

# Understanding Print Cartridge Page Yields

## Test Standards and Factors that Impact Actual Results



## Comparing Page Yields: The Role that ISO/IEC Standardized Testing Plays

Page yield describes the estimated number of pages that can be printed with a particular print cartridge. For many years, original equipment manufacturers of printers and multifunction products (MFPs) — Lexmark included — developed their own methods for testing and reporting the consumable yields of their toner and ink cartridges. Having so many differing, proprietary methods made it difficult for customers to objectively compare products from competing manufacturers when making a purchase decision.

In June 2004, the International Organization for Standardization (ISO), in conjunction with the International Electrotechnical Commission (IEC), published the ISO/IEC 19752 yield standard for monochrome toner cartridges. This was followed in December 2006 by new standards for color inkjet cartridges (ISO/IEC 24711) and color toner cartridges (ISO/IEC 19798). Lexmark, along with other industry leaders, worked closely with ISO and IEC to create these new standards.

The ISO/IEC standards for cartridges clearly define the methods for testing and calculating average yield measurements under a defined set of parameters and conditions. For example, they require that a minimum number of printers or MFPs are tested, using a minimum number of cartridges per device. The ISO/IEC specifications also stipulate the use of standardized test pages printed in a controlled environment with printer default settings.

Because ISO/IEC yield testing is done in such a controlled manner, in actual use customers are not very likely to replicate the same conditions in their own offices or workplaces. As a result, actual page yields can vary considerably — either higher or lower — depending upon a variety of factors. In fact, section 4.3 of the ISO/IEC 19798 standard includes the following statement: "... It is realized that customers do not normally print in a continuous fashion, but these changes are made to decrease testing time and increase the repeatability of the testing process. Depending on use conditions, the yield experienced by a given customer may vary significantly from the yield measured by this test method."

To apply a common analogy, ISO/IEC page yields are a lot like miles per gallon ratings (MPG) for automobiles. While MPG is useful for comparing the fuel economies of different makes and models, it is not an accurate prediction of the actual gas mileage a particular driver will get. That is because average fuel economy can also be affected by a variety of factors, including how aggressively you drive, the condition of the vehicle (such as tire pressure), road conditions, fuel variations, and other factors.



## ISO/IEC Test Procedures

### Monochrome toner cartridge yield

The ISO/IEC 19752 test procedure requires a standard test page (Figure 1) with approximately 5 percent coverage to be printed continuously until the cartridge reaches end of life. Lexmark has used this methodology to test monochrome print cartridge yields since 2004, when the standard was introduced, and has applied it retroactively to products introduced after 2000. A small number of Lexmark cartridges introduced prior to 2001 continue to use previous proprietary Lexmark test methodologies.

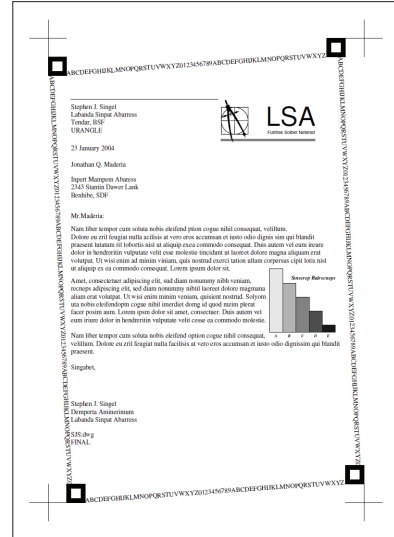


Figure 1: ISO/IEC 19752 monochrome test page

### Color toner cartridge yield

The ISO/IEC 19798 test procedure requires a standard set of five test pages (Figure 2) to be printed continuously until the cartridge reaches end of life. Lexmark has used this methodology to test its color toner cartridge yields since 2006. Some Lexmark color toner cartridges introduced prior to 2006 continue to use Lexmark's proprietary yield test method.

### Inkjet cartridge yield

The ISO/IEC 24711 test procedure requires a standard set of five test pages (Figure 2) to be printed continuously until the cartridge reaches end of life. Lexmark has used this methodology to test its inkjet cartridge yields since the standard was introduced in 2006. Some Lexmark inkjet cartridges introduced prior to 2006 continue to use Lexmark's proprietary yield test method.

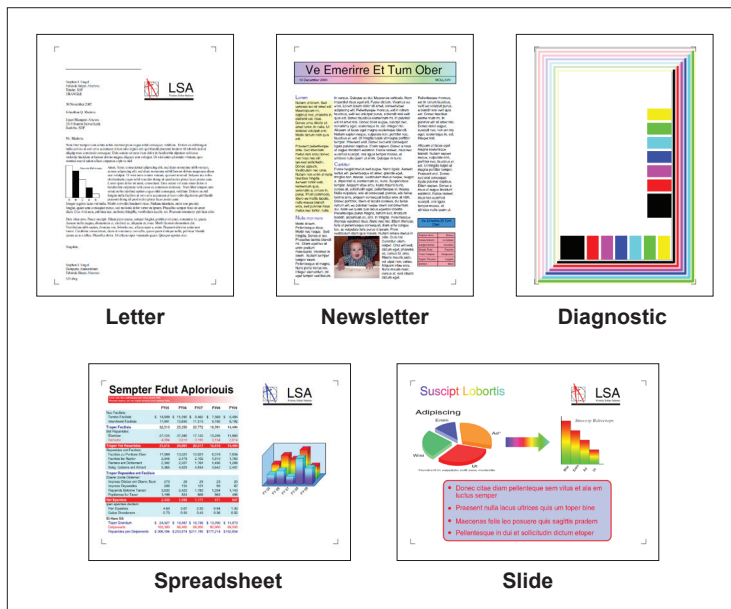


Figure 2: ISO/IEC 19798 and 24711 Color test pages

Color printing involves cyan, magenta, yellow and black ink or toner. The five standard pages contain a mix of text and graphics and different amounts of coverage to achieve an average of approximately 5% coverage per color per page.

## Toner Cartridge Declared Yield vs. Actual Page Yield

In actual use, customers are not likely to replicate the exact file content and test parameters and conditions required in the ISO/IEC tests. In addition, their printers and MFPs may not always use the default drivers and settings required by the ISO/IEC test standards. As a result, the actual page yields that customers will experience can vary considerably higher or lower. Here are the leading factors that can impact affect actual page yield performance in Lexmark laser printers and MFPs:

- Page coverage
- Image type
- Job size
- Duplex mode and paper tray/ exit bin selection
- Environmental conditions
- Cartridge handling at end of life
- Calibration
- Power on time without printing
- Spot color
- Copy and fax mode for MFPs

### Page coverage

Page coverage, represented as the percentage of the page containing toner, is the factor with the most obvious impact on cartridge yield. Industry research has shown that the average page coverage for a black and white page is between 4 percent and 5 percent. Color printing typically involves higher average page coverage than black and white printing. The pages shown at right provide a good illustration of differing page coverage. A customer who primarily prints documents like Figure 3, which consists of mostly text, will experience a higher page yield than a customer who primarily print documents with images or graphics, such as shown in Figure 4 and Figure 5. The document in Figure 3 simply has lower total page coverage than Figures 4 and 5.

### Image type

The content of two pages with the same percentage of coverage can affect the amount of toner used. This is because the thickness of the toner layer deposited on the paper is often different on edges than in the middle of printed areas. So for images composed of lots of edges (like dot patterns), a different amount of toner may be used to create a given coverage than is used for the same coverage in solid areas or even in text. This results in a different yield than expected based on page coverage alone.

### Job size

The number of pages printed at a time (job size) has an impact on print cartridge yields. Typically, print cartridge yields improve with a higher average job size. For example, one three-page print job conserves yield better than three one-page print jobs. This is because a small amount of toner is consumed whenever the printer is running, and the printer does not have to run as long to print the three-page job as it does for the three one-page jobs.

### Duplex mode, paper tray and exit bin selection

In an effect similar to that produced by small job sizes, printing in duplex mode (two-sided printing) or selecting paper trays or exit bins that are located farther from the print cartridges can induce toner loss due to increased machine run time per page printed.

### Environmental conditions

Environmental conditions such as temperature and humidity outside of standard office parameters can affect print cartridge yields. The effect can also vary by printer model.



Figure 3: 10% – 15% Total Coverage

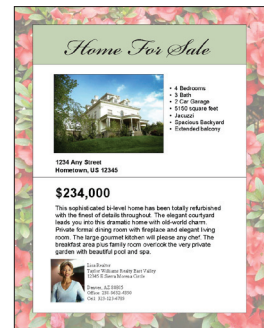


Figure 4: 40% – 60% Total Coverage



Figure 5: 80% – 100% Total Coverage

### **Cartridge handling at end of life**

Some cartridges require a shake when “toner low” is reported or when print begins to fade to redistribute the toner within the cartridge and ensure maximum cartridge life is achieved. When recommended, the shake technique will be described in the printer’s user guide. Customers who don’t perform this recommended step and instead replace the cartridge at the initial toner low signal, may discard a significant amount of usable toner that remains in the cartridge.

### **Calibration**

Many Lexmark laser printers and MFPs use a calibration procedure to improve print quality and maintain print consistency throughout the life of the device. Calibration cycles use a small amount of toner each time they occur. Factors such as a large number of power-on and power-off cycles, cartridge movement from device to device, and abrupt or frequent changes in office temperature can increase calibration frequency.

### **Power-on time without printing**

Some laser printers will cycle or “jog” at preset intervals when idle or at rest to maintain cartridge quality. While the number of jogs is kept to a minimum, each one may result in a small loss of usable toner. Devices powered on for long periods of time without printing can reduce the amount of toner available for printing.

### **Spot color**

Printing a small amount of color on pages that are mostly black and white requires the color device to engage its color print supplies; the Letter test page in Figure 2 is a good example of a page with spot color. Many Lexmark color devices are equipped with a black-only run mode that automatically engages when a series of pages are printed that contain no color content. This run mode improves the yield of color cartridges by disengaging the color supplies when printing black-only pages.

### **Copy or fax mode for MFPs**

Toner usage in copy or fax mode for MFPs is different than in direct printer mode. The scanning process of a document and the application of a number of image adjustment features (e.g. copy darkness and sharpness) can result in output that has more or less actual coverage than the original being scanned.

## **A Note About Photoconductor Unit Yield**

In some Lexmark print cartridges, the photoconductor unit is included as part of or integrated into the complete toner cartridge assembly. In others, the photoconductor unit is separate from the toner supply. In either case, the photoconductor unit contains a photoconductor drum. This key component is subject to wear during the printing process. Factors that can affect photoconductor drum wear and photoconductor unit page yield include job size, paper feed direction, and paper type. For example, a small average job size, short-edge paper feeding, and envelope printing can all negatively impact photoconductor unit page yield.

In certain non-typical use patterns, such as low-coverage printing on a large number of envelopes, the photoconductor drum in an integrated cartridge assembly may reach its usable life before all toner in the print cartridge is consumed.

Currently, there are no ISO/IEC standards for testing or reporting life on photoconductor units. Lexmark provides yields for photoconductor units based on our internal test method, which typically uses three- to five-page job sizes (depending on printer model and expected use) at approximately 5 percent page coverage on a letter-size page. These specific parameters are selected to represent typical usage and provide customers a reasonable estimate of photoconductor unit life.





## Inkjet Cartridge Declared Yield vs. Actual Page Yield

As with toner-based printers and MFPs, customers are not likely to replicate the exact file content and test parameters and conditions required in the ISO/IEC tests. In addition, their printers and MFPs may not always use the default drivers and settings required by the ISO/IEC test standards. As a result, the actual page yields that customers will experience can vary considerably higher or lower. Here are the leading factors that can affect actual page yield performance in Lexmark inkjet printers and MFPs:

- Page coverage and color usage
- Job frequency and time without printing
- Print quality selection
- Paper type selection
- Duplex mode
- Ink usage selection



### Page coverage and color usage

As with toner, page coverage, represented as the percentage of the page containing ink, is the factor with the most obvious impact on cartridge yield. With color printing enabled, cyan, magenta, and yellow inks are used to deliver the wide range of desired printed colors, and black ink is added to achieve the darkest colors. Similarly, in black or dark gray image and fill areas, inkjet printing may include a limited amount of the cyan, magenta, and yellow inks so that the black and gray shades blend smoothly with adjacent colors. By default when printing with plain paper and with color printing off, only black ink is used.

### Job frequency and time without printing

Frequent printing is helpful to proper ink flow throughout the ink handling system. As a result, with frequent printing, less ink is used in non-printing maintenance processes and cartridge page yield improves. When an inkjet printer is idle, an occasional maintenance process is required to ensure that the ink handling system remains print ready. If the printer is powered on and idle, periodically a limited amount of ink will be used in the maintenance process. If long periods of time elapse with no printing, particularly in the case of printers and MFPs designed for high levels of usage, ink may be used in a priming sequence to ensure the health of the ink handling system. The priming sequence may also be triggered when a printer has been powered off and is then powered on after some passage of time. In certain models, a user may also trigger the related Clean Printhead processes.

### Print quality selection

Different amounts of ink are used for Draft, Normal, and Best quality printing. In general, draft quality printing uses approximately  $\frac{1}{2}$  of the ink amount used in normal quality printing. The loss of colorfulness and blackness will be apparent; however draft printing may be suitable for certain situations. Best quality printing uses only slightly more ink than Normal quality printing, up to 5% more in dark print areas.

### Paper type selection

Various kinds of paper require different amounts of ink to achieve desirable print quality. The Paper type selection in the host driver and in the printer's user interface (certain models only) can be used to ensure that the appropriate amount and proportion of cyan, magenta, yellow and black inks are used for each kind of paper. For example, lighter weight plain paper may not absorb ink as well as heavier weight paper. When printing a job in which colorfulness is not significant, the Plain paper type can be used to deliver the appropriate ink amount for a less expensive paper. Certain paper types, particularly photographic micro-porous media, use only cyan, magenta and yellow inks for both color and black and white printing.

**Duplex mode**

Because Lexmark inkjet ink is water-based, ink usage may be reduced by up to 5% for printing on both sides of lightweight plain paper. This adjustment is activated when the Plain paper type is selected.

**Ink usage selection**

When the option is available, the Ink to Use selection in the host driver and in the printer's user interface (certain models only) can be used to request particular inks in a print job. For example, for compatibility with an unusual kind of paper, a user may limit a job to use only cyan, magenta and yellow inks. Ink usage selection will affect the overall yield, using less of the deselected ink and in some cases compensating with slightly more of the selected inks.

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**For more information:**

Further details of the ISO/IEC standards are available at:  
[www.iso.org/jtc1/sc28](http://www.iso.org/jtc1/sc28).

To review Lexmark's ISO page yield reports,  
visit [www.lexmark.com/pageyields](http://www.lexmark.com/pageyields).

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