G7® Master Pass/Fail Requirements

For the G7 Master Program

Published April 2019 Version 35

Table of Contents

Scope:

This document specifies the criteria for assessing printed samples submitted under the G7® Master program for G7® Grayscale, G7® Targeted and G7® Colorspace compliance.

1.0 Conformance Introduction

1.1 Idealliance Certified G7 Experts submit an application and supporting data to the program auditor as specified in the procedural document: "G7 Master Qualification Submission Procedures"

1.2 The G7 Expert supervises preparation of the print samples to be submitted by the Master site candidate. The Expert then uploads the relevant files as specified in 3.0.

1.3 The sample prints, proofs or press sheets are shipped to the Idealliance auditor for analysis.

1.4 The samples are analyzed to determine if they are within tolerance using the criteria outlines in this document.

1.5 For G7 Targeted or Colorspace submissions, the measurement data must correspond to the G7-based CRPC selected by the applicant within tolerances specified herein.

1.6 For G7 Grayscale submissions, the printed samples must conform to the G7 gray requirements. The printed samples must meet the G7 tonality and gray balance tolerances contained herein.

1.7 The colorimetric values or specifications used in this document are based on ISO 13655 – 'Spectral measurement and colorimetric computation for graphic arts images'. All auditor measurements are taken using the M0 or M1 measurement mode, unless otherwise requested[1].

[1] Regarding measurement modes:
G7 Grayscale is substrate-relative and therefore not dependent on the measurement mode. G7 Grayscale submissions may be measured in M0, M1, or M2.

2.0 Regarding Non-Standard Substrates (SCCA)

2.1 Where the printing substrate to be used has a color that differs from the CRPC by more than 2 but less than 5 ΔE_{00}, the CRPC data may be adapted using the SCCA (Substrate-Corrected Characterization Aims) method[2], which is defined in the downloadable SCCA kit: 'Substrate_Relativity_Calculator_20120606.zip'.

2.2 This creates a new sub-category of qualified conditions known, for example, as "GRACoL Targeted Relative" or "GRACoL Colorspace relative".[3]

GRACOL 2006 was based on M0, but can also be measured in M1 or M2 mode if submitted as a "relative" match, i.e. with SCCA (Substrate-corrected Colorimetric Aims) on.
GRACoL 2013 and the other six CGATS.21 / ISO 15339 CRPCs were based on M1, but can also be measured in M0 or M2 mode if submitted with SCCA on.
For best results, submissions that do not use SCCA should be measured in the M mode on which the target CRPC was based.

[2] See ISO 15339 for more information.

[3] Note that a "Relative" reproduction will look different to the eye from an "Absolute" reproduction, but is still valid for qualification purposes.

3.0 Sample Submission Requirements

3.1 Basic Target Submission Requirements

The G7 Expert must ensure the candidate G7 Master site produces valid print samples, which are measured by the Idealliance designated auditor as shown below:

Condition	Charts[4]
G7 Grayscale	G7 Verifier[5], P2P25 or P2P51
G7 Targeted	G7 Verifier[5], P2P25 or P2P51
G7 Colorspace	P2P25 or P2P51 and IT8.7/4 or TC1617 (no P2P needed) **(TC1617 has been updated to IT8.7/5)**

Example of the G7 Verifier chart:

3.2 Additional Target Submission Requirements - Colorspace

3.2.1 Smallest possible target: IT8.7/5 (TC1617)

3.2.2 Alternate target combinations: IT8.7/4 plus P2P25 or P2P51

Note: Duplicate patches in the IT8.7/4 (or a combination of IT8.7/4 plus P2P) submitted for Colorspace will always be averaged; however, if an IT8.7/5 (TC1617) is submitted, there is no need for averaging because there are no duplicate patches.

---

[4] Never reduce or enlarge the standard target images.

[5] The G7 Verifier is a new CMYK target designed for evaluating G7 Grayscale and G7 Targeted compliance levels. It contains the minimum patches required for G7 Grayscale or Targeted compliance testing. The G7 Verifier is not a calibration target and does not replace a P2P target.

3.3 Custom Target Submission Requirements

3.3.1 A custom target can be used to substitute for the above. A custom target must contain identical CMYK patch values to columns 4 and 5 of the P2P25 or P2P51 target, and CMYK solids and RGB overprints.

3.3.2 If a custom target is supplied, the original electronic version must also be supplied along with an approved CGATS.txt reference file to enable measurement by the auditor. Custom targets require prior approval from Idealliance.[6]

3.4 Target Submission Requirements for Hard Copy Proofs

3.4.1 Proofs must meet G7 Colorspace aims. (See section 6.0, G7 Colorspace Pass/Fail Requirements).

3.5 Pre-verifying Submitted Samples

3.5.1 The G7 Expert should analyze the sample proofs or press sheets, or identical copies, before their submission, using either the candidate's or the G7 Expert's own measuring equipment. (See section 7.0).

[6] Contact Jordan Gorski (jgorski@idealliance.org) at Idealliance for custom chart submission procedure information.

4.0 G7 Grayscale Pass/Fail Requirements

"G7 Grayscale Compliance" is achieved when a device or process is calibrated to the basic G7 definition of constant neutral Grayscale appearance as defined in ANSI/CGATS TR015, but does not necessarily use standard colorants or match a standard CRPC.

Remember that G7 Grayscale compliance provides no assurance of accuracy in colored image areas.

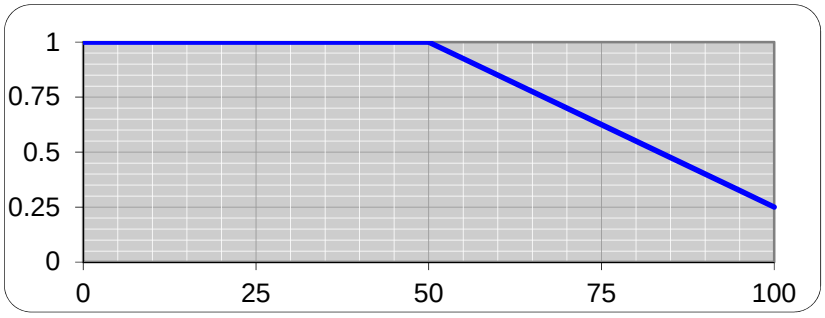
4.1 NPDC (CMY and K-only scales) and Gray Balance (CMY scale only)

Target	Press Tolerance
Weighted ΔL^* ($w\Delta L^*$)[7] CMY and K-only scales	Average $w\Delta L^* \leq 1.5$ Maximum $w\Delta L^* \leq 3.0$
Weighted ΔC_h ($w\Delta C_h$)[8] CMY scale	Average $w\Delta C_h \leq 1.5$ Maximum $w\Delta C_h \leq 3.0$

---

[7] Where; $\Delta L^* = \sqrt{(L^*_{sample} - L^*_{target})^2}$ and; $w\Delta L^* = \Delta L^* * (1 - \max\left(0, \frac{\%-50}{50} * 0.75\right))$

The $w\Delta L^*$ formula reduces the significance of the ΔL^* measurement above a Grayscale percentage (%) value of 50% on a linear scale beginning at 100% significance when % = 0 through 50 and terminating at 25% significance when % = 100.



The goal of the weighting function is to minimize the significance of hard-to-control lightness errors in very dark grays, which are usually less noticeable to the eye than L* errors in lighter tones.
$W\Delta L^*$ can be calculated using various software solutions available in the marketplace.

[8] Where $\Delta C_h = \sqrt{(a^*_{sample} - a^*_{target})^2 + (b^*_{sample} - b^*_{target})^2}$; and;

$w\Delta C_h = \Delta C_h * (1 - \max\left(0, \frac{c\%-50}{50} * 0.75\right))$

The $w\Delta C_h$ formula is similar to the $w\Delta L^*$ function, reducing the significance of the ΔC_h measurement above a cyan percentage (c%) value of 50% on a linear scale beginning at 100% significance when c% = 0 through 50 and terminating at 25% significance when c% = 100. The goal of the weighting function is to minimize the significance of hard-to-control gray balance errors in very dark CMY grays that are usually covered by black ink.
$W\Delta C_h$ can be calculated using various software solutions available in the marketplace.

4.2 Spatial Uniformity Informative (Not required)

If the sheet has two (2) measureable targets, then the CMYK solids on all targets *should pass*. Idealliance International Affiliates can modify this clause based on their region/market.

4.3 A Caution About Tolerances

The above tolerances are the bare minimum needed to pass G7 Grayscale compliance and do not necessarily reflect excellent printing. Serious print providers should aim for tolerances about half of the permitted values, i.e. weighted average 0.75 (vs. 1.5) and maximum 1.5 (vs. 3.0).

4.4 Exceptions Based on Print Process

Idealliance provides certain exceptions when qualifying printing processes whose inherent characteristics may cause them to fail normal G7 compliance tests. These print processes include flexo, screen printing, and any system that cannot achieve a near-neutral 300% CMY patch due to unusual colorants or process limitations. These exceptions are covered in the Annex to this document.

5.0 G7 Targeted Pass/Fail Requirements

"G7 Targeted Compliance" is achieved when a printing process passes G7 Grayscale compliance and the CIELab values on the primary (CMYK), secondary (RGB) solid ink patches and substrate match a selected CRPC within tolerances contained herein. For example, a commercial sheetfed offset press is in "G7 GRACoL Targeted Compliance" when it passes G7 Grayscale compliance and its seven ink solid patches and substrate meet the specified colorimetric aims for GRACoL.

5.1 Must meet G7 Grayscale requirements *(see above section 4.0).*

5.2 Must identify a G7-based CRPC, either in the public domain or custom (See Section 3.4: Custom Target Submission Requirements).

5.3 Solids, Overprints and Substrate[9]

Target	Press Tolerance
Substrate	$\Delta E_{00} \leq 3.0$
CMY Solids	$\Delta E_{00} \leq 3.5$
K Solids	$\Delta E_{00} \leq 5.0$
RGB Overprint Solids	$\Delta E_{00} \leq 4.2$

5.4 G7 Targeted Relative

If the substrate is significantly different from the defined CRPC, the sample may pass "G7 Targeted Relative Compliance", if selected in the application. For more details, see section 2.0 – Non-Standard Substrates.

6.0 G7 Colorspace Pass/Fail Requirements

"G7 Colorspace Compliance" is achieved when a device or process passes G7 Targeted Compliance and the CIELab values in an IT8.7/4 target match those in the selected CRPC within the following tolerances.[10]

6.1 Proof and Press Tolerances

Target	Proof Tolerance	Press Tolerance
Substrate	$\Delta E_{00} \leq 1.5$	$\Delta E_{00} \leq 3.0$
CMY Solids	$\Delta E_{00} \leq 3.5$	$\Delta E_{00} \leq 3.5$
K Solids	$\Delta E_{00} \leq 5.0$	$\Delta E_{00} \leq 5.0$
RGB Solids	$\Delta E_{00} \leq 4.2$	$\Delta E_{00} \leq 4.2$
All patches of IT8.7/4	Average $\Delta E_{00} \leq 1.5$ 95th percentile $\Delta E_{00} \leq 3.0$ Maximum $\Delta E_{00} \leq 5.5$*	Average $\Delta E_{00} \leq 3.5$ 95th percentile $\Delta E_{00} \leq 5.0$

*Maximum ΔE_{00} of IT8.7/4 will change to ≤ 4 beginning October 1, 2019.

6.2 G7 Colorspace Relative

If the substrate is significantly different from that of the defined CRPC, the sample may pass "G7 Colorspace Relative Compliance", if selected in the application. For more details, see section 2.0 – Non-Standard Substrates.

---

[9] The solid and 2-color overprint CIELab target values can be either the absolute values from the reference data set or the substrate-relative versions of the aims

[10] These tolerances are relative to the absolute or substrate-relative aim CIELab values.

7.0 Pre-Verification of Print or Proof Samples

The G7 Expert should verify the print samples will pass the selected G7 Master compliance level by one or more of the following methods:

7.1 Use of a certified G7 System software that can verify the above conditions. Click Here for a list of G7 Certified Systems

7.2 Manual measurement analysis by other software applications (e.g. custom spreadsheet).

8.0 Color Measurement Method

All targets are to be submitted in a layout and size readable by the X-Rite i1iSis 2 or X-Rite i1iO II in i1Profiler. If customer targets are provided, the target and related reference file must be pre-approved[11] and readable using an X-Rite i1iSis 2 or X-Rite i1iO II in i1Profiler.

8.1 Measurement Mode

Unless otherwise agreed, all measurements should be made in M1 mode.

8.2 Thickness Limitations

Materials that are too thick to be read by an i1iSis2 will be read using an i1iO II. The Idealliance designated auditor reserves the right to reject these materials if measurement is impractical.

8.3 Transparent Samples

Transparent or translucent samples will be measured on the Barbieri LFP. Transparent samples should only be submitted after confirming with the G7 Master auditor that the actual targets and sample materials are acceptable by the Barbieri LFP and Gateway software.

8.4 Sample Size

All targets must be reproduced at 100% of their original size.

---

[11] Contact Jordan Gorski (jgorski@idealliance.org) at Idealliance for custom chart submission procedure information.

9.0 Affidavit

The G7 Expert is required to provide an affidavit attesting to the completion of the G7 Master candidate's training requirements. The affidavit must be signed by both a designated representative of the G7 Master candidate company and the G7 Expert

9.1 Submission will not be analyzed until receipt of a properly completed affidavit.

9.2 Penalties for deliberately falsifying an affidavit include suspension of G7 Master status and/or loss of G7 Expert Status.

10.0 Failure of Samples

In the event of failure, the G7 Expert will have 60 days beyond the initial submission to resubmit new samples. An additional charge will apply for resubmission to cover the auditor's additional reading and analysis costs.

Annex A: Screen Printing

Scope

This annex modifies the Pass/Fail requirements for Screen Printing due to the special challenges faced by this process, notably the difficulty in producing consistent results from print-to-print, or prints with even coverage edge-to-edge.

A.1 Introduction

This Annex is necessary because exceptions to the basic G7 compliance levels of offset printing do not apply to screen printing. The key areas include:

- 1.1 Screen Printing compliance for G7 Gray Balance
- 1.2 Lower halftone screening frequencies
- 1.3 Expanded tolerances:
  - 1.3.1 $w\Delta L^*$ and maximum $w\Delta L^*$
    - 1.3.1.1 Minimizes the need for multiple NPDC curves
    - 1.3.1.2 Ink film thickness is not static across the press form
    - 1.3.1.3 Screen Printing has limited print station control points
  - 1.3.2 $w\Delta C_h$ and maximum $w\Delta C_h$
    - 1.3.2.1 The tonal range of the 3 color overprints are not neutral at the suggested G7 (a^*, b^*) values of (0,0)

A.2 Sample Submission Requirements

The G7 Expert must ensure the candidate G7 Master site provides valid print samples from which measurements can be obtained by an auditor.
(See Section A.3).

A.3 Minimum Target Submission Requirements

3.1 Submit at least three of each of the following:

3.1.1 Idealliance 12647-5 screen print control wedge and

3.1.2 Either: the standard P2P25 or P2P51 target

3.1.3 Or: a pre-approved custom target containing identical CMY and K patch values to columns 4 and 5 of the P2P51 target as well as solid C, M, Y and K patches. If a custom target is supplied, the original electronic version must also be supplied along with suitable reference files.

A.4 Pre-verifying Submitted Samples

The recommendation is that the G7 Expert analyzes the samples submitted for compliance evaluation, or identical copies, before their submission, using either the candidate site's or the G7 Expert's measuring equipment. (See section 7.0).

A.5 G7 (Grayscale) Pass/Fail Requirements – Screen Printing

All NPDC calculations for screen printing are based on the following seven control points of rows 4 and 5 from the P2P25 target, P2P51 target or a custom target containing identical CMY and K patch values:

0, 10, 25, 50, 75, 90, 100

5.1 NPDC (CMY and K-only scales) and Gray Balance (CMY scale only)[12]

Target	Tolerance
Weighted ΔL^* ($w\Delta L^*$) CMY and K-only scales	Average $w\Delta L^* \leq 2.5$ Maximum $w\Delta L^* \leq 5.0$
Weighted ΔC_h ($w\Delta C_h$) CMY scale	Average $w\Delta C_h \leq 3.0$ Maximum $w\Delta C_h \leq 7.0$

[12] These tolerances are extremely generous and represent only a vague visual compliance with the expected "shared neutral appearance" of G7. It is strongly recommended to try and reach tighter tolerances and/or to use maximum GCR in production work to minimize the effects of unstable gray balance.

Annex B: Flexographic Printing

Introduction

This annex modifies the Pass/Fail requirements for Flexographic printing. Flexo presses cannot achieve the smooth continuous tonality in very light tones using traditional platemaking systems that other printing systems, such as lithography, can achieve.

Notes:

Flexo printers using new screening systems or other techniques that effectively solve the above problem need not use this annex.

The averaging of three sheets is allowed for legacy flexographic printing.

B.1 Sample Submission Requirements

The G7 Expert must ensure the candidate G7 Master site provides valid print samples from which measurements can be obtained by an auditor.
(See Section B.2).

B.2 Minimum Target Submission Requirements

2.1 Either: at least three P2P25 or P2P51 targets

2.2 Or: at least three customer targets containing identical CMYK patch values to columns 4 and 5 of the P2P25 or P2P51 target including solid C, M, Y and K patches. If a custom target is supplied, the original electronic version must also be supplied along with suitable reference files.

2.3 Relative proofs are allowed; however, no longer meet standard datasets and must reflect a named SCCA dataset (i.e., GRACoL 2006 Relative 95 0 -6)

2.4 Special cases, such as small web, may contact Idealliance for assistance.

B.3 Pre-verifying Submitted Samples

The recommendation is that the G7 Expert analyzes the samples submitted for compliance evaluation, or identical copies, before their submission, using either the candidate site's or the G7 Expert's own measuring equipment. (See Section 7.0).

B.4 G7 Grayscale Pass/Fail Requirements – Legacy Flexographic Printing

If not using modern flexographic platemaking technology, the G7 Grayscale evaluation will ignore NPDC and gray balance errors under 20% dot value.

B.5 G7 Targeted Pass/Fail Requirements – Legacy Flexographic Printing

Because solid ink areas are unaffected by legacy flexo platemaking, no changes are necessary for G7 Targeted compliance except for the special G7 Grayscale compliance.

B.6 G7 Colorspace Pass/Fail Requirements – Legacy Flexographic Printing

Because legacy flexo screening may affect many IT8.7/4 patch values, G7 Colorspace compliance may require submission of a custom G7 dataset to Idealliance. Please contact Idealliance for more information.

Annex C: G7 Native CMY

Scope

This annex modifies the G7 Pass/Fail requirements to allow for printing processes that cannot achieve near-neutrality at 300% CMY, which includes most dry-ink electro-photographic (xerographic) printing systems.

C.1 Introduction

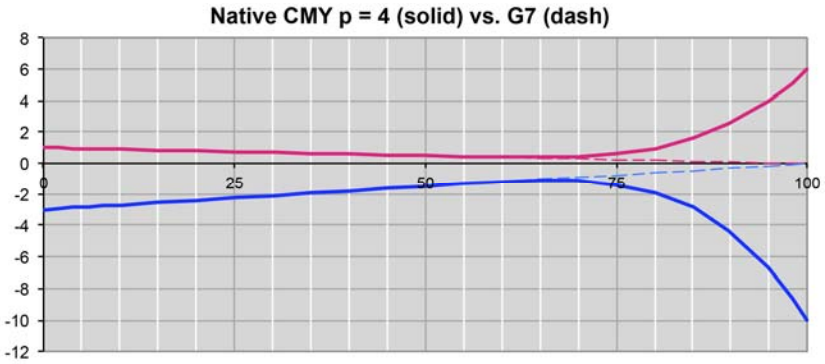
Certain printing processes (e.g. dry-ink electro-photography) cannot achieve G7 compliance "natively" (without the help of color management) due to the G7 requirement that 300% CMY must be "neutral" (0.0 a^* and b^*).

The arbitrary G7 requirement for a neutral 300% CMY point came from G7's origins in photography, where color film and paper always produce a nearly-neutral black with just three CMY dyes. However, in CMYK printing, the black ink largely hides any non-neutral gray balance in darker CMY values, and the 300% CMY value is seldom, if ever printed in actual work. So, the arbitrary insistence on a neutral 300% patch can be safely suspended for certain printing systems without significantly altering the basic concepts, intents, and benefits of G7.

The "G7 Native CMY Annex" by-passes the "neutral 300% CMY" rule for systems that cannot achieve neutral 300% CMY by mechanical means.

C.2 G7 Grayscale Native CMY Compliance

"G7 Native CMY" is similar to G7 Grayscale, except the target a^* and b^* values for CMY gray levels darker than 50% cyan are adjusted along a trajectory that ends at the native a^* and b^* values of that device's 300% CMY level. (See graph below.)



2.1 The example graph above depicts:

The "target" a^* (red) and b^*(blue) for a device whose paper is 1 a^*, -3 b^* and the G7 Native CMY gray balance when 300% CMY = 6.0 a^*, -10 b^*.

2.2 Target a^*, b^* algorithm

Given: a^*_s, b^*_s (s = substrate) and a^*_300, b^*_300;

For index percentage values 0 to 100;

$a^*\_tgt = a^*\_s \times (1\text{-}C/100) + a^*\_300 \times if(C < 50, 0, ((C - 50)/50)^4)$

$b^*\_tgt = b^*\_s \times (1\text{-}C/100) + b^*\_300 \times if(C < 50, 0, ((C - 50)/50)^4)$

2.3 G7 Native CMY maintains G7's original neutrality up to approximately 75% because CMY gray balance only deviates from legacy G7 in tonal areas normally covered by high amounts of black ink.

C.3 Important Notice

3.1 Printing systems that can achieve neutral 300% CMY (e.g. offset) should continue to aim for neutral 300% CMY, especially when the goal is G7 Targeted or G7 Colorspace compliance.

Annex D: Deriving $L^*a^*b^*$ Aims for Neutral Scales from TR015 Equations

D.1 Background

CGATS/Idealliance TR 015:2015 (TR015) was developed to provide a framework for G7 methodology that could be incorporated into standards documents. The equations in TR015 provided a formal representation of Neutral Print Density (NPD) and color (a^*, b^*) for CMY and K neutral scales that is equivalent to the original G7 formulation. When evaluating neutral scales for G7 compliance, it is often necessary to first calculate $L^*a^*b^*$ aims that correspond to ideal G7 neutral scales. This annex is intended to clarify the derivation of these aims from the equations in TR015.

D.2 Deriving L^* Neutral Scale Aims from NPD Equations of TR015

NPD equations for CMY and K neutral scales are found in Sections 5.4 and 5.5 of TR015. When evaluating neutral scales using metrics that depend on L^*, it is necessary to first calculate L^* values corresponding to NPD aims for a G7 neutral scale. This requires conversion of NPD aims to "absolute" NPD, by adding substrate density, then converting this quantity to L^* as follows:

$$NPS_{abs} = NPD + log10(1/Y_L)$$
$$Y_{abs} = 10^{NPD_{abs}}$$
$$L^* = 116 * Y_{abs}^{1/3} - 16 \quad if \quad Y_{abs} > (6/29)^3$$
$$= (841/108) * Y_{abs} \quad if \quad Y_{abs} \leq (6/29)^3$$

where Y_L is the luminous reflectance factor of the substrate as defined in TR015.

The following approximation, when L^* is calculated directly from NPD and L^*_s, the substrate lightness can be used when $NPD_{abs} < 2$, which is true in most applications:

$$L^* = 10^{-NPD/3} * (L_S^* + 16) - 16$$

D.3 Deriving a* and b* Neutral Scale Aims based on TR015

Section 5.3 of TR015 has clarified that for most applications, the a^* and b^* should use the following equations that represent a linear scaling of substrate a^* and b^*:

$$a^* = a_s^* \times (1 - TV_C / 100)$$

$$b^* = b_s^* \times (1 - TV_C / 100)$$

Note: The alternative method found in Appendix C or TR015 is intended for calculation of substrate corrected data sets.

D.4 Example

The example chart on page 20 lists aims that have been calculated for a given paper substrate and CMY solid. Tone values for M and Y are calculated according to section 5.2 in TR015. NPD was calculated according to section 5.4 of TR015. NPD_{abs} and $L^*a^*b^*$ aims were calculated according to the equations in D.2 and D.3 above.

Example Chart

		L*	a*	b*		
	Paper	**95**	**1**	**-4**		
	CMY solid	**23**	**0**	**0**		
TV_C(%)	**TV_{MY}(%)**	**NPD**	**NPD_{abs}**	**L* aim**	**a* aim**	**b* aim**
0.00	0.00	0.000	0.057	95.00	1.00	-4.00
2.00	1.49	0.019	0.077	93.37	0.98	-3.92
4.00	2.98	0.039	0.096	91.75	0.96	-3.84
6.00	4.47	0.058	0.116	90.14	0.94	-3.76
8.00	5.96	0.078	0.135	88.55	0.92	-3.68
10.00	7.46	0.098	0.155	86.98	0.90	-3.60
15.00	11.21	0.148	0.205	83.08	0.85	-3.40
20.00	15.01	0.199	0.257	79.27	0.80	-3.20
25.00	18.88	0.252	0.309	75.51	0.75	-3.00
30.00	22.83	0.305	0.363	71.82	0.70	-2.80
35.00	26.90	0.361	0.418	68.17	0.65	-2.60
40.00	31.11	0.418	0.475	64.55	0.60	-2.40
45.00	35.46	0.477	0.535	60.96	0.55	-2.20
50.00	40.00	0.539	0.596	57.39	0.50	-2.00
55.00	44.74	0.604	0.661	53.82	0.45	-1.80
60.00	49.69	0.673	0.730	50.24	0.40	-1.60
65.00	54.90	0.745	0.803	46.65	0.35	-1.40
70.00	60.37	0.823	0.880	43.03	0.30	-1.20
75.00	66.12	0.905	0.963	39.41	0.25	-1.00
80.00	72.19	0.993	1.051	35.79	0.20	-0.80
85.00	78.59	1.087	1.144	32.21	0.15	-0.60
90.00	85.34	1.183	1.240	28.77	0.10	-0.40
95.00	92.47	1.278	1.336	25.62	0.05	-0.20
98.00	96.94	1.331	1.388	23.96	0.02	-0.08
100.00	100.00	1.363	1.420	23.00	0.00	0.00