of visual sensation combining the hue and saturation.

3.2.2 *hue, n*—the attribute of color perception by means of which an object is judged to be red, yellow, green, blue, purple, or intermediate between some adjacent pair of these, considered in a closed ring (red and purple being an adjacent pair).

3.3 Definitions of Terms Specific to This Standard:

3.3.1 *Colorcurve atlas, n*—physical exemplification of the Colorcurve system, consisting of a three-dimensional array of 2187 samples displayed on CIELAB cartesian coordinates in two atlases.

3.3.2 *Colorcurve system, n*—a color order system based on the CIE 1964 space, which uses the CIELAB L^* lightness scale ($L^* = L$) and in which chromaticity is represented by opponent-color scales R/G (reds-greens) and Y/B (yellows-blues).

³ Annual Book of ASTM Standards, Vol 06.01.

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3.3.3 *lattice scaling constant, n* —ratio of the distance between adjacent samples at a system boundary (CIELAB chroma $C^* = 60$ for a major or minor hue axis) and the distance between the major and adjacent minor hue axes. In the Colorcurve system, this is $1/7$.

3.3.4 *major hue axis, n* —in the Colorcurve system, central vertical or horizontal axis, that is, a line of sample points whose notations contain only a single hue term, for example, L45 R3.

3.3.5 *minor hue axis, n* —in the Colorcurve system, central diagonal axis, that is, a line of sample points whose notations contain two hue terms in the same amounts, for example, L45 R3Y3.

4. Summary of Practice

4.1 *Visual Method of Determining Colorcurve Notations*—Colorcurve atlas samples are used as references in judging the color of a specimen. Observers shall have normal color vision. Good illumination by either natural daylight or any broad band source shall be used. Specimens shall be viewed on a background with lightness similar to that of the Colorcurve atlas samples with which the specimen is being compared.

4.2 *Computation Method of Determining Colorcurve*

Notations—CIE 1964 tristimulus values for standard illuminant D65 and the 1964 supplementary (10°) standard observer are obtained from spectrophotometric or spectrophotometric measurements. See Practice E 308 and Practice E 1164. Available computer software can be used to convert the tristimulus values into Colorcurve notations. A Colorcurve notation can be estimated without software by interpolating between the tristimulus values for Colorcurve samples listed in Table 1 or in the data tables furnished with the Colorcurve atlases.

4.3 *Determining Tristimulus Values for Colorcurve Notations*—Tristimulus values for a Colorcurve sample, or color specimen for which a Colorcurve notation is known, are found by referring to Table 1, or the data tables furnished with the Colorcurve atlases. If the specimen's Colorcurve notation lies between those listed in the table, a method of calculating the specimen's tristimulus values is given.

4.4 *Method for Formulating Matches*—The spectrophotometric or spectrophotometric data given in the atlas for the chosen aim color are entered into a computer with formulation software, which calculates the match using the colorants characterized in the software.

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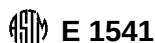


TABLE 1 Spectral and Colorimetric Data for the Aim Points of the Colorcurve System

Colorcurve	400	420	440	460	480	500	520	540	560	580	600	620	640	660	680	700	L*	a*	b*	X	Y	Z
L30 N	6.15	6.40	6.25	6.17	6.22	6.27	6.18	6.12	6.40	6.30	6.24	6.16	6.06	5.93	5.88	5.82	30.00	0.00	0.00	5.91	6.24	6.70
L30 Y1	5.16	5.22	5.15	5.19	5.56	6.03	5.95	6.19	6.61	6.56	6.55	6.52	6.42	6.29	6.25	6.21	30.00	0.00	4.34	5.92	6.24	5.67
L30 R1Y1	5.70	5.70	5.50	5.37	5.19	5.15	5.07	5.38	6.08	7.29	7.94	8.24	8.24	8.14	8.10	8.09	30.00	7.14	3.60	6.57	6.24	5.82
L30 R2Y1	7.58	6.80	5.69	5.02	4.63	4.50	4.48	4.53	4.86	6.62	9.65	12.33	13.62	14.10	14.42	14.71	30.00	17.20	3.58	7.59	6.24	5.83
L30 R1	7.28	7.20	6.54	5.98	5.47	5.23	5.03	5.12	5.37	7.10	8.44	9.17	9.49	9.54	9.59	9.65	30.00	10.65	0.00	6.93	6.24	6.69
L30 R1B1	8.82	9.75	9.27	8.35	7.20	6.33	5.69	5.51	5.51	6.29	6.90	6.90	7.27	8.46	9.49	10.16	30.00	7.15	-0.88	6.58	6.24	9.20
L30 R1B2	10.47	13.18	13.89	12.75	10.24	7.50	6.06	5.46	5.23	5.29	5.58	5.40	5.75	7.17	8.59	9.10	30.00	7.15	-20.72	6.58	6.24	13.44
L30 B1	8.86	10.33	10.71	10.35	9.34	7.92	6.78	6.02	5.43	5.07	4.98	4.98	5.19	5.52	5.71	5.81	30.00	0.00	4.16	5.90	6.24	10.91
L30 G1B1	7.60	8.37	8.60	8.72	8.63	8.25	7.57	6.56	5.49	4.83	4.64	4.71	4.89	4.96	4.96	5.04	30.00	-5.06	-8.86	5.48	6.24	9.21
L30 G1	5.64	5.92	5.99	6.24	6.84	7.33	7.17	6.76	6.21	5.67	5.13	4.85	4.77	4.78	4.93	5.01	30.00	-6.52	0.00	5.36	6.24	6.71
L30 G1Y1	5.14	5.22	5.19	5.30	5.97	6.92	6.83	6.64	6.33	6.01	5.66	5.42	5.32	5.29	5.38	5.43	30.00	-5.06	3.59	5.47	6.24	5.83
L30 G1Y2	4.20	4.15	4.17	4.29	5.04	6.69	6.69	6.70	6.47	6.21	5.95	5.79	5.72	5.69	5.78	5.86	30.00	-5.06	8.40	5.48	6.24	4.79
L30 G2Y1	4.77	4.86	4.95	5.28	6.49	8.15	8.00	7.21	6.06	5.15	4.53	4.30	4.28	4.35	4.54	4.65	30.00	-11.91	3.61	4.91	6.24	5.83
L35 N	8.21	8.76	8.52	8.39	8.49	8.57	8.42	8.35	8.73	8.65	8.53	8.39	8.21	8.00	7.89	7.79	35.00	0.00	0.00	8.06	8.50	9.13
L35 Y1	7.04	7.30	7.14	7.13	7.64	8.23	8.16	8.21	8.93	9.00	8.92	8.80	8.63	8.41	8.31	8.22	35.00	0.00	4.38	8.05	8.50	7.82
L35 Y2	5.80	5.88	5.80	5.88	6.68	7.94	7.96	8.13	9.18	9.36	9.32	9.23	9.06	8.86	8.77	8.71	35.00	0.00	9.31	8.06	8.50	6.52
L35 R1Y1	7.53	7.82	7.55	7.38	7.18	7.01	6.86	7.17	8.77	10.13	10.58	10.63	10.44	10.19	10.05	9.96	35.00	7.10	3.74	8.86	8.50	8.00
L35 R1Y2	6.19	6.31	6.18	6.17	6.37	6.59	6.54	7.00	9.37	10.52	10.89	10.95	10.74	10.48	10.34	10.26	35.00	7.02	8.61	8.86	8.50	6.71
L35 R2Y1	8.37	8.45	7.80	7.23	6.61	6.27	5.89	6.13	6.66	10.21	13.90	14.88	15.04	14.90	14.83	14.81	35.00	17.05	3.74	10.08	8.50	8.01
L35 R2Y2	6.70	6.77	6.51	6.34	6.11	6.01	5.85	6.31	7.81	10.97	13.03	13.51	13.42	13.17	13.04	12.98	35.00	13.74	7.91	9.67	8.50	6.88
L35 R3Y1	9.99	9.70	8.08	6.80	5.85	5.46	5.15	5.24	5.48	8.63	16.25	20.14	21.33	21.63	21.81	22.00	35.00	26.19	3.76	11.29	8.50	8.00
L35 R3Y2	7.61	7.39	6.72	6.17	5.64	5.42	5.19	5.44	5.93	9.49	16.12	18.66	19.29	19.34	19.38	19.48	35.00	23.14	7.85	10.88	8.50	6.89
L35 R1	9.02	9.42	8.85	8.31	7.79	6.88	6.35	5.93	6.09	9.60	14.49	16.07	16.49	16.47	16.47	16.50	35.00	10.57	-0.01	9.28	8.50	9.13
L35 R2	10.34	10.52	9.21	7.99	6.88	6.35	5.82	5.93	6.09	9.60	14.49	16.07	16.49	16.47	16.47	16.50	35.00	20.13	0.00	10.50	8.50	9.14
L35 R1B1	11.31	12.65	11.99	1.00	9.77	8.80	7.81	7.57	7.30	8.75	9.58	9.52	9.66	10.21	10.58	10.75	35.00	7.10	-8.62	8.87	8.50	12.08
L35 R1B2	13.57	16.83	17.24	16.03	13.48	10.29	8.28	7.39	7.09	7.26	8.00	7.65	8.09	10.48	12.74	13.55	35.00	7.11	-20.24	8.87	8.50	16.99
L35 R1B3	15.19	20.56	22.68	21.19	16.82	11.67	8.70	7.36	6.64	6.32	6.44	6.13	6.42	7.64	8.52	8.44	35.00	7.04	-29.77	8.80	8.50	21.89
L35 R2B1	13.82	14.89	12.57	10.23	8.27	7.37	6.46	6.05	6.31	9.62	12.53	12.86	13.06	13.48	13.51	12.80	35.00	16.99	-8.62	10.07	8.50	12.07
L35 R2B2	13.64	18.99	16.00	12.58	9.73	8.45	7.15	7.05	6.65	9.39	10.34	10.07	10.19	10.74	10.78	9.93	35.00	13.75	-15.89	9.67	8.50	15.03
L35 R2B3	15.72	20.57	21.18	18.58	14.09	9.85	7.63	6.84	6.64	7.17	8.48	8.14	8.96	14.49	23.25	29.29	35.00	13.68	-26.11	9.66	8.50	19.92
L35 B1	11.76	13.31	13.59	13.24	12.30	10.71	9.23	8.24	7.45	7.09	7.26	7.01	7.17	8.05	8.60	8.69	35.00	0.00	-13.55	8.06	8.50	14.03
L35 B2	13.08	16.95	18.86	18.46	15.94	12.27	9.53	7.88	6.68	5.95	5.72	5.60	5.82	6.27	6.50	6.46	35.00	0.00	-24.46	8.03	8.50	18.90
L35 B3	12.90	19.47	23.83	24.26	20.35	14.48	10.24	7.62	5.68	4.74	4.55	4.29	4.40	5.01	5.31	5.25	35.00	0.00	-33.17	8.06	8.50	23.84
L35 G1B1	10.17	11.51	11.47	11.24	10.90	10.49	9.94	9.10	7.98	7.00	6.51	6.31	6.34	6.41	6.36	6.21	35.00	-5.06	-8.61	7.51	8.50	12.08
L35 G1B2	11.80	14.78	16.38	16.54	15.36	13.13	10.67	8.46	6.63	5.61	5.29	5.26	5.46	5.68	5.71	5.69	35.00	-5.06	-20.23	7.51	8.50	16.98
L35 G1B3	10.61	14.25	19.94	23.97	22.04	16.38	10.67	7.00	5.14	4.46	4.37	4.55	4.83	4.97	4.96	5.06	35.00	-5.09	-29.81	7.52	8.50	21.92
L35 G2B1	8.51	11.81	10.63	11.81	12.70	12.47	11.34	9.40	7.29	5.94	5.32	5.15	5.23	5.31	5.40	5.45	35.00	-12.11	-8.61	6.80	8.50	12.08
L35 G3B1	7.11	8.08	9.30	12.04	15.76	15.83	12.72	8.75	5.99	4.85	4.49	4.49	4.64	4.73	4.83	4.97	35.00	-19.49	-8.62	6.09	8.50	12.07
L35 G1	7.57	8.19	8.24	8.47	9.15	9.75	9.58	9.16	8.58	7.92	7.13	6.62	6.41	6.33	6.51	6.63	35.00	-6.63	0.00	7.36	8.50	9.14
L35 G2	6.65	7.30	7.73	8.68	10.24	11.20	10.85	9.82	8.34	6.90	5.69	5.17	5.05	5.08	5.35	5.54	35.00	-13.73	0.00	6.64	8.50	9.13
L35 G3	5.77	6.31	6.95	8.74	12.08	13.43	12.48	10.07	7.28	5.53	4.61	4.34	4.32	4.41	4.63	4.77	35.00	-21.19	0.00	5.93	8.50	9.12
L35 G1Y1	6.96	7.28	7.17	7.25	8.11	9.27	9.24	8.99	8.64	8.25	7.82	7.48	7.29	7.15	7.19	7.21	35.00	-5.09	3.76	7.51	8.50	8.00
L35 G1Y2	5.87	5.97	5.89	5.98	7.01	8.89	9.01	8.92	8.76	8.54	8.36	8.21	8.06	7.89	7.81	7.76	35.00	-4.36	8.59	7.59	8.50	6.71
L35 G2Y1	6.36	6.75	6.88	7.32	8.08	10.49	10.42	9.74	8.65	7.47	6.31	5.73	5.56	5.56	5.84	6.05	35.00	-12.06	3.76	6.80	8.50	8.00
L35 G2Y2	5.75	5.91	5.91	6.14	7.44	9.83	10.03	9.62	8.86	7.97	6.97	6.40	6.20	6.17	6.43	6.63	35.00	-10.41	7.89	6.96	8.50	6.88
L35 G3Y1	5.67	6.06	6.42	7.36	9.96	12.37	12.08	10.35	7.99	6.16	5.01	4.61	4.55	4.62	4.88	5.06	35.00	-19.63	3.79	6.09	8.50	8.00
L35 G3Y2	5.28	5.53	5.67	6.14	7.99	11.24	11.47	10.42	8.66	6.93	5.51	4.92	4.78	4.82	5.14	5.39	35.00	-17.76	7.91	6.26	8.50	6.88
L35 G3Y3	4.53	4.67	4.70	4.98	6.63	10.31	10.93	10.34	8.09	7.63	6.13	5.36	5.13	5.12	5.48	5.79	35.00	-16.06	12.51	6.42	8.50	5.76
L40 N	10.03	11.54	11.27	11.15	11.22	11.28	11.03	10.98	11.63	11.52	11.27	11.04	10.79	10.55	10.30	10.17	40.00	0.00	0.00	10.67	11.25	12.08
L40 Y1	9.09	9.79	9.52	9.54	10.21	10.90	10.72	10.80	12.00	11.99	11.76	11.53	11.28	11.03	10.78	10.65	40.00	0.00	4.55	10.67	11.25	10.45
L40 Y2	7.67	8.05	7.85	7.93	9.03	10.43	10.66	10.89	12.04	12.23	12.25	12.18	12.04	11.85	11.74	11.59	40.00	0.00	9.62	10.67	11.25	8.81
L40 Y3	6.30	6.34	6.22	6.35	7.71	9.88	10.47	10.96	12.31	12.60	12.70	12.69	12.61	12.48	12.42	12.30	40.00	0.00	15.35	10.67	11.25	7.18
L40 R1Y1	9.54	10.40	10.01	9.83	9.52	9.18	8.91	9.33	12.39	13.50	13.53	13.32	13.03	12.74	12.44	12.30	40.00	6.99	3.94	11.62	11.25	10.66
L40 R1Y2	8.11	8.56	8.29	8.26	8.64	8.95	8.92	9.30	12.46	13.64	14.11	14.19	14.06	13.86	13.74	13.59	40.00	7.00	8.94	11.62	11.25	9.02

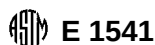


TABLE 1 Continued

Colorcurve	400	420	440	460	480	500	520	540	560	580	600	620	640	660	680	700	L*	a*	b*	X	Y	Z
L40 R1Y3	6.67	6.77	6.60	6.67	7.52	8.51	8.70	9.28	12.68	14.03	14.59	14.73	14.66	14.51	14.45	14.35	40.00	7.00	14.57	11.62	11.25	7.39
L40 R2Y1	10.26	11.07	10.33	9.70	8.96	8.37	7.77	7.99	9.61	14.48	17.43	18.09	18.17	18.07	18.01	17.89	40.00	16.87	3.96	13.07	11.25	10.66
L40 R2Y2	8.62	9.13	8.72	8.50	8.21	7.90	7.66	8.09	11.62	14.82	16.28	16.62	16.56	16.38	16.28	16.16	40.00	13.61	8.27	12.57	11.25	9.23
L40 R2Y3	13.57	7.91	6.83	6.91	6.94	6.53	6.50	7.47	14.03	16.03	16.28	16.09	15.82	15.47	15.21	14.88	40.00	13.62	13.80	12.58	11.25	7.61
L40 R2Y4	5.54	5.33	5.34	5.59	5.96	6.38	6.51	7.59	13.25	16.61	17.11	16.82	16.43	16.07	15.77	15.71	40.00	13.63	20.19	12.58	11.25	5.98
L40 R3Y1	11.21	11.98	10.69	9.44	8.18	7.41	6.63	6.77	7.48	14.07	21.28	23.28	23.79	23.94	24.04	24.02	40.00	26.05	3.95	14.51	11.25	10.66
L40 R3Y2	9.33	9.74	8.99	8.36	7.65	7.14	6.62	6.94	78.00	15.03	20.38	21.73	22.02	22.04	22.07	22.03	40.00	23.02	8.27	14.02	11.25	9.24
L40 R3Y3	7.49	7.70	7.38	7.24	6.97	6.69	6.29	6.86	10.16	17.08	19.04	19.51	19.46	19.28	19.20	19.11	40.00	19.90	13.06	13.53	11.25	7.81
L40 R1	10.97	12.31	11.65	11.10	10.30	9.66	8.96	9.16	10.38	13.71	14.72	14.62	14.36	14.07	13.75	13.59	40.00	10.43	0.00	12.11	11.25	12.08
L40 R2	12.00	13.25	12.04	10.81	9.48	8.62	7.69	7.76	8.36	13.97	18.37	19.44	19.67	19.66	19.65	19.54	40.00	20.05	0.00	13.55	11.25	12.08
L40 R3	13.20	14.56	12.48	10.38	8.49	7.51	6.53	6.53	6.72	13.24	22.01	24.74	25.51	25.79	25.96	25.97	40.00	29.02	0.00	15.00	11.25	12.08
L40 R1B1	12.76	15.93	15.25	14.27	12.78	11.68	10.36	10.03	9.71	11.86	12.64	12.43	12.43	12.75	12.72	12.64	40.00	6.99	-8.39	11.62	11.25	15.51
L40 R1B2	16.15	20.97	21.22	19.89	17.15	13.67	11.11	9.81	9.35	9.65	10.76	10.46	11.29	14.56	17.44	18.46	40.00	7.00	-19.80	11.62	11.25	21.14
L40 R1B3	18.53	25.88	27.58	25.61	20.75	15.17	11.59	9.83	8.91	8.65	8.99	8.54	9.11	11.31	12.86	12.59	40.00	7.00	-29.33	11.62	11.25	26.77
L40 R2B1	14.72	17.48	15.84	13.74	11.55	10.24	8.81	8.58	8.26	12.78	16.04	16.72	17.09	17.57	17.80	17.74	40.00	16.87	-8.39	13.06	11.25	15.51
L40 R2B2	16.49	20.62	19.47	17.11	14.16	11.82	9.77	9.11	8.72	11.18	13.55	13.66	14.74	18.09	20.59	21.47	40.00	13.62	-15.62	12.58	11.25	18.94
L40 R2B3	18.79	25.53	25.75	22.81	17.96	13.29	10.31	9.09	8.68	9.61	11.42	11.21	12.61	18.99	27.43	32.37	40.00	13.61	-25.78	12.58	11.25	24.57
L40 R3B1	16.23	19.20	16.38	13.17	10.34	8.86	7.44	7.26	7.05	12.69	19.37	21.11	22.41	24.63	25.91	26.24	40.00	26.05	-8.39	14.51	11.25	15.51
L40 R3B2	18.45	23.01	20.23	16.26	12.47	10.21	8.31	7.89	7.60	11.78	16.60	17.39	19.45	25.96	31.78	34.18	40.00	23.01	-15.61	14.02	11.25	18.94
L40 R3B3	20.05	26.63	24.11	19.51	14.55	11.34	9.09	8.52	8.32	10.97	14.08	13.72	15.58	24.76	39.13	51.62	40.00	19.90	-22.01	13.53	11.25	22.37
L40 B1	13.09	17.05	17.15	16.68	15.42	13.71	11.96	10.93	10.22	9.87	9.80	9.37	9.49	10.25	10.45	10.17	40.00	0.00	-13.14	10.67	11.25	17.71
L40 B2	17.37	22.54	22.79	22.07	20.31	16.68	12.37	10.05	9.21	9.01	8.31	7.27	7.77	9.39	9.65	8.28	40.00	0.00	-23.71	10.67	11.25	23.34
L40 B3	15.36	23.70	29.01	29.50	24.54	17.85	13.01	10.37	8.36	7.11	6.57	6.28	6.33	6.63	6.63	6.43	40.00	0.00	-32.69	10.67	11.25	28.97
L40 G1B1	12.25	14.62	14.69	14.55	14.04	13.57	12.85	11.99	10.79	9.62	8.88	8.50	8.41	8.52	8.40	8.13	40.00	-5.17	-8.39	10.00	11.25	15.51
L40 G1B2	15.66	20.23	20.68	19.69	18.49	17.11	13.35	11.53	9.11	8.41	7.44	7.02	7.00	7.22	7.15	6.85	40.00	-5.16	-19.81	10.00	11.25	21.14
L40 G1B3	15.90	22.63	26.22	26.63	23.65	18.85	14.37	10.94	8.13	6.57	5.97	5.72	5.84	6.18	6.23	5.98	40.00	-5.16	-29.34	9.99	11.25	26.77
L40 G1B4	14.49	22.36	30.91	34.93	30.05	21.84	14.73	9.74	6.54	5.20	4.79	4.71	4.83	4.99	4.99	4.90	40.00	-5.16	-37.61	10.00	11.25	32.40
L40 G2B1	10.33	12.87	13.89	15.12	15.68	15.47	14.41	12.65	10.30	8.40	7.29	6.80	6.67	6.72	6.80	6.76	40.00	-12.28	-8.39	9.12	11.25	15.51
L40 G2B2	15.30	15.70	17.20	18.70	18.50	16.90	14.60	11.90	9.56	7.64	6.67	6.50	6.77	6.97	6.74	6.52	40.00	-10.58	-15.62	9.32	11.25	18.94
L40 G2B3	12.48	18.57	23.04	25.06	23.79	20.59	15.51	10.83	7.59	6.16	5.67	5.52	5.52	5.60	5.55	5.49	40.00	-10.57	-25.78	9.33	11.25	24.57
L40 G2B4	13.03	19.74	27.67	32.67	30.30	23.77	15.84	9.58	6.06	4.80	4.46	4.44	4.54	4.63	4.60	4.55	40.00	-10.57	-34.49	9.32	11.25	30.20
L40 G3B1	9.31	11.41	12.89	15.45	17.85	18.04	16.29	13.08	9.31	6.96	5.85	5.43	5.37	5.42	5.51	5.48	40.00	-19.88	-8.39	8.24	11.25	15.51
L40 G3B2	11.17	14.37	16.51	18.98	20.35	19.52	16.64	12.36	8.31	6.25	5.46	5.22	5.24	5.34	5.35	5.22	40.00	-18.05	-15.62	8.45	11.25	18.94
L40 G1	9.43	10.82	10.91	11.25	12.04	12.77	12.51	12.04	11.40	10.60	9.55	8.87	8.55	8.43	8.56	8.72	40.00	-6.80	0.00	9.79	11.25	12.08
L40 G2	8.97	9.30	10.10	11.70	13.70	14.40	13.90	12.80	11.30	9.37	7.75	7.05	6.82	6.79	7.02	7.24	40.00	-14.03	0.00	8.91	11.25	12.08
L40 G3	7.83	8.33	9.52	11.98	14.92	15.98	15.22	13.60	11.33	8.43	6.00	4.95	4.60	4.56	4.90	5.23	40.00	-21.74	0.00	8.04	11.25	12.08
L40 G4	7.19	8.24	9.10	11.33	16.20	20.08	18.24	13.77	9.10	6.24	4.85	4.37	4.43	4.74	4.92	4.79	40.00	-30.03	0.00	7.16	11.25	12.08
L40 G1Y1	9.41	9.68	9.55	9.70	10.77	12.19	12.13	11.84	11.42	11.01	10.43	10.03	9.73	9.54	9.47	9.48	40.00	-5.17	3.95	10.00	11.25	10.66
L40 G1Y2	7.96	8.09	7.90	8.03	9.49	11.90	12.05	11.83	11.52	11.26	10.96	10.71	10.48	10.28	10.07	9.98	40.00	-5.16	8.94	10.00	11.25	9.02
L40 G1Y3	6.24	6.43	6.29	6.46	8.17	11.07	11.83	12.05	11.86	11.61	11.35	11.15	10.99	10.82	10.78	10.69	40.00	-5.17	14.57	10.00	11.25	7.40
L40 G2Y1	8.32	9.04	9.22	9.79	11.53	13.63	13.51	12.76	11.58	10.13	8.56	7.75	7.44	7.39	7.67	7.95	40.00	-12.29	3.95	9.12	11.25	10.66
L40 G2Y2	7.56	7.07	7.58	8.84	10.60	12.20	12.80	12.80	12.00	10.60	9.27	8.73	8.50	8.42	8.51	8.61	40.00	-10.57	8.27	9.33	11.25	9.24
L40 G2Y3	4.94	5.68	6.08	6.86	9.53	12.11	12.50	12.46	12.14	11.39	9.91	8.95	8.64	8.70	9.40	10.18	40.00	-10.57	13.80	9.33	11.25	7.60
L40 G3Y1	7.17	7.78	8.47	10.09	13.28	15.41	14.57	13.08	12.46	8.62	6.54	5.90	5.73	5.77	6.09	6.43	40.00	-19.88	3.95	8.24	11.25	10.66
L40 G3Y2	6.99	7.23	7.55	8.40	10.92	14.08	13.80	12.93	13.60	9.50	7.05	6.26	6.06	6.09	6.47	6.87	40.00	-18.04	8.26	8.45	11.25	9.24
L40 G3Y3	6.65	6.63	6.56	6.75	8.63	13.08	14.46	13.55	12.04	10.22	8.35	7.39	7.07	7.01	7.27	7.52	40.00	-16.25	13.05	8.65	11.25	7.81
L40 G4Y1	6.15	6.93	7.74	10.12	14.83	17.90	17.10	14.21	10.16	7.10	5.40	4.81	4.66	4.67	4.90	5.11	40.00	-28.02	3.94	7.36	11.25	10.66
L40 G4Y2	5.93	6.44	6.92	8.40	12.29	16.60	16.58	14.38	10.85	7.88	6.02	5.32	5.13	5.14	5.43	5.70	40.00	-26.07	8.27	7.57	11.25	9.23
L40 G4Y3	6.01	6.02	6.18	6.72	9.46	15.40	15.87	14.06	12.53	8.57	6.38	5.71	5.51	5.52	5.76	6.10	40.00	-24.13	13.07	7.78	11.25	7.81
L45 N	12.79	14.72	14.44	14.49	14.59	14.48	14.22	14.15	14.95	14.89	14.56	14.23	13.91	13.58	13.26	13.07	45.00	0.00	0.00	13.79	14.54	15.61
L45 Y1	11.04	12.30	12.15	12.64	13.59	13.94	13.87	13.96	15.39	15.50	15.20	14.89	14.58	14.26	13.95	13.79	45.00	0.00	4.82	13.79	14.54	13.56
L45 Y2	9.84	10.54	10.26	10.34	11.80	13.57	13.81	13.94	15.58	15.89	15.83	15.67	15.45	15.17	14.98	14.75	45.00	0.00	10.19	13.79	14.54	11.51
L45 Y3	8.14	8.39	8.18	8.35	10.17	12.94	13.57	13.95	15.92	16.38	16.40	16.31	16.14	15.91	15.77	15.59	45.00	0.00	16.19	13.79	14.54	9.45
L45 Y4	6.38	6.31	6.19	6.38																		