How to Interpret the IT8 Target results from the NAA/IFRA Color Quality Contest

August 2000 Volume XXXIV

With the introduction of the NAA / IFRA International Color Quality Contest, a lot of interest has been raised about the use of the IT8 color target.

The IT8 target can be an excellent tool to review the process within a newspaper. The target provides a way to measure the colors reproduced on press with calculated values (based on the original target values) to compare the results. The target should be used in normal newspaper controlled testing to benchmark the process.

Color input scanners do not see color the same way the human eye does. The IT8.7 1 & 2 are targets that were created as a standard so that scanners could be calibrated. The IT8.7.1 is a reflective target, while the IT8.7.2 is a transparency target. The specifications for these targets are described in ISO 12641 Graphic Technology – Prepress Digital Data Exchange – Color Targets for Input Scanner Calibration. This publication describes the target L* a* b* values that each of the color squares are to achieve. These targets are available from either AGFA or Kodak. In addition to having specific universally defined colors, IT8.7 targets are defined in terms of specific physical colorants.

These targets are basically precision photographic images that provide the following carefully defined sets of color patches according to internationally accepted specifications:

- A set of standard "conservative" color patches that are likely to fall within most device-color gamuts.
- A standard neutral lightness scale
- Target-specific color patches, many at the gamut limits of the colorants used to produce each target
- Each target also contains vendor-specific material - additional patches or images

The color values of the standard patches are specified in terms of device-independent CIELAB color, otherwise known as the L*a*b* color space, or in Photoshop simply as Lab. The color values of the other patches are specified in terms of the colorants (photographic dyes) used in specific targets. Since targets are real physical objects and not just a set of numerical specifications, a color error of 10 Delta E* units (See page 4 for a definition of Delta E*) (maximum Delta-E* = 10) is permitted in the standard patches

to allow for reasonable manufacturing tolerances. For the NAA/IFRA Color Quality Contest, a set of batch calibrated targets are used. These calibrated targets have tighter tolerances; the goal is to be less than 2 Delta E*'s for each patch.

How is the Target layed out?

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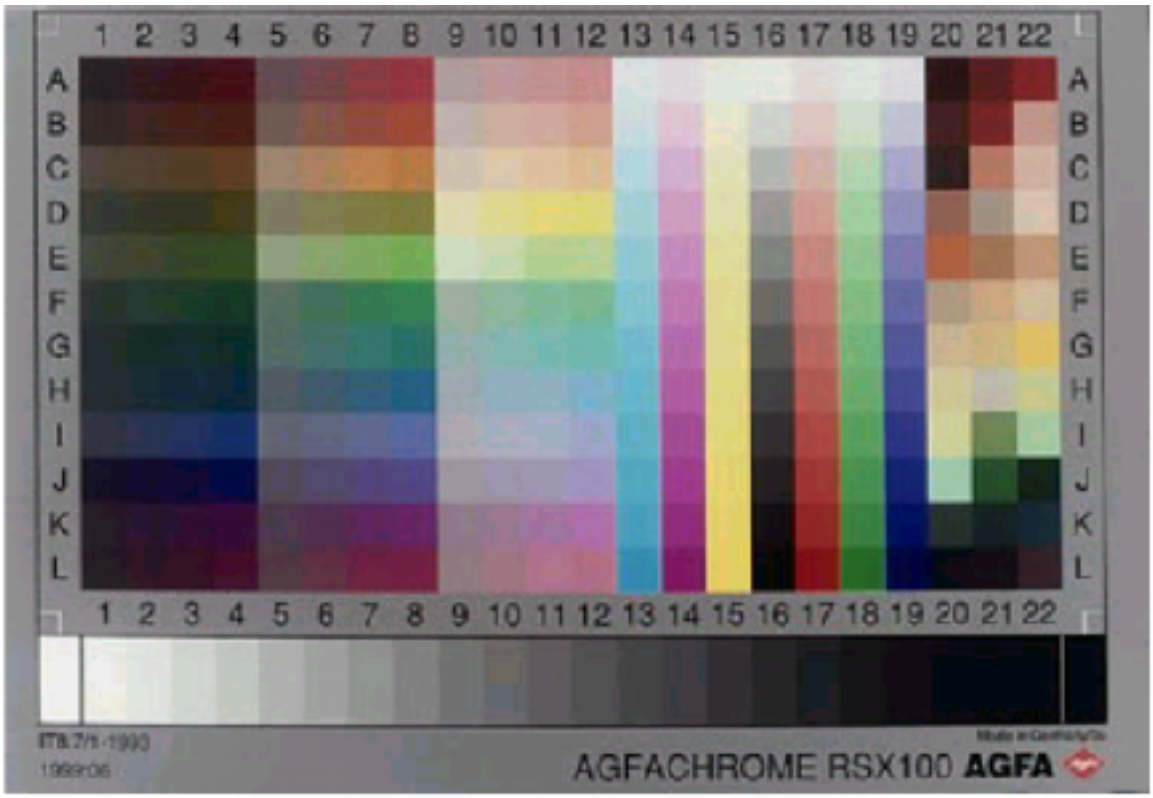


Figure 1 IT8 target

The NAA / IFRA Color Quality Contest uses the IT8 target to measure a newspaper's control over their process. For this part of the contest, a newspaper is given the IT8 target and asked to reproduce it through their process. The target must be scanned and then reproduced on press. The press reproduction is then measured spectrophotometrically and compared to target values established by IFRA. For the contest, the measurements breakdown into the following three categories:

1. Color Accuracy

Columns 1 through 12, rows A through L (144 total patches) are measured via a spectrophotometer to establish their color in L* a* b* color space. The measured values are compared to their corresponding target values for the particular patch with a formulation called Delta E*. Delta E* is a mathematical calculation that compares the differences in L*, a*, b*. The formula for this is the square root of the differences in L* a* b* squared, or

$$\text{Delta } E^* = ((L_{test}-L_{std})^2 + (a_{test} - a_{std})^2 + (b_{test} - b_{std})^2)^{0.5}$$

The higher the Delta E* the greater the deviation from the required color. In the last Color Quality Contest there are 60 points allotted to this portion. If a newspaper achieves less than 1000 total Delta E*'s, they would receive the maximum of 60 points. If a newspaper achieves 2000 total Delta E*'s they would receive no points for this section. For newspapers that fall in between these Delta E* goals, a portion of the 60 points will be awarded based on a linear scale.

In order to illustrate these differences, several three-dimensional figures have been created. The figures on the next page are a graphical representation of the measured values for the printed target patches (the small colored circles) vs. the standard color gamut as defined by SNAP (the wire cage). The color gamut is the total range of colors for the process. Figure A shows the target values (for a newspaper to achieve this they would have zero Delta E*'s), Figure B shows a newspapers results that achieved 600 total Delta E*'s, and Figure C is a newspaper's results that achieved 1400 total Delta E*'s. As you can see from the figures, as the total Delta E*'s get larger the reproduced colors on press form a tighter cluster within the standard gamut.

Figure A

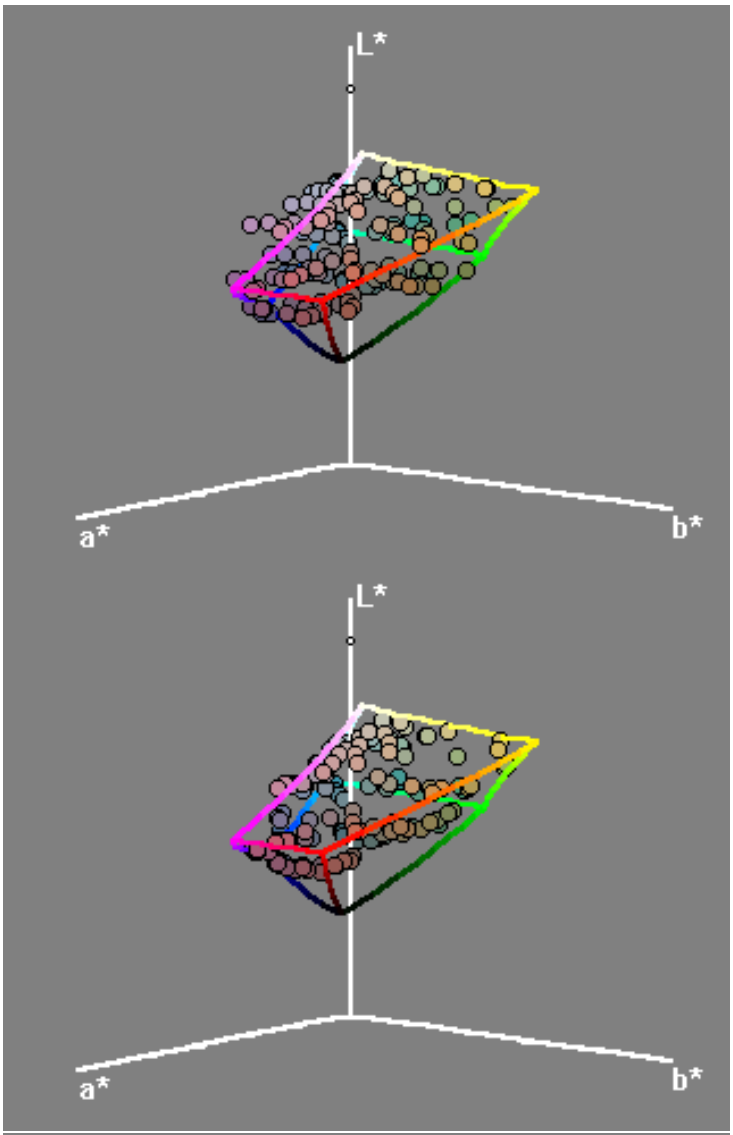
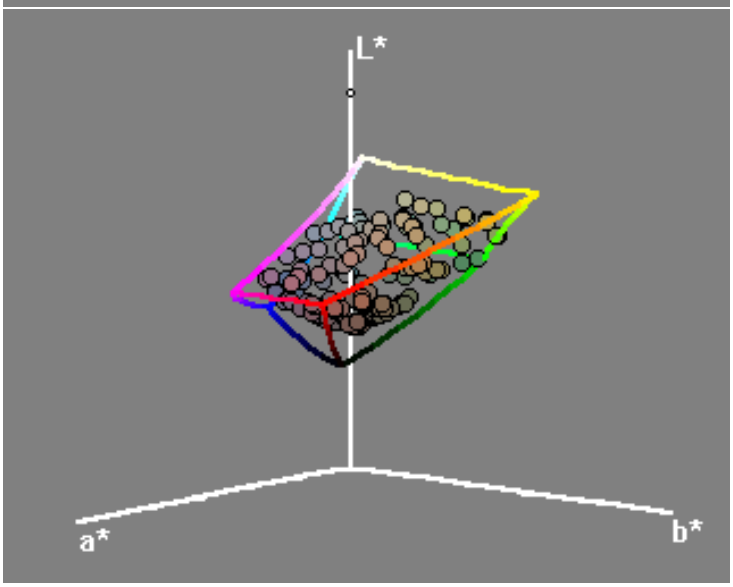


Figure B

Figure C



2. Tone Gradation Evaluation

The Gray step wedge will be measured for lightness values. The L* for five of the steps will be measured for lightness and compared to Standard values. If a newspaper achieves a delta lightness difference of 5 or less, 15 points would be awarded for this section. If 30 or higher delta lightness units are achieved, no points will be awarded for this section. Again, for newspapers that fall between these values the points will be distributed on a linear scale. The target values for the step wedge are listed below. The gray lines are the proposed areas that will be measured for the contest.

Step	
1	81.4
2	80.31
3	77.98
4	75.95
5	72.73
6	70.4
7	68.04
8	65.11
9	62.72
10	60.27
11	57.93
12	55.91
13	53.79
14	51.49
15	48.78
16	46.18
17	43.75
18	41.52
19	38.82
20	36.37
21	35.47
22	34.58

3. Gray Balance Evaluation

The third part of the target that was measured is for gray balance. The step wedge will also be used to measure this section. The chroma for the grays produced will be measured

again via a spectrophotometer. The closer the chroma is to zero the more the color will resemble a gray. Since newsprint is not a pure white, it is difficult to get a zero chroma on each of the steps in the wedge, therefore IFRA has come up with target values for each of the steps in the wedge. The chroma of a color is defined as the square root of ($a^{*2} + b^{*2}$). So to calculate the chroma differences for the reproduced color, the formula would be the square root of the differences in a^{*2} plus the difference in b^{*2}. The following table lists the target values for a* and b* for the step wedge.

	a*	b*
Step 1	-0.11	3.3
2	-0.11	3.14
3	-0.1	2.96
4	-0.09	2.8
5	-0.08	2.63
6	-0.05	2.43
7	-0.01	2.27
8	0.05	2.11
9	0.12	2
10	0.27	1.87
11	0.42	1.79
12	0.57	1.78
13	0.68	1.77
14	0.82	1.82
15	0.95	1.91
16	1.07	2.03
17	1.14	2.19
18	1.17	2.35
19	1.2	2.52
20	1.21	2.7
21	1.23	2.92
22	1.25	3.16

If a newspaper achieves a delta chroma difference of 5 or less, 15 points would be awarded for this section. If 30 or higher delta chroma units are achieved, no points will be awarded for this section. Again for newspapers that fall between these values the points will be distributed on a linear scale.

Several factors need to be reviewed to maximize the results.

a. Print to the solid ink density standard values. Lower solid ink densities will result in a lower color gamut.
b. Print uniformly within the process colors, incorrect gray balance will result in a color shift.
c. Proper press maintenance to insure that the press conditions are correct.
d. Proper trapping of the process color on press.
e. Proper separation. This is the most critical in the process. The separation must be set up correctly for the press so that the target will be reproduced on press.

The IT8 target can be an excellent tool to review the process within a newspaper. The target provides a site, the ability to measure the colors reproduced on press and compare those to specified values. The target should be used in normal newspaper controlled testing to benchmark the process and not just as a color quality contest device.

So what do you do if the target is printed and the results do not match the expected values? There are two important steps to understand. The first is the color gamut and the second is L*a*b* color space. Once the target is printed, the first thing to check is the color gamut. If the color gamut does not meet SNAP standards, it is probably not even worth reading the rest of the targets. Achieving the color gamut on press is critical to be able to create the colors in the IT8 target.

In looking at the gamut, the gamut is measured by printing solid ink targets and the trap overprints on press. The solid ink density is critical in this step. The SNAP density specification should be achieved to maximize the gamut. After the solid ink densities have been achieved, the spectral values for the targets can be measured in L*a*b* color space.

- Target the higher end of the Density range and be sure to allow for dry back after printing.

- Minimize the Ink and Water Balance to achieve the best results.

Production Printing Specifications

Solid Ink Density (Dry)	Offset Newspaper	Offset Commercial	Flexography	Letterpress
Cyan	0.90	0.90	0.95	0.90
Magenta	0.90	0.90	0.97	0.90
Yellow	0.85	0.90	0.79	0.85
Black	1.05	1.10	1.05	1.00
SNAP Tolerances	+/- 0.05	+/- 0.10	+/- 0.04	+/- 0.05

CIELAB L*, a*, b* Aim Values	L*	a*	b*
Cyan	57	-23	-27
Magenta	53	48	0
Yellow	79	-5	60
Black	40	1	4
Cyan & Yellow	53	-34	18
Cyan & Magenta	41	7	-22
Magenta & Yellow	52	41	25

Values come from ISO 12647-3. They represent offset and letterpress inks only. Measurements are according to ISO 13655 (2° observer, illuminant D_{50}, 45°/0° or 0°/45°, black backing).

The figures above show a plot of the a*b* values for the standard SNAP values and two test results. In figure 2 one can see that the lines for the test and the standard overlap, which means the color gamut meets the standard values. In figure 3 however, you can see that the test gamut is smaller than the gamut for the standard. In this example, it would be difficult to match the other colors within the target.

Figure 2

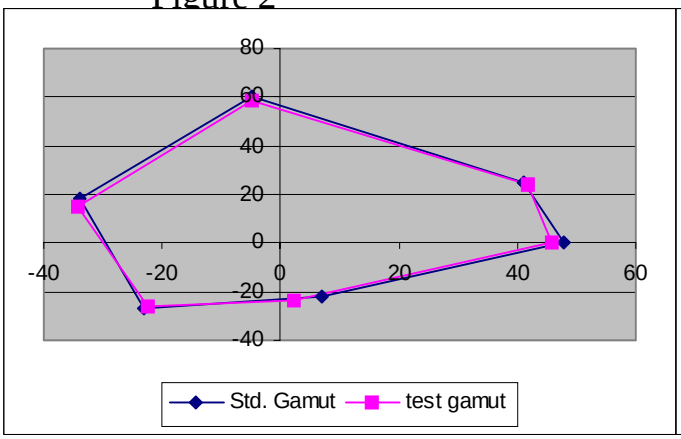
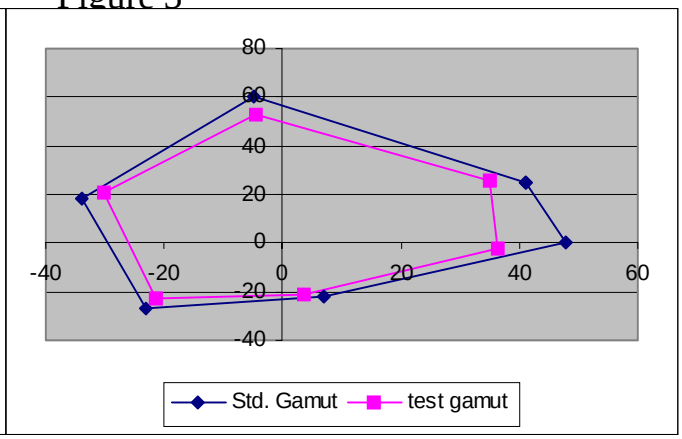


Figure 3



In looking at these diagrams, they show both the solid points and the overprints. If the solid ink points are acceptable or close to the standard and the overprint value if off, there may be a trapping problem on press. Ensure that the proper printing sequence is used (CMYK or KCMY).

Once the correct color gamut has been achieved on press, one can then look at the values for the rest of the target. Again the target should be measured with a spectrophotometer in the L*a*b* color space. The target will be compared to the standard values based on the calculation of Delta E*. The Delta E* calculation is based on the differences in L*a*b* values, so it is important that each of the values are close to the target values.

The most common cause of differences is based on the L*. This will have the greatest impact and should be one of the first checks in adjusting the target. The L* values should be looked at globally to see if any adjustments can be made. If there are large differences in these values, the target should be adjusted for this first. You should look at different areas on the gray step wedge to see if a global adjustment is necessary or a particular area of the tonal curve (i.e. shadow areas or midtones) needs adjustment. This could be easily accomplished in Photoshop by placing the target in L*a*b* color space. The target can then be adjusted by going into the curves and adjusting the L* curve. By doing this the lightness of the target can be adjusted without affecting the a* or b* values.

As a guide you can look at the gray step wedge lightness values and compare them to the target values. For example the lightness of step 11 is supposed to be 57.93 and you are printing darker than the target let's say 45. You can look at your printed target and see at what step the lightness of 58 is. You can then use this as a guide to readjust the target in pre-press. The target should then be reprinted and re-measured until the L* values are similar to the target values.

Once the color gamut and lightness have been corrected, the next step would be to get the gray balance in line. As stated before, a printed area having a chroma close to zero would appear as a neutral gray. The balance within the separation needs to be adjusted so that these printed areas have a neutral color balance to them. Again you would need to compare the printed values to the reference values and then go back and make adjustments to pre-press.

Look at different areas of the tonal curve and check again if a global or local area tonal correction is needed.

If these steps are followed the resulting color balance of the 144 areas to be measured should be within acceptable tolerances. We do not recommend going through and trying to adjust each of these squares individually. This is not something that would happen on a daily production run and the intent of the Color Quality Contest is to test the principles and practices in reproducing a color gamut on press.