3M Print Quality

3M Corporate Reference Document RD1200

Description: Print Quality Management (PQM) Program

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Overview
The 3M Co. Print Quality Management (PQM) Program is designed to provide information related to the consistent reproduction of commercially printed packaging and printed product across all 3M Business Groups brands. This collection of requirements is intended to provide direction to any resource that plays a role in achieving print quality.

Purpose
Packaging is the first contact with our consumers where they are influenced to choose our brands. As such, the goal of 3M Print Quality and 3M Business Groups is to consistently maintain high print quality and color accuracy for all commercially printed packaging and printed product from around the world to leverage the value of packaging and product in expressing a brand promise, delivering a positive and consistent experience while differentiating from our competition. The information contained in this document provides information related to standards, equipment, tolerances, and sampling expectations that must be used to assess and control 3M Business Groups brands.

Scope
The set of requirements outlined in this document have been established to provide a procedure on how to perform digital color comparisons between a color “Target” and our commercially printed packaging and printed product items. Note: If the packaging item or product is not printed, adherence to the requirements set forth in this document is not required.

Deviations
Any deviations to the requirements set forth in this document must be both reviewed and approved (in written format) by 3M Print Quality or the 3M Business Group (or its designee) for acceptance.

Confirmation
See Page #2 for confirmation requirements that you have read, acknowledged and implemented the requirements stated in this document.

Print Quality Management (PQM) Program - Confirmation

I have read, acknowledged, and implemented the requirements stated in this document within the applicable functions of my facility. I certify my company can, and will, conform to all the requirements outlined to consistently maintain high print quality and color accuracy for all commercially printed packaging and printed product for 3M.

If my company is a contract supplier to 3M and we hire print services from our print supplier, I acknowledged that my print supplier has read, acknowledged, and implemented the requirements stated in this document and that I'm directly responsible for their conformance.

Return to:

3M Global Print Quality
Att: Michael John
3M Center, Bldg #225-3N-01
St. Paul, MN 55144

Email: mjohn@mmm.com

_____ _____
Signature of Supplier Rep. Date

_____ _____
Supplier Rep. Name (Please Print) Supplier Rep. Title

_____ _____
Supplier Rep. Phone Number Supplier Rep. E-Mail Address

If you are a contract supplier to 3M and you hired print services from a printer, list the printer name and location below.

_____
Printers Name

_____

_____
Printers Location

1.1 Color Tolerance Method

The approved color tolerance methods to be used when measuring printed color for 3M Print Quality or the 3M Business Group as it relates to the CIELab color space are:

Delta E 2000 (ΔE00) for spot or line colors (e.g., Pantone® 354 Green) and process colors (i.e. cyan, magenta, yellow, and black (CMYK)).

Ink density for "light strength" spot line colors (e.g., greys, pastels, tans). Colors defined during ink draw down process.

Note: Use of any other color measurement system is not acceptable.

1.2 Instrumentation

Spectrophotometers are used when measuring printed color for 3M Print Quality or the 3M Business Group (refer to Table 1 for details regarding device utilization by color type and instrumentation settings).

Table 1

Device Type	Color Type	Instrumentation Settings
Spectrophotometer	Process or Line Colors	Aperture: 2.0 mm (minimum value) Illuminant: D50 (simulation for daylight illuminate) Observer Angle: 2° Color tolerance method: Delta E 2000 (ΔE00) with l:c ratio of 1:1 (lightness to chroma ratio) Instrument must be set as a M0 measurement device unless substrate contains optical brighteners then set as M1 device upon notification.

Notes:

- Ensure all instrumentation is set to operate with no filters (e.g., "UV Cut").
- Ensure all instrumentation is utilized in compliance with manufacturer's instructions related to set-up, operation, and calibration requirements.

1.3 Viewing Conditions

All color measurements taken from printed samples, prepress proofs or ink drawdowns must be:

- In an environment that offers a "neutral" surrounding (refer to Munsell N7 as specified in ASTM D1729-96 for more details).
- Under a D50 light source (ensure proper maintenance guidelines are followed with respect to light source) per ISO 3664:2009
- In compliance with stated instrumentation settings included in this document.

1.4 Measurement Surface

Utilization of a "backing material" to back up print with a defined white substrate ensures consistent color reading. As such, all color measurements taken from printed samples, prepress proofs or ink drawdowns that are on a clear, translucent, or other non-opaque substrate must be taken:

- On a flat surface.

1.5 By using a "white backing" material with a material grade equivalent to GRACol7® Grade 1 premium coated substrate complying to ISO 13655 and ISO 5-4. CIELab values are as follows: L = 95, a = 1, b = -4. This backing material is defined in ISO 13655 without brighteners.

1.6 Color Standards/Ink Color Targets

Standards are the key to consistently reproducing both printed process and line color during every production run. As such, 3M Print Quality or the 3M Business Group has established standards to control both print reproduction for process and spot\line colors. The following information defines the color standards for all package printers/converters.

Inks Containing Mineral Oils

In accordance with French law, 3M requires the avoidance of mineral oils in printing inks and packaging components intended for the public as defined under the French Order of April 13, 2022: (Arrêté du 13 avril 2022 précisant les substances contenues dans les huiles minérales dont l'utilisation est interdite sur les emballages et pour les impressions à destination du public - Légifrance (legifrance.gouv.fr). Furthermore, 3M is required to report SVHCs defined under the EU REACH Regulation, hazardous substances defined under the French Order of August 30, 2023 related to the identification of hazardous substances in waste-generating products: (Arrêté du 30 août 2023 relatif à l'identification des substances dangereuses dans les produits générateurs de déchets - Légifrance (legifrance.gouv.fr)) and endocrine disruptors defined under the French Order of September 28, 2023 : (Arrêté du 28 septembre 2023 fixant la liste des substances présentant des propriétés de perturbation endocrinienne mentionnées aux I et II de l'article L. 5232-5 du code de la santé publique et les catégories de produits présentant un risque d'exposition particulier mentionnées au II de l'article L. 5232-5 du code de la santé publique - Légifrance (legifrance.gouv.fr) in printing inks and packaging components. Exceptions should be reported to 3M immediately regarding the presence of these substances.

Process Colors

For 3M Brands or the 3M Business Group color targets, reasonable to the print process and substrate, the process colors shall be based on the use of one input standard for consistent CMYK ink color control. This input standard uses CIELab (Lab) values.

The initial CIELab (Lab) values below shall be defined as the values when setting up the press for the initial first run (see Tables 2 and 3 for additional details). These can be used as the initial target values when getting the press "up" to the print industry standard. For litho printing, reference International Standard ISO 12647-2:2013. For flexo printing, reference International Standard ISO 12647-6.

The final "Target" CIELab (Lab) values are determined by 3M or its assigned designee attending the press check. If 3M or its designee is not present at the press check the final "Target" CIELab (Lab) values are represented by the CMYK colors on the 3M approved CMYK prepress "hard" proof for that part number and similar line extension items. If the final "Target" color was not determined from a press check or approved "hard" proof, then the CIELab (Lab) values in Table 2 (offset) and Table 3 (Flexo) are the "Target".

These CIELab targets will be used against which all printed samples of identical or similar packaging artwork trade dress (ie. background, photos) are measured and evaluated. Contact 3M Print Quality or the 3M Business Group (or its designee) if any question.

Note: The CIELab targets in parentheses found in Table 2 below uses the CGATS method using a white backing. This is the required method for measuring these colors and will be the method of print evaluation.

Table 2
Offset & equivalent Digital Printing CIELab (Lab) Values – (ISO 12467-2:2013) Offset Illuminant: D50 / Observer Angle: 2° Color tolerance method: Delta E 2000 (ΔE00) with l:c ratio of 1:1 (lightness to chroma ratio). Spectrophotometer must be set as a M0 measurement device unless substrate contains optical brighteners then set as M1 device.

Paper Type and Surface	PS1 Premium Coated Sheets Verbiage			PS5 Wood-free Uncoated Sheets Verbiage		
	Coordinates			Coordinates		
	L	a	b	L	a	b
Black	16	0	0	33	1	1
Cyan	56	-37	-50	60	-25	-44
Magenta	48	75	-4	55	60	-2
Yellow	89	-4	93	89	-3	76

Table 3 – Flexography & equivalent Digital Printing

CIELab (Lab) Values – (based upon ISO 12467-6) Flexography
Illuminant: D50 / Observer Angle: 2°
Color tolerance method: Delta E 2000 (ΔE00) with l:c ratio of 1:1 (lightness to chroma ratio).
Spectrophotometer must be set as a M0 measurement device unless substrate contains optical brighteners then set as M1 device.

Packaging Substrates	1,2 Uncoated Paper, Corrugated Board[a]			3 Coated Paper, Film and Foil		
	Coordinates			Coordinates		
	L	a	b	L	a	b
Cyan	58	-25	-43	57	-37	-45
Magenta	54	58	-2	48	68	-2
Yellow	86	-4	75	88	-5	88
Black	31	1	1	20	0	0

a. Coated or uncoated.
b. Printing in the sequence yellow-cyan-magenta

Line Colors

The 3M Print Quality Team or the 3M Business Group color targets are the only targets for printing line color since line colors are commonly used to identify 3M Business Group/Div. brands. As such, drawdowns will be required as a primary input to provide confirmation that the package printer can reproduce 3M Business Group/Div. line colors in compliance with the color measurement values and applicable tolerances (refer to section 1.6 "Delta E (ΔE) Tolerances" for tolerancing details) contained within this document. Ink drawdowns values and cxf files will: 1) be provided to the package printer by 3M Print Quality the 3M Business Group (or its designee), or 2) developed through collaboration between 3M Print Quality or the 3M Business Group (or its designee) and the package printer/converter.

For Pantone colors

- 3M "Brand" colors (see listing on Tables 4, 4A and 4B) – use the target CIELab (Lab) color values on Tables 4, 4A and 4B.

  3M Business Groups
  Table 4 – All 3M Business Groups
  Table 4A – Consumer
  Table 4B – Safety and Industrial
  Table 4(TBD) – Technology and Electronics

- Non-3M "Brand" colors - use the target CIELab (Lab) color values provided by 3M Print Quality or the 3M Business Groups/Div. (or its designee) or target CIELab (Lab) color values in the Pantone Plus digital library.

For other spot colors, use the CIELab (Lab) values of the color target provided by 3M Print Quality or the 3M Business Group (or its designee).

Note: Contact 3M Print Quality Team or the 3M Business Group (or its designee) to verify target CIELab (Lab) values or if any questions.

Table 4 – All 3M Business Groups

Color Measurement CIELab (Lab) Targets
3M and Scotch® Brand Identity Colors

Illuminant: D50 / Observer Angle: 2°
Color tolerance method: Delta E 2000 (ΔE00) with l:c ratio of 1:1 (lightness to chroma ratio).
Spectrophotometer must be set as a M0 measurement device unless substrate contains optical brighteners then set as M1 device.

Note: *Color targets in Table 4 are based on instrumentation settings defined under Section 1.2 "Instrumentation"*

			Lab Targets (per 2010 Pantone Digital Library)				
3M Brand Color Description	**3M Brand Color Number**	**Pantone Color Reference**	**L**	**a**	**b**	**C**	**h**
3M Red	3M_RD001A	NA	45.74	67.74	46.81	82.33	34.64
3M Red (Uncoated substrate)	3M_RD001B	NA	47.37	57.76	39.08	69.74	34.08
Scotch® Yellow	3M_YL001A	116C	255	8.35	87.98	88.38	84.58
Scotch® Yellow (Uncoated substrate)	3M_YL001B	116 FYWK	82.38	8.26	86.03	86.43	84.52

Table 4A – 3M Consumer Business Group

Color Measurement CIELab Targets
3M Consumer Business Group - Brand Identity Colors

Illuminant: D50 / Observer Angle: 2°
Color tolerance method: Delta E 2000 (ΔE00) with l:c ratio of 1:1 (lightness to chroma ratio).
Spectrophotometer must be set as a M0 measurement device unless substrate contains optical brighteners then set as M1 device.

Note: *Color targets in this Table are based on instrumentation settings defined under Section 1.2 "Instrumentation"*

			Lab Targets (per 2010 Pantone Digital Library)				
3M Brand Color Description	**3M Brand Color Number**	**Pantone Color Reference**	**L**	**a**	**b**	**C**	**h**
Post-it® Yellow	3M_YL002A	109C	86.32	6.01	97.68	97.86	86.48
Post-it® Yellow (Uncoated substrate)	3M_YL002B	109 FYWK	82.26	5.6	87.41	87.59	86.33
Scotch® Yellow, Duct Tough® Duct Tape (Yellow) Futuro™ Yellow	3M_YL001A	116C	85.48	8.35	87.98	88.38	84.58

Post-it® Super Sticky Purple	3M_PR002A	247C	45.52	70.66	-35.20	78.94	333.52
Post-it® Super Sticky Purple (Uncoated substrate)	3M_PR002B	247 FYWK	42.28	50.65	-26.77	57.29	332.14
Scotch® GiftWrap® Purple	3M_PR001A	2665C	45.67	36.69	-56.90	67.7	302.81
Scotch® GiftWrap® Purple (Uncoated substrate)	3M_PR001B	2665 FYWK	44.01	29.69	-45.50	54.33	303.13
Scotch-Blue™ Painter's Tape	3M_BL001A	285C	45.75	-1.89	-62.36	62.39	268.26
Scotch-Blue™ Painter's Tape (Uncoated substrate)O	3M_BL001B	285 FYWK	44.12	-1.01	-50.65	50.66	268.86
Scotch-Brite™ Green	TBD	376C	70.30	-37.38	72.79	81.83	117.18
Scotch-Brite™ Green (Uncoated substrate)	TBD	376 FYWK	72.19	-33.99	66.64	74.81	117.02
Nexcare™ Teal	3M_BL004A	3135C	48.78	-53.36	-35.04	63.84	213.29
Nexcare™ Teal (Uncoated substrate)	TBD	3135 FYWK	48.64	-38.04	-24.88	45.45	213.19
Scotch® Magic Green	3M_GR001A	354C	60.37	-76.33	39.21	85.81	152.81
Scotch® Magic Green (Uncoated substrate)	3M_GR001B	354 FYWK	60.80	-56.60	29.01	63.60	152.86
CLAW™ Grey	TBD	7540C	33.37	-0.27	-4.94	4.95	266.87
CLAW™ Grey (Uncoated substrate)	TBD	7540 FYWK	33.27	-0.22	-4.89	4.89	267.42
Ace™ Red	3M_RD002A	485C	49.88	69.06	53.87	87.59	37.96
Ace™ Red (Uncoated substrate)	3M_RD002B	485 FYWK	52.52	57.11	43.69	71.91	37.42
Nexcare Reflex Blue	3M_BL002A	Reflex BlueC	15.29	33.82	-68.82	76.68	296.17

Table 4B – Safety and Industrial Business Group

Color Measurement CIELab (Lab) Targets
3M Safety and Industrial Business Group - Brand Identity Colors

Illuminant: D50 / Observer Angle: 2°
Color tolerance method: Delta E 2000 (ΔE00) with l:c ratio of 1:1 (lightness to chroma ratio).
Spectrophotometer must be set as a M0 measurement device unless substrate contains optical brighteners then set as M1 device.

Note: Color targets in this Table are based on instrumentation settings defined under Section 1.2 "Instrumentation"

			Lab Targets				
3M Brand Color Description	**3M Brand Color Number**	**Pantone Color Reference**	**L**	**a**	**b**	**C**	**h**
Scott Safety	3M Red 3M_RD001A	NA	45.74	67.74	46.81	82.33	34.64
Scott Safety		186C	44.87	67.75	37.46	77.42	28.94
Scott Safety (Uncoated substrate)	3M Red 3M_RD001B	NA	47.37	57.76	39.08	69.74	34.08
PROTECTA®	3M Red	NA	45.74	67.74	46.81	82.33	34.64

	3M_RD001A						
PROTECTA® (on uncoated substrate)	3M Red 3M_RD001B	NA	47.37	57.76	39.08	69.74	34.08
DBI-SALA® Blue	TBD	2748c	13.93	23.92	-55.46	60.40	293.33
E●A●R Blue	TBD	2748 FYWK	31.11	18.27	-39.65	43.66	294.74
Scotch-Brite™ Dark Red	TBD	187C					
Scotch-Brite™ Dark Red (Uncoated substrate)	TBD	187 FYWK	44.17	45.19	21.11	49.88	25.04
ASD Purple	TBD	267C					
ASD Purple (Uncoated substrate)	TBD	267 FYWK	31.12	34.76	-44.05	56.11	308.28
ASD Grey	TBD	Cool Grey 4C					
ASD Grey (Uncoated substrate)	TBD	Cool Grey FYWK	76.06	0.76	-3.68	3.76	281.67

1.7 Ink Draw Downs

It is the responsibility of the package printer/converter to develop and submit ink drawdowns in compliance with the following requirements:

- Ink drawdowns of line color over the target substrate are required from the package printer/converter prior to initial production run.
- **Two (2) sets** of ink drawdowns must be supplied to 3M Print Quality or the 3M Business Groups/Div. (or its designee) for review/approval prior to the initial production run. The following assets must be supplied with each ink drawdown submission:
  - *Printer/converter's name, address and contact information.*
  - *Identification of the ink company (e.g.: Sun Chemical, INX, Kohl & Madden, Color Resolutions International, other)*
  - *PMS number and color description*
  - *Substrate definition (e.g.: SBS, CCNB, Clear Film, other)*
  - *Date (defined as the date the ink drawdown was produced)*
  - *Coating type/number and description (if/where applicable)*
  - *Target and actual CIELab targets and its Delta E 2000 (ΔE00) variance including a printout verifying targets and Delta E results*

REMINDER!
Ensure the utilization of color tolerance method: Delta E 2000 (ΔE00) with l:c ratio of 1:1 using the following settings: Illuminant: D50 and Observer Angle: 2° for ALL ink draw-down measurements.

Allowable Delta E Tolerances for ALL ink draw-downs must be <u>less than</u> or <u>equal to</u> 2.0 Delta. With the target being: 0.0ΔE00

<u>Notes</u>:

- DO NOT print a job if you do not have an approved ink draw for any spot color running on the substrate it is running on.
- All ink drawdowns should be packaged in such a way that they are protected from all reasonable environment interactions during shipment. In addition, all approved ink drawdowns should be stored in a cool and dark environment.

- Paper-based print substrates (e.g.: paperboard) will be compared to the appropriate GRACoL7 paper grade of 1&2 for gloss and dull coated, grades 3 and 5 for publication.
- Film-based print substrates (e.g.: flexible packaging) will be compared to the CIELab D50/2 values of printed whites should be >88L, between -3 and +3 a, and -5 to +5 b.
- **3M Red** litho ink is available premixed from Sun Chemical. When printing on a SBS substrate, the Sun Chemical reference number is SAP# 91219368. When printing on a CCNB substrate, the Sun Chemical reference number is SAP# 91235873.
- Reference Sun contacts and SAP#'s When printing on an SBS substrate. The Sun Chemical reference SAP# is: 91219368. CCNB substrate, the SAP# is: 91235873.
- When a Delta E less than 2.0 is unachievable, a revised dependent target may be issued based on direction given to the supplier by 3M Print Quality or it's designee.

1.8 Delta E Tolerances

Ink Drawdowns: All ink measurements captured as part of ink drawdown evaluations to be compared to CIELab targets as defined/provided by 3M Print Quality or the 3M Business Group (or its designee). Allowable Delta E tolerance for all ink drawdowns is less than or equal to 2.0 Delta E 2000 (ΔE00).

Printed Samples: All ink measurements captured to compare a given "Target" against a printed sample must be processed in compliance with the following tolerance methods (reference Table 5 below for specific Delta E Tolerances).

Table 5

Print Process/Substrate	Delta E Tolerances (Process Ink)[1]	Delta E Tolerance (Primary Line Color)[2]	Delta E Tolerances (Secondary Line Color)
Offset Lithography	5.0 for K (black)[1] 3.5 for C,M,Y[1]	2.5	3.0
Flexography (All Other)	5.0 for K (black)[1] 3.5 for C,M,Y[1]	2.5	3.0
Digital (Indigo) and Ink Jet (equivalent to Offset Litho or Flexo (above))	5.0 for K (black)[1] 3.5 for C,M,Y[1]	2.5	3.0
Flexography ("Mottled White/Bleached" and "High Holdout" (high definition) Corrugated)	TBD	2.5	3.0
Flexography ("Brown" Corrugated)	TBD	2.5	3.0
Stamp, Pad or Screen Printing	3.0	2.5	3.0
Gravure	5.0 for K (black)[1] 3.5 for C,M,Y[1]	2.5	3.0
Dry Offset	5.0 for K (black)[1] 3.5 for C,M,Y[1]	2.5	3.0

1. Delta E Tolerances to the target CIELab targetss outlined in Section 1.5 Table 2 (litho and digital) and 3 (flexo). Tolerances includes the color variability of the substrate. Delta E Tolerance if no approved press sheet or "hard" proof is available.

2. Includes:
   a. 3M Brand Identity colors (refer to Section 1.5, "Color Standards/Ink Color Targets" (Table 4)).

b. 3M brandmark, non-3M brandmark (e.g. Post-it®, Scotch™, Meguiar's®, Tartan, Highland) and private label trade dress colors. Some private label colors may specify a different Delta E tolerance (e.g. 2.0) dependent of the private label customer requirements. The printer will be informed by 3M Print Quality or the 3M Business Group (or its designee) of this unique Delta E tolerance c. Significant background (e.g. trade dress) colors

Note: Visual overrides to these specifications may be granted (refer to Section 2.1, "Visual Overrides" for details). Does not come up often as deviations are managed at ink draw phase.

1.9 Ink Density Tolerances

Use the following allowable ink density tolerances (reference Table 6 below for specific Ink Density Tolerances) within a given production run for "light strength" line colors.

Table 6
"Light Strength" Line Colors

"Light Strength" Line Color Reproduction	+/- 0.02 for all "light strength" line colors (e.g. greys, pastels, tans). Note: Colors defined during ink draw down process. Note: Use the "Target" ink density per the approved ink drawdown. These ink densities targets will be used against which all printed samples are measured and evaluated.

2.0 Process Control/Color Bar Requirements Imagery

Color Patches for Process or Line Colors: Solid patches of line colors are also required to measure Delta E variance to the target color. These patches must be at minimum large enough to be read by standard handheld Spectrophotometer or Spectrodensitometer, and run in dead area or trim. If the package has a treatment like a varnish, white ink backing, or lamination, this patch must have the same treatment so that this patch is representative of the color on the package. If the live artwork has single color elements that are larger than a .25" square, the live work may be used in lieu of this patch.

If litho printing:

- if process colors, recommend 18 color patches in the control strip (4 CMYK solids, 4CMYK 75% tints, 4CMYK 50% tints, 4CMYK 25% tints, C50M40Y40, and the substrate)
- if spot line colors, recommend 2 color patches in the control strip (100% solid and 50% tint (if screens are present))

If flexo printing:

- if process colors, recommend 7 color patches in the control strip (minimum dot size, and tonal values of 10%, 30%, 50%, 70%, a solid, and the substrate).
- if spot line colors, recommend 2 color patches in the control strip (100% solid and 50% tint (if screens are present))

Web Presses: In situations where print reproduction utilizes web presses, the color bar should be placed in the trim area. Note: In situations where a print cylinder repeat does not provide the proper space to incorporate the needed color bar, it is acceptable to split the color bar and place half on the left side and half on the right side of the web in the allocated trim areas. The printer may substitute color patches inside of the bearer bar, waste at the edge of the web, or in waste area between die cuts if the patches are, at minimum large enough to be read by standard handheld color reading equipment.

Notes:

- In situations where available "dead space" doesn't allow for the inclusion of a detailed color bar, please contact 3M Print Quality or the 3M Business Group (or its designee) to discuss alternate color bar requirements as required.
- White Under Prints: In situations where print reproduction requires the use of white ink to "back-up" the artwork, the color bar should also be backed up with the same white ink to ensure consistent colorimetric data collection.

2.1 Dot Gain

Dot gains should be managed to achieve neutral grays. It is recommended that the G7® methodology should be utilized for developing TVI (Tonal Value Increase), though it is not required. Quarter Tone, Mid Tone and Lower Quarter Tone are required on print samples submitted as neutral grays will be read as part of the print evaluation (reference Table 8 for applicable reflectance % by tonal type and associated tolerances).

Table 8

Dot Gain Tolerances (%)			
Print Process	**75% (Upper Quarter Tone)**	**50% (Mid-Tone)**	**25% (Lower Quarter Tone)**
Offset Lithography	Target: 88% Tolerance: +/- 3%	Target: 68% Tolerance: +/- 4%	Target: 40% Tolerance: +/- 3%
Flexography	Target: TBD Tolerance: TBD	Target: TBD Tolerance: TBD	Target: TBD Tolerance: TBD

Notes:

- Exact percentages may vary due to gains required for neutral grays.
- Standard focuses on measuring optical dot gain, not a physical dot size.
- If in a situation where the dot gain tolerance cannot be met, please contact your applicable 3M Production Artwork personnel (or its designee) to discuss any deviation to these requirements.

2.2 Halftone Resolution

All printed packaging items produced for 3M Print Quality, or the 3M Business Group must meet the following halftone image quality requirements (reference Table 9 below for specific resolution minimums by print process):

Table 9

Print Process	**Minimum Target Resolution**
Offset Lithography	150 LPI (for premium grade coated paper, text, and cover substrates)
Flexography (All Other)	120 LPI
Flexography (Narrow-Web)	120 LPI
Flexography (Mid-Web)	100 LPI
Flexography (Corrugated)	45 LPI
Flexography (Corrugated – Micro-Flute Grades)	100 LPI
Gravure	150 LPI
Dry Offset	100 LPI

2.3 Visual Overrides:

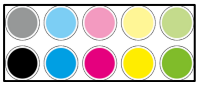
Ink drawdown and print continuity readings will be done by spectral instrument measurement. There may be cases where a visual approval may override an instrument reading. In certain situation, visual approvals may be granted by your 3M Print Quality or the 3M Business Group contact (or its designee). A visual override will be documented in a similar manner to instrument validation.

2.4 Print Sample Evaluations

All printers/converters shall be required to submit the following,

For **initial production run:**

Submit a minimum of three (3) random unconverted print samples to your 3M Print Quality or the 3M Business Group contact (or its designee) as part of a "first article" inspection process. Submit one (1) represented print sample from each of the beginning, middle and end of the production run. Print samples must include a process control area, such as a color bar or density balls.



Digital Option: Submit actual colorimetric and print performance data using digital communications quality assurance software (e.g. X-Rite ColorCert or equivalent) via near-real time data for this initial press run. Send file to Michael John email address: mjohn@mmm.com

For **BOTH** initial and subsequent (every 3rd or 4th production) runs:

For line and CMYK colors, provide colorimetric data report that includes both the "Target" and "Actual" CIELab target and it's Delta E 2000 (ΔE00) variance for each printer color. Print samples must include associated printed color bar.

For "light strength" line colors (eg: greys, pastels, tans), provide colorimetric data report that includes both the "Target" and "Actual" CIELab targets and it's Delta E 2000 (ΔE00) variance…and ink density "Target" and "Actual" values and it's variance.

Digital Option: Submit actual colorimetric and print performance data using digital communications quality assurance software (e.g. X-Rite ColorCert or equivalent) via near real-time data for the initial and subsequent press runs. Send file to Michael John email address: mjohn@mmm.com

This information must be provided until otherwise informed by your 3M Print Quality or the 3M Business Group contact (or its designee).

Reminder to verify the printed UPC/EAN bar code symbol is in conformance with GS1 General Specifications and the human readable match the encoded data within the printed bar code symbol per 3M Corp. General Spec. RD-138 - Printing Requirements for Point-of-Sale Bar Code Symbols Using EAN/UPC Symbology

3.0 Corrugate Print Defects

Objective

To establish minimum quality standards for print output on corrugate substrates, focusing on print defects such as dirt, over impression, and ink coverage. This policy is designed to align with industry best practices and ensure consistently high-quality print results.

Scope

This policy applies to all production runs involving printing on white corrugate substrates.

Sample Review and Inspection

3.1 Sample Size

Every production run, set an early production standard, then a minimum of 1% of the total print output will be randomly selected for quality inspection. For runs exceeding 10,000 units, at least 100 samples should be reviewed.

3.2 Inspection Criteria:

Dirt: The presence of unwanted marks, smudges, or particles on the substrate must not exceed specified thresholds. Samples should exhibit no visible dirt larger than 1/16 in (1,6 mm) in diameter when viewed under standard inspection lighting from a distance of 18 inches.

Over Impression: This is evaluated based on whether the print design aligns accurately without doubling or ghosting. Tolerances must adhere to design specifications, allowing less than 1% variance in alignment.

Ink coverage: Ink uniformity and color consistency must be maintained within a tolerance of ±5% deviation from approved proofs. Overall coverage should meet or exceed 95% of designated print areas without fading or streaking.

Tracking: Marks left by the press mechanism on the substrate surface. Samples should exhibit no visible tracking when viewed under standard inspection lighting from a distance of 18 inches.

Registration / Alignment: Overprint and alignment of each print station should be ≤ 1/16 in (1,6 mm) at each print station < 1/8 in (2,2 mm) total.

Misc. Anomalies: Anything within the print (ex: digital print is fuzzy), not aligned with the digital file where 2% criteria is met and there is a visual issue.

3.3 Testing Methodologies:

- Visual inspection using appropriate inspection equipment and controlled lighting conditions.
- Use of densitometers or spectrophotometers for quantitative assessment of ink density and color accuracy.
- Magnification devices may be used to detect subtle defects more precisely.

3.4 Acceptable Quality Levels (AQL):

- Set an AQL of 2.0 for critical defects and 1.5 for major defects following the ANSI/ASQ Z1.4 standard.

3.5 Inspection Process:

- **Initial Setup:** Review first-off prints at the beginning of each run to establish baseline quality.
- **On-going Monitoring:** Continuous spot-checks should occur throughout the production process. Increase sampling if defects are detected at any stage.
- **Post-Production Review:** After run completion, final inspections using an agreed-upon checklist against above criteria.

Documenting and Reporting:

Maintain records of all quality inspections, noting any defects observed, corrective actions taken, and feedback provided. Regularly report this data to the quality management team for analysis and continuous improvement efforts.

Corrective Actions:

When defects exceed AQLs, halt production immediately to identify and resolve the cause. Implement corrective action plans and verify resolution before resuming production.

Training and Accountability:

Regular training sessions must be conducted to educate staff on quality standards and inspection protocols. Designate quality assurance personnel responsible for enforcing this policy and ensuring adherence.

Review and Enhancement:

This policy will be reviewed annually or when industry standards evolve. Continuous improvements based on technology advancements and feedback from quality control analysis will be integrated.

By adhering to this Print Quality Assurance Policy, your organization commits to maintaining high standards in print quality, minimizing defects, and delivering superior results for all print projects on white corrugate substrates.

DEFINITIONS

This section of the document provides definitions associated with various references included in other section of this document.

- **CIELab:** A uniform (opponent color scale) color space in which colors are located within a three-dimensional rectangular coordinated system; the three dimensions are lightness (L), redness/greenness (a) and yellowness/blueness (b) expressed in numeric values. When color is expressed in CIELab, L defines lightness, a denotes the red/green value and b denotes the yellow/blue value.
- **CIELab2000 (ΔE00):** The CIE 2000 color difference formula was developed to solve the problem of the differences in the evaluation between color meters and the human eye caused by the difference in the shape and size of the color discrimination threshold of the human eye.

  The CIE 2000 color difference formula is not an attempt to build a color space in which the widths of the color discrimination thresholds of the human eye are uniform. Instead, it defines a calculation so that the color difference calculated by color meters becomes close to the color discrimination threshold of the human eye on the solid color space of CIE Lab color space.
- **CGATS:** The Association for Suppliers of Printing, Publishing and Converting Technologies supports and administers the activities of the ANSI-accredited Committee for Graphic Arts Technologies Standards (CGATS). CGATS was formed in 1987 following a year-long assessment of the need for an umbrella standards committee by the Image Technology Standards Board (ITSB) of the American National Standards Institute (ANSI) and received ANSI accreditation in 1989. The goal of CGATS is to have the entire scope of printing, publishing and converting technologies represented in one national standardization and coordination effort, while respecting the established activities of existing accredited standards committees and industry standards developers.
- **Delta E (DE or ΔE):** In color tolerancing, the following symbol is used to express delta error. Delta error is a mathematical equation computed to measure color difference between two or more items, typically measuring the color difference between the target color (i.e. ink drawdown, Pantone 2010 CIELab digital library values or gray scale patch) to another item (i.e. press sheet). Color data is expressed in CIELab.
- ***FIRST**: FIRST stands for Flexo Image Reproduction Specifications & Tolerances (FIRST), published by the Flexographic Technical Association Inc. (FTA) focusing on flexography (flexo) commercial printing guidelines (standards) and recommendations.
- **G7®:** A specification providing formal digital colorimetric definitions for neutrality and tonality that together control the visual appearance of the grayscale component of an image located on a proof and printed sheet. “G” denotes the focus on “Grays” while “7” refers to the seven colorimetric ink targets of Cyan (C), Magenta (M), Yellow (Y), Black (K), Red (M+Y), Green (C+Y) and Blue (C+M). Note: GRACol and SWOP standards are both based on G7 gray balance and tonality specifications. Gray balance is the means to determine if 4 color process reproduction is being produced correctly on the approval proof, prepress proof and printed sheet. This methodology utilizes the existing ISO 12647 Standards as the basis for quality printing. Its goal is to specify a simple calibration process that will help the printers reliably achieve a “visual match” within allowable variability from proof-to-press based on the principles of digital imaging and spectrophotometry.
- **G7® Complaint:** A methodology allowing printers who maintain a G7® compliance to reliably produce high quality commercial printing that matches color from proof-to-press (computer to plate) per G7 specifications.
- *GRACol®: GRACol® stands for “General Recommendations for Applications in Offset Lithography” focusing on sheet fed offset (litho) commercial printing guidelines (standards) and recommendations.
- **Gray Balance:** The relationship of C (cyan), M (magenta) and Y (yellow) percentages typically defined as C = 50 (i.e. 50c, 40m, 40y). These tones, called gray scales, are found on the prepress proofs and printed sheet color bars used to measure CIELab targets to calculate Delta E_{00} color variability to make ink adjustments to meet acceptable color tolerances and/or approved prepress proof targets. Note: Gray balance is the means to determine if 4 color process reproduction is being produced correctly on the prepress proof or printed sheet.
- **ISO 12467-2:** International Organization of Standards that specifies a number of process parameters and their values to be applied when preparing color separations for four-color offset printing or when producing four-color prints by one of the following methods: heat-set web, sheet-fed or continuous forms process printing, or proofing for one of these processes; or offset proofing for half-tone gravure. The parameters and values are chosen in view of the complete process covering the process stages color separation, film setting, making of the printing form, proof production,

production printing and surface finishing. ISO 12647-2 is: directly applicable to proofing and printing processes that use color separation films as input; directly applicable to proofing and printing from printing forms produced by filmless methods as long as direct analogies to film production systems are maintained; applicable to proofing and printing with more than four process colors as long as direct analogies to four-color printing are maintained, such as for data and screening, for print substrates and printing parameters; applicable by analogy to line screens and non-periodic screens.

- **ISO 12467-6:** International Organization of Standards that specifies a number of process parameters and their values to be applied to four-color process printing by the flexographic printing process for packaging and publication, excluding newsprinting. The parameters and values are chosen in view of the complete process covering the process stages "color separation", "film setting", "making of the printing form", "proof production", "production printing" and "surface finishing". This covers printing on printing substrates which are nearly white or on films to which a white coating has been applied. ISO 12647-6 is directly applicable to: publication flexographic printing including magazines, catalogues and commercial materials, and packaging flexographic printing including labels, boxes and flexible packages; half-tone and continuous tone proofing processes that predict the colorimetric results of flexographic printing.
- **Kelvin Degrees:** The scale of absolute temperature in which the zero is approximately -273°C, abbreviated: K.
- **Spectrodensitometer:** A combination spectrophotometer and densitometer, convenient for measuring the color reproduction quality, typically located on the press sheets and prepress proof color bar. A spectrodensitometer has the capacity to measure both ink density and colorimetry functions.
- **Spectrophotometer**: A piece of computerized equipment that defines the attributes of color precisely in terms of lightness (L), redness/greenness (a) and yellowness/blueness (b) name ab targets and in lightness (L), chroma (C), and hue angle (h) numeric CIELCh targets.
- ***SWOP®:** SWOP® stands for "Specifications for Web Offset Publications" focusing on web offset (litho) commercial publication printing standards.
- **TVI (Tonal Value Increase):** The percent increase in the apparent darkness of an image in the mid-tone range during the production run. Example: With 15% dot gain, a 55% halftone will increase to 70%. This increase is compensated for in reproduction by making the image lighter in the color separations.

* G7®, SWOP® and GRACoL® are registered trademarks of IDEAlliance. Objective is to provide all participants in the print reproduction process – customers, designers, prepress providers, and printers – with a common set of guidelines, targets, and tolerances that can be used as communication and production tools. The goal is to improve quality, reduce cycle times, minimize rework and waste, and facilitate producing a predictable, consistent result, print run after print run.

REVISION DETAILS

Revision: 03/30/2018

Page #1 Add Table 4B – Safety and Graphics Business Group. Added PROTECTA®, Scott Safety and DBI-SALA® target brand colors

Revision: 08/09/2017

Page #6 Corrected LabCh targets for the uncoated colors 3M_YL001B PMS 116C in Table 4
Page #7 Added and corrected LabCh targets for the uncoated colors in Table 4A

Revision: 09/01/2023

Throughout: Design Operations changed to 3M Print Quality
All tables: Brand Color Lab Targets updated to Pantone + Lab targets
New brand colors added to Table A4 and 4B
Various minor changes. Throughout for spelling and other cosmetics

Revision: 02/22/2024

Added language for inks containing Mineral Oils to accommodate French Law

Revision: 08/02/2024

*Removed references to Pantone 2003 Library. Changed/Removed all astericks in L*a*b* also changed "values" to "targets"*

Revision: 02/11/2025

Add Quality section to document to help align printers and manufacturing to one level of allowable defects in the print.