

### Original HP Inkjet Print Cartridges vs. Third-Party Refilled Cartridges from Asia-Pacific Countries



#### EXECUTIVE SUMMARY

In January 2016, Buyers Laboratory LLC (BLI) completed a study for HP designed to test the page yield and reliability performance of Original HP #564XL Black, #564XL Cyan, #564XL Magenta, #564XL Yellow, #61XL Black, #61XL Color, #678 Black, #678 Color, #703 Black, #703 Color, #802 Black, #802 Color, #901XL Black and #901 Color inkjet print cartridges compared to refilled cartridges that BLI-hired mystery buyers acquired from leading refill service providers in six countries in the Asia-Pacific region: Australia, China, India, Indonesia, Korea and Thailand.

The refilled test samples included cartridges from the following refill service providers:

- Australia: Cartridge World (two locations)
- China: Beijing Zhongguancun Electronic City (two locations)
- India: Sachin Enterprises and Sai Fillers
- Indonesia: Oliser and Venata System
- Korea: InkTec (two locations)
- Thailand: IT Ink (three locations)

The results of the study, in which 828 cartridges were tested on 36 printers, unequivocally show that the Original HP inkjet print cartridges tested significantly outperformed the refilled ink cartridges.

**Page Yield:** When comparing the total pages printed from all cartridges tested, it was concluded that overall Original HP inkjet print cartridges produced 180% more pages than the refilled cartridges tested, based on the average page yields.

**Cartridge Reliability:** The Original HP inkjet print cartridges tested in the study had no failures, whereas the refilled cartridges tested had an overall average failure rate of 64%.

## LAB TEST RESULTS

### Page Yield

When comparing the total pages printed from those cartridges tested, it was concluded that overall the Original HP inkjet print cartridges produced 180% more pages than the refilled cartridges tested, based on a comparison of the average page yields. (See Appendix II for study definitions.)

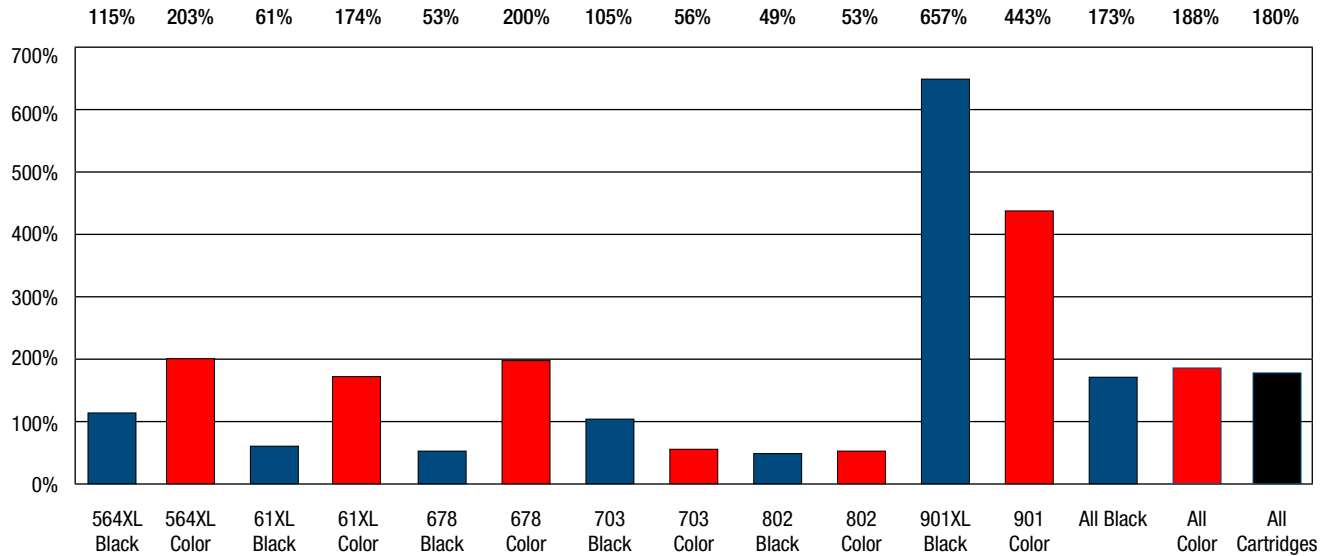
**Table I: Comparison of Overall Average Page Yields**

Cartridge Type	Number of Cartridges Tested	Average Percentage More Pages for HP Cartridges
HP	252	Not applicable
Cartridges refilled by Refill Service Providers	576	180%

Throughout testing, each of the Original HP inkjet print cartridge types produced average page yields that were superior to those of the refilled cartridges and, as illustrated in Graph I below, outperformed the refilled cartridges by printing the following percentages of additional pages:

- Original HP #564XL Black cartridges: 115% more pages printed
- Original HP #564XL Color cartridges: 203% more pages printed
- Original HP #61XL Black cartridges: 61% more pages printed
- Original HP #61XL Color cartridges: 174% more pages printed
- Original HP #678 Black cartridges: 53% more pages printed
- Original HP #678 Color cartridges: 200% more pages printed
- Original HP #703 Black cartridges: 105% more pages printed
- Original HP #703 Color cartridges: 56% more pages printed
- Original HP #802 Black cartridges: 49% more pages printed
- Original HP #802 Color cartridges: 53% more pages printed
- Original HP 901XL Black cartridges: 657% more pages printed
- Original HP 901 Color cartridges: 443% more pages printed

**Graph I: Percentage More Pages Printed by HP than by Re-fillers per SKU, per Color and per All Cartridges**



When looking at the average page yields for the black and color cartridges separately, Original HP black inkjet print cartridges produced 173% more pages on average than the refilled cartridges, while Original HP color inkjet print cartridges produced 188% more pages on average than the refilled cartridges tested.

## Cartridge Reliability

None of the Original HP inkjet print cartridges tested failed in the study, whereas an average of 64% of the refilled cartridges tested were either dead-on-arrival (DOA) or reached end of life early (premature expires). (See Appendix II for study definitions of DOA and premature expires).

**Table II: Cartridge Reliability**

Cartridge Type	Number of Cartridges Tested	Premature Expires		Dead on Arrival		Total Failed Cartridges	
		No.	%	No.	%	No.	%
HP	252	0	0%	0	0%	0%	0%
Cartridges refilled by Refill Service Providers	576	238	41%	138	23%	376	64%

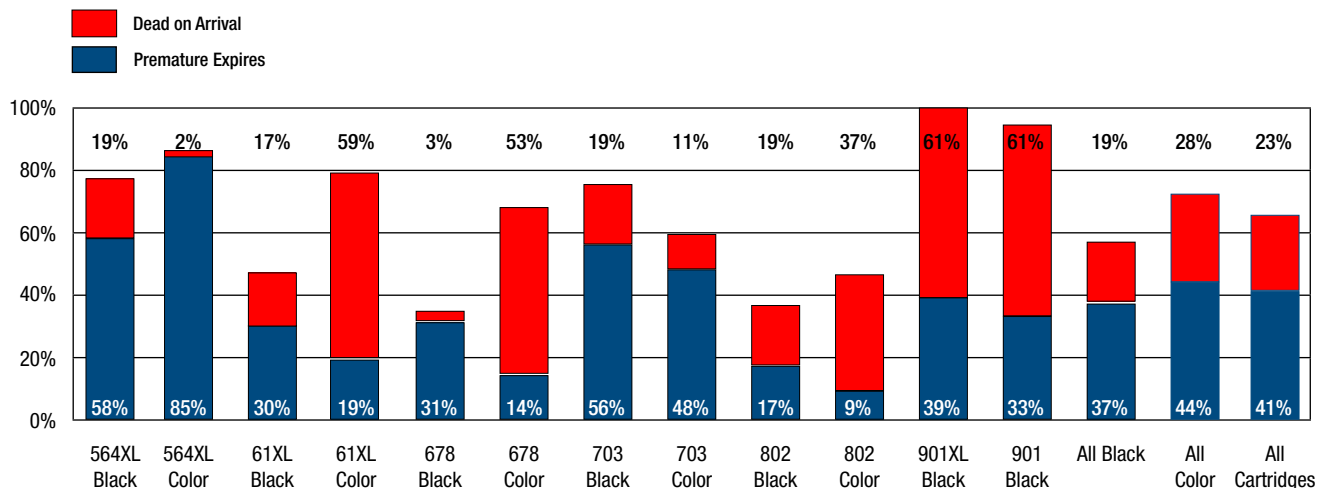
In analyzing the breakdown of the refilled cartridge failures, it was observed that of the 576 refilled cartridges tested, 41% expired prematurely, while 23% were DOA. Per cartridge type, the failure rates for the refilled cartridges were as follows:

- Refilled #564XL Black cartridges: 58% premature expires, 19% DOA
- Refilled #564XL Color cartridges: 85% premature expires, 2% DOA
- Refilled #61XL Black cartridges: 30% premature expires, 17% DOA

- Refilled #61XL Color cartridges: 19% premature expires, 59% DOA
- Refilled #678 Black cartridges: 31% premature expires, 3% DOA
- Refilled #678 Color cartridges: 14% premature expires, 53% DOA
- Refilled #703 Black cartridges: 56% premature expires, 19% DOA
- Refilled #703 Color cartridges: 48% premature expires, 11% DOA
- Refilled #802 Black cartridges: 17% premature expires, 19% DOA
- Refilled #802 Color cartridges: 9% premature expires, 37% DOA
- Refilled #901XL Black cartridges: 39% premature failures, 61% DOA
- Refilled #901 Color Cartridges: 33% premature failures, 61% DOA

This data is presented graphically below:

**Graph II: Percentage of Re-filler Cartridge Failures by Failure Type, per SKU, per Color and per All Cartridges**



Overall, the black refilled cartridges failed at a rate of 56% (37% premature expires, 19% DOA) while the tri-color refilled cartridges failed at a rate of 72% (44% premature expires, 28% DOA).

The failure to print one or more of the colors was the most prevalent cause of DOA failures with the refilled color cartridges, accounting for 47% of all refilled color cartridge DOA failures. Poor color mix was the second leading cause, at 39% of all color DOA failures. The remainder of the DOA color failures was cartridge failure, accounting for 14%.

Failure to print was the most prevalent cause of DOA failure with the refilled black cartridges, at 56% of all DOA failures. The two next-most prevalent causes were cartridge failure and streaking, both at 19%, and the remainder were accounted for by low yield (less than 10 pages but more than 0) at 6%.

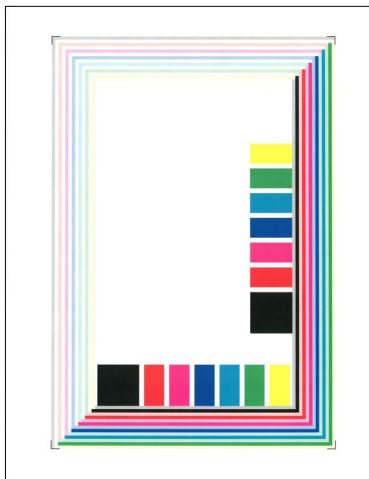
Premature expires among the color refilled cartridges was mainly due to: unacceptably low page yields, 96%. Less prevalent were streaking, 3% and cartridge failure, 1%.

With the black cartridges, premature expires were mainly due to low yields, at 90%. The remainder was caused by streaking, at 10%.

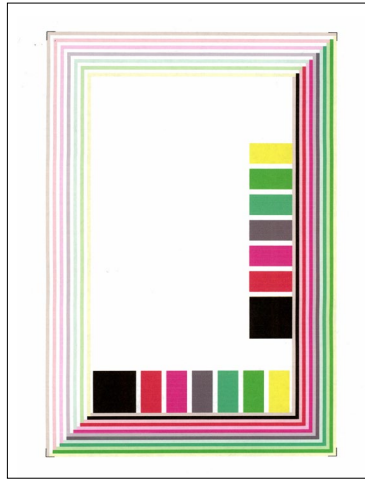
### Percentage of Refilled DOA Failures

CAUSE OF FAILURE	BLACK	COLOR
Cartridge Failure	19%	14%
Color Mix	0%	39%
Failed to Print a Color	56%	47%
Low Yield	6%	0%
Streaking	19%	0%
<b>TOTALS</b>	<b>100%</b>	<b>100%</b>

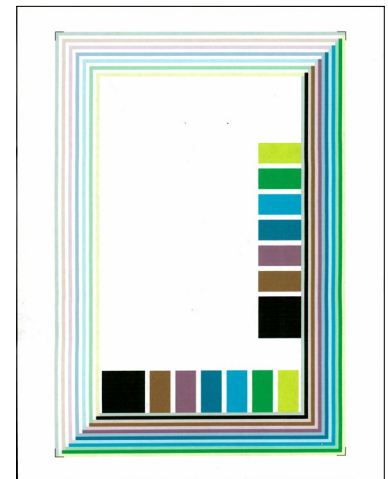
A cartridge “failure” occurs when a cartridge is rejected by the printer which will not operate as long as that cartridge remains installed. Thus it differs from “failure” to print one or more colors, where the printer accepts the cartridge which then fails to print a full range of colors. There is often obvious physical damage to the rejected cartridge, such as corrosion on the contact points or damage to the contact strip itself. On occasion a cartridge can simply not be loaded, such as with the 564XL cartridges, which are clicked into place and will sometimes not sit properly in the cartridge chamber.



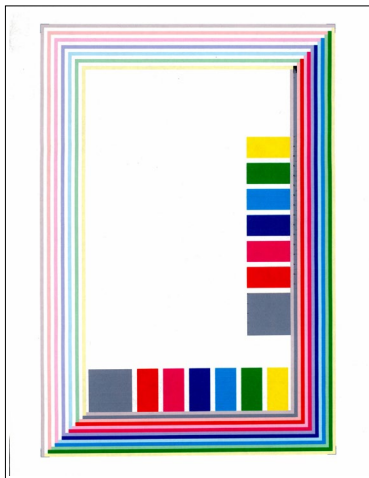
Correct Diagnostic Page



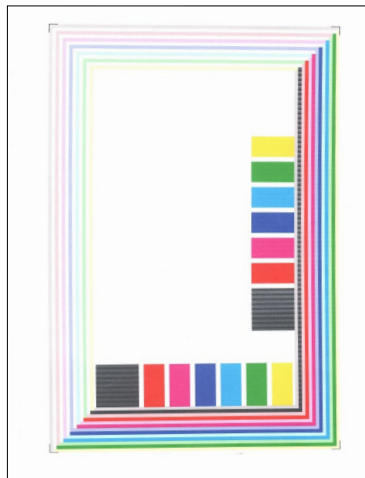
Color Mix 1



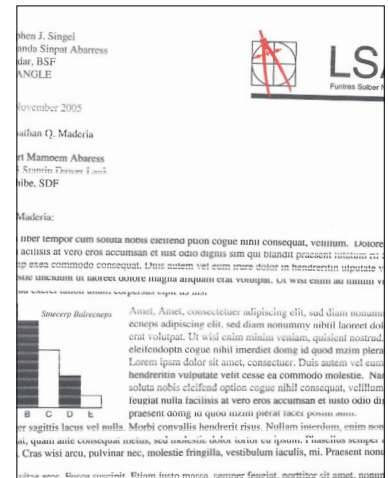
Color Mix 2



Black Printing as Gray



Black Streaks



Black Text Streaks

## APPENDIX I: TEST METHODOLOGY

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

### Printers and Print Cartridges Selected for this Study

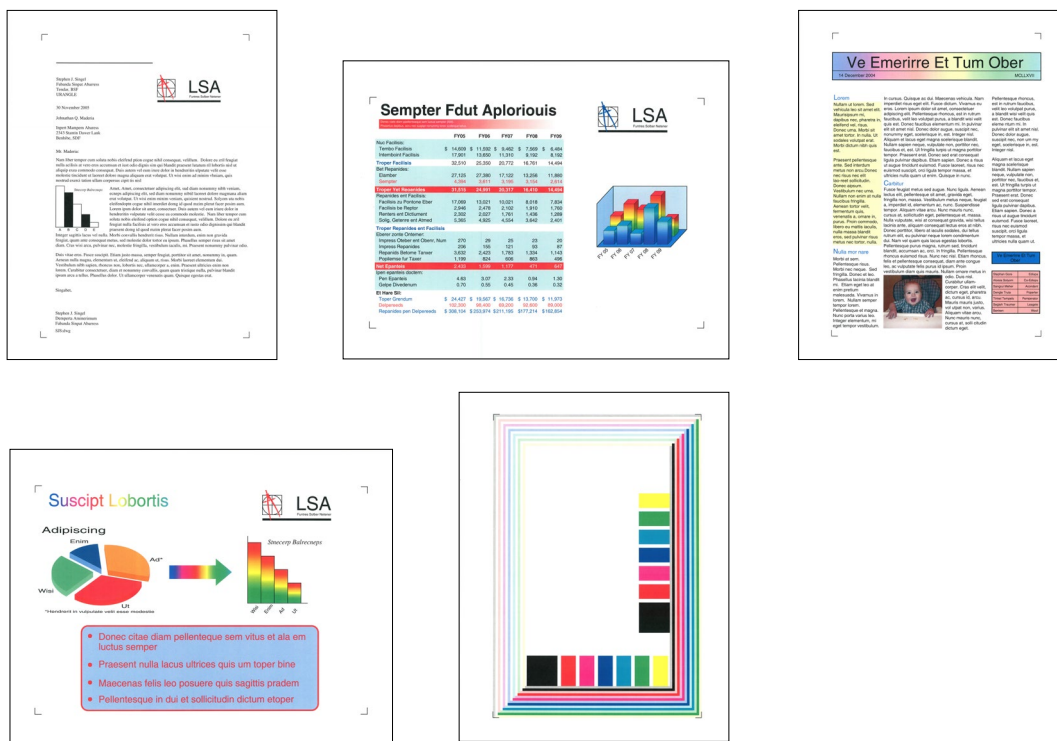
Printer	Black Cartridge	Color Cartridge
HP Photosmart 5520 (CX042A)	HP564XL (CN684WN)	HP564XL Cyan (CB323WN)
		HP564XL Magenta (CB324WN)
		HP564XL Yellow (CB325WN)
HP Deskjet 2540 (A9U22A)	HP61XL (CH563WN)	HP61XL (CH564WN)
HP Deskjet 2545 (A9U23B)	HP678 (CZ107AA)	HP678 (CZ108AA)
HP Photosmart Ink Advantage 510a (CQ796A)	HP703 (CD887AA)	HP703 (CD888AA)
HP Deskjet 1510 (B2L56A)	HP802 (CH563ZZ)	HP802 (CH564ZZ)
HP Officejet 4500 (CB867A)	HP901XL (CC654AN)	HP901 (CC656AN)

A total of 576 refilled ink cartridges and 252 Original HP inkjet print cartridges were tested using a total of six HP Photosmart 5520 printers, six HP Deskjet 2540 printers, six HP Deskjet 2545 printers, six HP Photosmart Ink Advantage K510a printers, six HP Deskjet 1510 printers and six HP Officejet 4500 printers. These devices and SKUs represent a large range of the HP portfolio, including old, previous, and current generation of product. This was done to capture a wide range of products that most users may own. It should be noted that these cartridges are also compatible with a number of other HP printer models (see table below), so the user experience reported in this report would not be limited to just three HP printer models.

### Compatible Printers

564XL	61XL	678	703	802	901XL/901
Black & Color (CMY)	Black & Color	Black & Color	Black & Color	Black & Color	Black & Color
Photosmart Plus eAiO (B210a)	Deskjet 1050 AiO (J410a)	Deskjet Ink Advantage 1515 AiO	Deskjet D730	Deskjet 1000	Officejet J4500
Photosmart eAiO (B110a)	Deskjet 1000 AiO (J110a)	Deskjet Ink Advantage 2515 AiO	Deskjet Ink Advantage Printer (K109a)	Deskjet 2000	Officejet J4580 AiO
Photosmart Premium Fax eAiO (C410)	Deskjet 1510	Deskjet Ink Advantage 2545 AiO	Deskjet F735	Deskjet 3000	Officejet J4640 AiO
Photosmart Premium eAiO (C310a)	Deskjet 2000 (J210a)	Deskjet Ink Advantage 2645 AiO	Deskjet Ink Advantage AiO (K2109a)	Deskjet 1050 AiO	Officejet J4680 AiO
Photosmart eStation (C510a)	Deskjet 2050 AiO (J510a)	Deskjet Ink Advantage 3515 AiO		Deskjet 2050	
Photosmart 5520	Deskjet 2510 AiO	Deskjet Ink Advantage 3545 AiO		Deskjet 2510	
Photosmart 7520	Deskjet 2540 AiO	Deskjet Ink Advantage 4515 AiO		Deskjet 3050 AiO	
Deskjet 3520	Deskjet 3000 (J310a)	Deskjet Ink Advantage 4645 AiO		Deskjet 3050A AiO	
Photosmart 5530	Deskjet 3050 AiO (J610a)			Deskjet 3510	
Photosmart 6520	Envy 4500 eAiO				
	Envy 5530 eAiO				
	Officejet 2620 AiO				
	Officejet 4630 AiO				

Printing was performed in a continuous mode in a controlled environment using the ISO/IEC 24712 five-page color test suite, and the environmental conditions specified in ISO/IEC 24711. To account for reliability-driven cartridge issues, defective cartridges were included in the page yield calculations. Consequently, the reported page yield numbers are not based on the ISO/IEC 24711 standard, as ISO/IEC 24711 requires that defective cartridges are excluded from the page yield calculation. This was done to account for the negative user experience with defective or failed cartridges.



## The ISO/IEC 24712 Test Suite

Printers were either supplied by HP or purchased by BLI through standard retail channels. BLI procured all paper and Original HP inkjet print cartridges.

To test cartridges refilled by refill service providers, new HP cartridges were prepared for refilling by printing the ISO test suite to the first sign of fade. This is consistent with re-filler recommendations that cartridges to be refilled not be completely emptied. BLI then sent the empty cartridges to six countries in the Asia-Pacific region, which mystery buyers in those locations took to multiple locations of each cartridge refiller service provider. Refill service provider cartridges were tested in the BLI's Fairfield, NJ, test facility. For the refill service providers tested, 100% of the test data is based on cartridges that had been refilled once.

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

Buyers Laboratory selected Georgia-Pacific Spectrum Multi-Use plain paper (8½ x 11, 20 lb., 92 Brightness) for all printing in this study.

Each cartridge was inspected for leaks or other damage upon entering the test, and a cartridge with substantial visible ink spilled in the bag or on the cartridge was declared DOA. All other cartridges were printed to End-of-Life (EOL; see study definitions).



Printing continued until all test cartridges reached EOL. Color and black cartridges were tested in parallel. As the color or black cartridges reached EOL, Original HP “substitute” cartridges were used to complete the testing of the unfinished cartridge in the set. All results and effects of these Original HP “substituted” cartridges were ignored in the study.

This study tested average performance of the market, not individual brand performance. The brands and providers in the sample were included because, together, they make up a significant portion of the overall market for refilled cartridges.

Eighteen cartridges of each type were tested for HP. A total of eighteen cartridges of six types were tested for refillers in Australia; of six types for refillers in China; of four types for refillers in India; of four types for refillers in Indonesia; of eight types for refillers in Korea and of four types for refillers in Thailand.



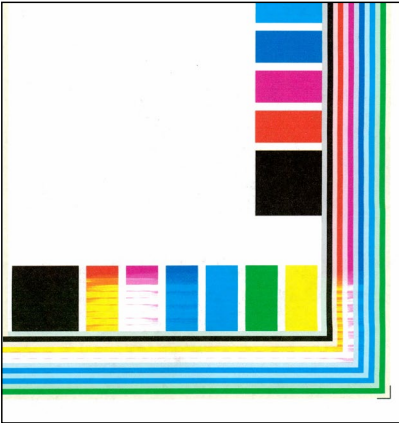
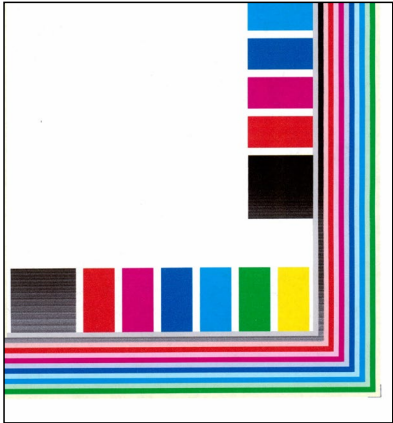
Lab testing at BLI

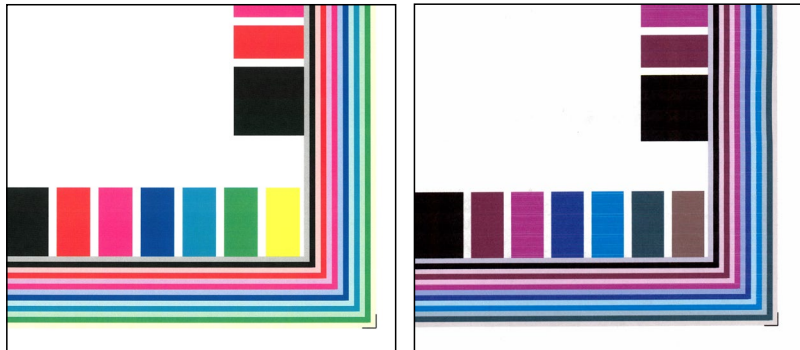
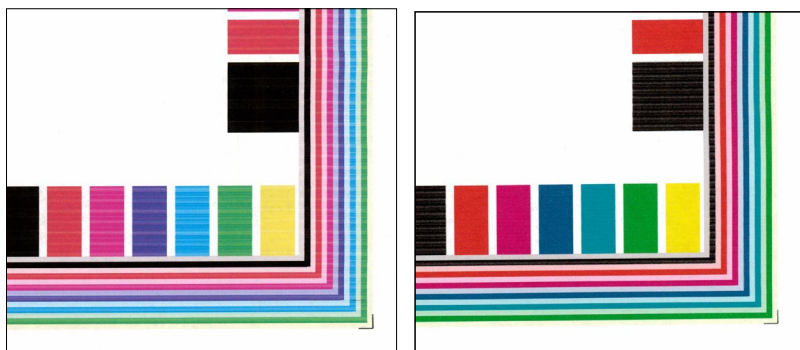
### Refill Cartridges per Country

		Original HP	Australia	China	India	Indonesia	Korea	Thailand	Total Refill Cartridges
564XL	Black	18	18				18		36
	Color	54	54				54		108
61XL	Black	18	18				18	18	54
	Color	18	18				18	18	54
678	Black	18				18	18		36
	Color	18				18	18		36
703	Black	18		18	18			18	54
	Color	18		18	18			18	54
802	Black	18		18	18	18			54
	Color	18		18	18	18			54
901XL	Black	18		18					18
901	Color	18		18					18
Total by Color	Black	108	36	54	36	36	54	36	252
	Color	144	72	54	36	36	90	36	324
Overall Cartridge Total		252	108	108	72	72	144	72	576



## APPENDIX II: 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"> <li>1. Fade has occurred on the diagnostic page per ISO definition.</li> <li>2. Significant reduction in density in the bands or blocks per ISO definition.</li> <li>3. Streak removal procedure steps have been exhausted per ISO definition.</li> <li>4. Significant leakage before or during installation or any time during printing.</li> <li>5. 10 consecutive pages with color mix.</li> <li>6. Cartridge fails to print or stops printing and efforts to recover are unsuccessful.</li> </ol>
Individual Cartridge Yield	Individual cartridge yield 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.
Average % More Pages	Percent More Pages is calculated for each cartridge type for each model: $100 \times (\text{HP Page Yield} - \text{Refilled Page Yield}) / (\text{Refilled Page Yield})$ . From these calculations the Average Percent More Pages was obtained, which is defined as percent more pages printed by all HP cartridges versus all aftermarket cartridges tested. Note that these are simple averages and not weighted averages.
Dead On Arrival (DOA)	<p>A condition determined by one of three mechanisms:</p> <ol style="list-style-type: none"> <li>1. Cartridge found to have substantial leakage (as defined above) at start or during testing.</li> <li>2. 10 or fewer pages printed by a cartridge before end of life.</li> <li>3. Cartridge fails to operate upon installation.</li> </ol>
Early End of Life (Premature Expire)	A cartridge that has a page yield of less than 75% of the HP mean page yield for that cartridge model in the test.
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.</p> <div style="display: flex; justify-content: space-around; align-items: flex-end;"> <div style="text-align: center;">  <p>Color Fade</p> </div> <div style="text-align: center;">  <p>Black Fade</p> </div> </div>

<p><b>Color Mix</b></p>	<p>Defined as a color cartridge that cannot print the correct Cyan, Magenta and Yellow colors as shown on the diagnostic page 5 of the page yield test suite. Ink has mixed in an unintended manner inside the cartridge and has caused a dis-coloring of the ink.</p> <p>An example of Color Mix is provided below. Compare the colored blocks in the correct example to those of the color mix page.</p> <div data-bbox="690 304 1485 651">  </div> <div data-bbox="776 661 1328 693"> <p>Correct Diagnostic Page      Color Mix</p> </div>
<p><b>Streaks</b></p>	<p>Very thin lines of color or the lack of color 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> <div data-bbox="690 787 1485 1134">  </div> <div data-bbox="812 1144 1364 1176"> <p>Color Streaking      Black Streaking</p> </div>
<p><b>Streak Removal Procedures</b></p>	<p>This is the cartridge cleaning procedure (servicing) used to restore print performance. If streaks were observed on three consecutive diagnostic pages a streak removal procedure was implemented. Streak removal operations were conducted according to the HP printer manual documentation. If there were additional cleaning steps advised for non-HP cartridges, these were included within the cleaning process.</p> <ol style="list-style-type: none"> <li>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.</li> <li>2. Use of a "light" and a "strong" cleaning procedure counts as one cartridge cleaning operation.</li> <li>3. Cleaning is verified by the reprinting of the diagnostic plot. If streaks are still present then the cleaning procedure is repeated.</li> <li>4. Any pages printed during the nozzle cleaning operation are not counted in the yield calculation.</li> </ol> <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 three (3). Cartridges which require a fourth service are considered to be at EOL.</p> <p>All cleaning steps were recorded and reported by cartridge, i.e. page number streak occurred on, number and types of services required and result (Did the cartridge recover?)</p> <p>A cartridge not demonstrating streaking or other problems but which has experienced three (3) cleanings because the other cartridge in the sku pair has experienced streaking was not considered to be at EOL.</p>

<b>Substantial Ink Leakage</b>	<p>Significant amount of ink visibly spilled in the plastic bag containing the cartridge.</p> <p>Significant amount of ink visibly spilled in the interior of the cartridge packaging.</p> <p>Significant amount of ink visibly spilled over the printhead nozzles.</p>
<b>Test Page Suite</b>	<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>

## 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 document imaging devices 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, fusers and photoconductors), solutions evaluations, and imaging media runnability testing.

For more information on BLI, call (973) 797-2100, visit [www.buyerslab.com](http://www.buyerslab.com), or e-mail [info@buyerslab.com](mailto:info@buyerslab.com).