
**Method for the determination of ink
cartridge yield for colour inkjet printers
and multi-function devices that contain
printer components**

*Méthode pour la détermination du rendement de cartouche d'encre pour
les imprimantes couleur à jet d'encre et pour les dispositifs
multifonctionnels qui peuvent contenir des composants d'imprimantes*

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Contents

Page

Foreword.....	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions.....	1
4 Test parameters and conditions	3
4.1 Set-up	3
4.2 Sample size	4
4.3 Print mode	4
4.4 Print environment	5
4.5 Paper	5
4.6 Maintenance	5
4.7 Test files	6
5 Test methodology.....	6
5.1 Testing procedure.....	6
5.2 Procedure for handling streaks.....	7
5.3 Procedure for handling a defective cartridge, printhead or printer	8
6 Determination of the declared yield value and declaration.....	9
6.1 Yield of primary cartridges	9
6.2 Yield of supplemental cartridges	10
6.3 Test data reporting	11
6.4 Declaration of the yield	12
Annex A (informative) Examples of fade.....	18
Annex B (informative) Examples of streaks	19
Annex C (normative) Testing reporting form	20
Annex D (informative) Process flowchart	24
Annex E (informative) Method for comparison of inkjet performance to ISO/IEC 19752.....	26

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

ISO/IEC 24711 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 28, *Office equipment*.

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Introduction

The purpose of this International Standard is to provide a process for determining the ink cartridge yield for a given colour inkjet printer model (i.e. integrated ink cartridges and ink cartridges without integrated printheads) using a standard consumer type test suite. Ink cartridge yields determined on one printer model and cartridge configuration are not applicable to another printer model or cartridge configuration even if the ink jet cartridges used in testing are the same. This test page suite is not focused on printing of photographs, but is intended to be a sampling typical business consumer pages.

This International Standard prescribes the following:

- The test method that manufacturers, test labs, etc. use to determine ink cartridge yield;
- The method for determination of declared yield values from the test results; and
- The appropriate method of describing the yield of cartridges in documentation supplied to the consumer by the manufacturer.

The cartridge yield is determined by an end of life judgement, or signalled with either of two phenomena: *fade*, caused by depletion of ink in the cartridge, or *automatic printing stop*, caused by an Ink Out detection function. It is envisioned that one of the uses of this International Standard will be for the calculation of cost per page (CPP). While this International Standard measures a portion of this cost, it is not used as the sole component of CPP calculation. Additional factors are considered for CPP calculations.

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Method for the determination of ink cartridge yield for colour inkjet printers and multi-function devices that contain printer components

1 Scope

The scope of this International Standard is limited to evaluation of ink cartridge page yield for ink-containing cartridges (i.e. integrated ink cartridges and ink cartridges without integrated print heads) for colour inkjet printers. This International Standard can also be applied to the printer component of any multifunctional device that has a digital input printing path, including multi-function devices that contain inkjet printer components. Both liquid and solid ink products can be tested using this International Standard.

This International Standard is only intended for the measurement of ink cartridge page yield when printing on plain paper. No other claims can be made from this testing regarding quality, reliability, etc.

This International Standard can be used to measure the yield of any cartridge that is used in a significant amount during the printing of the test suite defined in ISO/IEC 24712.

This International Standard is not for use with printers whose minimum printable size is equal to or greater than A3 or for printers designed or configured to print photos (for example, maximum printable size less than A4 or a printer configuration intended for photo only printing). In addition, it only applies to drop on demand printing systems.

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2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 24712 *Colour test pages for the measurement of office equipment consumable yield*

ISO/IEC 19752, *Information technology — Method for the determination of toner cartridge yield for monochromatic electrophotographic printers and multi-function devices that contain printer components*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 fade

phenomenon in which a significant reduction in uniformity occurs due to ink depletion

NOTE 1 In this test, fade is defined by a significant increase in lightness, L^* , or a decrease in density on the bands surrounding the edge of the last page in the test page suite (Diagnostic Page). This decrease in density does not have to occur completely across the page. This comparison is made using the second diagnostic test page generated during testing (the 10th page printed). For examples of fade, please consult Annex A.

NOTE 2 In some printer systems, fade can occur prematurely due to the way that ink is provided to the printing system. If a printer exhibits fade, a five minute pause is allowed to provide for recovery of the ink delivery system and printing can continue. If fade appears on the next suite, then the cartridge is judged at end of life and the additional diagnostic page printed is not counted in the yield calculation. If fade does not appear on the next diagnostic page, then printing can continue until the next fade or ink out is encountered and the additional diagnostic pages will be counted.

**3.2
streaks**

very thin lines of colour, other than intended in the bands surrounding the edge of the last page in the test page suite (Diagnostic Page)

NOTE Streaks differ from fade in the width and severity of increase in lightness, L^* , or reduction in density. Streaks can appear due to a number of reasons, thermal issues and clogged nozzles being two of the main causes. If these streaks occur in three consecutive diagnostic pages, then a streak removal operation is required. Comparisons are made using the phenomena sample provided in Annex B

**3.3
streak removal operation**

procedure used to restore the print performance by removing streaks

NOTE If streaks are observed on three consecutive diagnostic pages, first the printer can be left idle for five minutes. Then an additional three test suites are printed. If the streaks are still observed, then a streak removal operation is conducted according to the latest printer manufacturer documentation. 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 prescribed in 5.2.1.2. All test page suites printed during this process will be included in the page count for determining the yield.

**3.4
print head alignment operation**

function that aligns newly installed print heads

NOTE If it is mandatory according to the latest printer manufacturer documentation, this operation is performed during testing. The pages used in the alignment procedure are not counted in the measurement of yield.

**3.5
ink low**

warning generated by the printing system when it has determined that the amount of ink is such that a cartridge change may be required soon

NOTE It does not indicate that the system is out of ink.

**3.6
ink out**

signal generated by the printing system when the useable ink in the system is depleted and the printer stops printing

**3.7
end of life**

a condition determined by one of two mechanisms:

- fade as defined in 3.1, or
- ink out as defined in 3.6.

NOTE For cartridges with more than one colour of ink in a single cartridge, end of life is defined when the first colour within the cartridge exhibits fade or ink out. In the event that the printer can continue printing after ink out is reported, the cartridge will still be considered at end of life.

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3.8**test page suite**

series of five pages defined by ISO/IEC 24712 that are printed consecutively as a single job, ending with a diagnostic page

3.9**individual cartridge yield**

value determined by counting the number of diagnostic pages (last page of the test page suite) printed between cartridge installation and end of life (as defined in 3.7) and multiplying by five

NOTE 1 If the printer stops due to ink out in the middle of a test page suite, the number of the diagnostic pages printed is counted. Then, the first diagnostic page of the remaining print job is included in the subsequent cartridge yield.

NOTE 2 The number of test page suites counted may contain some pages that show visible fade. To simplify the testing, determination of end of life is only made on the diagnostic page (last page of the test page suite).

3.10**declared cartridge yield**

at or below the lower 90 % confidence bound of the mean as prescribed in section 6.1 and 6.3.

3.11**primary cartridge**

cartridge containing full density black, cyan, magenta or yellow ink or a combination of full density cyan, magenta and yellow

NOTE These colours represent the primary inks used in a traditional four-colour printing process.

3.12**supplemental cartridge**

cartridge other than the full density cyan, magenta, yellow and black cartridges

NOTE The determination of yield for a supplemental cartridge is made according to 6.2.

4 Test parameters and conditions**4.1 Set-up**

Place the printer on a horizontal surface and set-up the printer according to the installation guide provided in the printer user's manual. Use the most recent printer driver available from the manufacturer's website or the supplied driver with the printer. The driver version will be specified on the test report. Cartridge installation shall be completed following the instructions in the cartridge installation guide. If there is a contradiction between the printer and cartridge manuals for the cartridge installation, the cartridge manual will take precedence except if changes are recommended for printer or driver settings.

At the start of the test, all printers shall be set-up using a set of priming cartridges to insure that the ink used in testing is primarily for printing, not for initial priming/cleaning. After the printer is set-up according to the manufacturer's instructions, the priming cartridges shall be used to print a minimum of 25 pages, 5 cycles of the standard test page suite. The priming cartridges shall be removed and replaced with new cartridges that will be used for testing yield. The pages printed during this step are not counted towards yield. Even if required by the printer, print head alignment does not have to be performed on the priming cartridges. The number of pages used in the priming operation will be included in the test report. The replacement of the priming cartridges with the first test cartridges may be done all at once or staggered individually. If done all at once, all test cartridges begin with test suite number 1 and continue until end of life. If the staggered start method is used, the test suite number must be tracked separately for each cartridge. The test start method will be included in the test report.

All image and print quality modifiers shall be at their factory pre-set configuration for the printer and default-installed condition for the driver. If auto media detection is available on the printer, it shall be disabled and media-type set to plain paper. This is to avoid inaccurate sensing of the media. If the printer and driver settings differ, then the driver defaults shall be used. Any user selectable ink conservation modes, (e.g. draft) shall be disabled during testing.

To assure that the test page suite is printed correctly, any page size modifiers such as *Fit to Page* and font substitution shall be turned off. The files shall be printed using the fonts embedded in the file and shall be printed on the page in a size corresponding to the dimensions in the test suite standard (ISO/IEC 24712). Page placement modifiers such as page centering can be used to place the image properly on the page.

To facilitate automated testing, the test suite may be pre-generated using the printer driver. This is often accomplished using a print to file command. This method is only valid if it does not affect the measured yield. If a pre-generated file is used, it shall be noted on the test report.

NOTE The application software (for example, PDF Reader©), printer driver and printer may have page size modifier functions, such as *Fit to Page*. Make sure that all of these functions are disabled.

4.2 Sample size

Inkjet cartridges are designed in two common styles, single colour and multi-colour. The sample size shall be determined such that for each calculated yield value, a minimum of three physical cartridges are tested in each of three printers. In the case of a typical four colour printer with four single primary colour cartridges this would result in 36 cartridges being tested, 9 Black (K), 9 Cyan (C), 9 Magenta (M) and 9 Yellow (Y). For a typical multi-colour cartridge system where one cartridge contains C, M and Y and another cartridge contains K, the testing would use 18 total cartridges, 9 Black and 9 CMY.

In some printer configurations, supplemental cartridges may be installed. Please see the procedure in section 5.4 for details on the treatment of supplemental cartridges

When testing additional engines and cartridges above the minimum, an effort shall be made to test an equal number of cartridges on each engine. For example, if an additional engine were to be tested then the minimum number of cartridges to be tested would be 48 (3 cartridges X 4 colours X 4 printers) for a four-cartridge system.

When testing cartridges for a commercially available product, it is recommended that cartridges and printers be procured from various sources, or sampled from different production lots. The printers and cartridges must be within their useful life as stated in their user's manual.

NOTE It is recommended that additional engines and/or cartridges be used in testing.

4.3 Print mode

For reporting cartridge yield, the test will be run in semi-continuous simplex printing and set in the driver default print mode at or near rated print speed. Each copy of the test suite shall be printed as a separate five page print job. This allows for some intra-job servicing and calibration to take place. Additional pauses can take place due to paper refills and idle time due to end of work days.

NOTE This does not mean that the printer must stop between printed jobs.

Colour inkjet printers commonly need to service the printing system after a number of prints, or when the device has been powered down or not used for a given amount of time. This servicing uses ink that could have been used to print additional pages. 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.

NOTE Depending on use conditions, the yield experienced by a given user may vary significantly from the yield measured by this test method.

4.4 Print environment

The temperature can have a profound effect on test results. For this reason, the test must be carried out according to the following test conditions:

Temperature: Testing room average $23.0^{\circ}\text{C} \pm 2^{\circ}\text{C}$

Readings to be made with a running average of 1 hour with readings recorded at least every 15 minutes, all running average temperatures are to be between 20.0°C and 26.0°C .

Example: An example of the calculation of the temperature is shown below for temperature readings taken on 15-minute intervals for the testing of one cartridge.

	t_1	t_2	t_3	t_4	t_5	t_6	t_7	t_8	t_9	t_{10}	t_{11}	t_{12}	Testing Room Average
Temperature t_i	24.0	23.4	20.5	24.2	23.6	22.0	25.5	24.7	22.1	20.8	22.0	23.5	23.0
Running Average T_i	N/A	N/A	N/A	23.0	22.9	22.6	23.8	24.0	23.6	23.3	22.4	22.1	

Table 1 — Running temperature calculation example

$$\text{Running Average } T_i = (t_{i-3} + t_{i-2} + t_{i-1} + t_i) / 4$$

$$\text{Testing Room Average} = (t_1 + t_2 + \dots + t_{12}) / 12$$

From this the testing room average would be 23.0°C , the maximum running average reading 24.0°C and the minimum running average reading 22.1°C . These values can be found highlighted in the table of temperature measurements. It shall be noted that the testing room average for temperature are averages of all measurements, not the running averages.

Environmental conditions shall be included in the test report. The maximum and minimum running averages for temperature shall be reported for each cartridge tested. Please see Annex C for a sample reporting form.

All materials shall be temperature acclimated to the test room environment. Prior to testing, the printer, paper and cartridges shall be acclimated to the above conditions. Before acclimation, packaging and shipping materials shall be opened with care to prevent damage to the cartridges during acclimation. Paper may be acclimated in the ream wrapper.

Any water condensation must be avoided when printer, paper and cartridges are carried in the test environment

4.5 Paper

The paper used in this test shall represent a common medium weight paper and must conform to the printer's list of approved papers. The paper manufacturer, weight and size, A4 or equivalent, used in the test will be noted on the report. If auto media detection is available on the printer, it shall be disabled and the media type set to plain paper. The auto-detect process can have a significant effect of the yield performance.

4.6 Maintenance

Printer maintenance shall be performed per the printer and cartridge user's manual.

4.7 Test files

The test files are outlined and specified in ISO/IEC 24712. The test must be conducted using the most recent official electronic test files as the input. The most recent official file can be located at (<http://www.iso.org/jtc1/sc28>). Failure to use the exact file specifications will invalidate test results. In addition to the test files a publicly available PDF Reader will be used in conjunction with the printer driver to generate the printer input and send the files directly to the printer. The method used for connection between the host computer and the printer shall be recorded on the test report. For automated testing, a pre-generated print file can be used if the results are equivalent to direct printing methods. This will be recorded on the test report. The version of the test file, the printer driver version and the PDF Reader version will be included in the test report. Before starting the test, a sample file set shall be printed to check the image and assure the proper size. The proper size for each of the pages in the test suite is specified in ISO/IEC 24712.

Note: There are often several PDF reader versions available; each version can have an impact on the yield results. It is recommended that the latest version of the chosen PDF reader be used for testing.

To reduce test variability due to other programs, it is recommended that test file generation be conducted on a printer with a "clean" install of the operating system with only the printer driver, PDF reader and any test control software installed. Testing has shown that old installed drivers from the same or different printers can affect the yield results.

Note: To aid in counting and tracking pages, a header or footer can be added to the test page suite. Every attempt shall be made to reduce the size of this addition to minimize the effect on calculated yield. If this information is included in the test suite, it shall be documented in the test report.

The host computer environment such as Operating System (OS), RAM size, CPU type and application software may affect the yield test results; the computer environment recommended by the printer's user manual shall be used for the test. All of this information will be recorded on the test report.

5 Test methodology

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5.1 Testing procedure

5.1.1 Preparation

- 1) Install at least three printers following the user's manual.
- 2) Install a priming cartridge for each colour into the printers.
- 3) Using each priming cartridge, print at least 5 complete test page suites.
- 4) Remove each priming cartridge.

5.1.2 Installation of test cartridges

- 1) Remove all packaging material from a new complete set of cartridges to be tested and install these cartridges by following the cartridge installation guide. Weigh each cartridge individually to within 0.01g and record the weight.

NOTE: If there is a contradiction between the printer and cartridge manuals for the cartridge installation, the cartridge manual will take precedence except if changes are recommended for printer or driver settings.

NOTE: In the case that the printing system does not use supplemental cartridges, weighing of the cartridges is not mandatory.

- 2) If the printer has a mandatory print head alignment operation, it will be conducted according to the printer manual.

NOTE: These pages are not to be counted in the measured yield.