



Comparison Study

HP Color LaserJet Toner Cartridges vs. Remanufactured Brands

2008

For Distribution in North America

Executive Summary

In 2008, QualityLogic completed a study for Hewlett-Packard (HP) designed to test the reliability of page quality for HP Color LaserJet toner cartridges for the HP Color LaserJet CP3505 printer (HP Q7581A, Q7583A, Q7582A, and Q6470A cartridges) compared to 5 brands of the remanufactured color toner cartridges sold as substitutes for them. The study evaluated the quality of the pages printed and the usability of those pages.

A total of 20 cartridges were tested for each brand in the study. Printing was performed in a continuous mode in a controlled environment using test pages jointly developed by HP and QualityLogic.

Overall Result

The results of the study show that HP LaserJet toner cartridges clearly outperformed the remanufactured color toner cartridges.

HP Color LaserJet toner cartridges printed an average of 98.3% of sample pages categorized as acceptable for all uses, compared to 74.7% for the average of the five remanufactured brands tested.

Remanufactured Brands Tested

- Elite Image
- Nukote
- PTi
- RhinoTek
- Verbatim

Test Overview

Page quality distribution was determined by inspecting a sample of pages taken from the printed output for each brand in the study. To create a page quality scale calibrated to actual business laser printing user behavior, QualityLogic conducted a psychometric study. An independent market research organization recruited a representative demographic cross-section of color laser printing users. Study participants provided input on the page quality levels appropriate for certain uses. The study data was used to create a scale. QualityLogic page inspectors used the scale to sort sampled pages into the following categories:

- All uses, including external distribution
- Limited use: Not for external distribution
- Limited use: Not for distribution
- Unusable

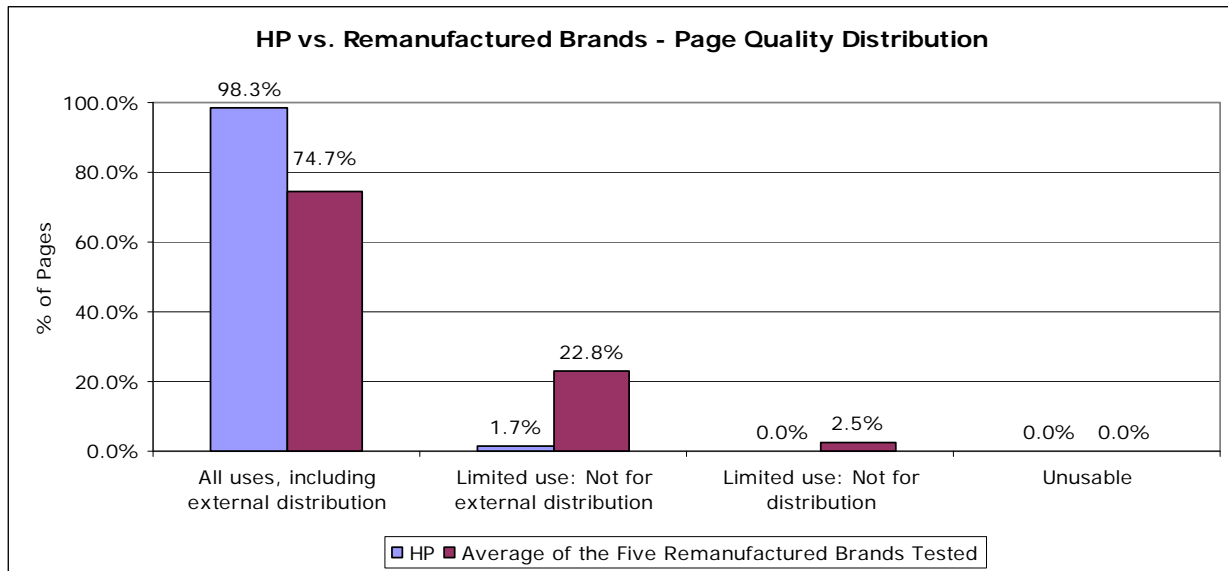
The results for cartridges tested were combined to create the overall percentage of pages for each category by brand and an average for the five remanufactured brands tested. (See Appendices 2 & 3 for additional information on the psychometric and test methodologies.)

Detailed Results

HP Color LaserJet toner cartridges printed an average of 98.3% of sample pages categorized as acceptable for all uses, compared to 74.7% for the average of the five remanufactured brands tested. (Additional detail is provided in Appendix 1.)

Brand	All uses, including external distribution	Limited use: Not for external distribution	Limited use: Not for distribution	Unusable
HP	98.3%	1.7%	0.0%	0.0%
Average of the Five Remanufactured Brands Tested	74.7%	22.8%	2.5%	0.0%

**Table 1:
Page Quality Distribution**



**Graph 1:
Page Quality Distribution**

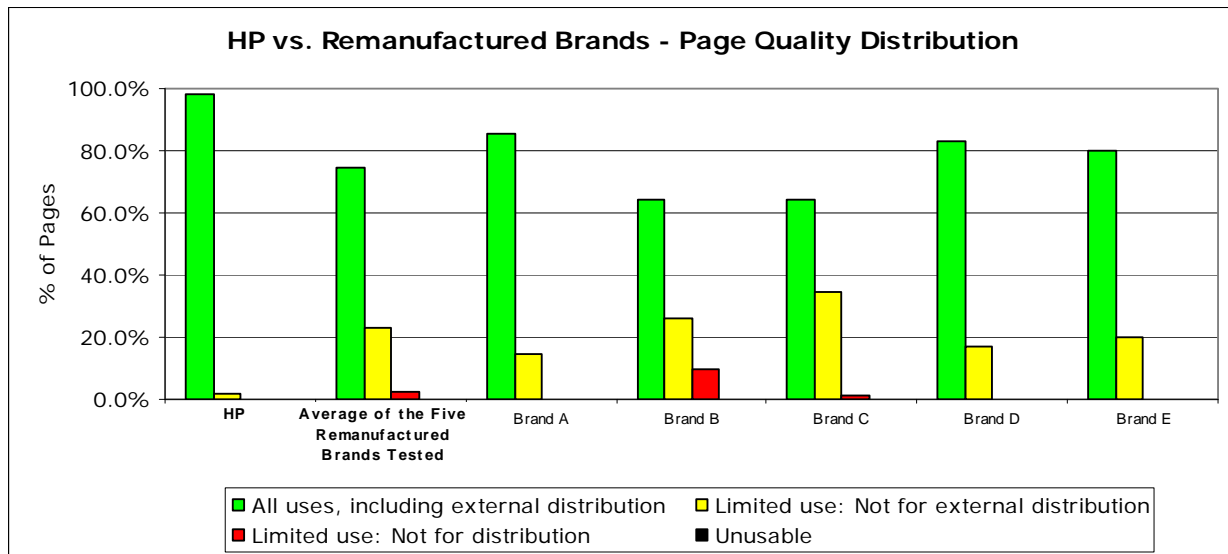
During the study, there were also a significant number of remanufactured cartridges that would not print at all or printed only a small fraction of the pages printed by HP cartridges. Additionally, some remanufactured cartridges leaked toner into the shipping container or leaked toner into the printer after installation. Photos of some of these cartridges can be found in Appendix 1.

Appendix 1: Additional Test Results

Page Quality Distribution

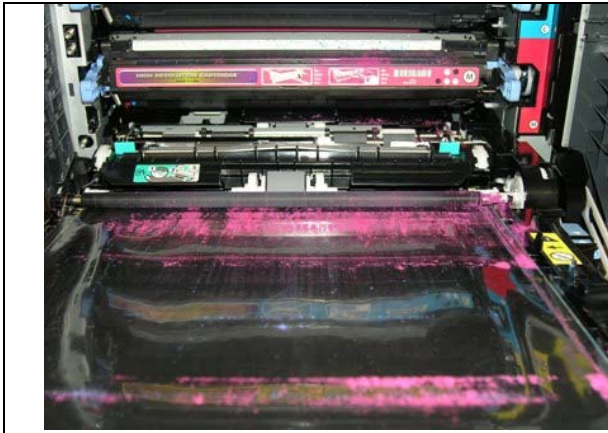
Brand	All uses, including external distribution	Limited use: Not for external distribution	Limited use: Not for distribution	Unusable
HP	98.3%	1.7%	0.0%	0.0%
Average of the Five Remanufactured Brands Tested	74.7%	22.8%	2.5%	0.0%
Brand A	85.6%	14.4%	0.0%	0.0%
Brand B	64.4%	26.0%	9.6%	0.0%
Brand C	64.1%	34.6%	1.3%	0.0%
Brand D	82.9%	17.1%	0.0%	0.0%
Brand E	80.0%	20.0%	0.0%	0.0%

**Table 2:
Page Quality Distribution**

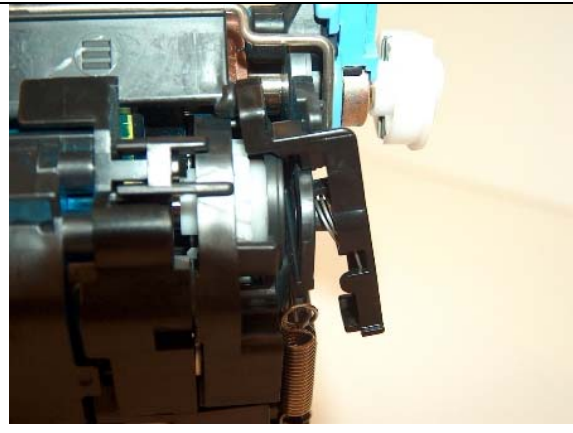


**Graph 2:
Page Quality Distribution**

Cartridge Issue Example Photos



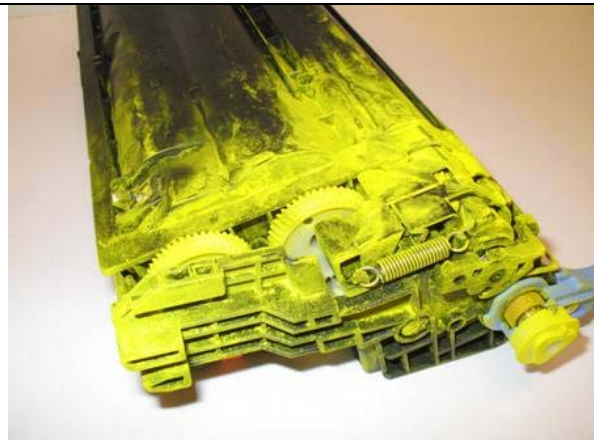
Brand B magenta cartridge leaking toner immediately after insertion into the printer.



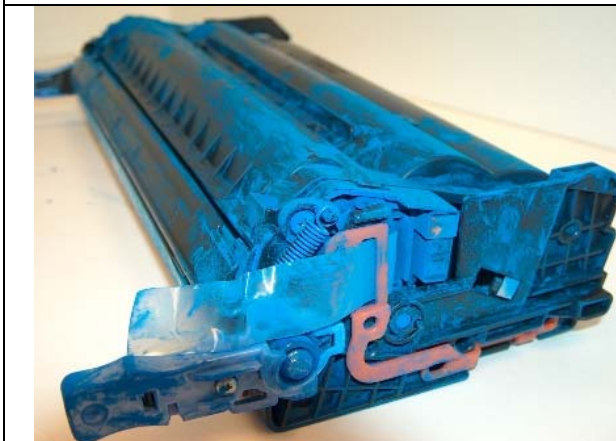
Brand E cyan cartridge with a broken wiper door. No pages could be printed.



Brand B yellow cartridge leaking toner into the shipping container, photo 1 of 2.



Brand B yellow cartridge leaking toner into the shipping container, photo 2 of 2.



Brand E cyan cartridge leaking toner into the shipping container.



Brand E yellow cartridge with a broken wiper door spring. No pages could be printed.

Appendix 2: Test Methodology

The following is a summary of the methodology used for this study:

The printer and print cartridges selected for this study were as follows:

Printer	Cartridges
HP Color LaserJet CP3505 (CB442A)	HP Q7581A (Cyan)
	HP Q7583A (Magenta)
	HP Q7582A (Yellow)
	HP Q6470A (Black)

A total of 20 cartridges, split between the four color cartridges, were tested for each brand in the study. As each individual cartridge reached end of life, that single cartridge was replaced with a new cartridge of the same color. Printing continued until a total of 20 cartridges arrived at end of life for each brand.

Printing was performed in a continuous mode in a controlled environment using the three-page test suite shown below. Test pages were as follows:

		
Page 1 – Spreadsheet	Page 2 – Flyer	Page 3 – Presentation Slide

QualityLogic procured all printers, paper and HP toner cartridges through standard retail channels in North America. Remanufactured toner cartridges were obtained through retail channels or directly from the manufacturer in North America. A set of two new HP Color LaserJet CP3505 printers were used for the testing of each brand to assure uniformity and accuracy of the test data independent of a particular printer. Cartridges were obtained in small lots from multiple vendors when possible, and cartridge markings were examined to ensure lot variation.

The impact of the toner cartridge on the printer's functionality was also recorded in the areas of consistent operation, leakage of toner inside the printer and failure of printer components (fusers, image drums, etc.). The cartridge bays were inspected and wiped clean of any residual toner particles and/or paper dust before any new cartridge was installed.

Cartridge end of life (EOL) was determined by one of five events:

1. Cartridge failed to print when installed.
2. Cartridge leaked substantial toner (1 cc or more) before or during installation or anytime during printing.
3. Printing stops, control panel indicates the need for cartridge replacement.

4. Cartridge stops printing, without control panel indication of need to replace, but efforts to recover and continue printing are unsuccessful.
5. Degradation of page quality to Unusable for all three test pages. (A cartridge could be cleaned to attempt to recover the page quality no more than 2 times during the life of a cartridge. Once page quality degraded a 3rd time, the cartridge was considered EOL.)

Printer and driver settings were left at factory default. All printer/cartridge warnings were noted, and cartridges were printed to EOL.

Normal office conditions of temperature (23C \pm 2C) and relative humidity (50% \pm 10% RH) were maintained for the duration of the test. All toner and paper consumables were stabilized in these conditions for a minimum of 12 hours prior to use, tested in the same environment, and were subject to the same fluctuations.

All test pages were printed using standard 8 ½ x 11 office paper (24 lb, 96 brightness) from Hammermill (Fore MP-White).

Each test page was serialized and identified by printer to provide exact page counts.

Page quality distribution was determined by inspecting a sample of pages taken from the pages printed by the cartridge sets tested for each brand. The printed output from each printer in the study was divided into equal intervals with a single random page sample taken from each interval. Approximately 7% of the pages printed were sampled. The scale used for grading sampled pages was created using data from a psychometric research study of business color laser printing users. Further information on the psychometric study can be found in Appendix 3.

QualityLogic page inspectors categorized each of the sampled pages based on overall page quality, using the scale created from the psychometric study data. The inspectors were trained using the 30 page psychometric page set. These samples had known values on the scale based on customer research. Page inspection was performed in a test room with 18-20% reflective neutral gray walls, floor and work surfaces, and full spectrum lighting (5,000K \pm 500) with luminance of 550 LUX \pm 50 at the grading table. Each sampled page was graded by three inspectors. The average of the three grades determined the page quality category for the page. The consistency of grades across inspectors was monitored on a daily basis and retraining against the psychometric page set, with known scale values, was repeated as necessary.

The test methodology for this reliability comparison study was developed by Hewlett-Packard and implemented by QualityLogic.

Appendix 3: Psychometric Study

To create a page quality scale calibrated to actual business color laser printing user behavior, QualityLogic conducted a psychometric study. An independent market research organization recruited a representative demographic cross-section of business color laser printing users. The thirty-five participants were from a range of industries and business sizes, from micro/small (1-49 employees) to large/enterprise (>500 employees). All respondents used color laser printers to create documents for a variety of uses, including external distribution. The study was conducted in Los Angeles, California in the winter of 2007.

QualityLogic selected a set of 30 test pages (10 each of the 3 test pages in this study) chosen to provide a range of page quality. In the psychometric study, participants were asked to rank order each group of 10 pages from best to worst. They were then asked to sort the pages into groups based on the following four acceptability statements (categories):

- **All uses, including external distribution**
Acceptable for all uses, including distribution outside a company to customers, vendors, suppliers, etc. Examples: marketing materials to promote the company or products, official company correspondence, invoices.
- **Limited use: Not for external distribution**
Acceptable for distribution inside a company, but not acceptable for distribution outside a company, to customers or others. Examples: documents to distribute to colleagues, superiors or subordinates as business communication. Reprint required if intended for external distribution.
- **Limited use: Not for distribution**
Usable as a copy to read, file or mark-up but not acceptable for distribution, either within or outside a company. Reprint required if intended for external or internal distribution.
- **Unusable**
Not acceptable for any business purpose. Reprint required for any use.

Average ranks were calculated for each of the 30 pages. A normalized z-score was determined from the distribution of ranks, and then a classification scheme rooted in a logistic model was used to determine category boundaries for page grades.

Appendix 4: Page Samples

The following page scans illustrate pages typical of each of the Page Quality Categories for this study.

<p>Project Status</p> <p>LANDOR & SMITH Ltd. COMMERCIAL REAL ESTATE</p> <p>Start: 10.2007 West End Project Budget on track for completion on 12.2008. Phase 2 starts 02.2009.</p> <p>Start: 01.2008 Downtown Corridor Completion date: 06.2008. Planning is on schedule.</p> <p>Start: 05.2008 Southside Development Completion date: 06.2009. Project is</p> <p>Contractor selection due 6 months prior to start date.</p> <p>Projects % Complete</p> <ul style="list-style-type: none"> West End Retail (11%) West End Direct (17%) Downtown Direct (17%) Downtown Retail (25%) Southside Direct (30%) 	<p>Project Status</p> <p>LANDOR & SMITH Ltd. COMMERCIAL REAL ESTATE</p> <p>Start: 10.2007 West End Project Budget on track for completion on 12.2008. Phase 2 starts 02.2009.</p> <p>Start: 01.2008 Downtown Corridor Completion date: 06.2008. Planning is on schedule.</p> <p>Start: 05.2008 Southside Development Completion date: 06.2009. Project is</p> <p>Contractor selection due 6 months prior to start date.</p> <p>Projects % Complete</p> <ul style="list-style-type: none"> West End Retail (11%) West End Direct (17%) Downtown Direct (17%) Downtown Retail (25%) Southside Direct (30%)
<p>All uses, including external distribution</p>	<p>Limited use: Not for external distribution (In this example, note the vertical streaks at the top of the page, inconsistent page fill, and repeating image to the left of the pie chart legend.)</p>
<p>Project Status</p> <p>LANDOR & SMITH Ltd. COMMERCIAL REAL ESTATE</p> <p>Start: 10.2007 West End Project Budget on track for completion on 12.2008. Phase 2 starts 02.2009.</p> <p>Start: 01.2008 Downtown Corridor Completion date: 06.2008. Planning is on schedule.</p> <p>Start: 05.2008 Southside Development Completion date: 06.2009. Project is</p> <p>Contractor selection due 6 months prior to start date.</p> <p>Projects % Complete</p> <ul style="list-style-type: none"> West End Retail (11%) West End Direct (17%) Downtown Direct (17%) Downtown Retail (25%) Southside Direct (30%) 	<p>Project Status</p> <p>LANDOR & SMITH Ltd. COMMERCIAL REAL ESTATE</p> <p>Start: 10.2007 West End Project Budget on track for completion on 12.2008. Phase 2 starts 02.2009.</p> <p>Start: 01.2008 Downtown Corridor Completion date: 06.2008. Planning is on schedule.</p> <p>Start: 05.2008 Southside Development Completion date: 06.2009. Project is</p> <p>Contractor selection due 6 months prior to start date.</p> <p>Projects % Complete</p> <ul style="list-style-type: none"> West End Retail (11%) West End Direct (17%) Downtown Direct (17%) Downtown Retail (25%) Southside Direct (30%)
<p>Limited use: Not for distribution (In this example, note the severe repeating image of the pie chart and legend.)</p>	<p>Unusable (In this example, note the reduced density across the page, inconsistent fills, and yellow smudge across the bottom of the page.)</p>

*Note: Page scans may not be accurately reproduced when printed from this report. See an electronic version of the report for the most accurate representation of the scanned pages.

**Scanned pages are for demonstration purposes only, and not specific to any single printer platform or brand in the study.