Comparative Performance Evaluation

MAY 2013

Genuine Xerox Phaser 6010 Brand Print Cartridges

vs. Ninestar Brand

Buyers Laboratory (BLI) was commissioned by Xerox Corporation to conduct an independent comparative lab evaluation of the performance of genuine Xerox brand print cartridges against that of Ninestar print cartridges in the Xerox Phaser 6010 color printer. The objective of the test was to compare the page yield, reliability, image quality and image permanence of the two brands of cartridges. Nine sets of black, cyan, magenta and yellow cartridges of each brand were tested across three printers dedicated to each brand (three sets per printer), in accordance with ISO/IEC 19798. All testing was conducted in BLI's 10,000-square-foot test lab located in Hackensack, NJ (USA; www.buyerslab.com).

PERFORMANCE SUMMARY

The results of BLI's test showed that, with the exception of image permanence, for which there was performance parity, the Xerox Phaser 6010 print cartridges were superior to the Ninestar cartridges in the other three test categories. With regard to tested page yield for each color, the Xerox cartridges output more pages on average than the Ninestar cartridges. In addition, all nine of the black Xerox cartridges surpassed their 2,000-page rated yield and all of the color cartridges surpassed their 1,000-page rated yield, except for one cyan cartridge that fell slightly under. In contrast, five of the Ninestar cartridges fell short of their rated yields, three of which were out-of-box failures. Thus, the Xerox cartridges, with no failures of any kind, also displayed superior reliability performance.

Image quality was the third area in which Xerox displayed an advantage. Although the text and line art of the two brands were on par, the Xerox cartridges displayed a clear advantage with business color graphics, color photo images, and solids. While the Xerox color images were consistently vibrant and uniform, those printed with the Ninestar cartridges were inconsistent, with some being vibrant and others appearing faded and mottled. In addition, the Ninestar brand was marked down for mottling, streaking, speckling and voids in solids, none of which occurred with the Xerox cartridges. The Xerox cartridges also displayed a clear edge with color density when printing magenta and yellow. While the Ninestar cartridges printed slightly denser blacks, mottling of solids with white spots (loss of coverage) offsets this advantage. The cyan densities were comparable. Overall, this translates to a higher average density reading for Xerox.

TABLE 1: Performance Summary

	XEROX	NINESTAR
Average Page Yield	+	
Reliability	+	
Image Quality	+	
Image Permanence	O	O
OVERALL	+	

+ denotes which cartridge brand has the advantage, while an O denotes parity.

OVERALL PERFORMANCE

PAGE YIELD

The nine Xerox black, magenta and yellow cartridges all exceeded their rated yield, with only one of the cyan cartridges falling slightly short. Of the nine Ninestar cartridge sets, at least one of each color failed to reach the rated yield, for a total of five, of which three (two black and one yellow) were out-of-box failures. Consequently, the average tested yield of the black Xerox cartridges was 450 pages higher (28%) than that of the Ninestar cartridges and the average tested yield for the yellow Xerox cartridges was 114 pages (12%) higher than that of the Ninestar cartridges. The Xerox cyan and magenta cartridges also netted higher yields than the Ninestar cartridges, but here the difference was only 1% or less. The tested ISO 90% LCB yields were also in favor of Xerox for all colors, specifically by 985 pages (93%) for black, 321 pages (45%) for yellow, 43 pages (4%) for magenta and by six pages (1%) for cyan.

TABLE 2: Page Yields

		Number of Cartridges Tested	Failed to Meet Rated Yield	Rated Yield	Average Tested Yield	Tested ISO 90% LCB Yield*
Xerox	Black	9	0	2,000	2,075	2,047
	Cyan	9	1	1,000	1,069	1,042
	Magenta	9	0	1,000	1,066	1,053
	Yellow	9	0	1,000	1,052	1,042
Ninestar	Black	9	2	2,000	1,625	1,062
	Cyan	9	1	1,000	1,058	1,036
	Magenta	9	1	1,000	1,063	1,010
	Yellow	9	1	1,000	938	721

* ISO 90% LCB calculation accounts for variations in yields across the nine cartridges and is therefore more accurate than simply averaging the results for all cartridges; it represents a yield that can be expected to be achieved or exceeded with 90% confidence.

RELIABILITY

There were no failures whatsoever with the Xerox cartridges, whereas two of the Ninestar black cartridges and one of the Ninestar yellow cartridges failed out of box. Both of the black Ninestar cartridges failed because the printers would not accept the cartridges, while the yellow cartridge failed due to a loud grinding noise. It should also be noted that two spare Ninestar cartridges that were used as fillers when completing the yield tests on the black cartridges also exhibited the unacceptable loud grinding noise.

TABLE 3: Reliability

		Number of Cartridges Tested	Failures*		
			Out-of-Box	Premature	Total
Xerox	Black	9	0	0	0
	Cyan	9	0	0	0
	Magenta	9	0	0	0
	Yellow	9	0	0	0
Ninestar	Black	9	2	0	2
	Cyan	9	0	0	0
	Magenta	9	0	0	0
	Yellow	9	1	0	1

* Out-of-Box Failure: a cartridge that was inoperable upon installation or produced 20 or fewer acceptable pages. Premature Expire: a cartridge that produced less than 75% of the rated yield.

Also noteworthy is the occurrence of significant toner spill in the package with four of the black Ninestar test cartridges and with one of the yellow Ninestar test cartridges (see Exhibits A and B on page 4), although this did not prevent these cartridges from operating normally in testing and reaching an acceptable end of life.

IMAGE QUALITY

With image quality, Xerox again had the advantage over the Ninestar brand, with the exception of text and line art, where performance was on par for both brands. However, the Xerox cartridges excelled with color business graphics and color photo image output, providing images that were consistently vibrant, clear and uniform (see Exhibits C and D on page 5). The Ninestar cartridges, in contrast, provided inconsistent images that appeared bright at times, but at other times appeared washed out and mottled (see Exhibits E and F on page 5). The Xerox cartridges also printed superior solids, as the Ninestar cartridges produced solids with significant mottling and white spots/image voids and the Xerox cartridges did not. In addition, the Ninestar cartridges exhibited print defects such as streaking, speckling and extraneous imaging that did not occur with the Xerox cartridges (see Exhibits G and H on page 6). In the density readings, the Xerox cartridges were clearly better with magenta, with an average reading of 0.85 versus 0.75 for Ninestar, and yellow, with 0.92 for Xerox and 0.79 for Ninestar. With black density Ninestar did better, with an average reading of 1.27 versus 1.19 for Xerox; however, this advantage is offset by the white spots/image voids and excessive mottling on black solids with the Ninestar brand. The cyan densities were equivalent.

BLI also observed extraneous banding of toner and smudge marks (print defects) in a number of print samples from the Ninestar cartridges (see Exhibits I and J on page 7) that BLI believes was due to excessive toner build-up on the transfer roller (see Exhibit L on page 7). In contrast, the rollers in the printers used to test the Xerox cartridges had no toner build-up (see Exhibit K on page 7) and none of the prints from the Xerox cartridges showed

print defects. In addition, significant toner dumping in the printer cartridge bays with the Ninestar cartridges was observed after the first Ninestar cartridge set was depleted, which BLI believes very likely contributed to the toner contamination of the transfer rollers. In fact, after running three sets of cartridges through each of the test printers, the toner bays of the Xerox-dedicated printers were clean (see Exhibit M on page 8), while those of the Ninestar-dedicated printers showed considerable toner contamination (see Exhibit N on page 8). BLI believes that over time such excessive toner dumping will result in premature expire of printer components and premature end of printer life.

TABLE 4: Overall Image Quality*

	Xerox	Ninestar
Text	4	4
Line Art	4	4
Solids	3	1
Color Business Graphics	3	2
Color Photo Image Output and Density	3	2
Total	17	13
AVERAGE	3.40	2.60

* 4 represents excellent, 3 is very good, 2 is good, 1 is fair and 0 is poor.

Exhibits

Exhibit A: Toner spill with black Ninestar cartridge.

Exhibit B: Toner spill with yellow Ninestar cartridge.

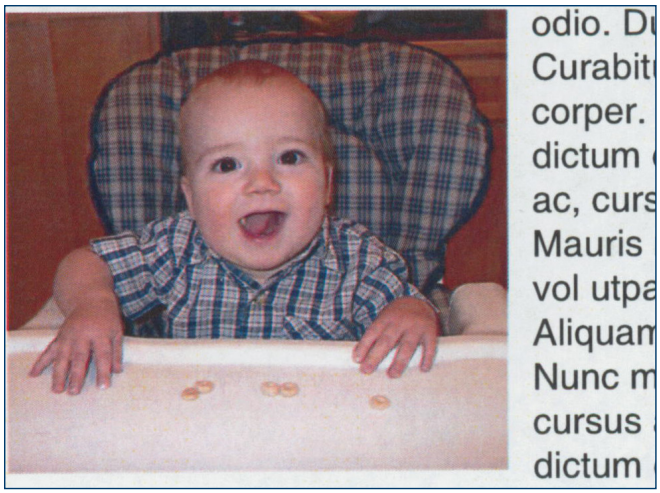


Exhibit C: Xerox Color Photo Image output with vibrant, clear and uniform images.

Exhibit E: Ninestar Color Photo Image output with with inconsistent images that were bright at times but otherwise washed-out and mottled.

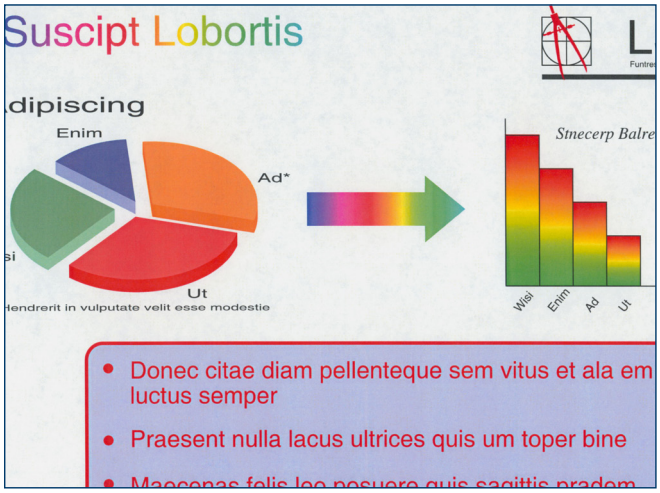


Exhibit D: Xerox Color Business Graphics output with vibrant, clear and uniform images.

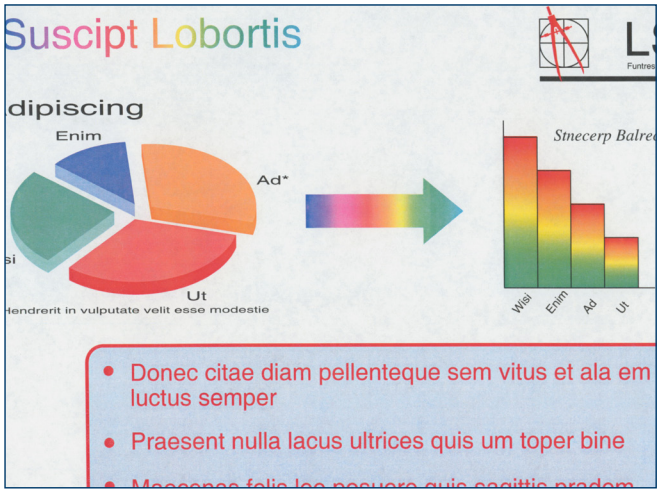


Exhibit F: Ninestar Color Business Graphics output with inconsistent images that were bright at times but otherwise washed-out and mottled.

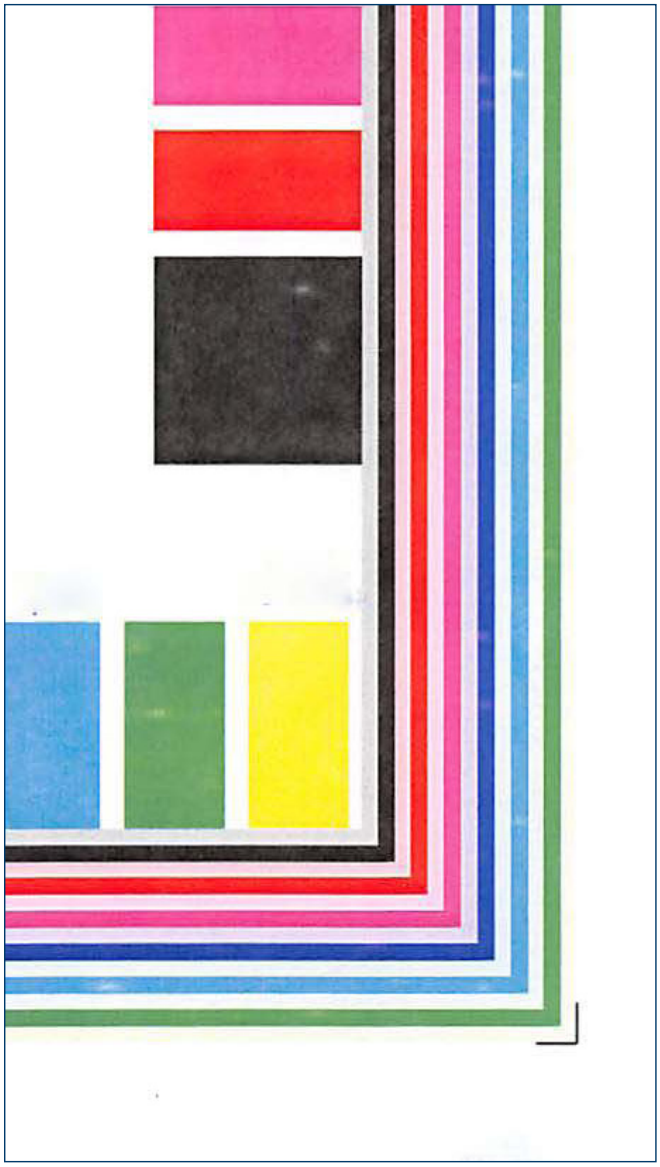


Exhibit G: Voids in Ninestar solids.

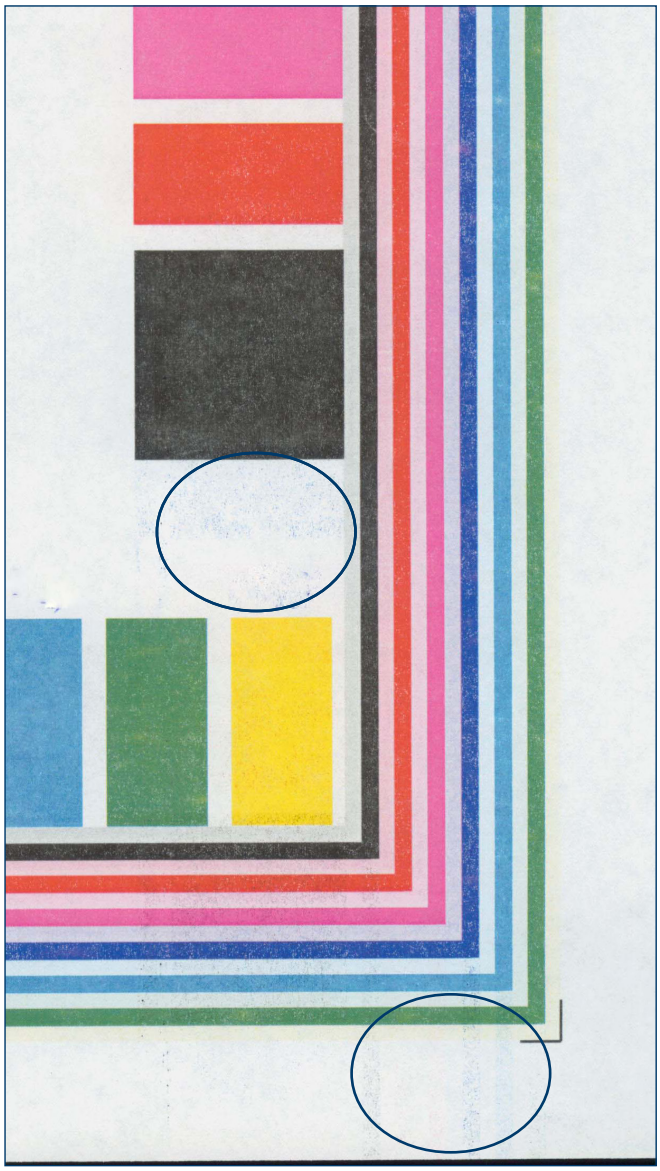


Exhibit H: Ninestar solids with streaking, speckling and extraneous images.

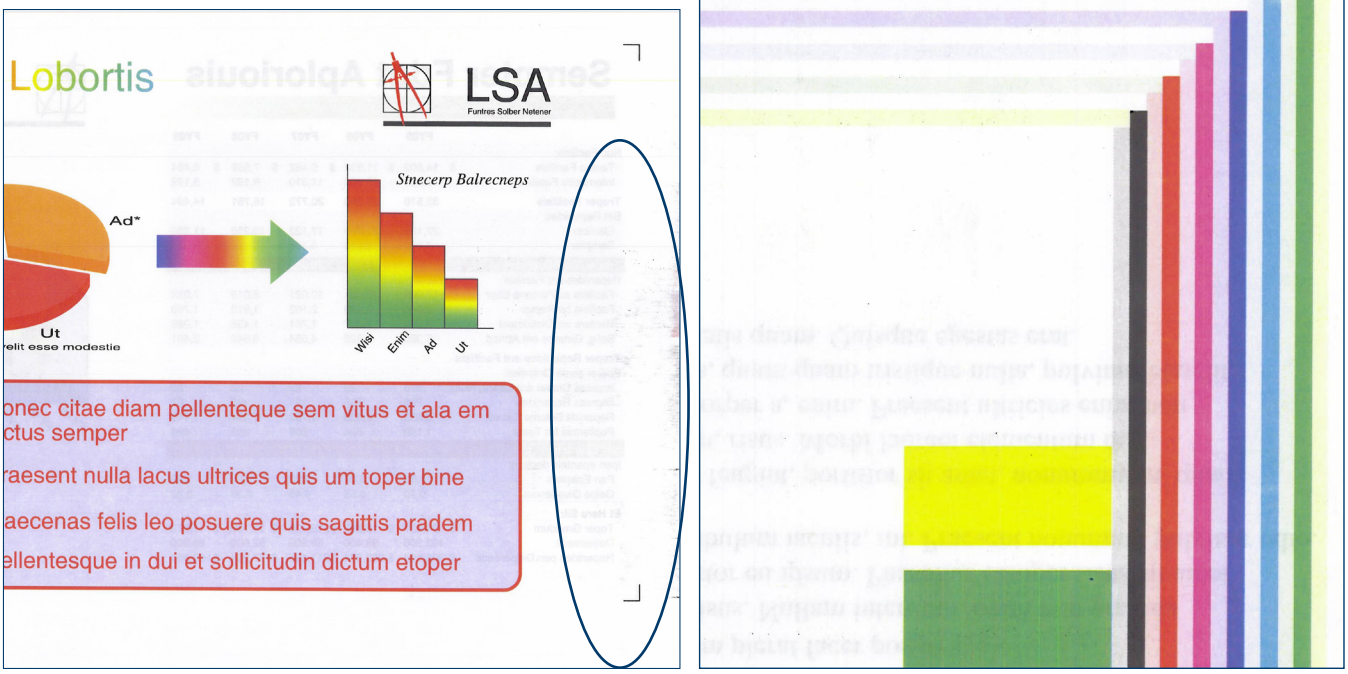


Exhibit I and J: Extraneous toner banding and smudge marks due to excessive toner build-up on transfer rollers with Ninestar cartridges.

Exhibit K: No toner build-up on transfer rollers with with Xerox cartridges.

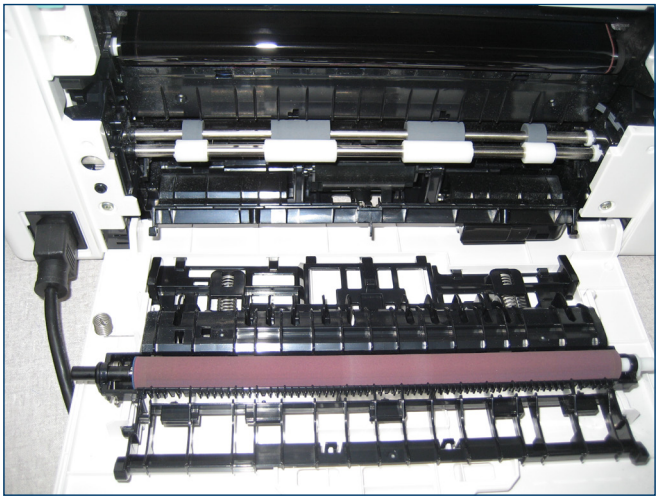


Exhibit L: Excessive toner build-up on transfer rollers with Ninestar cartridges.

Exhibit M: Clean toner bays in Xerox-dedicated printers.

Exhibit N: Toner contamination in toner bays in Ninestar-dedicated printers.

DENSITY READINGS

BLACK CARTRIDGE PRINT DENSITIES							
XEROX	High	Low	Average	NINESTAR	High	Low	Average
A1	1.39	1.23	1.31	A1	1.44	1.12	1.28
A2	1.19	1.01	1.10	A2	1.40	1.21	1.31
A3	1.19	1.11	1.15	A3	1.33	1.03	1.18
B1	1.40	1.16	1.28	B1	1.55	1.10	1.33
B2	1.30	1.00	1.15	B2	Out-of-box Failure		
B3	1.06	0.98	1.02	B3	Out-of-box Failure		
C1	1.32	1.18	1.25	C1	1.35	1.19	1.27
C2	1.28	1.16	1.22	C2	1.40	1.20	1.30
C3	1.31	1.11	1.21	C3	1.31	1.19	1.25
AVERAGE	**1.27**	**1.10**	**1.19**	**AVERAGE**	**1.40**	**1.15**	**1.27**

The higher the number the darker the color.

CYAN CARTRIDGE PRINT DENSITIES							
XEROX	High	Low	Average	NINESTAR	High	Low	Average
A1	0.73	0.67	0.70	A1	0.70	0.63	0.67
A2	0.74	0.59	0.67	A2	0.74	0.63	0.69
A3	0.74	0.63	0.69	A3	0.69	0.61	0.65
B1	0.77	0.64	0.71	B1	0.73	0.63	0.68
B2	0.87	0.64	0.76	B2	0.92	0.60	0.76
B3	0.73	0.64	0.69	B3	0.75	0.62	0.69
C1	0.83	0.62	0.73	C1	0.80	0.72	0.76
C2	0.83	0.63	0.73	C2	0.88	0.71	0.80
C3	0.73	0.57	0.65	C3	0.77	0.56	0.67
AVERAGE	**0.77**	**0.63**	**0.70**	**AVERAGE**	**0.78**	**0.63**	**0.71**

The higher the number the darker the color.

MAGENTA CARTRIDGE PRINT DENSITIES							
XEROX	High	Low	Average	NINESTAR	High	Low	Average
A1	0.91	0.81	0.86	A1	0.97	0.70	0.84
A2	0.93	0.78	0.86	A2	0.69	0.48	0.59
A3	0.88	0.78	0.83	A3	0.61	0.51	0.56
B1	0.97	0.80	0.89	B1	0.91	0.79	0.85
B2	1.08	0.77	0.93	B2	0.97	0.70	0.84
B3	0.87	0.73	0.80	B3	0.76	0.66	0.71
C1	0.86	0.75	0.81	C1	0.86	0.79	0.83
C2	0.96	0.77	0.87	C2	0.94	0.67	0.81
C3	0.89	0.75	0.82	C3	0.88	0.61	0.75
AVERAGE	**0.93**	**0.77**	**0.85**	**AVERAGE**	**0.84**	**0.66**	**0.75**

The higher the number the darker the color.

YELLOW CARTRIDGE PRINT DENSITIES							
XEROX	High	Low	Average	NINESTAR	High	Low	Average
A1	0.95	0.87	0.91	A1	0.97	0.78	0.88
A2	0.91	0.86	0.89	A2	0.77	0.63	0.70
A3	0.93	0.83	0.88	A3	0.77	0.64	0.71
B1	0.97	0.94	0.96	B1	0.94	0.83	0.89
B2	0.98	0.91	0.95	B2	0.97	0.61	0.79
B3	0.91	0.88	0.90	B3	Out-of-box Failure		
C1	0.96	0.87	0.92	C1	0.94	0.79	0.87
C2	0.97	0.89	0.93	C2	0.79	0.69	0.74
C3	0.93	0.92	0.93	C3	0.82	0.76	0.79
AVERAGE	**0.95**	**0.89**	**0.92**	**AVERAGE**	**0.87**	**0.72**	**0.79**

The higher the number the darker the color.

IMAGE PERMANENCE

Sutherland Rub Test

Image permanence of output delivered by the Xerox and Ninestar cartridges was considered to be very good. Both cartridge types netted identical results in the Sutherland rub test, showing virtually no image degradation at every reading point. The differences in density from the start (no cycles) to the end (160 cycles) were negligible; consequently, both cartridge types passed this test.

AVERAGE SUTHERLAND RUB TEST DENSITY READINGS

XEROX	Cycles				NINESTAR	Cycles			
	0	5	40	160		0	5	40	160
A1	0.00	0.00	0.00	0.00	D1	0.00	0.00	0.00	0.01
A2	0.01	0.01	0.01	0.01	D2	0.01	0.00	0.00	0.01
A3	0.01	0.01	0.01	0.01	D3	0.00	0.00	-0.01	0.00
B1	0.00	0.00	0.00	0.00	E1	0.00	0.00	0.00	0.00
B2	0.02	0.01	0.01	0.02	E2	0.00	0.00	0.01	0.01
B3	0.01	0.01	0.01	0.02	E3	0.00	-0.01	-0.01	0.00
C1	0.00	0.01	0.01	0.01	F1	-0.01	-0.01	-0.01	-0.01
C2	0.01	0.01	0.01	0.01	F2	0.00	0.00	0.01	0.01
C3	0.01	0.01	0.01	0.01	F3	0.00	0.00	0.00	0.00

Hard-Creasing Test

The Xerox and Ninestar cartridges both demonstrated good image adhesion in the hard-creasing test. A visual examination of print samples revealed little to no cracking on solid lines (there are five horizontal lines printed for this test).

TEST METHODOLOGY

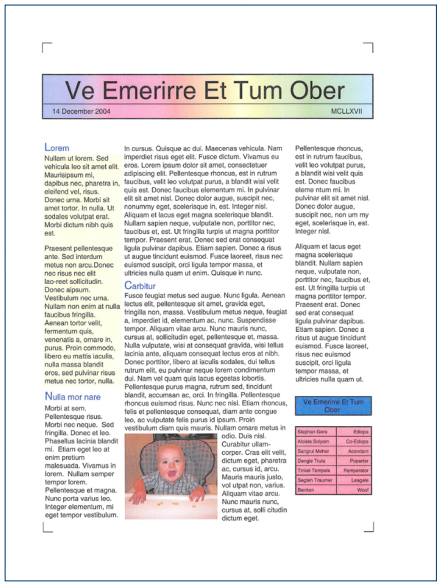
Test Conditions

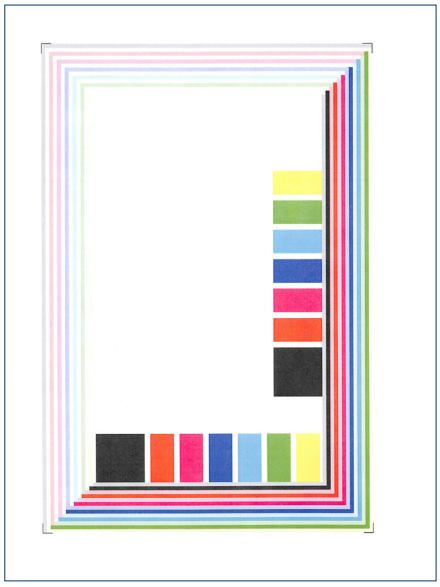
BLI performed all testing in its 10,000-square-foot U.S. lab located in Hackensack, NJ. All tests were conducted under controlled conditions of temperature and humidity, with conditions monitored 24/7 by an Extech RH S20 Digital RH/Temperature Recorder and Honeywell Model 61 Seven-Day Temperature/Humidity Chart Recorder.

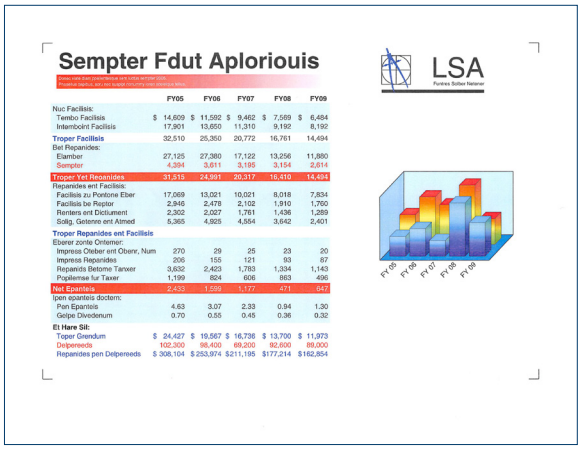
Running average temperature was 68°F to 78°F, and running average humidity range was 35% to 65%. All test devices and materials were conditioned for a minimum of eight hours prior to testing. A total of 18 cartridges were evaluated across six printers: nine Xerox cartridges in three devices, and nine Ninestar cartridges in the other three devices.

Page Yield

BLI used the five-page ISO 24712 color test target (see Exhibit O below). When a device prompted BLI technicians on the display to insert a new cartridge, the previous cartridge was considered to be at the end of life. The total page count per cartridge was defined as the number of acceptable pages printed (that is, pages without image quality defects). The overall average page yield per brand was defined as the combined total number of acceptable pages printed by all of the cartridges and then divided by nine.







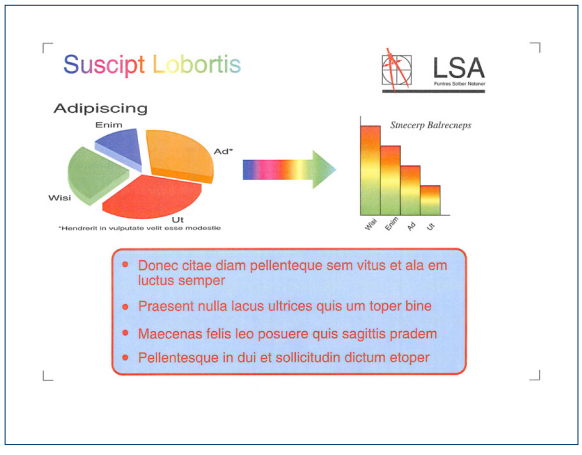


Exhibit: O

Reliability

Throughout testing, any malfunctions observed such as operational/mechanical failure, error messages, out-of-box failures, premature expires, physical defects or toner leakage were recorded. Out-of-Box Failure: a cartridge that was inoperable upon installation or produced 20 or fewer acceptable pages. Premature Expire: a cartridge that produced less than 75% of the rated yield.

IMAGE Quality

In assessing image quality, BLI's lab test technicians assigned a grade of 4, 3, 2, 1 or 0 to each performance category, with four being the best. Averages of the individual cartridge grades were calculated in order to assign a value and overall grade to each brand of cartridge. Visual assessments were made in a Graphiclite D5000 Standard Viewer and with an Edmund Scientific PL-B776U PixeLINK Camera. Black density was measured with an X-Rite 508 Series Spectrodensitometer.

Image quality was evaluated based on the following categories: text, line art, halftones and solids. Samples were taken at the start of testing and at 25%, 50% and 75% of claimed page yield. Based on the test target, each was rated according to a cartridge's performance in the following related sub-categories: boldness, sharpness, fullness of formation, and smoothness of serifs for Text; line consistency and formation of circles for Line Art; separation of grayscale levels, graininess and banding for Halftones; and visible darkness/boldness and consistency of coverage for Solids. Four density measurements were taken for each sample, two each on the right- and left-side of the page, top and bottom. The scores were totaled across each category and averaged to obtain a grade for each brand. All criteria were then averaged and constitute the overall grade for each brand.

IMAGE PERMANENCE

Samples were evaluated for image permanence via the ASTM F1571 Standard Test Method for Determination of Abrasion and Smudge Resistance of Images Produced from Copy Products (Sutherland Method), and via the ASTM F1351 Standard Practice for Determination of the Effect of Hard Creasing Paper on Images Produced by Business Imaging Systems.

ABOUT BUYERS LABORATORY

Since 1961, Buyers Laboratory LLC (BLI) has been the leading global independent office-equipment test lab and business consumer advocate. In addition to publishing the industry's most comprehensive and accurate test reports on office document imaging devices, each representing months of exhaustive hands-on testing in BLI's US and UK laboratories, the company has been the leading source for extensive runnability testing on imaging media and consumables, as well as extensive specifications/pricing databases on MFPs, printers, scanners and fax machines. BLI also has a long-standing reputation for being the industry's most trustworthy and complete source for quality testing services and global competitive intelligence.

In addition to testing over 200 office machines and related consumables annually for its subscribers, BLI provides consulting services to buyers and a range of private testing services that include document imaging device beta and pre-launch testing, performance certification testing, consumables testing (including toner, ink and photoconductors), solutions evaluations, and imaging media runnability testing.

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