

Original HP Inkjet Print Cartridges vs. Third-Party Refilled Cartridges



EXECUTIVE SUMMARY

In February 2011, Buyers Laboratory Inc. (BLI) completed a study for HP designed to test the page yield and reliability performance of Original Hewlett-Packard (HP) #56 Black, #57 Color, #60XL Black, #60XL Color, #74XL Black and #75XL Color inkjet print cartridges compared to a sampling of cartridges from leading refill service providers. All cartridges tested were sold in North America.

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

- Cartridge World
- Ink-O-Dem Refill Machines (located at Ace Hardware, Brown University and Micro Center)
- Office Max
- Walgreens

The results of the study, in which 540 cartridges were tested on 18 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 133% 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 72%.

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 133% more pages than the refilled cartridges tested, based on a comparison of the average page yields. (See Appendix II on page 7 for study definitions.)

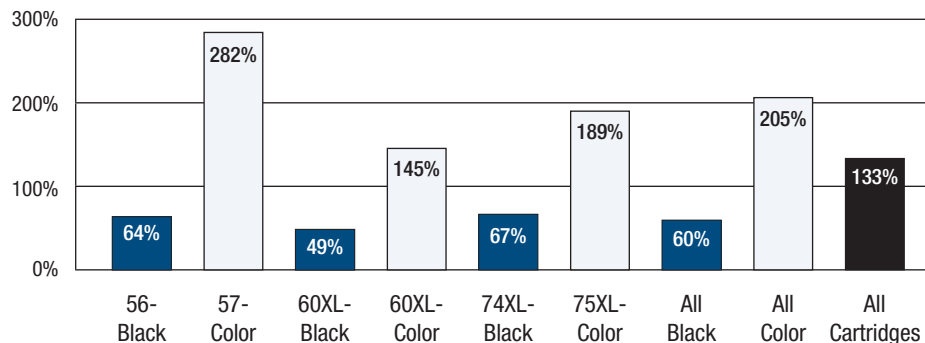
Table I: Comparison of Overall Average Page Yields

Cartridge Type	Number of Cartridges Tested	Average Percentage More Pages for HP Cartridges.
HP	108	n/a
Cartridges refilled by Refill Service Providers	432	133%

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 #56 Black cartridges: 64% more pages printed
- Original HP #57 Color cartridges: 282% more pages printed
- Original HP #60XL Black cartridges: 49% more pages printed
- Original HP #60XL Color cartridges: 145% more pages printed
- Original HP #74XL Black cartridges: 67% more pages printed
- Original HP #75XL Color cartridges: 189% 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 60% more pages on average than the refilled cartridges, while Original HP color inkjet print cartridges produced 205% 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 72% of the refilled cartridges tested were either dead-on-arrival (DOA) or reached end of life early (premature expires). See Appendix II on page 7 for a definition of DOA and premature expires.

Table II: Cartridge Reliability

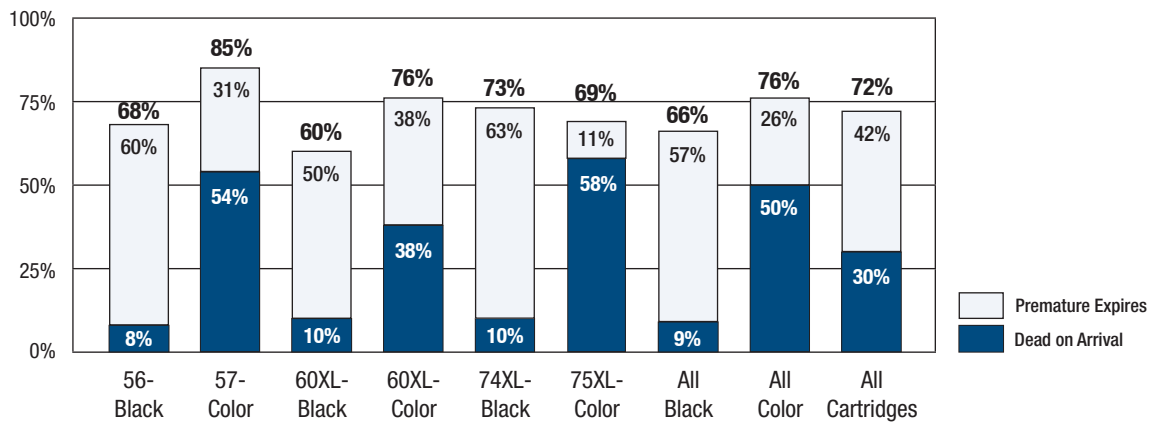
Cartridge Type	Number of Cartridges Tested	Dead On Arrival		Premature Expires		Total Failed Cartridges	
		No.	%	No.	%	No.	%
HP	108	0	0%	0	0%	0%	0%
Cartridges refilled by Refill Service Providers	432	128	30%	181	42%	309	72%

In analyzing the breakdown of the refilled cartridge failures it was observed that of the 432 refilled cartridges tested 42% expired prematurely, while 30% were dead on arrival (DOA). Per cartridge type, the failure rates for the refilled cartridges were as follows:

- Refilled #56 Black cartridges: 60% premature expires, 8% DOA
- Refilled #57 Color cartridges: 31% premature expires, 54% DOA
- Refilled #60XL Black cartridges: 50% premature expires, 10% DOA
- Refilled #60XL Color cartridges: 38% premature expires, 38% DOA
- Refilled #74XL Black cartridges: 63% premature expires, 10% DOA
- Refilled #75XL Color cartridges: 11% premature expires, 58% DOA
- Refilled #75XL Color cartridges: 11% premature expires, 58% 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



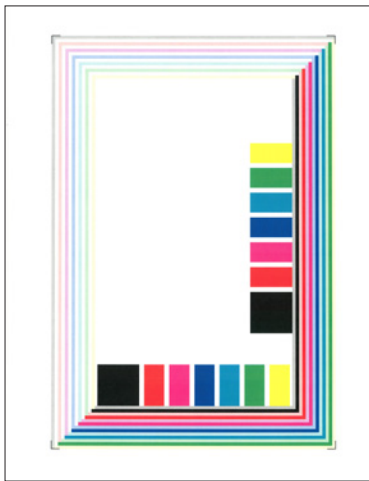
Overall, the black refilled cartridges failed at a rate of 66% (57% premature expires, 9% DOA) while the tri-color refilled cartridges failed at a rate of 76% (26% premature expires, 50% DOA).

Poor color fidelity (or color mix) was the most prevalent cause of DOA failures with the refilled color cartridges, accounting for 69% of all refilled color cartridge DOA failures. Other causes were streaking, early fade, failure to print individual colors or failure to print due to physical issues, such as non-recognition of a cartridge by the printer (in which case the printer displayed an “Incompatible Print Cartridge” message) and ink leaking.

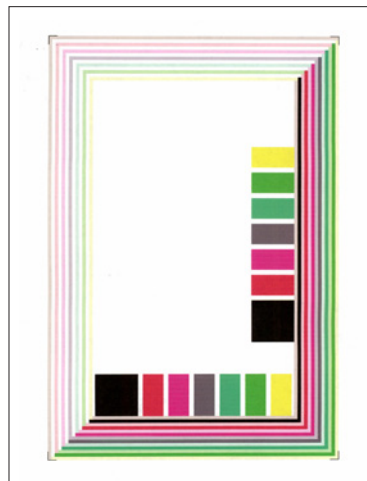
Unrecoverable streaking was the most prevalent cause of DOA failure with the refilled black cartridges, accounting for 60% of all refilled black color cartridge DOA failures. Other causes were black images printing as gray and failure to print due to physical issues, including two failures recorded due to the fact that the re-fillers had failed to fill the cartridge.

Premature expires amongst all of the refilled cartridges was mainly due to unacceptably low page yields.

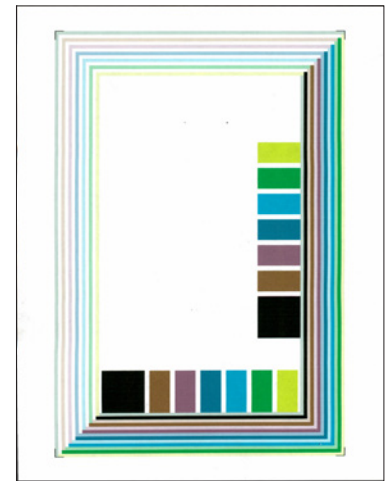
The exhibits below (excluding the one labeled “Correct Diagnostic Page”) are typical of the types of irreparable image quality failures experienced with the refilled cartridges that resulted in DOAs. As can be seen, color fidelity was severely off, with cyan and yellow printing as green, magenta printing as purple, red printing as gold, blue printing as brown, and black as gray. In addition, streaking such as that shown below resulted in cartridges being classified as DOA as it was excessive and could not be remedied with the three streak removal procedures.



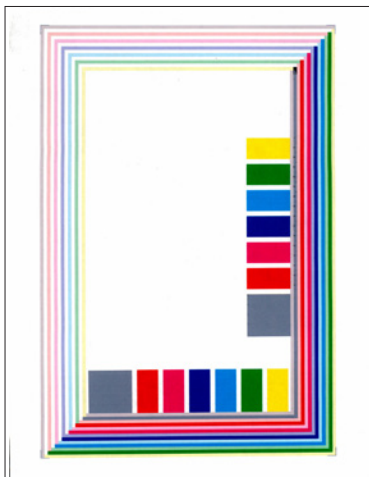
Correct Diagnostic Page



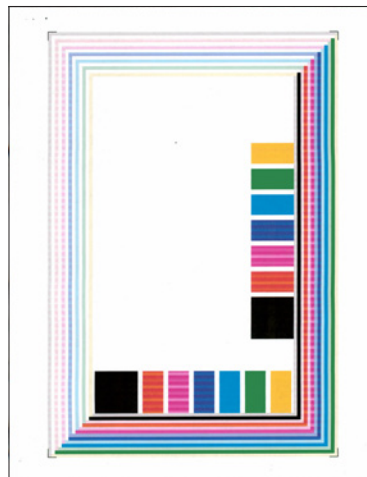
Color Mix 1



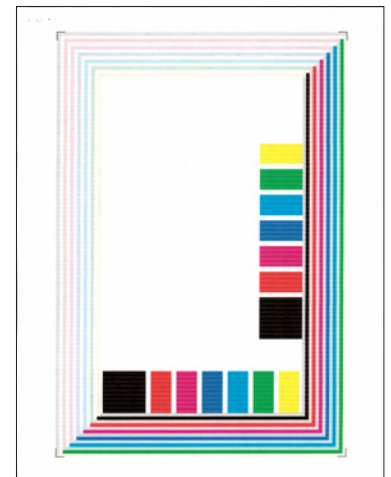
Color Mix 2



Black Printing as Gray



Color Streaks



Black and Color Streaks

APPENDIX I: TEST METHODOLOGY

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

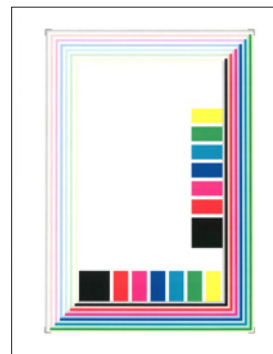
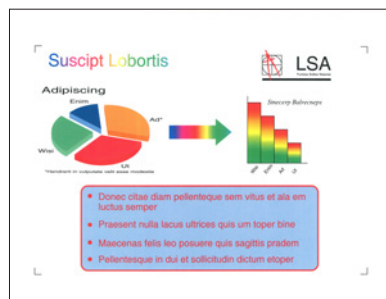
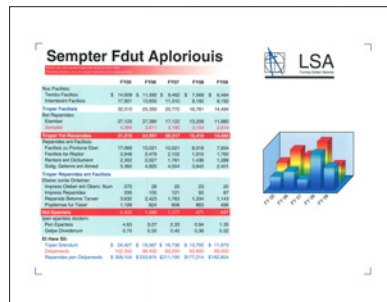
Printers and Print Cartridges Selected for this Study

Printer	Black Cartridge	Color Cartridge
HP Deskjet 5650 (C6490A)	HP56 (C6656AN)	HP57 (C6657AN)
HP Photosmart C4599 (Q8408A)	HP74XL (CB336WN)	HP75XL (CB338WN)
HP Photosmart C4795 (Q8382A)	HP60XL (CC641WN)	HP60XL (CC644WN)

A total of 432 refilled ink cartridges and 108 Original HP inkjet print cartridges were tested using a total of six HP Deskjet 5650 printers, six HP Photosmart C4599 printers and six HP Photosmart C4795 printers. These printers 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 (including the Deskjet 5150, 5550 and 5650, Officejet J5750, J5780 and J6450 and the Photosmart C4400, C4500 and C4600 series), so the user experience reported in this report would not be limited to just the three HP printer models used in testing.

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





With the exception of one printer model that had to be supplied by HP because of lack of availability on the open market, Buyers Laboratory Inc. procured all printers, paper, and Original HP inkjet print cartridges through standard retail channels in North America. Refill service provider cartridges were purchased at multiple locations for each provider in 15 US cities. All cartridges were tested in the BLI's Hackensack, NJ test facility. For the refill service providers tested, approximately 80% of the test data is based on cartridges that had been refilled once, and approximately 20% of the data is based on cartridges that were swapped for pre-filled cartridges, as some Cartridge World locations swap used cartridges with cartridges that have already been refilled.

To test cartridges refilled by refill service providers, new HP cartridges were prepared for refilling by printing the ISO 24712 test suite to the first sign of fade. This is consistent with re-filler 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 End-of-Life (EOL) per the definition in Appendix II. A cartridge that had been swapped for an emptied cartridge was tested by printing to EOL.

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.

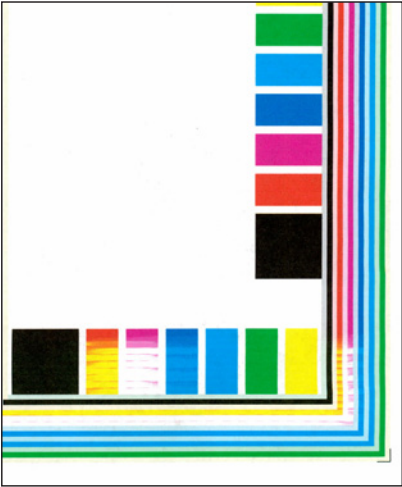
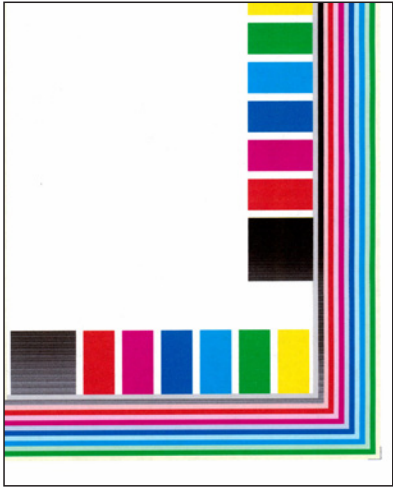
Each cartridge was inspected for leaks or other damage upon entering the test and a cartridge with substantial visible ink spilled in the bag or on the cartridge was declared DOA. All other cartridges were printed to EOL as defined in Appendix II: Definitions.

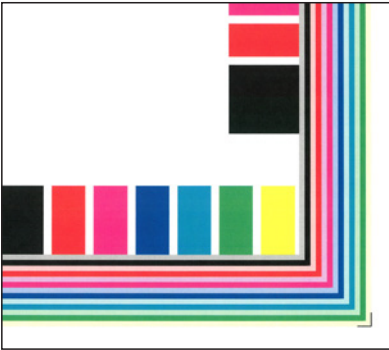
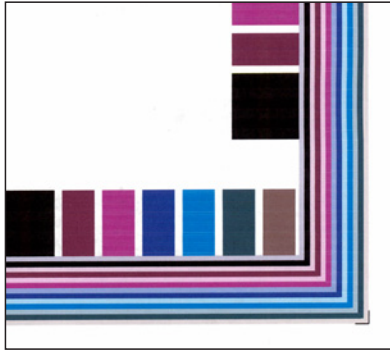
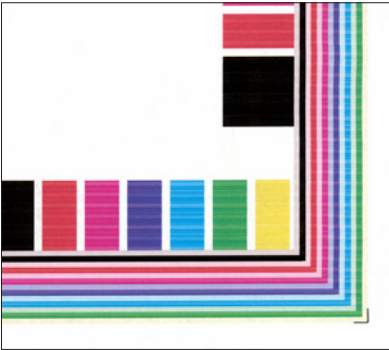
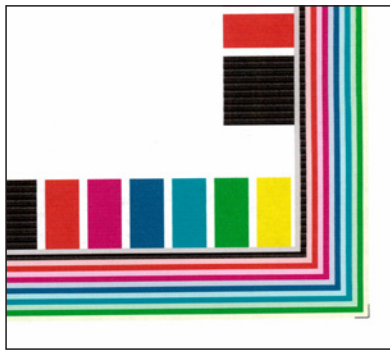
Printing continued until all test cartridges reached EOL. Color and black cartridges were tested in parallel. As the color or black cartridges reached EOL, Original HP "substitute" cartridges were used to complete the testing of the unfinished cartridge in the set. All results and effects of these Original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

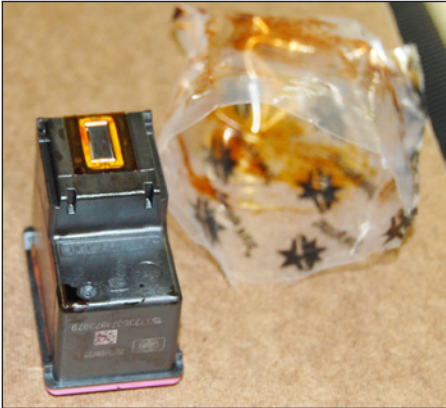

This study tested average performance of the market, not individual brand performance. The brands and providers in the sample were included because, together, they make up a significant portion of the overall market for refilled cartridges.

Eighteen cartridges of each type were tested for HP, and a total of 18 cartridges of each type were tested for each re-filler. All cartridge types were available from all re-fillers with the exception of the 60XL, which could not be refilled by one re-filler brand.

APPENDIX II: DEFINITIONS:

Test Project Terminology	Definition
End-of-Life (EOL)	<p>A condition determined by one of six mechanisms:</p> <ul style="list-style-type: none"> Fade has occurred on the diagnostic page per ISO 27411 definition. Significant reduction in density in the bands or blocks per ISO 24711 definition. Streak removal procedure steps have been exhausted after using the printer servicing procedures and following the ink refill brand's trouble-shooting instructions. Significant leakage before or during installation or any time during printing. 10 consecutive pages with color mix. Cartridge fails to print or stops printing and efforts to recover are unsuccessful.
Individual Cartridge Yield	<p>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.</p>
Average % More Pages	<p>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.</p>
Dead On Arrival (DOA)	<p>A condition determined by one of three mechanisms:</p> <ul style="list-style-type: none"> Cartridge found to have substantial leakage (as defined above) at start or during testing. 10 or fewer pages printed by a cartridge before end of life. Cartridge fails to operate upon installation.
Early End of Life (Premature Expire)	<p>A cartridge that has a page yield of less than 75% of the HP average page yield for that cartridge model in the test.</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> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>Color Fade</p> </div> <div style="text-align: center;">  <p>Black Fade</p> </div> </div>

<p>Color Mix</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 at right. Compare the colored blocks in the correct example to those of the color mix page.</p> <div style="display: flex; justify-content: space-around;">   </div> <div style="display: flex; justify-content: space-around;"> <p>Correct Diagnostic Page</p> <p>Color Mix</p> </div>
<p>Streaks</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 style="display: flex; justify-content: space-around;">   </div> <div style="display: flex; justify-content: space-around;"> <p>Color Streaking</p> <p>Black Streaking</p> </div>
<p>Streak Removal Procedures</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, the refill brand's trouble-shooting instructions were followed.</p> <p>If the cleaning operation has the option of multiple cleaning strengths, the procedure indicated in the printer manual for resolving streaking should be followed.</p> <p>Use of a "light" and a "strong" cleaning procedure counts as one cartridge cleaning operation.</p> <p>Cleaning is verified by the reprinting of the diagnostic plot. If streaks are still present then the cleaning procedure is repeated.</p> <p>Any pages printed during the nozzle cleaning operation are not counted in the yield calculation.</p> <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>

Substantial Ink Leakage	Significant amount of ink visibly spilled in the plastic bag containing the cartridge.	
	Significant amount of ink visibly spilled in the interior of the cartridge packaging.	
	Significant amount of ink visibly spilled over the print head nozzles.	
Test Page Suite	A series of five pages that are printed consecutively in order as a single job, ending with a diagnostic page, ISO/IEC 24712. See sample on page 5.	

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 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.

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