INTERNATIONAL STANDARD

ISO/IEC 19752

Second edition
2017-01

Information technology — Office equipment — Method for the determination of toner cartridge yield for monochromatic electrophotographic printers and multi-function devices that contain printer components

Technologies de l'information — Méthode pour la détermination du rendement des cartouches de toner pour les imprimantes électrophotographiques monochromatiques et pour les dispositifs multifonctionnels qui contiennent des composants d'imprimantes

Reference number
ISO/IEC 19752:2017(E)

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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. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/IEC JTC 1, *Information technology*, SC 28, *Office equipment.*

This second edition cancels and replaces the first edition (ISO/IEC 19752:2004), which has been technically revised.

It also incorporates the Technical Corrigendum ISO/IEC 19752:2004/Cor 1:2012.

Introduction

The purpose of this document is to provide a process for determining the page yield for toner cartridges for monochromatic print systems using a standard office consumer type test page. In the case where a cartridge 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 1 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 use to determine cartridge yield;

— the method for determination of declared yield values from the test results;

— the appropriate method of describing the yield of cartridges in documentation supplied to the consumer by the manufacturer.

The end of life is judged with either of the two phenomena, “image fade” caused by toner depletion of the cartridge in the printing system or “automatic printing stop” by the toner out detection function.

NOTE 2 A comparison of yield for two printing systems is shown in Annex E.

Information technology — Office equipment — Method for the determination of toner cartridge yield for monochromatic electrophotographic printers and multi-function devices that contain printer components

1 Scope

This document is limited to the evaluation of toner cartridge page yield for toner containing cartridges (i.e. all-in-one toner cartridges and toner cartridges without a photoconductor) for monochrome electrophotographic print systems. This document could also be applied to the printer component of any multifunctional device that has a digital input-printing path (i.e. multi-function devices that contain printer components).

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

NOTE 1 Application of this document for yield measurement of toner replenishment systems (i.e. toner cartridge- and bottle-type systems where the toner reservoir is internal to the printing system and not user-replaceable) requires some procedural modifications specifically noted herein. This document is intended for equipment used in the office space and does not apply to production volume or large format printing machines where the major cost of ownership is not caused by the consumable yield measured in this document.

NOTE 2 An all-in-one cartridge is a cartridge that includes at least a toner containment part, a photoreceptor part and a developer part (see ISO/IEC 29142-1).

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

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

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
fade
phenomenon whereby a noticeable reduction in density uniformity across the page occurs

Note 1 to entry: In this test, fade is defined as a noticeably lighter, 3 mm or greater, gap located in the text or boxes around the periphery of the test page. The determination of the change in lightness is to be made referenced to the 100th page printed for each cartridge in testing. For examples of fade, see Annex A.

3.2
shake procedure
specified method to carry out shaking of a cartridge according to the user manual

Note 1 to entry: If a shake procedure is used in testing, it will be noted in the report.

3.3
toner low
signal generated by the printer when it has been detected that the amount of toner is such that a toner change will be required soon

Note 1 to entry: It does not indicate that the system is out of toner.

3.4
toner out
signal generated by the printer when the toner in the system is depleted and the printer is incapable of reliable printing without user intervention

Note 1 to entry: For the purpose of this test, the toner out signal will only be used if it causes the printer to stop printing and requires toner replacement to continue printing.

3.5
end of life
when the printer declares "*toner out*" (3.4) or when *fade* (3.1) is observed

Note 1 to entry: For more information about the exact requirements for judging end of life, see 4.8.

3.6
individual page yield
number of "standard page file" pages printed between cartridge installation and *end of life* (3.5)

Note 1 to entry: For replenishment systems, the individual page yield is determined by counting the number of "standard page file" pages printed between prescribed quasi-end of life conditions (defined in 4.5).

3.7
declared page yield
value at or below the lower 90 % confidence bound as prescribed in 6.1

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. 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.

If the cartridge used in testing is a toner replenishment or toner bottle type, then one complete toner cartridge will be used in each printer before the start of the test. The pages printed to deplete this priming cartridge do not have to be recorded and printing can be conducted at any environment. This priming cartridge is used to bring the printing system to a set toner level condition.

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 the printer and driver differ, then the driver defaults shall be used. Any user selectable toner conservation modes shall be disabled during testing.

For printers that default to duplex printing, the default shall be overridden and the printer shall be set to simplex for yield testing.

If the printer under test uses an internal PDF interpreter, it is okay to use it as long as the printer defaults are set to not substitute fonts. If the internal interpreter is used, this shall be noted on the report.

To assure that the test page is rendered correctly, any page size modifiers such as "Fit to Page", "Page Centring" and font substitution shall be turned off. To further ensure that font substitution does not

occur, fonts shall be downloaded as TrueType fonts if the driver provides that option. If the option exists, rendering of graphics shall be performed by the printer, not the application software or operating system. The file shall be printed using the fonts embedded in the file and shall be rendered on the page in a size corresponding to the dimensions in the test page description. Page placement modifiers, such as page centring, may be used to place the image properly on the page. If there is a question about rendering settings affecting the yield, the setting shall be noted in the report.

NOTE The application software (i.e. Adobe Reader™[1]), 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

A combination of at least three cartridges shall be run on a combination of at least three printers (for a minimum of nine cartridges and three printers). This is the minimum number of engines and cartridges that shall be used for testing. When feasible, it is recommended that additional engines and cartridges be used in testing. When testing additional engines and cartridges above the minimum, an effort should be made to test equal number of cartridges on each engine. For example, if an additional engine is to be tested then the minimum number of cartridges to be tested would be 12 (3 cartridges × 4 engines). When testing cartridges for a released product, it is recommended that cartridges and printers are procured from various sources, or selected from different production lots. The printers and cartridges shall be within their useful life as stated in their user's manual.

It is recommended that an additional cartridge be procured to allow for the possibility of cartridge failure during testing.

4.3 Print mode

For reporting cartridge yield, the test shall be run in semi-continuous print mode simplex printing. The actual print speed will be semi-continuous because of printing being interrupted for paper replenishment, etc. Every attempt should be made to have printing be continuous from the start of a cartridge to the end of cartridge life. If the printer is powered down at the end of day during testing, this shall be noted on the test report.

4.4 Print environment

The temperature and humidity 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 min, all running average temperatures are to be between 20,0 °C and 26,0 °C.
Relative humidity (RH):	Testing room average 50 % ± 10 % RH Readings to be made with a running average of 1 h with readings recorded at least every 15 min, all running average RHs are to be between 35 % and 65 %.

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

1) Adobe Reader™ is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

	t_1	t_2	t_3	t_4	t_5	t_6	t_7	t_8	t_9	t_{10}	t_{11}	t_{12}	
Temperature	24,0	23,4	20,5	24,2	23,6	22,0	25,5	24,7	22,1	20,8	22,0	23,5	Testing room average
Running average	N/A	N/A	N/A	23,0	22,9	22,6	23,8	24,0	23,6	23,3	22,4	22,1	23,0

Running average at $t_i = (t_{i-3} + t_{i-2} + t_{i-1} + t_i)/4$

Testing room average = $(t_1 + t_2 + \ldots + t_{12})/12$

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 should be noted that the testing room average for both temperature and RH are averages of all measurements, not the running averages.

Prior to testing, the printer, paper and cartridges shall be acclimated to the above conditions for a minimum of 8 h. Before acclimation, packaging and shipping materials shall be opened with care taken to prevent any light damage from occurring to the cartridge during acclimation. Paper may be acclimated in the ream wrapper. Before final acclimation, all materials shall be temperature acclimated to an office environment.

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

4.5 Paper

The paper used in this test should represent a "common" medium weight paper and shall 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.

4.6 Maintenance

Printer maintenance shall be performed throughout yield testing per the printer and cartridge user's manual (e.g., developer roller or fuser replacement).

4.7 Test file

The print test file is outlined and specified in detail in Annex C. The test shall be conducted using the most recent official electronic test file as the input. The most recent official file can be located at http://standards.iso.org/ittf/PubliclyAvailableStandards/SC28_Test_Pages/. Failure to use the exact file specifications will invalidate test results. In addition to the test file, a publicly available PDF Reader will be used in conjunction with the latest version of 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. The printer under test may use an internal PDF interpreter as long as the test file fonts are not substituted from the original PDF. If an internal interpreter is used, this shall be noted on the report. Before starting the test, a sample file set shall be printed to check the image and assure the proper size. A measurement should be made between A and B for short edge feeding paper and the dimension should be 170,0 mm ± 1 %. For long edge feeding paper, these measurements shall be between A and C and the dimension should be 250,0 mm ± 1 % as shown in Annex C. This is done because image stretch can occur in the feeding direction that does not affect the use of toner.

To allow for automated testing, the complete original ISO/IEC PDF test file may be encapsulated within a secondary file in order to be compatible with automated print systems. This method shall be documented and the resulting print shall be proven to be equivalent in operation with sending the PDF file directly to the printer via a PC host.

The host computer environment, such as the 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.

To aid in counting and tracking pages, a header or footer can be added to the test page. Every attempt should be made by reducing the size of this addition to reduce the effect on calculated yield. If this header or footer is added to the test pages, it shall be noted on the test report.

If the given tolerances cannot be met with all scaling modifiers off, then testing cannot continue.

4.8 End of life

If the printer is equipped with a toner out device, then end of life occurs when the printer declares toner out. However, when fade occurs before toner out and no shake procedure is specified, then end of life is declared at the fade. If a shake procedure is specified for a printer with a toner out device, then up to two shake procedures can be executed when fade occurs before toner out. In this case, if fade occurs after two shake procedures but before toner out, then end of life is declared at the third fade. If toner out occurs at any time during testing, the cartridge is considered to be at end of life.

When shake procedures have been performed during the test, the test report will note for both the first and second shake procedures whether they were done at toner low or at fade. Any faded pages printed during the test are to be excluded from the cartridge page count.

The general intent of this definition is to allow two shake procedures near end of life and to declare end of life at the first fade after the two shake procedures. Nominally, the shake procedures are to be executed at print fade. However, if the printer is equipped with a toner low device, then the first, second or both shake procedures can be executed at toner low instead of at fade as a convenience for the tester. If the user's guide does not specify a shake procedure then the shake procedures are not done and end of life occurs at the first fade.

When applied to replenishment systems (bulk toner replacement or multi-part toner systems), the intent of this method is to declare a quasi-end of cartridge life. Quasi-end of life is a point such as toner out, toner low, or a point that image fade appeared that is repeatable for all installed cartridges. If the printer is equipped with a toner low or toner out signal, these can be used as the point of quasi-end of life. In either case, the end of life condition chosen shall be noted in the test report.

Application of this may be clarified by reference to a flow chart and examples found in Annex B.

5 Test methodology

5.1 Testing procedure

a) Install at least three printers following the user's manual. If the cartridge used in testing is a toner replenishment or toner bottle type, then one complete toner cartridge will be used in each printer before the start of the test. The pages printed to deplete this priming cartridge do not have to be recorded and printing can be conducted at any environment.

b) Install corresponding cartridges following 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.

c) Begin test and start tracking the number of pages run on each test cartridge.

d) When the 100th page is printed for the cartridge, save page for use as the fade reference.

e) When end of life is reached on any cartridge, record individual page yield.

f) Repeat steps b) through e) for the remaining toner cartridges.

5.2 Procedure for handling a defective cartridge or printer

5.2.1 General

During testing, a failure of the cartridge or printer may occur. This will be handled in the following manner. Cartridge failures are defined as occurrences of problems that would result in replacement of the toner cartridge before end of life. Examples of this could be optical photo-conductor (OPC) damage, excessive toner leakage, structural failure, etc. Printer failures are defined as non-user clearable errors that prevent normal printer operation from occurring. An example of this might be the failure of the laser beam on the printer.

5.2.2 Defective cartridge

In the case of a defective cartridge, the last page printed shall be recorded on the report and reason for failure. The cartridge will then be replaced with a new cartridge and the testing continued. For the purposes of yield calculation, the defective cartridge will not be used. For the test to be considered valid, at least nine cartridges shall be run to end of life.

5.2.3 Defective printer

In the case of a defective printer, the printer shall be repaired or replaced and the new cartridge shall be used for subsequent testing. On the report, the last page printed by the cartridge will be recorded and it shall be noted that the cartridge was replaced due to printer failure. The failure of the printer will be noted and the replacement printer serial number recorded. For the test to be considered valid, at least nine cartridges shall be run to end of life. If a printer fails during testing, the completed cartridges that have been run on the failed printer are still valid for calculation. Three additional cartridges do not have to be tested on the new printer.

If the printer used in testing is a toner replenishment or toner bottle type, then one complete toner cartridge will be used in the repaired or replaced printer before continuation of the test. The pages printed to deplete this priming cartridge do not have to be recorded and printing can be conducted at any environment.

6 Determination of the declared yield value and declaration

6.1 Determination of the declared yield value

An average and a standard deviation will be obtained from the test runs (e.g. $n = 9$).

$$\text{Sample average, } \bar{X} = \sum_{i=1}^{n} \frac{x_i}{n}$$

$$\text{Sample standard deviation, } s = \sqrt{\sum_{i=1}^{n} \frac{\left(x_i - \bar{X}\right)^2}{\left(n-1\right)}}$$

It can be stated with 90 % confidence that the true average yield of the cartridges is within the following values:

$$\text{lower confidence bound} = \bar{X} - \left(t_{\alpha,n-1}\right)\frac{s}{\sqrt{n}}$$