

HP LaserJet Cartridge Reliability Comparison Study – 2023

HP LaserJet Toner Cartridges vs. North American Remanufactured Brands

The *spencerLAB* DIGITAL COLOR LABORATORY has conducted a cartridge reliability comparison testing of original HP Inc. (HP) LaserJet monochrome toner cartridges and two brands of remanufactured toner cartridges sold in North America. The test included CF258A (58A) cartridge models for the HP LASERJET PRO M404n printer. Ten cartridges of each of brand were tested to get significant overall results.

The analysis compared the Reliability and the overall Print Quality throughout the life of the toner cartridge models tested for each brand. Cartridge Reliability factors, such as Low Quality (LQ) cartridges [see definitions in Appendix 4], were evaluated to determine the total number of Problem Cartridges for each brand. Print samples from each cartridge brand were collected at equal intervals over the life of the cartridges, and sorted using a Print Quality Acceptance scale generated from a psychometric research study. The four PQ acceptance levels were – External Use (all uses including distribution outside the company), Internal Use (distribution inside company), Individual Use, and Unusable.

KEY FINDINGS

- Testing of the Original HP toner cartridges yielded no Problem Cartridges, whereas 50% of the remanufactured cartridges exhibited some type of reliability problem, such as Low Quality.
- HP cartridges had the larger percentage of External Use Print Quality samples at 99.4%, whereas the tested remanufactured brands exhibited only 47.3% External Use Print Quality samples.
- Remanufactured brands tested exhibited more Print Quality Samples with defects, such as fade (45%), ghosting (37%), and streaks (9%).

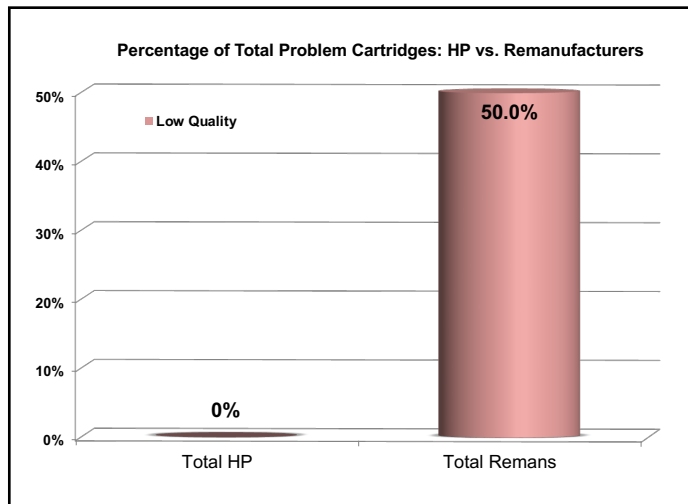
TEST RESULTS

CARTRIDGE RELIABILITY: LOW QUALITY

HP cartridges were more reliable than the tested remanufactured brands; none of the tested HP cartridges were deemed Problem Cartridges or Low Quality (LQ).

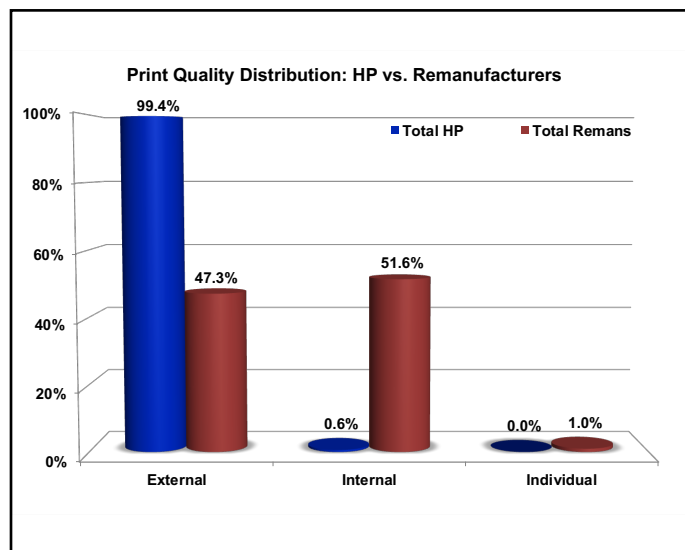
The remanufactured toner cartridges suffered from Low Quality Reliability issues yielding a total of 50% Problem Cartridges of the 20 cartridges tested. Low Quality cartridges are those cartridges with 50% or more pages categorized as Limited Use, but not DOA or PF..

For the average user, problem cartridges are disruptive and cause inconvenience due to a lack of reliability, including issues such as having to reprint content. Such problems impact time, labor, and supplies, and increase the overall cost of printing.



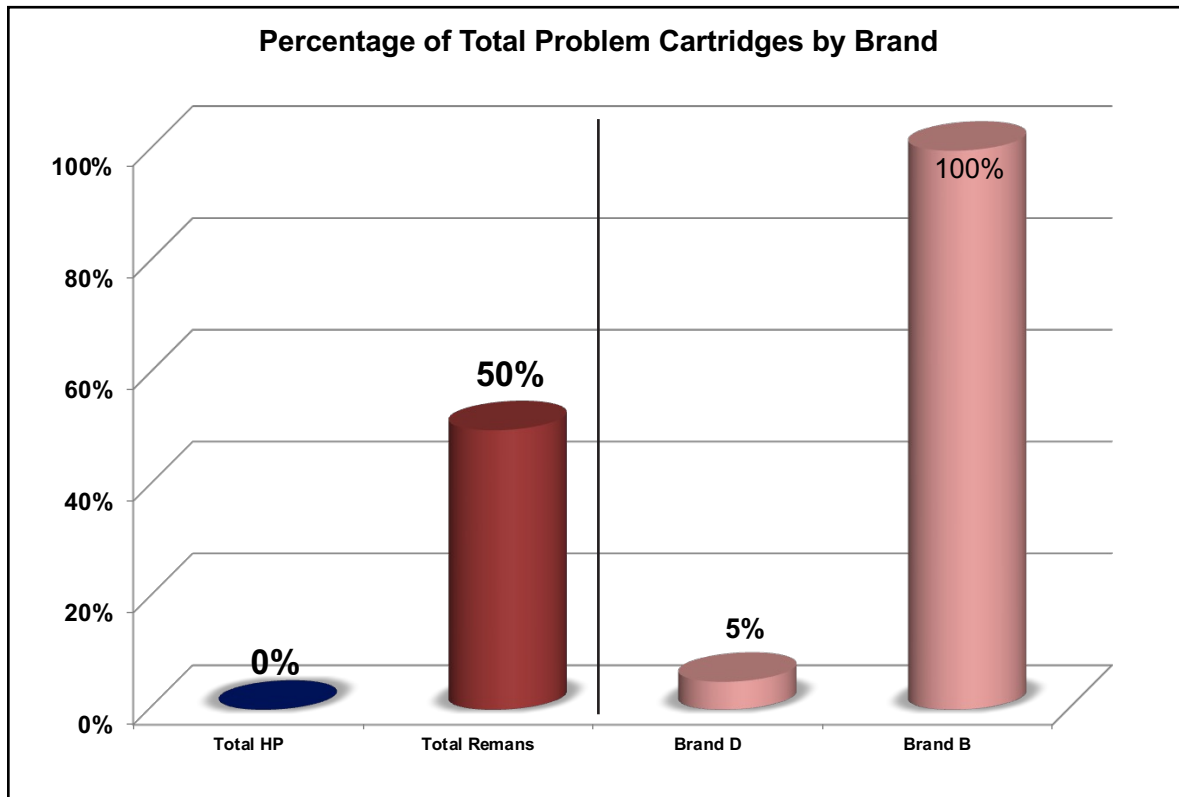
PRINT QUALITY DISTRIBUTION

HP cartridges produced significantly greater number of pages with higher Print Quality (PQ) than the remanufactured cartridges tested.



Tested HP cartridges produced a total of 99.4% of print samples categorized as good for External Use. Comparatively, the remanufactured brand cartridges produced only 47.3% of pages that were good for External Use.

HP cartridges produced only 0.6% Internal Use pages, with no pages deemed as Unusable or Individual; whereas, remanufactured brands produced 52.6% Limited Use pages (with PQ categorized as either Internal Use, Individual Use, or Unusable). The remanufactured cartridges Limited Use pages displayed print quality defects such as fade, ghosting, and streaks.



THE *spencerLAB* DIGITAL COLOR LABORATORY

With over thirty years of industry service, SPENCER & ASSOCIATES PUBLISHING, LTD. has earned a premier reputation for its expertise in evaluating digital color imaging and printing. Its independent test division, the *spencerLAB* DIGITAL COLOR LABORATORY, is internationally recognized as a leader in unbiased, third-party research and comparative analysis of digital imaging and printing system performance; the laboratory strictly adheres to the integrity of its methodology, even in commissioned studies. *SpencerLAB* provides leadership in quantitative and qualitative comparisons, benchmarking key performance metrics of digital printing systems in all technology classes, from desktop printers to digital color presses – providing research and evaluation services, compliance certifications, benchmark test software/hardware, and focus group management.

Leading vendors and firms for whom printing is mission-critical rely upon *spencerLAB* to provide strategic support and benchmarking of Print Quality, Ink/Toner Yield and Cost-per-Print, Throughput, Availability, Reliability and Usability for ink- and toner-based as well as other printing technologies. Corporate users rely upon *spencerLAB* for guidance in print system acquisition and usage optimization.

For more information, please visit www.spencerlab.com.

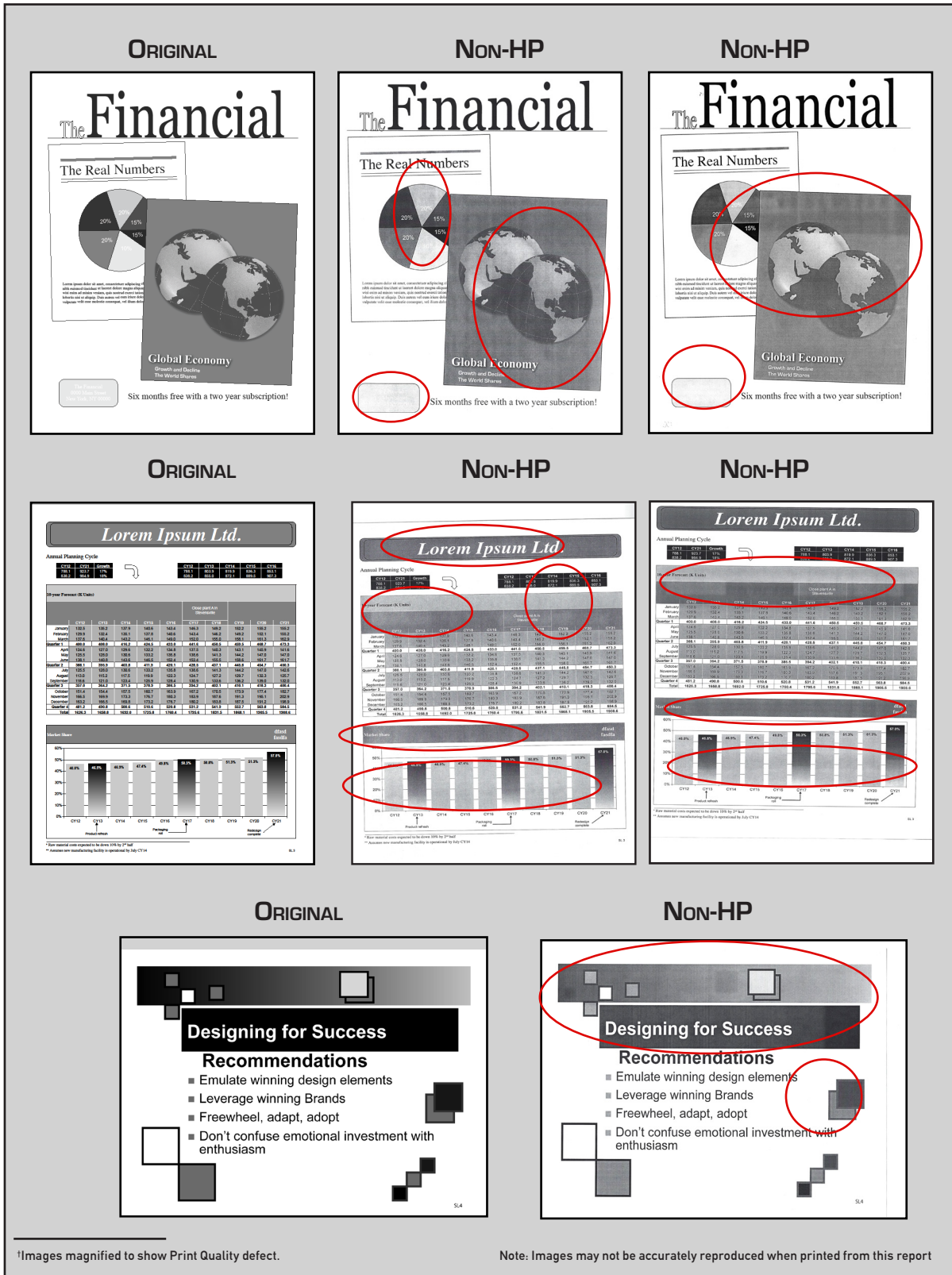
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APPENDIX 1: PROBLEM CARTRIDGES



¹Images magnified to show Print Quality defect.

Note: Images may not be accurately reproduced when printed from this report

APPENDIX 2: METHODOLOGY

TEST PARAMETERS

The test included the 58A cartridge model tested on the HP LASERJET PRO M404n printer. Remanufactured brands were selected by HP and procured for testing from North America by *spencerLAB*. Ten cartridges of each of the two remanufactured brands and HP branded cartridges were tested to get significant overall results.

A four-page PDF test suite was printed from a Windows 10 operating system, using Acrobat Reader 20.009.20067. Test files were printed in default mode for plain paper, using the latest printer drivers available from HP's website, on Hammermill Fore Multi-Purpose 20lb., 96 Brightness, office paper. All test printing was performed by *spencerLAB*.

All test supplies, such as printers, toner cartridges, and paper, were acclimated to office ambient temperature and humidity for at least 12 hours. Printing was performed in a semi-continuous manner, with stops for paper replenishment, overnight, etc., until toner cartridges reached End-of-Life (EOL). EOL is defined as degradation of Print Quality of any one page of the four-page suite to Unusable (grading scale with Unusable Print Quality benchmark established by psychometric study [see Appendix 3]). Two shake procedures were performed prior to a cartridge being deemed EOL.

CARTRIDGE RELIABILITY TESTING

Prior to printing, all cartridges were carefully unpacked and inspected for any toner leakage and/or broken parts.

PRINT QUALITY ASSESSMENT

Overall Print Quality was evaluated on a total of sixty-four print samples from each toner cartridge. The sixty-four print samples comprised of sixteen four-page suites collected at equally dispersed intervals over the life of each cartridge.

Using the psychometric Print Quality acceptance scale, *spencerLAB* evaluators independently assessed and graded the overall Print Quality of the samples by categorizing them into one of four Print Quality levels: External Use, Internal Use, Individual Use, and Unusable. The Print Quality level of each print sample was determined by the average of the evaluators' grades, with defects also noted.

As a part of evaluator training, the Print Quality evaluators graded a set of twenty print samples, three times each. Consistency of grading was measured among the evaluators,

as well as among each evaluators' grades for a sample. This exercise was repeated until all evaluators had acceptable consistency in grading among each other and among their three trials per sample. During evaluation of the test print samples, the Print Quality assessment was continuously monitored to ensure consistency. Each evaluation session lasted one hour with a thirty minute break between sessions.

The Print Quality scale samples, determined during psychometric testing, were mounted in front of evaluators' workstations for reference. Print Quality evaluation was performed in a neutral environment with uniform lighting.

APPENDIX 3: PSYCHOMETRIC STUDY – PRINT QUALITY SCALE

A psychometric study of monochrome office printing users was conducted by *spencerLAB* in the greater New York City area (Hicksville, New York) in March of 2012, to establish a Print Quality acceptance scale. Participants who printed monochrome documents for personal, internal, and external use, were recruited from a range of professions and business sizes, from micro business (1-49 employees) to enterprise business (>500 employees). A total of thirty-eight business printing users participated in the exercise.

TEST SUITE

SpencerLAB collaborated with HP to design a representative business-user test suite. *SpencerLAB* then utilized the test suite pages to simulate common Print Quality defects such as banding, streaks, dark and light density, ghosting, etc. A total of fifteen test sets were created and each test set had a range of up to twelve variations (based on severity of defect) for a single defect type.

Test sets were printed on a HP LaserJet P3015 using Windows 7 and Acrobat Reader 10.1.2. Test samples were printed in default mode for plain paper, using the latest print driver available from HP's web site at the time of printing on Hammermill Fore MP 20lb., 96 Brightness, plain office paper. All printing was performed by *spencerLAB* and test sets were reviewed to ensure that the test samples were rendered as intended.

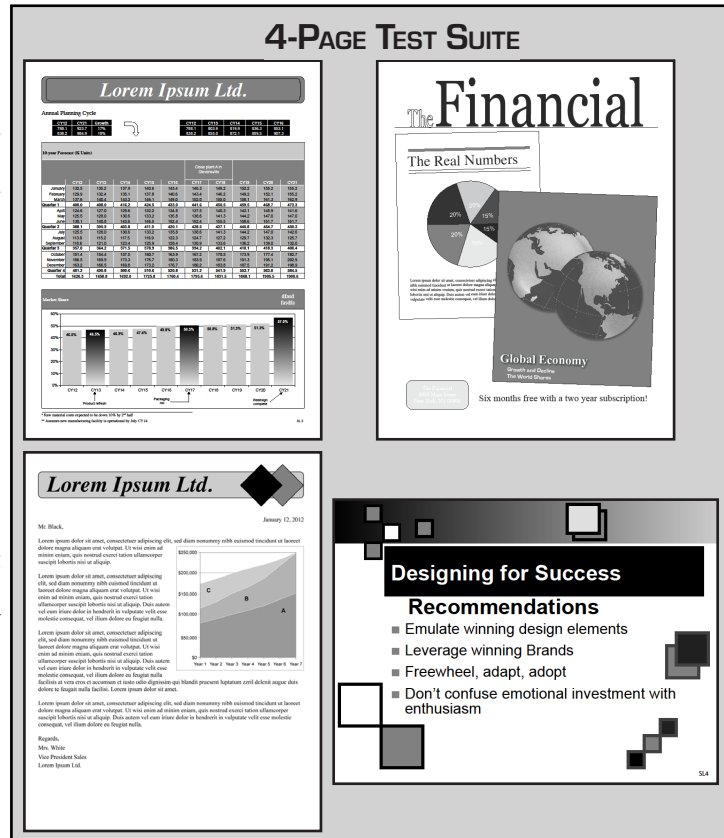
BUSINESS USER FOCUS GROUPS

The focus group participants judged fifteen sets of print samples and sorted the samples into four Print Quality levels based on their acceptance level of Print Quality. The test samples were rated in a neutral environment, with no external lights, and uniform lighting.

Participants sorted all the test samples into four Print Quality acceptance levels:

- External Use – acceptable for all uses, including distribution outside a company to customers, vendors, etc.
- Internal Use – acceptable for distribution inside a company, but not acceptable for distribution outside a company
- Individual Use – usable as a copy to read, file, or mark-up in the office, but not acceptable for distribution, either within or outside a company
- Unusable – not acceptable for any business purpose

SpencerLAB used proprietary sorting and analysis algorithms to calculate the average Print Quality rating of each sample for each test set. The resulting score was used to determine the rank order of samples in each test set.



APPENDIX 4: TEST TERMS AND DEFINITIONS

Terms		Definitions
End-of-Life, (EOL)		A condition determined by one of three mechanisms: <ol style="list-style-type: none"> 1. Cartridge is Dead on Arrival. 2. Cartridge stops printing and efforts to recover are unsuccessful. 3. Degradation of Print Quality to unacceptable (Unusable) for any one of the Test Suite pages. Any printer documentation recommendations are performed no more than two times to recover PQ. After the second recovery, if PQ does not recover or degrades to Unusable, EOL is reached and marked before pages of unacceptable quality.
Dead-on-Arrival, (DOA)		A condition determined by one of four mechanisms: <ol style="list-style-type: none"> 1. A cartridge that has at least 50% of the handling surface covered in leaked toner, before or during the installation process and/or toner visibly spilled in the plastic bag containing the cartridge and/or on the exterior of the cartridge. 2. A cartridge that within the first ten pages has at least one page categorized as Individual Use or Unusable, and does not improve during the recovery process. <ul style="list-style-type: none"> • Recovery process requires following the printer manual instructions for correction of the noted defect, or if the defect is not addressed in the manual, the first attempt to recover shall be to remove the cartridge and perform a shake procedure. Following this recovery process, ten more pages shall be printed and evaluated. If at least one page is categorized as Individual Use or Unusable, a second recovery attempt of printing a cleaning page, if available, shall be performed. Following the second recovery procedure, ten more pages shall be printed and pages evaluated for categorization. If at least one page is categorized as Individual Use or Unusable following this recovery process, the cartridge is DOA. 3. Cartridge is broken or missing parts. 4. Cartridge fails to operate upon installation and does not recover upon removing the cartridge and re-installation.
Premature Failure, (PF)		A cartridge with a page count of less than 80% of the average page count for all HP toner cartridges of that model that were not DOA, unless non-HP cartridge stated yield differs from HP stated yield.
Low Quality, (LQ)		A cartridge with 50% or more pages categorized as Limited Use, but was not DOA or PF.
Problem Cartridges		Cartridges categorized as either DOA, PF, or LQ.
Limited Use		Sample pages with PQ categorized as either Internal Use, Individual Use, or Unusable.
Print Quality Levels	External Use	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.
	Internal Use	Acceptable for distribution inside a company, but not acceptable distribution outside a company. Examples: documents to distribute to colleagues, immediate superiors or subordinates as business communication.
	Individual Use	Usable as a copy to read, file, or mark-up in the office, but not acceptable for distribution, either within or outside a company.
	Unusable	Not acceptable for any business purpose.
Usable Pages		Pages that were acceptable for any use, and not deemed Unusable.
Remanufactured Toner Cartridge		A reused HP cartridge shell that has been disassembled and had one or more components replaced. The cartridge is then refilled with non-HP toner and reassembled.

*spencer***LAB**
RELIABILITY TESTED