



Page Count/Reliability Comparison Study

HP Inkjet Print Cartridges vs. Refilled Cartridges

January 2010

(Updated January 2012)

For distribution in Europe, Middle East & Africa

Executive Summary

In January 2010, QualityLogic completed a study for HP designed to test the average page count and reliability of Hewlett-Packard (HP) 45, 78, 56, 57, 339 and 344 inkjet print cartridges compared to a sample of cartridges from what were, according to HP, the 4 most prevalent store/refill brands and 5 most prevalent refill station brands. All cartridges tested were sold in Europe.

The results of the study show that the HP inkjet print cartridges tested outperformed the refilled ink cartridges tested.

Average Page Count – When looking at the total pages printed from those cartridges tested, Original HP inkjet print cartridges produced an average of 34.7% more pages than the refilled cartridges tested.

Cartridge Reliability – The refilled cartridges tested had an average failure rate of 15.7% compared to less than one percent for the Original HP inkjet print cartridges tested.

The refilled cartridge test sample included cartridges from the following:

Store/Refill Brands

- Lyreco
- Office Depot
- Pelikan
- Tesco

Refill Station Brands

- Cartridge World
- Eco Store
- Prink
- Refill24
- Tintenstation

Detailed Results

Average Page Count

When looking at the total pages printed from those cartridges tested, Original HP inkjet print cartridges produced an average of 34.7% more pages than the refilled cartridges tested. (See Appendix 2 for study definitions.)

In the chart below, the average for HP cartridges tested are compared to the average performance for each refilled cartridge brand and type.

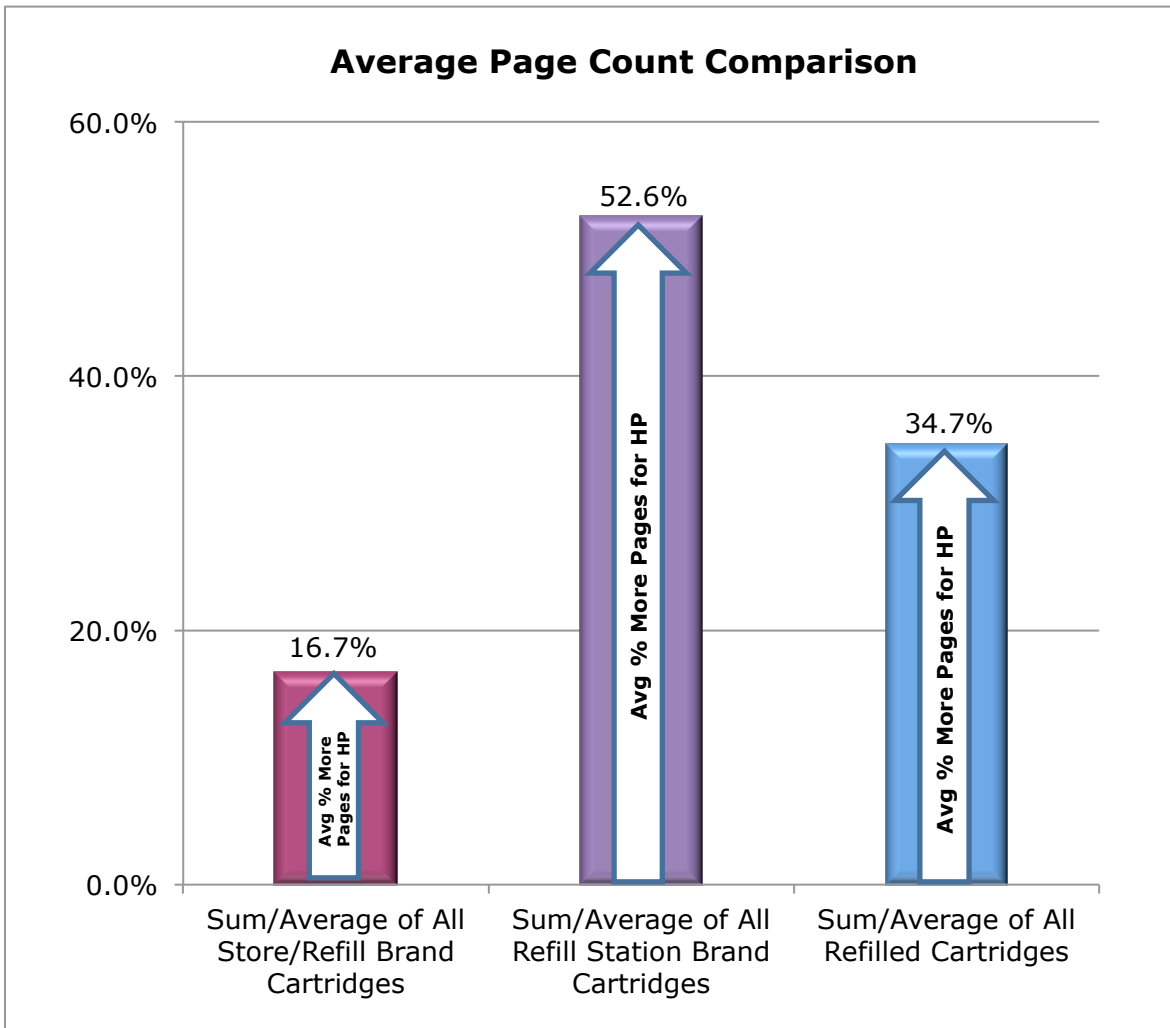
Cartridge Type	Brand	Total Number of Cartridges Tested	Average Percent More Pages for HP Cartridges
HP	HP	102	n/a
Sum/Average of All Store/Refill Brand Cartridges		410	16.7%
Sum/Average of all Refill Station Brand Cartridges		510	52.6%
Sum/Average of All Refilled Cartridges		920	34.7%

**Table 1:
Average Page Count Comparison**

Original HP inkjet print cartridges produced an average of 16.7% more pages than the store/refill brand cartridges tested.

Original HP inkjet print cartridges produced an average of 52.6% more pages than the cartridges refilled by refill station brand cartridges tested.

In addition, HP cartridges printed as much as 350 pages more, on average, for some cartridge models tested.



**Graph 1:
Average Page Count Comparison**

Cartridge Reliability

The refilled cartridges tested had an average failure rate of 15.7%, compared to less than one percent for the Original HP inkjet print cartridges tested.

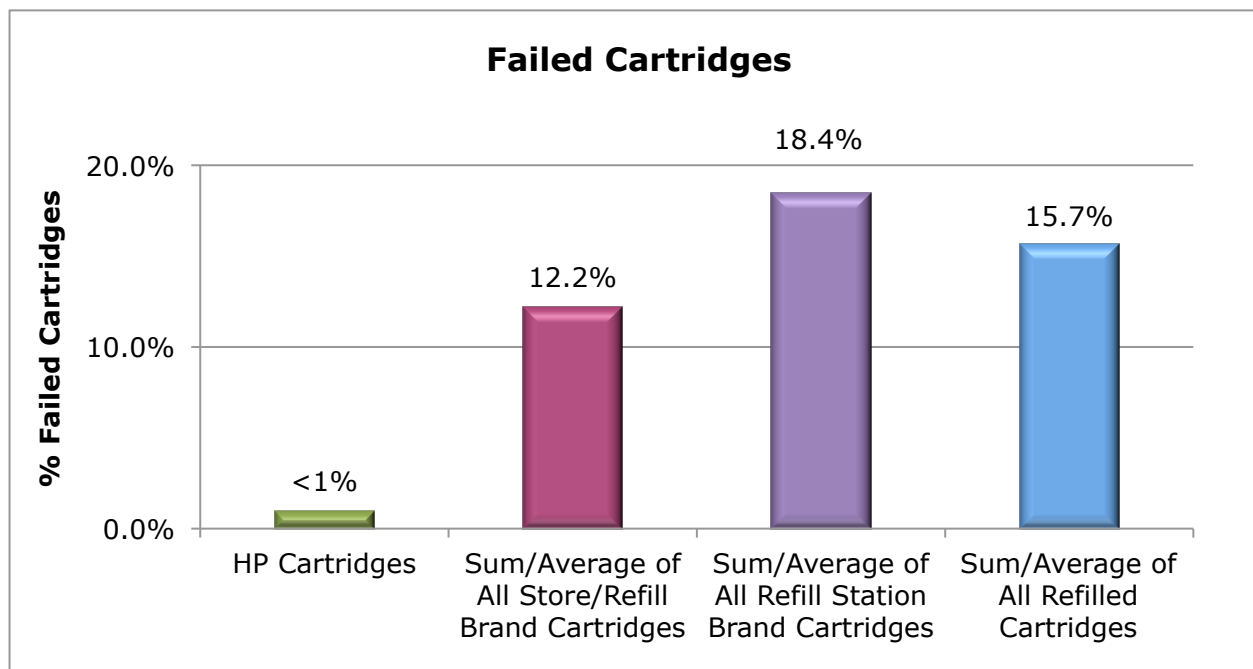
As shown in the table below, in the study 7.2% of the refilled cartridges tested were dead-on-arrival (DOA) and 8.5% failed prematurely (PF). (See Appendix 2 for study definitions.)

Store/Refill brand cartridges had an average failure rate of 12.2%, and refill station brand cartridges had an average failure rate of 18.4%.

Cartridge Type	Brand	Total Number of Cartridges Tested	Percent DOA	Percent PF	Total Percent Failed Cartridges
HP	HP	102	0.0%	<1%	<1%
Sum/Average of All Store/Refill Brand Cartridges		410	5.4%	6.8%	12.2%
Sum/Average of all Refill Station Brand Cartridges		510	8.6%	9.8%	18.4%
Sum/Average of All Refilled Cartridges		920	7.2%	8.5%	15.7%

**Table 2:
Cartridge Reliability**

The cartridges which were dead-on-arrival or failed prematurely are listed separately for each brand and cartridge type. Dead-on-arrival and premature failure cartridges were combined to create a total failed cartridge percentage for each cartridge brand and type.



**Graph 2:
Cartridge Reliability**

For the refilled cartridges that failed:

- 18 failed due to streaking that could not be resolved with cleaning.
- 22 failed due to a cartridge error that prevented it from printing, or continuing to print.
- 15 failed because one or more colours did not print or ceased to print.
- 21 failed because of colour mixing.
- 7 failed due to a substantial leak.
- 1 failed due to the cartridge physically coming apart during installation.
- 2 failed due to showing signs of fade almost immediately after cartridge installation.
- 58 cartridges reached standard ISO fade definition but reached end of life early. See definitions in Appendix 2.

The HP cartridge that failed prematurely failed due to streaking that could not be resolved with cleaning.

Store/Refill Brand Experience

It has been reported that some consumers believe that cartridges sold in office superstores are genuine original HP OEM supplies that are being sold in different packaging. But consumers need to know that all store/refill brand cartridges tested in this study came in brand labelled packaging, with descriptions on each box indicating that the cartridge contained in the box was remanufactured, recycled or 'compatible for' an HP OEM cartridge.

Refill Station Brand Experience

During the completion of this test, several anecdotal observations were made regarding the refill station brand practices and service levels.

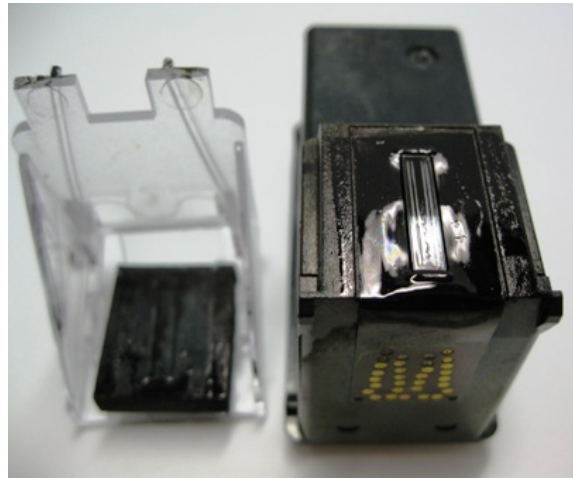
- Some refill station stores preferred to exchange the customer's empty cartridge for one which was already refilled. This creates the situation where a customer is asked to exchange their cartridge, with a known use history, for a cartridge of unknown history. These same stores were willing and able to refill the customer's specific cartridge upon request, however selecting that service made it necessary to return the next day to retrieve the refilled cartridge.
- Some refill station stores had very unreliable business hours. These stores were found to be closed during hours when the stores were advertised to be open.
- Some refill station stores offered refill service completion times on which they were repeatedly unable to deliver. Order completion was promised within hours, but cartridges were often not ready at the designated time.

These issues caused the purchaser to make additional trips to the refill station store to pick up cartridges.

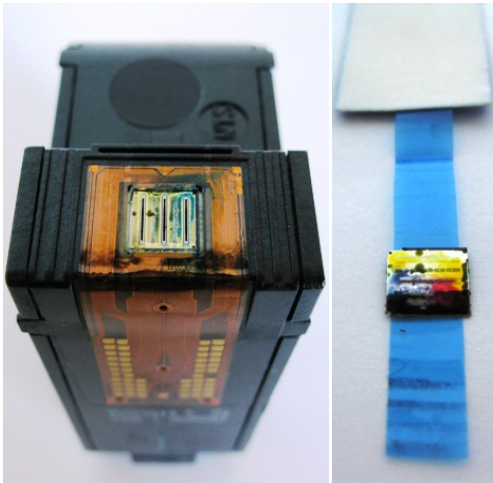
Cartridge Reliability Example Photos



Store/Refill brand cartridge leaking ink into the shipping container.



Store/Refill brand cartridge leaking after removing the protective clip, prior to installation into the printer.



Store/Refill brand cartridge printhead failure.



Refill Station brand cartridge leaking ink into the shipping container.

Appendix 1: Test Methodology

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




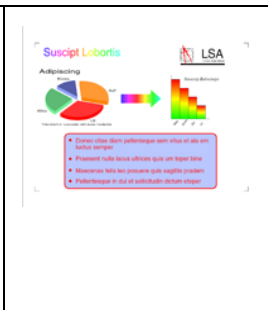
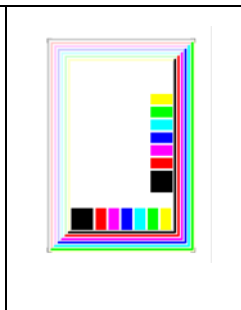
The printers and print cartridges selected for this study were as follows:

Printer	Black Cartridge	Colour Cartridge
HP Deskjet 930 (C6427A)		
HP Deskjet 970 (C6429B)	HP 45 (51645AE)	HP 78 (C6578AE)
HP Deskjet 5650 (C6490B)	HP 56 (C6656AE)	HP 57 (C6657AE)
HP Deskjet 6940 (C8970B)	HP 339 (C8767EE)	HP 344 (C9363EE)

A total of 920 refilled ink cartridges and 102 Original HP inkjet print cartridges were tested using a total of 19 HP Deskjet 930 & 970 printers, 11 HP Deskjet 5650 printers and 15 HP DeskJet 6940 printers.

Testing was conducted to align with the minimum sample size requirements in ISO/IEC 24711, which requires a minimum of three of each cartridge model to be tested in each of three printers. To ensure a statistically significant result, testing continued until a minimum of nine of each cartridge model arrived at EOL due to Fade as defined in ISO/IEC 24711. Printing was performed in a continuous mode in a controlled environment using the five-page test suite from ISO/IEC 24712, and the environmental conditions specified in ISO/IEC 24711.

The ISO/IEC 24712 test suite is shown below:

				
Page 1 – Business Letter	Page 2 - Spreadsheet	Page 3 - Newsletter	Page 4 - Slide	Page 5 - Diagnostic

To account for reliability-driven cartridge issues, DOA and Premature Failure cartridges were included in the mean page count calculations.

ISO test processes, sample sizes and test images were used for rigor and to ensure comparability of results between brands and categories. However, the mean page count data reflected in this report are not equivalent to ISO standard yields. ISO/IEC 24711 yields are the 90% Lower Confidence Bounds of the sample tested and defective cartridges are not included.

QualityLogic procured the HP Deskjet 6940 printers through standard retail channels in Germany. The HP Deskjet 930, 970 and 5650 printers have been discontinued and were therefore unavailable for purchase for the study. HP provided a sufficient number of each printer to complete the study. These printers were inspected and verified by the test team to be in good working order prior to the start of testing. Standard A4 paper was purchased

for the study in Germany, Italy and North America. Cartridges were purchased and tested in the summer of 2009. Original HP inkjet print cartridges were obtained through multiple retail channels in Germany and the United Kingdom. Store/refill brand ink cartridges were obtained through multiple retail channels or directly from the manufacturer in Germany and the United Kingdom. Refill station cartridges were purchased at multiple locations for each station brand in Germany (3 brands) and Italy (2 brands). Refill station cartridges were tested locally in the area where the cartridge was purchased. For the refill station brands tested, approximately 53% of the test data is based on cartridges that had been refilled once, and approximately 47% is based on cartridges that had been refilled twice. Test data from one of the refill station brands has been included in the refill station brand data, however some cartridges purchased at refill stations for this brand were swapped by the refill station for prefilled cartridges, which is the typical practice customers would encounter in the city visited for the study. Additionally, test data from two other refill station brands has been included in the refill station brand data, however all cartridges tested for those two refill station brands were purchased prefilled from store locations, which is the typical

practice customers would encounter in the city visited for the study.



To test cartridges refilled by refill station brands, new HP cartridges were prepared for refilling by printing the ISO test suite to approximately 90% of the published HP ISO yield or the first sign of fade, whichever came first. This is consistent with refill station recommendations that cartridges to be refilled not be completely emptied. A cartridge to be tested after one refill was prepared for refilling, refilled and then tested, printing to EOL per the definition in Appendix 2. A cartridge to be tested after two refills was prepared for

refilling, refilled, prepared for refilling again, refilled again and then tested, printing to EOL.

Pages printed while preparing cartridges for refilling were not part of the test.

QualityLogic selected Xerox Business plain paper (A4, 80 g/m²) for all printing in this study.

Printer settings were left at the factory default. Driver quality settings were set to Normal and plain media.

Each cartridge was inspected for leaks or other damage upon entering the test. A cartridge with substantial visible ink spilled in the bag or on the cartridge was declared DOA due to the leak. All other cartridges were printed to End-of-Life (EOL) as defined in Appendix 2: Definitions.

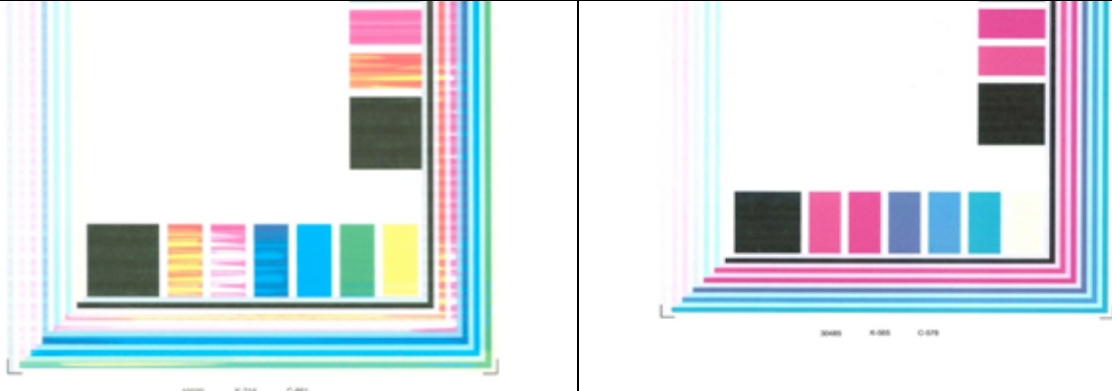
Printing continued until all test cartridges reached end of life. Colour and black cartridges were tested in parallel. As the final colour or black cartridges reached end of life, additional refilled cartridges for the brand under test were used to complete the testing. Where this wasn't possible, HP original cartridges were used to complete the testing. All results and effects of these additional refilled cartridges or HP original cartridges were ignored in the study.

This study tested average performance of each individual brand selected for the study and the refill market in the cities selected for the study. The brands in the sample were included because, together, they make up a significant portion of the overall market for refilled cartridges.

Seventeen cartridges of each model were tested for HP. A total of sixteen to twenty-one of each model were tested for each store/refilled brand and each refill station brand.

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

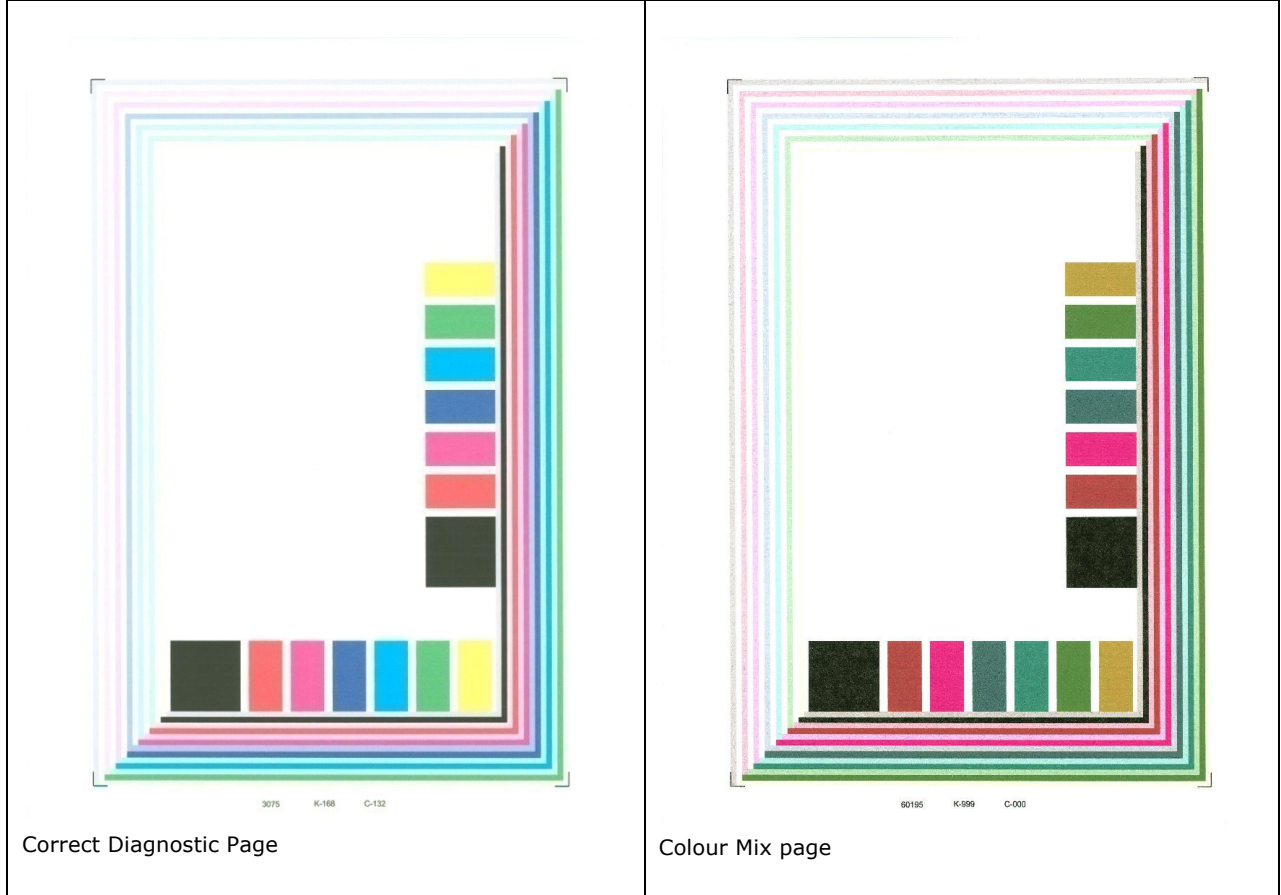
Appendix 2: Definitions

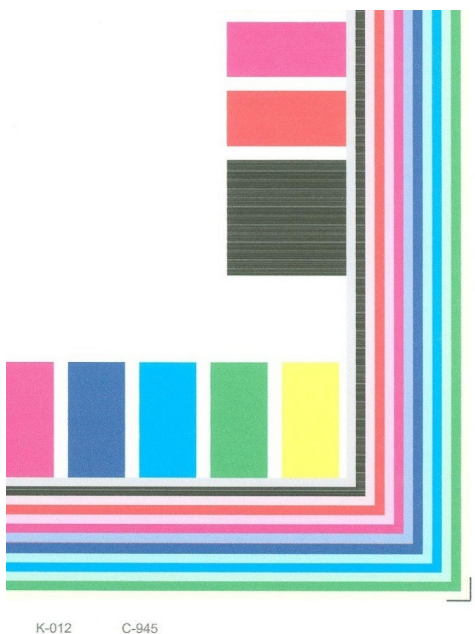
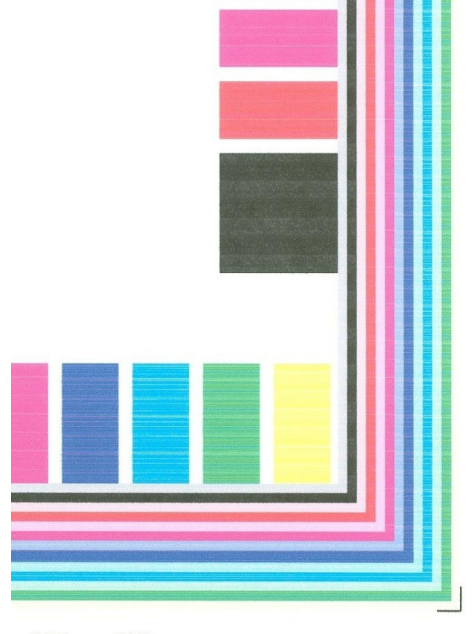
Test Project Terminology	Definition
End-of-Life (EOL)	<p>A condition determined by one of six mechanisms:</p> <ol style="list-style-type: none"> 1. Fade has occurred on the diagnostic page per ISO definition. 2. Significant reduction in density in the bands or blocks per ISO definition. 3. Streak removal procedure steps have been exhausted per ISO definition. 4. Substantial leakage before or during installation or any time during printing. (See definition below.) 5. 10 consecutive pages with colour mix. 6. Cartridge fails to print or stops printing and efforts to recover are unsuccessful.
Average % More Pages	<p>Average % More Pages was calculated by computing the difference between the HP average page count for each cartridge model and the average page count for each refilled brand for the same model and then expressing that difference as a percentage of the HP average page count. These percent values for each cartridge model were averaged to create a percent difference for each brand. The brand ratios were averaged to create the category ratios for the store/refill brand cartridges and the refill station brand cartridges. Finally, the two category ratios were averaged to create the overall Average % More Pages for HP.</p> <p>The mean page count values used for this calculation include cartridges identified as dead-on-arrival and premature failures.</p>
Individual Cartridge Page Count	<p>Individual cartridge page count is calculated by counting the number of diagnostic pages printed between cartridge installation and EOL, then multiplying by five. The diagnostic page is the last plot printed in the test suite.</p>
Dead On Arrival	<p>A condition determined by one of three mechanisms:</p> <ol style="list-style-type: none"> 1. Cartridge found to have substantial leakage before or during the installation process. (See definition below.) 2. 10 or fewer pages printed by a cartridge before end of life. 3. Cartridge fails to operate upon installation.
Premature Failure	<p>A cartridge that has a page count of less than 75% of the average page count for all cartridges tested for that brand and cartridge model.</p>
Fade	<p>A significant decrease in density on the bands or blocks of the last page in the test page suite, which is a diagnostic page. This decrease in density does not have to occur completely across the page to be considered fade. For a comparison to determine if fade is occurring, reference the 10th page printed by that printer.</p> <p>Two examples of fade pages are provided below.</p>
	

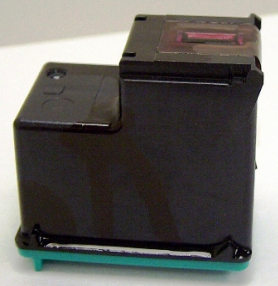
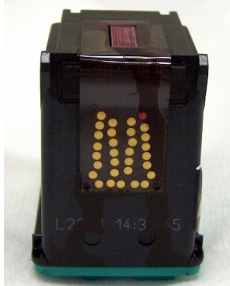
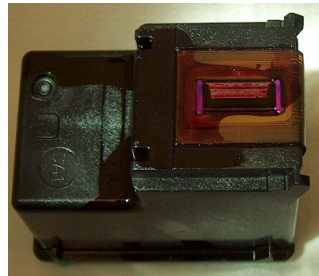

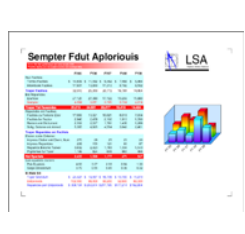


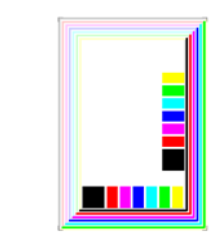
Colour Mix

Defined as a colour cartridge that cannot print the correct Cyan, Magenta and Yellow colours as shown on the diagnostic page 5 of the ISO page yield test suite. Ink has mixed in an unintended manner inside the cartridge and has caused a discolouring of the ink.

An example of Colour Mix is provided below. Compare the coloured blocks in the correct example to those of the colour mix page.



<p>Streaks</p>	<p>Very thin lines of colour or the lack of colour where it should be, in the blocks surrounding the edge of the diagnostic page. Streaks differ from fade in the width and severity of the reduction in density. Streaks can appear due to a number of reasons, including thermal issues and clogged nozzles.</p>
 <p style="text-align: center;">Black Streaks</p>	 <p style="text-align: center;">Colour Streaks</p>
<p>Streak Removal Procedures</p>	<p>This is the cartridge cleaning procedure (servicing) used to restoring print performance. If streaks are observed on three consecutive diagnostic pages, a streak removal procedure was implemented. Streak removal operation was conducted according to the HP printer manual documentation. If there were additional cleaning steps advised for the non-HP cartridges, they were included within the cleaning process.</p> <ol style="list-style-type: none"> 1. If the cleaning operation has the option of multiple cleaning strengths, the procedure indicated in the printer manual for resolving streaking should be followed. 2. Use of a "light" and a "strong" cleaning procedure counts as one cartridge cleaning operation. 3. Cleaning is verified by the reprinting of the diagnostic plot. If streaks are still present then the clean procedure is repeated again. 4. Any pages printed during the nozzle cleaning operation are not counted in the average page count calculation. <p>Due to the significant amount of ink that is used for cleaning, the maximum permissible number of times that the streak removal operation can be used on a given cartridge is 3 times. Cartridges which require a fourth service are considered to be at End of Life.</p> <p>All clean steps were recorded and reported by cartridge (i.e. page number streak occurred on, number and types services required and did the cartridge recover.)</p> <p>A cartridge not demonstrating streaking or other problems but which has experienced 3 cleanings because the cartridge in the sku pair has experienced streaking was NOT removed.</p>

<p>Substantial ink leakage</p>	<ul style="list-style-type: none"> - Ink visibly spilled in the plastic bag containing the cartridge. - Ink visibly spilled in the interior of the cartridge packaging. - Ink visibly spilled over the print head nozzles.
<div style="display: flex; justify-content: space-around;">    </div>	
<p>Test Page Suite</p>	<p>A series of five pages that are printed consecutively in order as a single job, ending with a diagnostic page. ISO/IEC 24712.</p>
<div style="display: flex; justify-content: space-between;">      </div>	

Note: Illustrations and photos in this table are for demonstration purposes and are not specific to any brand tested in this study.