

Genuine Lexmark Brand Laser Cartridges vs. Six Brands of Remanufactured Cartridges

JULY 2010

Buyers Laboratory Inc. (BLI) was commissioned by Lexmark International Inc. to conduct an independent comparative lab evaluation of the performance of new Lexmark brand extra-high-yield print cartridges against that of remanufactured brand cartridges in the Lexmark T644 monochrome printer. Test cartridges for the following six representative remanufactured brands were obtained on the open market: DataProducts (a division of Clover), Eco Elite, NewproNet, PageMax (Clarity Imaging), Sistek and West Point.

The test was designed to objectively compare the performance of genuine Lexmark cartridges to that of the remanufactured brands and their claim of equal performance to that of new Lexmark cartridges. All testing was conducted between December 2009 and March 2010 in BLI's 10,000-square-foot test lab located in Hackensack, NJ (USA; www.buyerslab.com).

A total of 719,060 pages were printed during the test. Nine cartridges from each brand were evaluated across three printers, so that three cartridges were tested in each printer. The cartridges were run to end of life utilizing a five-page black-and-white document set intended to be representative of customer usage (see Exhibit A below), during which time page yield, image quality and reliability performance were evaluated for each. Following the completion of testing for each brand, the printers were cleaned and serviced with new maintenance kits.

PERFORMANCE SUMMARY

Throughout BLI's test, the Lexmark extra-high-yield cartridges provided consistent and reliable performance. Lexmark cartridges exhibited zero reliability failures and maintained desired print quality performance throughout cartridge life.

Overall, the Lexmark performance was superior to that of the remanufactured cartridge brands. In fact, the test results of the remanufactured cartridge brands revealed problems in all three performance aspects of the test: page yield, image quality and reliability. More specifically, for the 54 remanufactured brand cartridges tested:

- 31% experienced reliability failures, with nearly one in five cartridges failing out-of-box for severe toner leaks, streaks, or just failing to function at all.
- The overall average page yield achieved was only 77% of that achieved by the Lexmark cartridges.
- Five of the six brands tested had at least one cartridge that produced images with gross printing defects such as dirty edges and recurrent background.

In commenting on the overall performance of the Lexmark cartridges, Anthony Polifrone, BLI's Managing Director, noted: *"The Lexmark T644 extra-high-yield cartridges showed strong, consistent performance throughout BLI's test, and outperformed the remanufactured brands overall in terms of pages produced, image quality and reliability."*

Exhibit A: Five-Page Test Suite

OVERALL PERFORMANCE

Page Yield

Individual Cartridge Page Yields

Individually and as a whole, the Lexmark cartridges that were tested delivered consistent, reliable page yield performance. There was relatively little variation in the pages printed by each Lexmark cartridge.

In contrast, the pages printed by the remanufactured brand cartridges tested were extremely variable. While some of the 54 remanufactured brand cartridges tested exhibited good performance, 54% performed below the lowest Lexmark cartridge page yield, including 19% which failed to perform at all.

Statistical Modeling

The variations in performance reported above can be modeled to derive a statistical prediction of expected performance (Graph I).

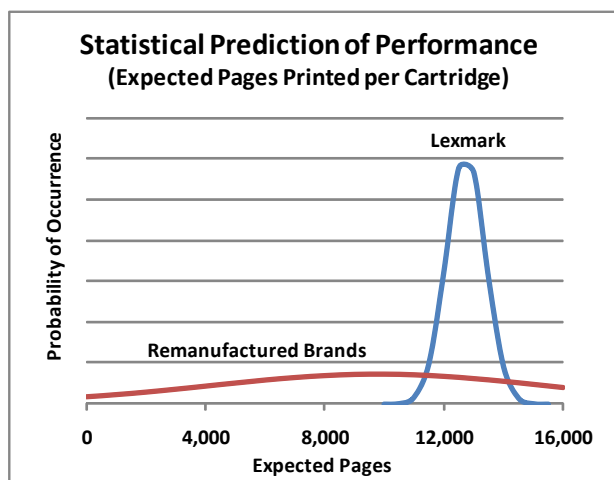
In modeling the test results of the Lexmark cartridges, the blue curve (Graph I), with its tall and thin shape, indicates a high probability that pages printed per cartridge will fall within the narrow range of page values shown.

In contrast, the flatness and width of the red curve for the remanufactured brand cartridges make it difficult to predict performance as there is little difference in the probabilities across the full range of expected pages.

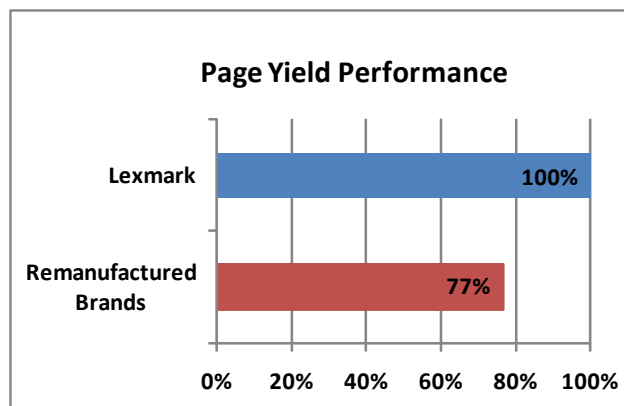
Average Page Yield Performance

Looking at pages printed, the remanufactured brand cartridges achieved an average yield of 9,781 pages or just 77% of the 12,735 average page yield of the Lexmark cartridges, as noted in Graph II.

Graph I



Graph II



Reliability

There were no reliability failures of any kind with the Lexmark cartridges tested. However, of the 54 remanufactured cartridges tested, 17 failed, resulting in a collective failure rate of 31%. In fact, all but one of the remanufactured brands had at least one reliability failure.

The reliability failures were classified as:

- **Out of Box Failures** – a cartridge that was inoperable upon installation or produced 20 or fewer acceptable pages
- **Image Quality Failures** – a cartridge that developed unacceptable image quality during life
- **Premature Expires** – a cartridge that produced below 75% of the average expected comparative page yield

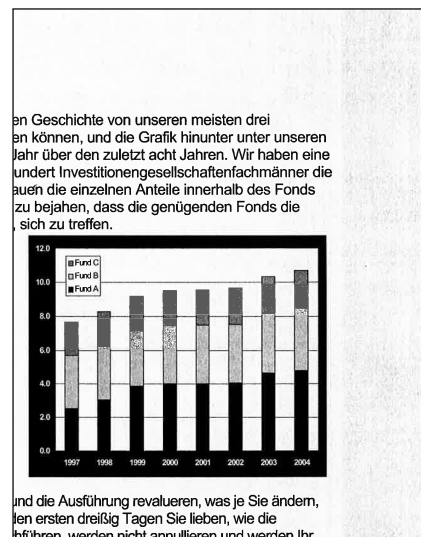
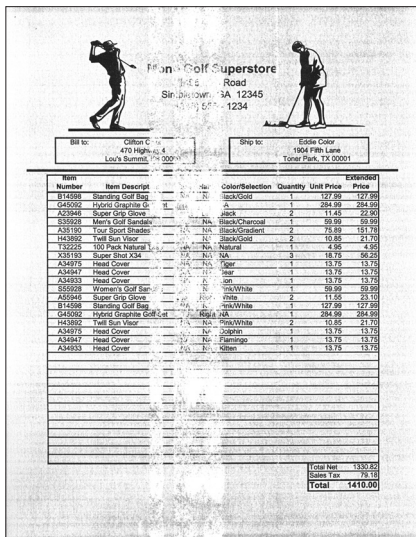
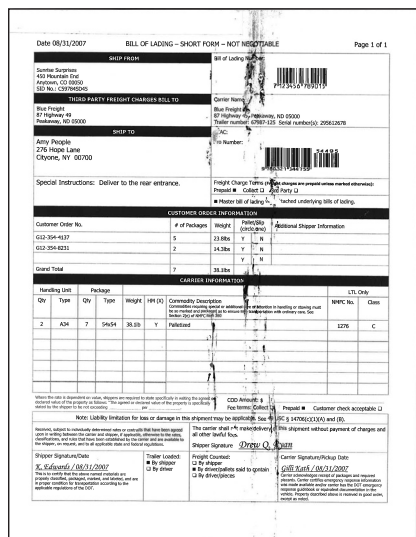
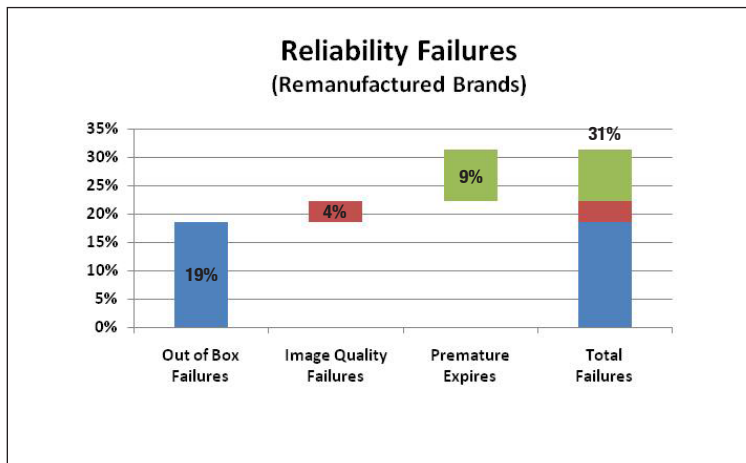
Of the 17 remanufactured brand cartridge failures, 10 were deemed out-of-box failures for the following reasons:

- One cartridge produced images with toner smeared on pages from the start*
- Four cartridges would not work at all and caused the printer to display an error message of “31 Replace Defective Print Cartridge”
- Four cartridges exhibited heavy toner banding and blotches on pages from the start of testing*
- One cartridge had severe voids, image fade and heavy background on pages at the test start*

Of the remaining seven remanufactured cartridge failures, five expired prematurely due to early fading of images, and two were classified as premature expires because of gross image quality defects that rendered output clearly unacceptable. Of the two cartridges with gross image quality defects, one produced prints with heavy streaking on the right half of pages, while the other produced images with excessively heavy background on the entire page (see Exhibits E and F on page 4).

* Exhibits: Out-of-Box Failures Due to Severe Image Quality Defects

Graph III



B: Extraneous Smeared Toner

C: Severe Voids, Image Fade and Heavy Background

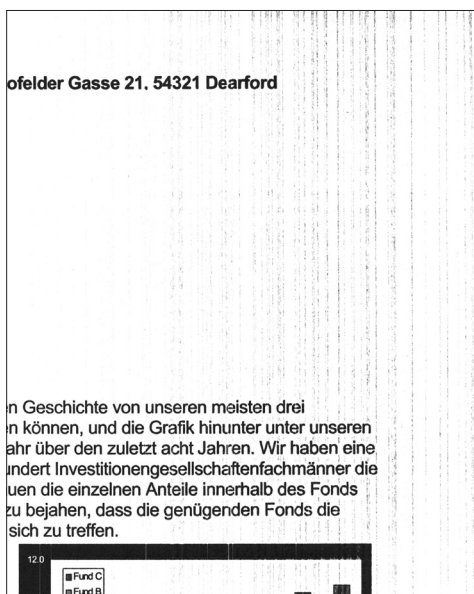
D: Right-side Toner Banding and Blotches

Print Quality

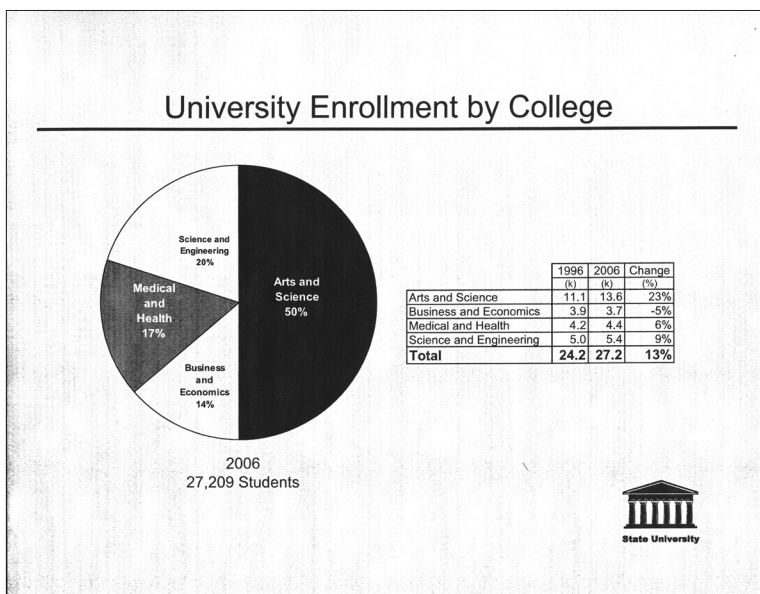
In addition to functional performance, the print quality of the cartridges was evaluated for consistency and acceptability of image quality throughout life. The images were evaluated using tests for five criteria (text, line art, halftones, solid, and density), as well as visually for acceptability for customer use. Test samples were taken at the start of testing, at the approximate midpoint, and when the first "Toner Low" message was displayed by the printer. Each sample was evaluated for clarity and definition of text and line art, crispness of characters, and production of halftones and solids, as well as for image quality defects such as toner overspray, background, smearing, graininess, banding, inconsistencies and serif fill. Image quality assessments for the five criteria were based on BLI's standard lab methodology and ratings, in which a grading scale of 0 to 4 is used, with 4 being the best performance.

While the Lexmark cartridges had zero image quality failures, five of the six remanufactured brands had at least one cartridge that produced images with gross failures such as those shown in the Exhibits E and F below. Overall, the Lexmark cartridges exhibited the best print quality and earned a score of 3.7 on a scale of 0 to 4, while the remanufactured brands earned an overall score of 2.7.

Exhibits: Premature Expires Due To Image Quality Failures



E: Heavy Toner Streaking on Right Half of Page



F: Excessively Heavy Background

SUMMARY

This extensive test, which included more than 700,000 pages printed, demonstrates the superiority of the page yield, reliability, and print quality performance of genuine Lexmark extra-high-yield T644 cartridges. It also provides independent test verification that overall the remanufactured brands fall short of their claim of equal to new Lexmark performance. These results are consistent with an earlier BLI comparative test of Lexmark genuine cartridges vs. remanufactured brands. In commenting on the overall results of the test, Anthony Polifrone noted: "In today's challenging business environment, consumers need to be extra diligent in getting the best overall value and performance for every dollar they spend on printing. We believe this test demonstrates that in this case Lexmark's extra-high-yield cartridges may be the best way to achieve that goal."

LAB TEST DATA

Data Table 1: Overall Tested Page Yields

Brands	Number of Cartridges Tested	Yield Claim	Actual			Adjusted		
			Mean	Std Dev	90% LCB	Mean	Std Dev	90% LCB
Lexmark New	9		12,735	647	12,334	12,735	647	12,334
A	9	Equals OEM	8,129	7,770	3,311	8,129	7,770	3,311
B	9	Equals OEM	13,125	5,291	9,845	13,125	5,291	9,845
C	9	Equals OEM	6,096	7,406	1,504	6,096	7,406	1,504
D	9	1.875X OEM	18,154	6,941	13,852	9,682	3,702	7,387
E	9	Equals OEM	12,773	1,719	11,708	12,773	1,719	11,708
F	9	Equals OEM	8,883	2,450	7,365	8,883	2,450	7,365
Remanufactured Brands	54		11,193	6,815	9,640	9,781	5,601	8,505

Data Table 2: Cartridge Failures

Brands	Number of Cartridges Tested	Out of Box Failure	Image Quality Failure	Premature Expiration	Total Failures
Lexmark New	9	0	0	0	0
A	9	4	0	0	4
B	9	0	2	0	2
C	9	5	0	0	5
D	9	1	0	0	1
E	9	0	0	0	0
F	9	0	0	5	5
Remanufactured Brands	54	10	2	5	17

Data Table 3: Overall Print Quality

Cartridge Type	Print Quality						Density Readings		
	Text	Line Art	Halftones	Solids	Density	Overall	Min	Max	Average
Lexmark	4.0	4.0	3.3	4.0	3.0	3.7	1.25	1.42	1.34
All Remanufactured Brands	3.3	4.0	2.9	3.7	2.7	2.7	1.16	1.39	1.31
Brand A ¹	3.5	4.0	3.2	3.9	3.0	1.7	1.25	1.39	1.34
Brand B ²	3.3	4.0	2.9	3.7	2.4	3.2	1.20	1.36	1.28
Brand C ³	3.3	4.0	3.1	3.7	2.5	2.7	1.04	1.37	1.29
Brand D ⁴	3.3	4.0	2.9	3.2	2.3	2.3	1.03	1.41	1.27
Brand E ⁵	3.3	4.0	2.8	3.9	2.6	3.0	1.21	1.38	1.30
Brand F	3.3	4.0	2.7	4.0	3.3	3.5	1.22	1.44	1.37

¹ Downgraded because four cartridges failed out of box due to poor images and two others showed consistently dirty edges.

² Downgraded due to consistent dirty edges on one cartridge.

³ Downgraded because one cartridge (out of five that could be run at all) failed out of box due to poor images.

⁴ Downgraded because one cartridge failed out of box due to poor images and four others showed consistent gross print defects.

⁵ Downgraded due to consistent background on three cartridges.

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. Nine of each cartridge brand was tested over three printers, and printers were replaced whenever an individual unit showed signs of diminished performance. The printers were rebuilt after running all cartridges from one brand; this involved vacuuming the inside of the printer and changing the fuser and all rollers. The printers were all run in default (normal) mode.

Though the remanufactured brands are referred to as Brands A through F in this report, it should not be assumed that the order in which the remanufactured brands are identified on page 1 of this report directly corresponds to A through F throughout this report.

Page Yield

To evaluate page yield, BLI used a Lexmark proprietary five-page black-and-white test target (see Exhibit A on page 1). A cartridge was considered to be at the end of its life when a fade occurred following two cartridge shake procedures. The cartridges were shaken either at the appearance of a “Toner Low” message from the printer or if a fade occurred before the cartridge had been shaken twice. Premature image quality deterioration also denoted the end of cartridge life.

The total page count per cartridge was defined as the number of acceptable pages printed (that is, pages without image quality defects, such as excessive streaking, textual imperfections or fading). The overall average page yield per brand was defined as the combined total number of acceptable pages printed by all of the cartridges, divided by nine. The average pages per gram of toner was defined as the page count divided by the grams of toner consumed, which was determined by weighing the cartridge before and after the test. The ISO 19752 90% Lower Confidence Bound (LCB) page yields were obtained using the standard ISO formula to determine average page yield based on a 90% confidence level.

Print 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 4 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 Graphiclith D5000 Standard Viewer, and density was measured with an X-Rite 508 Series Densitometer and imageXpert PQ Analyzer.

Print quality was evaluated based on five criteria: text, line art, halftones, solids and density, with test samples taken at the start of testing, at the approximate midpoint of the test and when the first “Toner Low” message was displayed by the printer. Based on the test target, each criterion was rated according to a cartridge's performance in the following related sub-categories: boldness, sharpness, fullness of formation and smoothness for Text; line consistency for Line Art; graininess and banding for Halftones; visible darkness/boldness and consistency of coverage for Solids. Two density measurements were taken for each print quality sample, one each on the right- and left-side of the page. Each sub-category was rated on a five-point scale (0 to 4), with four being the best. The scores were totaled across each category and averaged to obtain a grade for each cartridge brand for the first four criteria; density was graded according to an improvised scale, again on a four-point scale. The five criteria were averaged and constitute the overall grade for each brand; some scores were downgraded because of various imperfections that were not reflected in the print quality grades, as footnoted in the print quality table.

Reliability

Throughout testing, any cartridge malfunctions observed, such as operational/mechanical failure, physical defects, toner leakage and image quality failures, were recorded. **Out-of-box failures:** A cartridge that was inoperable upon installation, or produced 20 or fewer acceptable pages, was considered to be an “out-of-box” failure. **Image quality failures:** A cartridge that developed unacceptable image quality during life. **Premature expire:** Cartridges that produced below 75% of the average stated page yield were considered to be premature expires.

About Buyers Laboratory

Since 1961, Buyers Laboratory Inc. (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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