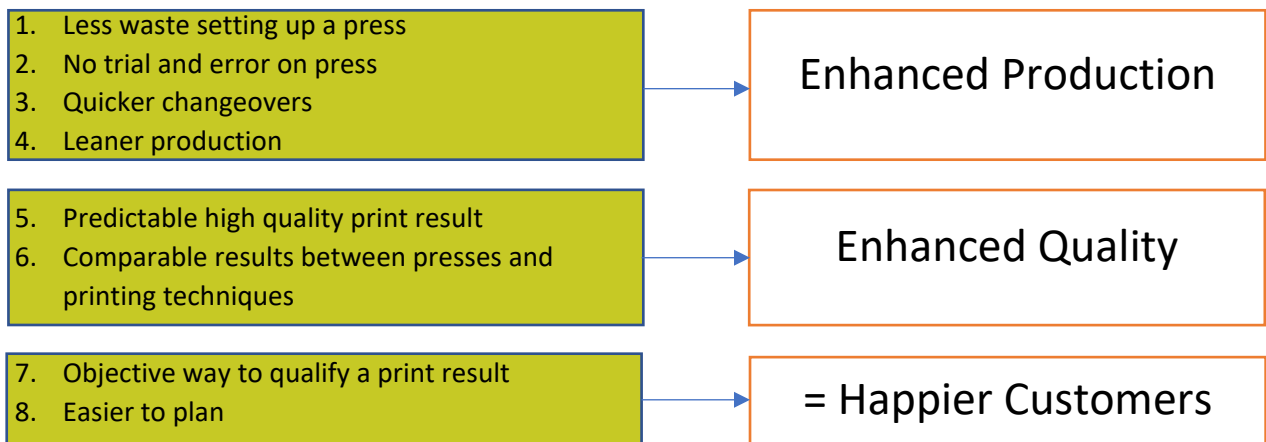# Print Control Wizard

What is a Printing Standard?

ESKO✲

1 **About Printing Standards**

In the process of becoming a mature sector, several printing standards were developed. The aim of such a standard is defining the quality parameters of a printed job. Setting up a printing environment that complies with a standard is a shared task between a prepress department, the plate department and the actual print room.

The benefits of a standardized production:

1. Less waste setting up a press 2. No trial and error on press 3. Quicker changeovers 4. Leaner production	Enhanced Production
5. Predictable high quality print result 6. Comparable results between presses and printing techniques	Enhanced Quality
7. Objective way to qualify a print result 8. Easier to plan	= Happier Customers

A printing standard always defines the measurable, mathematical features of a printed result. Simply put, depending on your printing technique and substrate, the following values should be within tolerance:

1. Full Tone LAB color value for Cyan, Magenta, Yellow and Black
2. TVI (dot gain) characteristic

Setting up a printing environment that produces according to a standard always begins at the press side. A typical way of reaching this goal is:

1. Define the press setup to produce highest quality and repeatable condition, so that your Full Tone LAB values are within tolerance.
2. Create a Screen and a Curve in prepress to make sure the repeatable press setup complies with the defined TVI values.
3. Set up a workflow where Quality Control measures are active in prepress, tool making and press environment.

2 **What parameters add up to a standard?**

1. **TVI**: Tonal Value Increase – the correct term for what is often called dot gain. Measured directly by a densitometric device or calculated from a spectral measurement.
TVI-based standards require actual printed TVI of each process color to be as close as possible to the reference TVI for the specific condition. This reference TVI is specified as pre-defined curves or is extracted from the profile that represents the specific printing condition.
Most ISO-based European standards use TVI as primary metric to adjust tonality of process inks.

2. **Gray balance and gray scales**: Compositions of C, M, Y that are intended to represent gray tints need to print as achromatic as possible. Both CMY composed gray scales and Black gray scales need to print with linear perceived densities.
Standards that are based on the G7 method (e.g. GRACol) use gray balance and gray scale as primary metrics to adjust tonality of process inks.

3. **Color**: measured by a spectrophotometric device. Each process color (CMYK) printed at 100% has to match a specific Lab / Lch value.
This metric is used for all standards.

4. **Substrate**: As color and TVI are influenced by the material used to print on, ISO has defined 5 classes of substrates. The difference is based on the white point of the substrate and the absorption level. A coated glossy material will have more saturated color values and lower TVI values compared to an uncoated material which absorbs and diffuses the ink more. This will lead to less bright colors at 100% and darker tone values due to increased TVI. To have the best possible visual match between printed jobs on these materials, ISO defined the different Lab and TVI values to reach this goal.

5. **Knowledge**: there are different methods of measuring density, color and calculating TVI. To match a standard, or to communicate about color, you need to be aware that the current range of densitometers and spectral devices have the ability to set up different 'measurement conditions'. When 2 identical and well calibrated devices measure a same color, the result can be very different according to which condition is chosen.

3 **Printing Standards in Color Pilot**

The 'Print Control Wizard' in Color Pilot requests you to select a specific 'printing standard' by selecting a specific pre-defined curve set template.

Selecting a curve set template is deciding on 3 important process control principles:

1. Which method do I use to calibrate my printing condition?
2. Which reference or standard best reflects my printing condition?
3. Do I want a template that also includes tolerances so that I can verify if my printing condition matches the selected reference or standard?

3.1 Available methods

- **G7 method**
  Printing standards based on the G7 method use gray balance as primary target to adjust tonality, to calculate adjustment curves.
  One part is to make sure CMY composed gray scales print achromatic.
  Second part is to make sure CMY composed gray scales and black scale print with linear perceived densities.
  This method does not require a reference profile or reference target curves, so it can be used on non-standardized printing conditions, keeping printed output gray balanced.
  However, deviation from a reference condition will reduce color accuracy making printed outcome less predictable / proof-able.

- **TVI method (Tone Value Increment method)**
  Printing standards that make use of single color tone scales as primary target to adjust tonality, to calculate adjustment curves.
  TVI is adjusted towards reference TVI curves that match/are in sync with a specific reference condition or profile.
  This method requires a reference profile or reference target curves, so it is used when the printing condition matches a standardized condition (paper, inks).

- **Mixture of G7 and TVI**
  Both the G7 method and TVI method generate similar result if the condition is close to a standardized condition. When the actual conditions deviates from a standard, the G7 method will better preserve gray balance in images and artwork while the TVI method will better preserver linearity and color of blends and technical objects.
  There are also curve set templates available that allow to mix both methods: they let you adjust tonality by using both gray scales and single color TVI scales.

For a list of curve set templates and the method they use, see the 'Overview of available templates for Color Pilot' chapter.

3.2 References or standardized conditions

For optimal printing process control and to be able to better predict or proof the outcome of a printing condition, the printing condition is calibrated as close as possible towards a reference or standardized condition.

There are different standardized conditions available to be used for specific substrates and inks. Each of these conditions are linked with a reference profile that matches the specific substrate and ink.

Calibrating a printing condition towards a standardized condition is making sure that color of paper, color of ink solids and tone scales print like the reference profile. Matching tone scales can be obtained by using pre-defined TVI curves or by extracting TVI curves directly from the reference profile.

For a list of curve set templates and their corresponding standard and reference profile, see the 'Overview of available templates for Color Pilot' chapter.

3.3   Enable verification

In order to verify if a printing condition matches a specific standardized condition, specific measurements are compared to reference values. A condition matches a standard if the deviations between the measured values and reference values are within specific limits or tolerances.

Depending on the method used, different measurements and their specific tolerances are needed.

There are curve set templates available where tolerances have been set up for ink solids, gray scales and/or tone scales, depending on the method or standard the template is created for.

When a curve set template where tolerances have been set up is selected, the final curve set created for the printing condition will allow verification in Curve Pilot.

For a list of curve set templates for which tolerances have been setup, see the 'Overview of available templates for Color Pilot' chapter.

4 <u>Selecting a printing standard in Color Pilot</u>

4.1 Curve set template groups and types

A list of curve set templates is available, to select a curve set template for a specific method, a specific standard and with or without tolerances. The curve set templates are smart-named:

- **Templates prefixed with 'G7_'**
  Printing standards that make use of the G7 method.
  Templates prefixed with G7_ also contain tolerances for ink solids and gray scales, so they enable verification.
- **Templates prefixed with 'TVI_'**
  Printing standards that make use of the TVI method.
  Templates prefixed with TVI_ also contain tolerances for ink solids and TVI, so they enable verification.
- **Templates prefixed with '3ck_'**
  Similar to templates prefixed with 'G7_'.
  These templates are not set up with tolerances, so they will not allow verification.
- **Templates prefixed with 'cmyk_'**
  Similar to templates prefixed with 'TVI_'.
  These templates are not set up with tolerances, so they will not allow verification.

Next to the main group of templates there are also some special templates:

- **TVI_Balanced Tone and Grey**
  Printing standards that use both gray scales and TVI method to adjust tonality.
  This template is also set up with tolerances for ink solids, gray scales and TVI, so it enables verification.
- **TVI_cmyk_LinearDensity**
  Template based on the TVI method, whereby the desired TVI curves are set to linear perceived density.
  The metric for measuring the tone value of the process inks is densitometric (%DotArea), the desired TVI curve is "ref.dgc".
  (Esko proprietary)
  This template is also set up with tolerances for ink solids and TVI, so it enables verification.
- **TVI_cmyk_Linear Color**
  Templates based on single color TVI adjustment, whereby TVI desired curves are set to linear color.
  The metric for measuring the tone value of the process inks is colorimetric (%ΔE_P), the desired TVI curve is linear.
  This template is also set up with tolerances for ink solids and TVI, so it enables verification.

- **Balanced Tone and Grey**
  (Esko proprietary)
  Printing standards that use both gray scales and TVI method to adjust tonality.
  This template is not set up with tolerances, so it will not allow verification.
- **cmyk_LinearDensity**
  (Esko proprietary)
  Template based on the TVI method, whereby the desired TVI curves are set to linear perceived density.
  The metric for measuring the tone value of the process inks is densitometric (%DotArea), the desired TVI curve is "ref.dgc".
  This template is not set up with tolerances, so it will not allow verification.

- **cmyk_Linear Color**
  (Esko proprietary)
  Templates based on single color TVI adjustment, whereby the TVI desired curves are set to linear color.
  The metric for measuring the tone value of the process inks is colorimetric (%ΔE_P), the desired TVI curve is linear.
  This template is not set up with tolerances, so it will not allow verification.

Notes about Esko proprietary templates:
The (TVI_)cmyk_LinearColor and (TVI_)cmyk_LinearDensity aim both for improved highlight printing characteristics in flexographic applications. As all standard templates and specifications originate in offset, it is hard to match the TVI behavior in the light printing areas when doing flexo. Flexo has a higher TVI compared to offset, which can be compensated by using stronger compensation curves.
Due to the characteristics of a densitometric device, the measurements in very light tones are not very reliable. That's why the 2 settings measure the entire tone scale in a spectral way and calculate a curve. As result the light areas will appear closer to the offset TVI.
LinearColor will match the cmyk_ISO_pt1&2 TVI values on 50%, while LinearDensity will have a TVI of around 18%.

4.2   Information about a selected curve set template

When a template is selected, the "Details" panel will show the main target values and metrics for the specific standard represented by the metric.
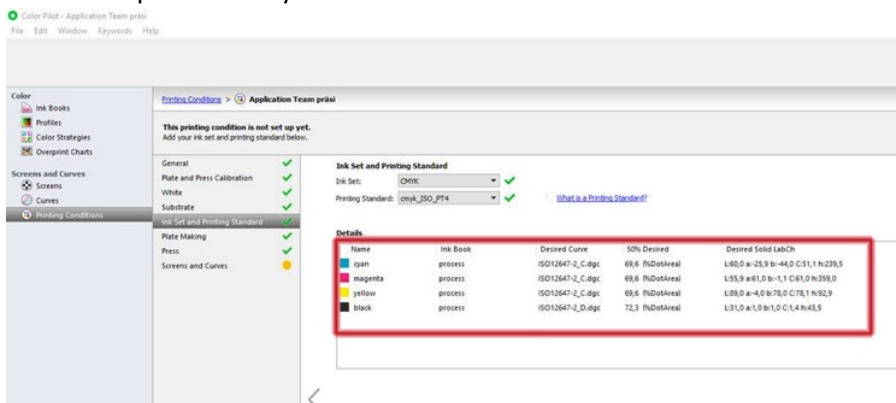
These values are the desired values, the values you want to measure after you have printed according the standard of choice. The software will create a screen and a curve, based on measurements from a printed sample (printed according to the previously set up printing condition) to match the chosen printing standard.
For each standard listed in the pop-up menu you can find a freely available ".icc" profile that can be used in prepress to simulate that specific printing condition on, for instance, a monitor or a proofing device. Profiles can be found on www.eci.org, but are also made available on your system by installing the Color Pilot software.

Note:
When a template based on the G7 method is selected, the desired TVI is not displayed (the details will show 'Gray Balance' instead of a TVI value).
That is because when using the G7 method there is no actual TVI target value: the tone is adjusted according to the G7 specified neutral print density curves (NPDC) and these curves are paper-dependent density curves.

5 Overview of available templates for Color Pilot

5.1 TVI based standards

Pop-up name	Subclass	Description	TVI 50%	Reference	tolerances Inks	Gray	TVI
cmyk_ISO_PT1&2	(*1) PT 1&2	Gloss and Matte Coated	14.3	ISOCoated_v2_300_eci.icc	☐	☐	☐
cmyk_ISO_PT1&2 (NP)	PT 1&2 FM	Gloss and Matte Coated	27.5	PSO_Coated_300_NPScreen_ISO12647_eci.occ	☐	☐	☐
cmyk_ISO_pt3	PT 3	Light Weight Coated	17	PSO_LWC_Standard_eci.icc	☐	☐	☐
cmyk_ISO_pt4	PT 4	Uncoated White Offset	19.5	PSO_Uncoated_ISO12647_eci.icc	☐	☐	☐
cmyk_ISO_pt5	PT 5	Uncoated Yellowish Offset	19.5	PSO_Uncoatedyellowish.icc	☐	☐	☐
cmyk_ISO_web	Coldset Web Offset	Super Calendered Paper	17	ISOWebCoated.icc	☐	☐	☐
cmyk_ISO_newsprint	Headset Web Offset	Standard Newsprint	16.5	PSO_SNP_Paper_eci.icc	☐	☐	☐
cmyk_Fogra51	PT 1	Premium Coated	16.5	PSOcoated_v3_Fogra51.icc	☐	☐	☐
cmyk_Fogra52	PT 5	Wood-free uncoated white	23	PSOuncoated_v3_Fogra52.icc	☐	☐	☐
cmyk_LinearDensity	PT 1&2	(*2) Esko proprietary	18	ISOCoated_v2_300_eci.icc	☐	☐	☐
cmyk_LinearColor	PT 1&2	(*2) Esko proprietary	(*3)0	ISOCoated_v2_300_eci.icc	☐	☐	☐

(*1): PT = Paper Type

(*2): Esko proprietary: standard adapted for flexo printing conditions – see 'Notes about Esko proprietary templates'

(*3): TVI 50% = 0%: TVI metric is colorimetric (%ΔE_P), target curve is linear

Pop-up name	Subclass	Description	TVI 50%	Reference	tolerances Inks	Gray	TVI
TVI_cmyk_ISO_PT1&2	(*) PT 1&2	Gloss and Matte Coated	14.3	ISOCoated_v2_300_eci.icc	☒	☐	☒
TVI_cmyk_ISO_PT1&2 (NP)	PT 1&2 FM	Gloss and Matte Coated	27.5	PSO_Coated_300_NPScreen_ISO12647_eci.occ	☒	☐	☒
TVI_cmyk_ISO_pt3	PT 3	Light Weight Coated	17	PSO_LWC_Standard_eci.icc	☒	☐	☒
TVI_cmyk_ISO_pt4	PT 4	Uncoated White Offset	19.5	PSO_Uncoated_ISO12647_eci.icc	☒	☐	☒
TVI_cmyk_ISO_pt5	PT 5	Uncoated Yellowish Offset	19.5	PSO_Uncoatedyellowish.icc	☒	☐	☒
TVI_cmyk_ISO_web	Coldset Web Offset	Super Calendered Paper	17	ISOWebCoated.icc	☒	☐	☒
TVI_cmyk_ISO_newsprint	Headset Web Offset	Standard Newsprint	16.5	PSO_SNP_Paper_eci.icc	☒	☐	☒
TVI_cmyk_Fogra51	PT 1	Premium Coated	16.5	PSOcoated_v3_Fogra51.icc	☒	☐	☒
TVI_cmyk_Fogra52	PT 5	Wood-free uncoated white	23	PSOuncoated_v3_Fogra52.icc	☒	☐	☒
TVI_cmyk_LinearDensity	PT 1&2	(*2) Esko proprietary	18	ISOCoated_v2_300_eci.icc	☒	☐	☒
TVI_cmyk_LinearColor	PT 1&2	(*2) Esko proprietary	(*3)0	ISOCoated_v2_300_eci.icc	☒	☐	☒

5.2 G7 based standards and use cases

Pop-up name	Description	TVI 50%	Gray scale	Reference	tolerances Inks	Gray	TVI
G7_CGATS21-2-CRPC1	Universal ColdsetNews Newsprint	26.1	NPDC Neutral paper	CGATS21-2-CRPC1.txt	☒	☒	☐
G7_CGATS21-2-CRPC2	Universal HeatsetNews Improved Newsprint	19.2	NPDC Neutral paper	CGATS21-2-CRPC2.txt	☒	☒	☐
G7_CGATS21-2-CRPC3	Universal Premium Uncoated Utility printing	19.1	NPDC Neutral paper	CGATS21-2-CRPC3.txt	☒	☒	☐
G7_CGATS21-2-CRPC4	Universal Supercalendared General printing on supercal paper	19.1	NPDC Neutral paper	CGATS21-2-CRPC4.txt	☒	☒	☐
G7_CGATS21-2-CRPC5	Universal Publication Coated Typical publication printing	16.0	NPDC Neutral paper	CGATS21-2-CRPC5.txt	☒	☒	☐
G7_CGATS21-2-CRPC6	Universal Premium Coated Large gamut (commercial) printing	16.0	NPDC Neutral paper	CGATS21-2-CRPC6.txt	☒	☒	☐
G7_CGATS21-2-CRPC7	Universal Extra Large Extra large gamut printing processes	16.1	NPDC Neutral paper	CGATS21-2-CRPC7.txt	☒	☒	☐
G7_GRACoL2006	Grade 1 coated paper (PT 1&2)	17	NPDC/Neutral paper	GRACol2006_Coated1 v2.icc	☒	☒	☐
G7_SNAP	Newsprint	19.1	NPDC/Neutral paper	SNAP2007.icc	☒	☒	☐

Pop-up name	Description	TVI 50%	Gray scale	Reference	tolerances Inks	Gray	TVI
GRACol_G7	General Commercial Offset Lithography	-	NPDC Neutral paper	GRACol2006_Coated1 v2.icc	☐	☐	☐
SNAP_G7	Newsprint Advertising Production	-	NPDC Neutral paper	SNAP2007.icc	☐	☐	☐
SWOP_G7	Web Offset Printing	-	NPDC Neutral paper	SWOP2006_Coated3_ GRC_bas.icc	☐	☐	☐

6 Overview of verification metrics and tolerances

6.1 Ink solids verification (G7 targeted)

A major verification metric is the color of the paper and ink solids.
When using the G7 methodology and certification, this verification metric is also called 'G7 targeted'.

The desired values for paper and ink solid colors are dependent on the curve set template that is selected.
These desired color values are extracted from the profile referenced in that template.
(Note: the 'reference' column in the 'Overview of available templates for Color Pilot' chapter shows the reference profile being used.)

The difference between measured and desired color is calculated from a ΔE function. This ΔE function is also set in the curve set template and is determined by the method or standard.

Curve set templates prefixed with 'G7_' or 'TVI_' are also set up with tolerances for ink solids.
The following tolerance values are used:

Paper: ΔE tolerance for paper

K: ΔE tolerance for the black process ink

Max CMY: ΔE tolerance for Cyan, Magenta and Yellow process inks.
(Note: 'Max CMY' tolerance is not used for 100% CMY overprint)

Max RGB: ΔE tolerance for Red, Green and Blue overprints

6.2 Gray scale verification

There are several metrics used to verify gray scales.
Both for black gray scale and CMY composed gray scales.

The desired density of gray scales is determined by G7-specific NPD (neutral print density) curves.
A curve set template that uses the G7 method will use these NPD curves to determine the desired densities for the different gray tints.

The desired color of the gray scales is calculated from the neutral paper color gray scale: the color of a CMY composed gray scale should start from the paper color and gradually became achromatic.
A curve set template that uses the G7 method or 'Balanced Tone And Gray' will use the color gray scale to determine the desired color for each CMY composed gray tint.

The following metrics and tolerances are used for gray scales:

Average wΔL* on K	1.5	■
Max wΔL* on K	3	■
Average wΔL* on CMY	1.5	■ ■ ■
Max wΔL* on CMY	3	■ ■ ■
Average wΔCh on CMY	1.5	■ ■ ■
Max wΔCh on CMY	3	■ ■ ■

Average wΔL* on K or CMY: the tolerance for the average weighted difference between measured lightness and desired lightness. 'Weighted' indicates that the lightness error is gradually reduced when the tone is higher than 50%.

Max wΔL* on K or CMY: the tolerance for the maximum weighted difference between measured lightness and desired lightness as determined. 'Weighted' indicates that the lightness error is gradually reduced when the tone is higher than 50%.

Average wΔCh on CMY: the tolerance for the average weighted difference between measured Chroma and desired Chroma. 'Weighted' indicates that the chroma error is gradually reduced when the tone is higher than 50%.

Maximum wΔCh on CMY: the tolerance for the maximum weighted difference between measured Chroma and desired Chroma. 'Weighted' indicates that the chroma error is gradually reduced when the tone is higher than 50%.

6.3 TVI verification

A 3rd verification metric is verifying if the tone scale of each individual process ink matches desired tone scales.
These desired tone scales or target curves are dependent on the selected curve set template.
They are set up in the template as pre-defined target curves, or they are extracted from the reference profile of the curve set template.

Curve set templates using the TVI method and prefixed with 'TVI_' are set up with a TVI tolerance.

In these curve set templates, tolerances have been set up for the 25%, 50% and 75% tones.
Note that during verification all tones are verified by interpolating the tolerance values for 25/50/75.

Below a table of desired TVI values and their tolerances.

	Patch 1		Patch 2		Patch 3	
Tones:		25%		50%		75%
Cyan:	37.7%	3.0%	66.6%	4.0%	88.0%	3.0%
Magenta:	37.5%	3.0%	66.3%	4.0%	87.9%	3.0%
Yellow:	37.8%	3.0%	66.6%	4.0%	88.1%	3.0%
Black:	37.2%	3.0%	66.0%	4.0%	87.7%	3.0%

The desired value is indicated with gray background.
The tolerance value is indicated with green background.