

INTERNATIONAL
STANDARD

ISO/IEC
29102

Third edition

**Information technology — Office
equipment — Method for the
determination of ink cartridge
yield for colour photo printing with
inkjet printers and multi-function
devices that contain inkjet printer
components**

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Reference number
ISO/IEC 29102:2023(E)

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Published in Switzerland

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives or www.iec.ch/members_experts/refdocs).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html. In the IEC, see www.iec.ch/understanding-standards.

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

This third edition cancels and replaces the second edition (ISO/IEC 29102:2015), which has been technically revised.

The main changes are as follows:

- the URL for test chart has been updated;
- the humidity requirement has been changed.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html and www.iec.ch/national-committees.

Introduction

The scope of this document is limited to evaluation of ink cartridge yield of ink-containing cartridges (i.e. integrated ink cartridges and ink cartridges without integrated print heads) for colour photo printing with colour inkjet printers. This document can be applied to colour inkjet printers having an interface to a computer as well as colour inkjet printers that cannot be connected to a computer. This document can also be applied to the inkjet 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 document.

The cartridge yields of primary cartridges are determined by an end of life judgment, 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. The cartridge yields of supplemental cartridges are estimated. It is envisioned that one of the uses of this document will be for the calculation of cost per page (CPP). While this document measures a portion of this cost, it is not used as the sole component of CPP calculation. Additional factors need to be considered for accurate CPP calculations.

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Information technology — Office equipment — Method for the determination of ink cartridge yield for colour photo printing with inkjet printers and multi-function devices that contain inkjet printer components

1 Scope

The purpose of this document is to provide a method to determine the ink cartridge yield of ink-containing cartridges (i.e. integrated ink cartridges and ink cartridges without integrated print heads) for colour photo printing with colour inkjet printers and multifunction devices that contain inkjet printer components. In the case where a cartridge set can be used in multiple printer models, only one yield test is performed as long as the difference between printer models does not impact yield.

NOTE A cartridge supplier can choose to use more than one market identifier for a single physical cartridge. In this case only one yield test is required as long as there are no differences in the cartridges other than market identifiers.

This document prescribes the following:

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

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This document is only intended for the determination of ink cartridge yield. No other claims can be made from this testing regarding quality, reliability, etc.

This document can be used to determine the yield of any cartridge that is used during the printing of the photo test file defined in ISO/IEC 29103.

This document is not for use with printers whose minimum printable size is equal to or greater than A3. This document is not intended to measure the yield of photo printing on paper size larger than 4" × 6", L or A6. In addition, this document is not for use with industrial printers or point of sale printers. It only applies to desktop printing systems.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 24711, *Information technology — Office equipment — Method for the determination of ink cartridge yield for colour inkjet printers and multi-function devices that contain printer components*

ISO/IEC 29103, *Information technology — Office equipment — Colour photo test pages for measurement of ink cartridge yield for colour photo printing*

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

fade

phenomenon in which a significant colour change occurs due to ink depletion

Note 1 to entry: 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 page, then the cartridge is judged at *end of life* (3.7) and the additional page printed after the five minute pause is not counted in the yield calculation. If fade does not appear on the next page, then printing can continue until the next fade or *ink out* (3.6) is encountered.

Note 2 to entry: For examples of fade, please consult [Annex A \(Figure A.1\)](#).

Note 3 to entry: In some printer systems, fade can occur prematurely due to the way that ink is provided to the printing system.

Note 4 to entry: It can be helpful to use the first *photo test suite* (3.5) print samples from the first cartridge set for colour comparison.

Note 5 to entry: A blue light source (such as a blue LED) can be used to help in the detection of yellow fade.

3.2

streak

thin lines of colour that appear in test images

Note 1 to entry: Streaks differ from *fade* (3.1) in the width.

Note 2 to entry: If streaks occur in two or more out of four consecutive test pages, then a *streak-removal operation* (3.3) is required.

Note 3 to entry: Streaks can appear due to a number of reasons; thermal issues and clogged nozzles being two of the main causes. Comparisons are made using the phenomenon sample provided in [Annex B \(Figure B.1\)](#).

3.3

streak-removal operation

procedure used to restore the print performance by removing *streaks* (3.2)

Note 1 to entry: It is often called a nozzle-cleaning operation.

Note 2 to entry: If streaks are observed in two or more out of four consecutive test pages, first the printer can be left idle for five minutes. Then an additional four pages 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 5.2.2. All test pages 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 1 to entry: 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

photo test suite

series of pages defined in ISO/IEC 29103 that are printed as separate jobs

3.6**ink out**

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

3.7**end of life**

condition determined by one of two mechanisms: *fade* (3.1) or *ink out* (3.6)

Note 1 to entry: For cartridges containing multiple colour inks, end of life is defined when the first colour 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.

3.8**end of testing**

point of time when all of *primary cartridges* (3.11) are consumed three times per printer under testing

3.9**individual cartridge yield**

number of pages printed between cartridge installation and *end of life* (3.7)

3.10**declared cartridge yield**

value at or below the lower 90 % confidence bound of the mean

Note 1 to entry: 90 % confidence bound of the mean is prescribed in 6.1 and 6.2.

3.11**primary cartridge**

major contributing cartridge for ink consumption

Note 1 to entry: The minimum number of primary cartridges to be tested for different printing systems is prescribed in 4.2. Cartridges that reach *end of life* (3.7) first are classified as primary cartridges. They should be consumed at least three times per printer at *end of testing* (3.8).

Note 2 to entry: Colour inkjet printers commonly utilize a set of different colour inks to improve quality of photo images. The number of different colour inks ranges from three to more than 10. Ink usages of different colours are not designed to be uniform. In order to maintain testing time and cost at a reasonable level, the definition of primary cartridges is introduced in this document.

3.12**supplemental cartridge**

cartridge that is not classified as *primary cartridge* (3.11)

Note 1 to entry: The determination of yield for supplemental cartridges is made according to the procedure prescribed in 6.2.

3.13**proxy cartridge**

primary cartridge (3.11) to be utilized for estimating yield of *supplemental cartridges* (3.12)

Note 1 to entry: More information about proxy cartridges can be found in 6.2.1.

3.14**photo paper**

coated paper for photo printing

3.15**content type selection**

selection that specifies the content for printing

Note 1 to entry: Examples include photo and document. This can be selected by the user or in some cases by the printing system based on the automatic media detection.

3.16

paper media selection

selection that specifies the type of media

Note 1 to entry: This can be selected by the user and/or by the automatic media detection.

3.17

print-quality level selection

user selection that specifies the various levels of printed image quality and enhancement

EXAMPLE Normal, best or highest.

Note 1 to entry: Some printers do not have a function of the selections specified in [3.15](#), [3.16](#) and [3.17](#).

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. If a printer has the capability to use both PC connection and another method of data input for photo printing, the PC connection shall be used for testing. If a printer does not have PC connection capability, the method of delivering photo test page suite to printer and printing procedure shall be included in the test report. Use the most recent printer driver available from the manufacturer's website or the supplied driver with the printer. The driver version shall 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 ensure 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 until consistent images are generated. The priming cartridges shall be removed and replaced with new cartridges that will be used for testing yield. The pages printed during priming operation will be included in the test report. However, those pages 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 replacement of the priming cartridges with the first set of test cartridges may be done all at once or staggered individually. If done all at once, all test cartridges begin with photo test suite number 1 and continue until end of life. If the staggered start method is used, the test suite number shall be tracked separately for each cartridge. The test start method shall be included in the test report.

Print-quality level selection shall be at factory pre-set configuration for the printer and default installed condition for the driver and shall be included in the test report. Any user selectable ink conservation modes (for example, draft mode) shall be disabled during testing. If content-type selection to photo is available on the printer, it shall be set to photo and included in the test report.

Paper media selection shall be set to photo paper. In case of multiple choices are available for photo paper setting, selection made for testing shall be included in the test report. If user selectable automatic media detection is available on the printer, it shall be disabled to make sure the same ink amount to be consumed for different media. If automatic media detection is used, it shall be noted on the test report. If these settings cannot be verified, then testing shall occur with automatic media detection on. If the printer and driver settings differ, then the driver defaults shall be used.

Any scaling to ensure that the photo test suite is printed correctly shall be based on printer system or driver. To facilitate automated testing, the photo 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.

4.2 Sample size

Colour inkjet printers commonly utilize different colour inks and/or overlays to improve quality of photo images. Number of different colour inks/overlays for colour photo printing is quite diverse. Some of the printers may utilize more than 10 different colour inks/overlays. Ink usages of different colours are not designed to be uniform. In order to maintain testing time and cost at reasonable level, major contributing cartridges are defined as primary cartridges in this document. The rest of cartridges are regarded as supplemental cartridges. During testing, cartridges that reach end of life first are classified as primary cartridges.

The minimum number of primary cartridges to be tested is determined based on the number of cartridges utilized for printing system. Inkjet cartridges are designed in two common styles, single colour and multi-colour contained cartridges. The number of cartridges may be smaller than the number of colour inks/overlays. The minimum number of primary cartridges for various printing system is listed in [Table 1](#).

Primary cartridges shall reach end of life at least three times on each of the printers tested. Regardless of the minimum number of primary cartridges specified in [Table 1](#), all of the cartridges depleted three or more times on all tested printers shall be treated as primary cartridges. The minimum number of printers for testing is three. For example, if the number of primary cartridges is three, at least 27 cartridges shall be tested (3 primary cartridges × 3 cartridges to reach end of life × 3 printers).

To represent yield variations due to cartridge and printer manufacturing tolerances, it is acceptable that additional engines and/or cartridges be used in testing.

Table 1 — Minimum number of primary cartridges

Printer system	The minimum number of primary cartridges
1 cartridge system	1
2 cartridge system	1
3 cartridge system	2
4 cartridge system	3
6 cartridge system	3
7 or more cartridge system	3

When testing additional printers and primary cartridges above the minimum, an effort shall be made to test an equal number of primary cartridges on each printer. For example, if an additional printer were to be tested for 3 primary cartridges, then the minimum number of cartridges to be tested would be 36 (3 primary cartridges × 3 cartridges to reach end of life × 4 printers).

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 shall be within their useful life as stated in their user's manual.

4.3 Print mode

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 photos. It is realized that customers do not normally print in a continuous fashion. However, the yield test will be run in semi-continuous simplex printing to decrease testing time and increase the repeatability of the testing process. Each photo test page shall be printed as a separate print job. This allows for some intra-job servicing and calibration to take place.

Additional pauses may take place due to paper refills and idle time due to end of working days, but pauses are not required. All print settings shall be documented in the test report to sufficient level to allow testing to be reproduced by a third party.

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

If a printer has capability to print both borderless and bordered, photo test suite shall be printed without border. If borderless printing is not allowed for a printer under testing, photo test suite can be printed with border. It shall be noted in test report. Any scaling to ensure that the photo test suite is printed correctly shall be based on printer system or driver.

4.4 Print environment

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

Temperature: testing room average 23,0 °C ± 2 °C

Readings to be made with a running average of 1 h with readings recorded at least every 15 minutes, all running average temperatures are to be between 20,0 °C and 26,0 °C.

An example of the calculation of the temperature is shown in [Table 2](#) for temperature readings taken on 15-min intervals for the testing of one cartridge.

Table 2 — Running temperature calculation example

	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_n	N/A	N/A	N/A	23,0	22,9	22,6	23,8	24,0	23,6	23,3	22,4	22,1	
Running average $T_n = (T_{i-3}+T_{i-2}+T_{i-1}+T_i)/4$ where $n = i$ Testing room average = $(T_1+T_2+ \dots +T_{12})/12$ From these formulae, 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.													

Humidity shall be within the range recommended by the manufacturer for operating the device. When range recommended by the manufacturer is not available, it may be within the range 50 %RH ± 10 %RH.

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 test 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 shall be avoided when printer, paper and cartridges are carried in the test environment.

4.5 Paper

The paper utilized in this test represents photo paper. If photo paper is tested, it shall conform to the printer’s list of approved photo papers for colour photo printing. If automatic media detection can be