

Reliability and quality tests

Original HP inks vs. non-HP inks for
HP Designjet T-series printers



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Executive summary

In June, 2013, Hewlett-Packard conducted tests of the reliability and quality of five market-leading¹ non-HP ink cartridges sold as substitutes for the HP 72 Ink Cartridges for the HP Designjet T1200 HD Multifunction Printer, T1300 ePrinter, and T2300 eMultifunction Printer. Impacts on the reliability of other components and productivity effects were also noted.

Three non-HP inks were subjected to accelerated life testing. Life test printing was performed in continuous mode. Five non-HP inks were evaluated in a beginning-of-life test in which initial plots were assessed against HP standards for a number of print-quality aspects. For both tests the suites of images used by HP to evaluate inks under development were used. Methodology for both tests can be found in Appendix A.

A total of 287 non-HP ink cartridges were tested.

In the tests, each of the brands of non-HP ink tested performed poorer on several metrics compared to HP's ongoing internal testing of Original HP inks. These results indicate there may be significant hidden costs of using non-HP inks.

Reliability

Three of the non-HP inks were tested for reliability and impacts on the reliability of other components.

- All non-HP inks tested had higher ink supply failure rates than Original HP inks.
 - Original HP inks are 26 times more reliable on average than non-HP inks tested
 - 7.8% of non-HP ink cartridges tested failed
- Use of all non-HP inks tested was associated with reduced printhead reliability including higher printhead failures, shorter printhead life, and decreased printhead performance that contributed to banding and other print-quality problems.
 - Printhead reliability is over 30 times better using Original HP inks than when using the non-HP inks tested
 - 62% of printheads tested with non-HP ink cartridges failed
 - Printhead life is 1.6 times longer using Original HP inks than when using the non-HP inks tested

Print quality

All five of the non-HP inks tested were compared to Original HP inks for print-quality issues. In all cases, Original HP inks delivered significantly better print quality.

- All non-HP inks tested had significantly poorer print-quality performance in more than one area.
- All non-HP inks tested had problems with smudge performance compared to HP.
- All non-HP inks tested had color accuracy and neutral gray issues compared to HP.

Productivity impacts from using non-HP inks were also noted.

- Over 4.5 times more downtime was experienced using non-HP inks during the test.
- Over 2.5 times more interventions were needed with non-HP inks in the test.

One of the most dramatic effects found in testing was the impact of non-HP ink on printhead reliability and functionality including resulting problems with print quality.

¹ Leading brands were identified through customer feedback in market research and input from distribution channels.

Brands tested

Brand	Type of non-HP ink supply	Life test for reliability and quality	Beginning-of-life test for print quality
Advanced Inks	Newly built non-OEM cartridges	X	X
Cactus	Newly built non-OEM cartridges		X
Ink Master	Newly built non-OEM cartridges		X
OCP Ink	Remanufactured cartridges	X	X
SAM Inks	Refill kit	X	X

Detailed test results

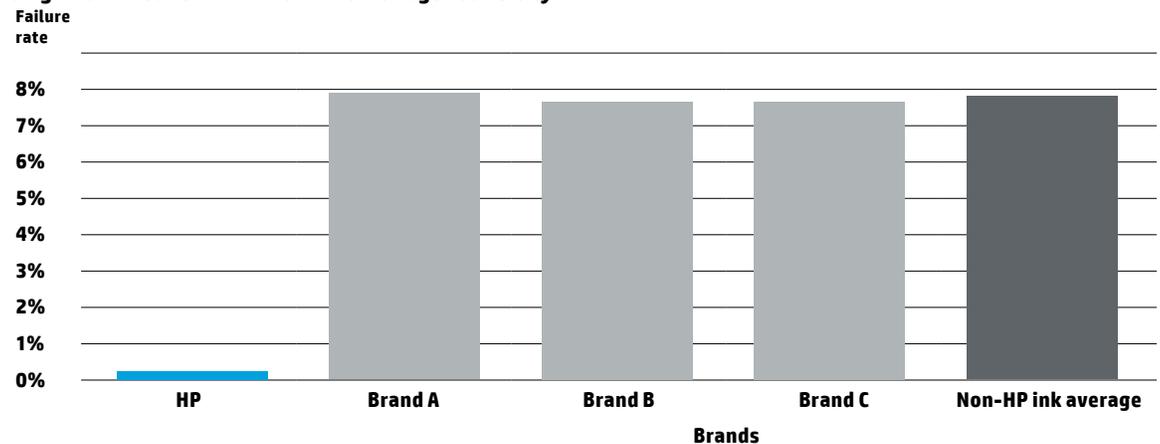
Ink supply reliability

All non-HP inks tested had higher ink supply failure rates than Original HP inks. Cartridges were considered failures when the printer front panel message reported 'Faulty Supply.' Original HP ink cartridge data is from ongoing internal testing.

Ink supply failures

Brand	Dead on arrival (DOA)	Other failures	Total failures	Cartridges tested	DOA rate	Other failures rate	Total failure rate
HP					.18%	.12%	.3%
Brand A	4	7	11	140	2.9%	5%	7.9%
Brand B	1	0	1	13	7.7%	0%	7.7%
Brand C	7	1	8	104	6.7%	1%	7.7%
Non-HP ink average	12	8	20	257	4.7%	3.1%	7.8%

Original HP vs. non-HP inks—Ink cartridge reliability



Based on examination of cartridges rejected by the printer as faulty supplies, ink leakage seemed to be a common cause for non-HP ink failures.

In testing, for one non-HP brand, the front panel message, 'Cartridge is Missing' appeared when there was still up to 50 ml remaining in the supply.

In addition to the failures noted above, one non-HP magenta ink cartridge purchased was mis-labeled as matte black.

Printhead reliability

Non-HP inks tested had higher printhead failure rates, shorter printhead life, and exhibited early deterioration in print quality due to the problems with ink interaction with the printhead, affecting nozzles and ink flow rate.

Printheads were considered failures when:

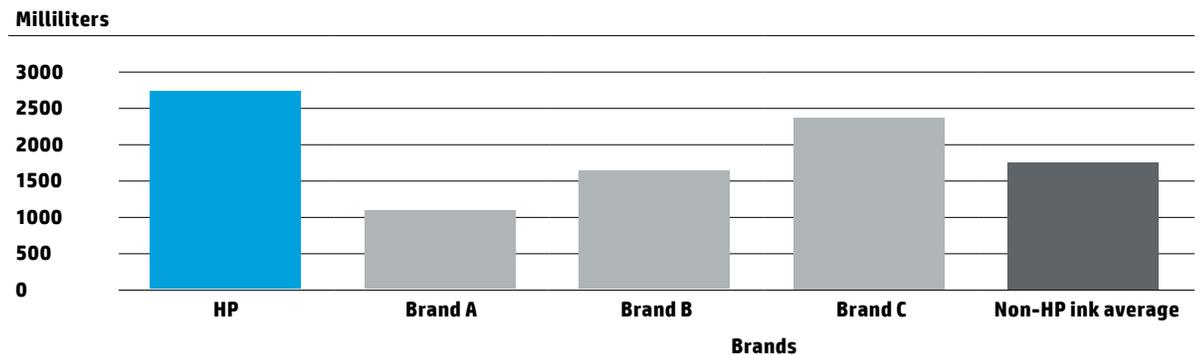
- the printer front panel message indicated printhead replacement was required and would not continue printing until a new printhead was installed or
- when print quality deteriorated to an unacceptable level as defined by HP standard reference plots, and could not be improved by initiating the printer's printhead cleaning routine.

HP data is from HP's ongoing internal testing.

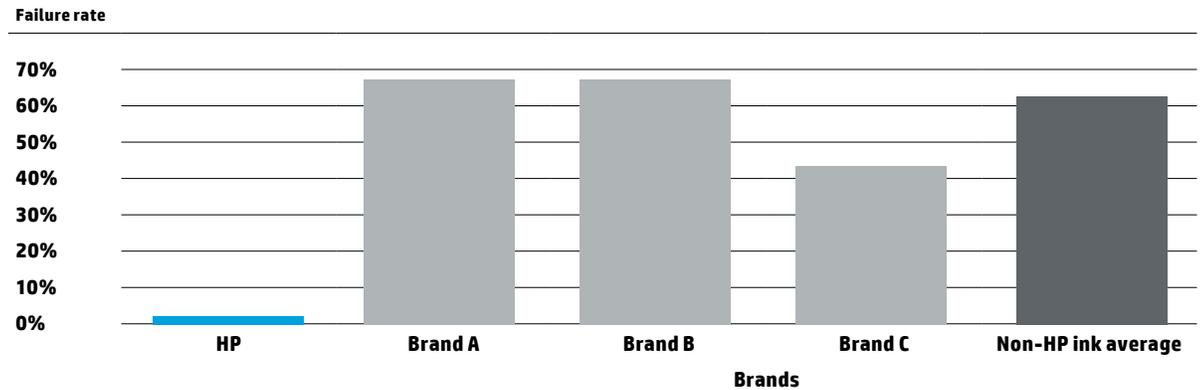
Printhead impacts

Brand	Average printhead life	Printhead failure before 1000 ml	Printhead failures after 1000 ml	Total failures	Printheads tested	Total failure rate
HP	2700 ml					2%
Brand A	1084 ml	8	4	12	18	67%
Brand B	1668 ml	6	0	6	9	67%
Brand C	2393 ml	0	3	3	7	43%
Non-HP ink average	1715 ml	14	7	21	34	62%

Original HP vs. non-HP inks—Printhead life



Original HP vs. non-HP inks—Printhead failures



The higher incidence of printhead failure naturally impacts intervention time and, therefore, productivity and downtime.

Even before actual printhead failure, poor and inconsistent print quality required frequent initiation of the printer's printhead cleaning routine. Increased printhead cleaning increases intervention time and overall ink use for non-printing purposes. 30 minutes of printer downtime is necessary every time a printhead needs to be cleaned to restore print quality. One brand tested was labeled with an instruction to customers to do daily nozzle checks, implying an expectation of the need for frequent use of printer printhead maintenance procedures that use ink for non-printing purposes.

Printhead cleaning was required to restore print quality 12 times more for non-HP inks than for Original HP ink. An average of 16 ml of ink is lost per printhead cleaning.

Close examination of printheads that failed or exhibited deteriorated print quality after using non-HP inks revealed various problems with the inks' interaction with the printhead and printer causing ink flow to be blocked leading to nozzle failure and banding or decreased print density. These included ink crusting and clogging in the printhead filter, particles settling out of the ink, air bubbles in the ink, and ink puddling. Resistors were also contaminated with pigment causing problems with drop ejection and print quality. In addition, for some non-HP inks the ink is not able to meet the maximum flow rate required to print acceptable plots in the HP Designjet printers' fastest print mode, resulting in areas without ink deposited. See photos in Appendix C.

Photo black printheads failed very early using non-HP inks, as early as 300 ml for one brand.

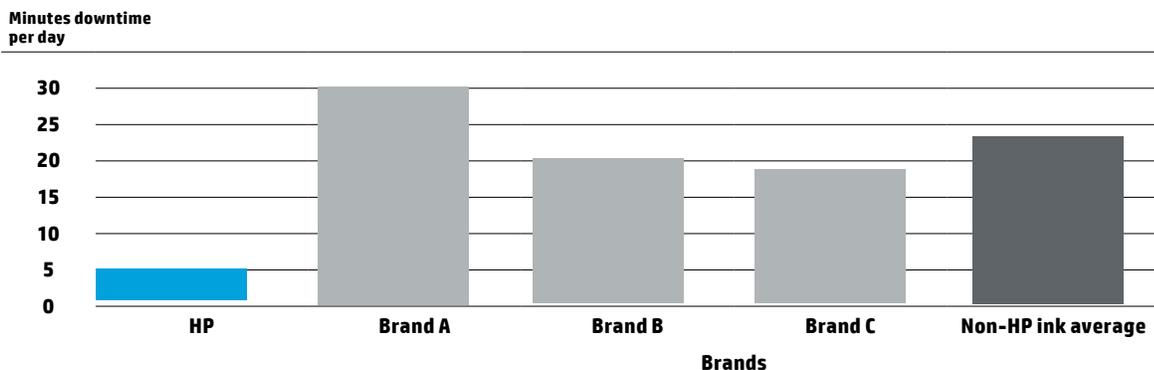
Productivity measures

The number of user interventions per day were tracked for printhead maintenance, ink and printhead replacements, and reprinting for unacceptable print quality. Printer downtime was also monitored. The test found significantly more interventions and printer downtime than is typical for HP.

Productivity impacts per day

Brand	User interventions/day	Printer downtime/day
HP	<5	<5 minutes
Brand A	15	30 minutes
Brand B	13	20 minutes
Brand C	10	18 minutes
Non-HP ink average	13	23 minutes

Original HP vs. non-HP inks—Printer downtime



In the test, the labor time to refill cartridges using refill kits was 60 minutes for six cartridges. The refilling experience was described by testers as ‘a time-consuming, difficult, and messy process.’ See photos in Appendix C.

Print quality

Print quality was tested by evaluating the initial prints using the five non-HP inks tested and comparing them to the print-quality performance expected of HP printing. The first 15 plots after new ink cartridge installation were examined and compared to HP standards.²

All non-ink brands tested showed significant compromises in quality, compared to Original HP inks, in several important aspects of print quality, durability, and color performance. All non-HP brands tested showed considerable problems with banding, indicating that the ink interacting with the printhead blocked nozzles even in initial plots. All brands smudged more than HP when touched with a wet finger. All brands performed worse than HP in color accuracy and grays printed were not true neutral grays.

Print-quality comparison

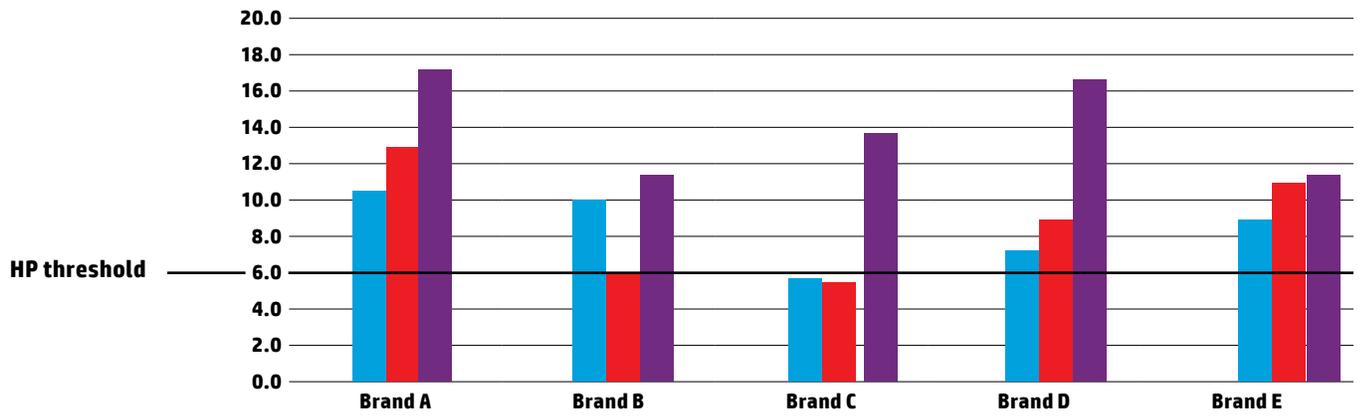
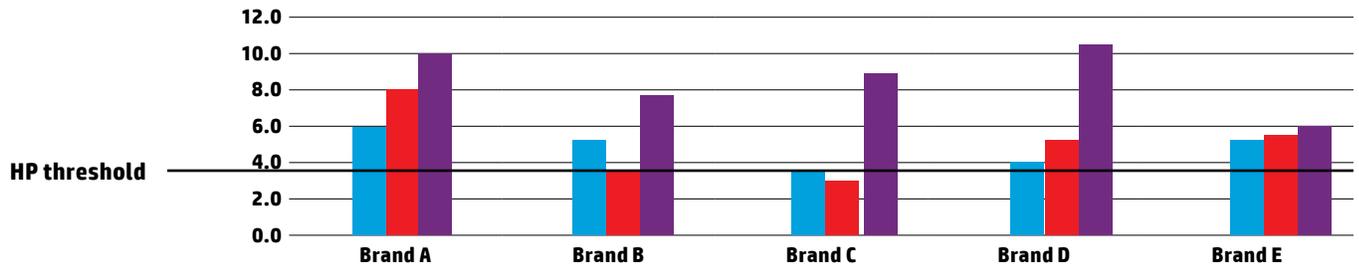
Print-quality metrics		Brand A	Brand B	Brand C	Brand D	Brand E
Number of cartridges tested		6 (complete set)	6	6	6	6
Number of plots evaluated		15	15	15	15	15
Print quality	Coalescence	Equal to HP	Worse than HP	Equal to HP	Worse than HP	Worse than HP
	Grain	Equal to HP	Worse than HP	Equal to HP	Worse than HP	Equal to HP
	Worms	Equal to HP	Worse than HP	Worse than HP	Equal to HP	Worse than HP
	Banding	Worse than HP	Worse than HP	Worse than HP	Worse than HP	Worse than HP
	Line and text quality	Equal to HP	Worse than HP	Worse than HP	Worse than HP	Worse than HP
Durability	Pigment/dye enrichment	Worse than HP	Worse than HP	Worse than HP	Worse than HP	Worse than HP
	Wet finger smudge	Worse than HP	Worse than HP	Worse than HP	Worse than HP	Worse than HP
	Dry smudge—1 minute	Worse than HP	Equal to HP	Worse than HP	Worse than HP	Equal to HP
	Dry smudge—15 minute	Equal to HP	Worse than HP	Worse than HP	Worse than HP	Equal to HP
	Rubberfastness	Worse than HP	Worse than HP	Worse than HP	Worse than HP	Worse than HP
Color	Color gamut	Equal to HP	Worse than HP	Equal to HP	Worse than HP	Worse than HP
	Color accuracy	Worse than HP	Worse than HP	Worse than HP	Worse than HP	Worse than HP
	Gray neutrality	Worse than HP	Worse than HP	Worse than HP	Worse than HP	Worse than HP
	Shadow details	Worse than HP	Equal to HP	Worse than HP	Worse than HP	Equal to HP
	Transitions	Equal to HP	Worse than HP	Equal to HP	Worse than HP	Equal to HP

See definitions for print-quality metrics in Appendix B.

■ Worse than HP ■ Equal to HP

² The results reported here do not include the impact of print-quality deterioration over time—i.e. the effects of adverse reactions between the inks and other components of the printing process such as the printhead and printer. Print-quality deterioration from use of non-HP inks is reflected in the printhead reliability section above.

Original HP ink print-quality threshold vs. non-HP performance



HP data is always below threshold **Bond** **HWC** **Gloss**

Colors printed with non-HP inks were especially distorted on glossy media and heavyweight coated media (HWC). All but one brand tested was distorted on bond media as well.

Appendix A: Test methodology

Accelerated life testing was used to assess non-HP ink reliability and interaction with printheads and printer components. Printhead performance and failures, as well as ink cartridge failures were measured. Print quality was also assessed. User intervention requirements for calibrations, replacement of ink cartridges and printheads, systems errors, and overall ink consumption were also tracked. Life testing is performed in continuous mode.

Beginning-of-life testing was used to assess non-HP ink print quality. The initial 15 plots after new ink cartridge installation were evaluated.

Both tests are used to test and qualify new HP inks and printing systems in development. All images and procedures used are identical to those used for HP internal testing.

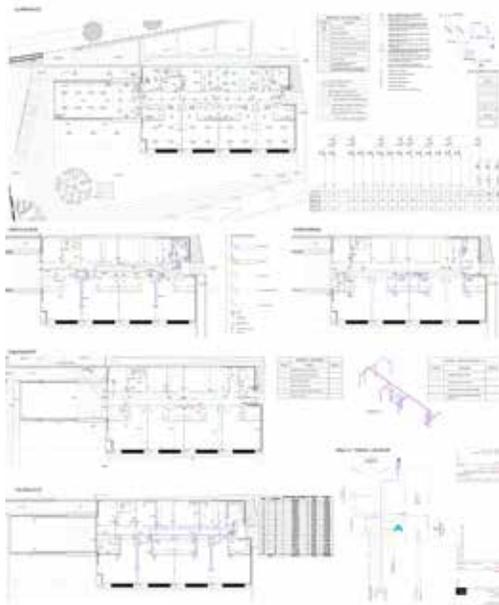
Three printers, one each HP Designjet T1200 HD Multifunction Printer, T1300 ePrinter, and T2300 eMultifunction Printer were used for all testing. The printers were cleaned between testing of each brand. Printer and driver settings were left at factory defaults. Test ink cartridges, kits, printheads, and printers were purchased for HP by a third-party purchasing agent through regular retail channels. Normal office conditions of temperature (23° C +/- 2° C) and relative humidity (50% +/- 10% RH) were maintained throughout testing. Test plots for the life testing were printed on rolls of HP Universal Bond Paper. For the beginning-of-life testing, rolls of HP Universal Bond Paper, HP Natural Tracing Paper, HP Coated and Heavyweight Coated Papers, and HP Universal Gloss Photo Paper were used.

A total of 287 non-HP cartridges, across three brands, were tested for reliability and quality. A total of 34 printheads were tested with these non-HP inks to determine the impact of non-HP inks on printhead reliability and health. One complete set of ink cartridges (6 individual cartridges) was tested for 5 brands of non-HP ink in beginning-of-life print-quality testing. All HP data is from HP ongoing internal testing.

Printer	Test	Cartridges sold as substitutes for:
HP Designjet T1300 ePrinter	Life test (reliability and quality)	HP 72 130-ml Magenta Ink Cartridge
		HP 72 130-ml Yellow Ink Cartridge
HP Designjet T2300 eMultifunction Printer		HP 72 130-ml Cyan Ink Cartridge
		HP 72 130-ml Gray Ink Cartridge
HP Designjet T1200 HD Multifunction Printer	Beginning-of-life test (print quality)	HP 72 130-ml Matte Black Ink Cartridge
		HP 72 130-ml Photo Black Ink Cartridge

Images printed are those used for internal testing to qualify and calibrate new HP inks and printers. Plots are chosen to be representative of the typical range of printing needs of customers of the HP Designjet T-series printers. CAD plots, maps, and photo renders are included.

Life test, image examples



Beginning-of-life image quality test, image examples



Appendix B: Definitions

Terminology	Definition
Newly built non-OEM cartridges	Non-HP design, newly manufactured cartridges filled with non-HP ink. These cartridges, while attempts to copy HP design, include no HP design or components.
Remanufactured cartridges	Empty HP ink cartridges which have been disassembled, filled with non-HP ink, and reassembled. While they reuse some HP components, the rebuilt cartridges are no longer calibrated or reconstructed to HP standards.
Refill kits	Kits include non-HP inks and tools for customers to refill empty HP ink cartridges themselves.
Coalescence	Blotchy variations in density or color.
Grain	Uneven or rough texture. Visible dots.
Worms	Irregular patterns, especially in solid fill areas.
Banding	Parallel lines in solid fill areas due to failure of some printhead nozzles.
Line and text quality	Issues with clarity of fine lines including roughness and alignment.
Pigment/dye enrichment	Variation in level of color saturation.
Rubberfastness	Smudge impact from rubber pencil eraser.
Color gamut	Range of colors that can be reproduced on a given media.
Color accuracy	Faithfulness with which colors reproduce input colors.
Gray neutrality	Grays appear pure gray without a yellow, red, or blue cast.
Transitions	Smoothness of gradation in light to dark color areas.

Appendix C: Images

Refill kit experience



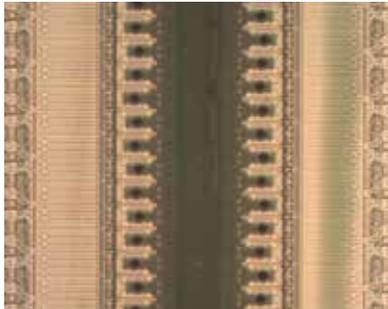
Labor time to refill cartridges with refill kits: about 60 minutes

Remanufactured ink cartridge



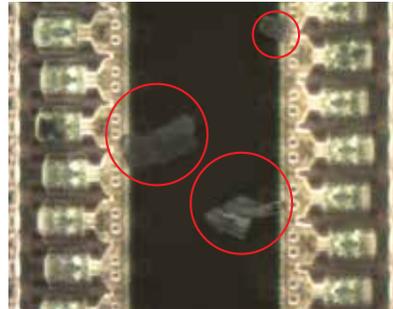
Remanufactured cartridge received "dead on arrival" and leaking

Printhead with Original HP ink



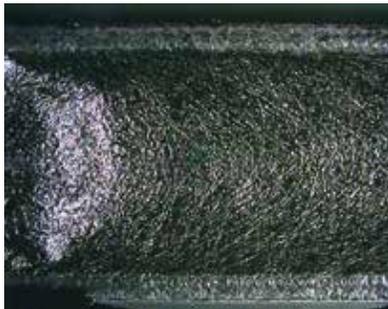
"Clean" printhead ink channels

Contaminants in non-HP ink



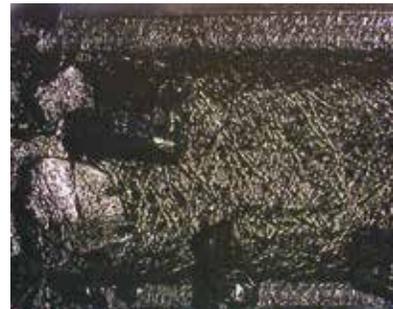
Non-HP ink particles clog printhead ink channels, causing nozzle failure, banding, and printhead failure

Original HP ink cartridge filter



Filter with no particles

Non-HP ink cartridge filter



Particles clog filter, block ink flow, and lead to printhead failure

Printed with Original HP ink



Crisp, clear print quality with Original HP inks

Printed with non-HP ink



Print-quality deterioration due to printhead performance compromised by contamination with non-HP inks

Learn more at
hp.com/go/OriginalHPinks

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