
**Information technology — Office
equipment — Measurement of image
quality attributes for hardcopy output —
Monochrome text and graphic images**

*Technologies de l'information — Équipement de bureau — Mesurage
des attributs de qualité d'image pour copies papier — Texte
monochrome et images graphiques*

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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.

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.

In other circumstances, particularly when there is an urgent market requirement for such documents, the joint technical committee may decide to publish an ISO/IEC Technical Specification (ISO/IEC TS), which represents an agreement between the members of the joint technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

An ISO/IEC TS is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/IEC TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

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

ISO/IEC TS 24790 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 28, *Office equipment*.

This first edition of ISO/IEC TS 24790 cancels and replaces the first edition of ISO/IEC 13660:2001, which has been technically revised.

Introduction

This Technical Specification is designed to help a quality control engineer evaluate the image quality of prints from office imaging systems.

In traditional imaging systems (such as ink-on-paper printing), an image is evaluated by comparison to an original or master version of that image. In many electronic imaging systems, however, the image is created digitally within the system. There is no hardcopy master and so there can be no evaluation by comparison in the ordinary way.

Often, those who operate electronic imaging systems ensure good image quality by controlling the imaging process. They use test targets and reference images to evaluate the performance of the system.

If it is not possible to control image quality by controlling the imaging process and if no test target or reference image is available, we can rely only on direct evaluation of properties of the image itself.

To perform intrinsic evaluations of image quality, we must consider the nature of an image that is output. An image is some organization of information in space. We assume that these signals have some purpose or are making some attempt at communication. Good image quality means that the image is legible (the organization and information can be interpreted) and that it has a pleasing appearance.

Our goals in developing this Technical Specification were to compile a list of image attributes that (taken together) correlate to human perception of print quality and to develop measurement methods for these attributes that can be automated and carried out on a simple system.

Legibility and appearance have several aspects:

- Detail can be detected easily.
- Image elements are well isolated from the background.
- The image has a minimum of gross defects.
- The imaging system has good geometric fidelity.

Not all these factors can be covered by evaluation of intrinsic, quantitative image quality attributes. Many of them have a large psychological or cultural component that is difficult to evaluate.

A print made with large optical reduction or one that is out of focus might still have excellent edge quality (and be totally lacking in gross defects, banding, noise, etc.) and yet be illegible. This could occur primarily because of the high process gamma (contrast) that is characteristic of many xerographic processes. Thus, the process can produce apparently sharp edges in spite of the loss in resolution. Without a resolution target of some kind, the extent of the resolution loss, and hence legibility, may not be known.

The purpose of this Technical Specification is to present a set of objective, measurable attributes that give some correlation to the perceived quality of an image to a human observer at a standard viewing distance. The standard will allow a user of printed material to sort samples into several groups, from excellent to bad.

The attributes and methods for their assessment are based on several assumptions:

- The image represents an attempt at communication.
- There is uniformity within identifiable image elements.

- Character images, symbols, and graphic elements are regular (that is, they are intended to be identical when they have multiple, similar occurrences).
- Samples with extreme gross defects have been screened out.

This Technical Specification applies to monochrome images made up of text, graphics, and other image objects with two tone levels of a single colour (typically black image on white paper) or halftones, images with more nominal gray levels. This Technical Specification does not cover continuous tone images, colour images, and so on.

Image quality measurement can be thought of as divided into diagnostic (high resolution), and visual scale (low resolution) procedures. Diagnostic measurements typically use precision test targets and instrumentation and are key to much engineering work. The present procedure, by contrast, is limited to phenomena visible to the naked eye and does not permit test patterns.

The working group has taken the approach of selecting simple and (in our judgment) effective metrics, rather than attempting to prove that our method of doing a given job will always be the most exact.

How will this Technical Specification actually be implemented? A complete evaluation system has four components: an image capture device, evaluation software, application-specific quality standards and sampling plan. The end user may choose to develop all these parts himself or he may choose to purchase one or more components from a commercial supplier.

Any equipment capable of gathering data appropriate to these measurements is understood to have a complex instrument function. Rather than attempting to explore the relationship among these instrument functions, the working group has defined reference images, and target values for them. If these target values are achieved by an instrument, calibration will be acceptably good.

This is not an attempt to break new ground in image science. It is an attempt to provide suppliers and customers for copies / prints with a practical and objective way to communicate about basic image quality parameters.

ISO/IEC 13660 was developed and standardized by the point of view described above. ISO/IEC 13660 is currently the only available systematic image quality attribute measurement standard. ISO/IEC 13660 has had a great influence on related industries and image quality measurement instruments based on ISO/IEC 13660 are already marketed. However, due to the limited development time, it was standardized with many issues unresolved, and therefore ISO/IEC 13660 has not been adopted as widely as expected. The main issues are listed as following.

1. The test chart and methods for measurement system conformance are only specified for some of character and line attributes. For large area graphic image attributes, neither test charts nor methods are specified. Eight items of image quality attribute for character and line image and six items of image quality attribute for large area graphic image are defined, and each measuring method is specified. Of the 14 image quality attributes, the conformance test method, the conformance test chart, and the targeted value for measurement apparatus conformance are specified for only four of the character and line image quality attributes, leaving 10 of the image quality attributes with no conformance specifications
2. Physical measures (line width, voids) and psychophysical factors (darkness, graininess, etc.) are intermingled, and are all defined as image quality attributes
3. The goal values for measurement system conformance are available for only four of character and line attributes. And the allowances are very large.
4. When one measures the character and line image quality attributes according to ISO/IEC 13660, the resulting values have large variation and they do not correspond well with subjective evaluations.

The Japanese WG4 which took charge of ISO/IEC 13660 within the SC28 committee of Japan pointed out these issues, and a NWIP to revise the ISO/IEC 13660 was proposed in January, 2006. Five participating nations were secured at the NWIP vote, and the NWIP was approved. The project to develop ISO/IEC NP

24790 (Information Technology 3 Office Equipment — Measurement of image quality attributes for hardcopy output — Monochrome text and graphic images) was started in July, 2006.

The ISO/IEC 24790 project added the following content to ISO/IEC 13660 to resolve the issues which ISO/IEC 13660 had and to improve the measurement accuracy.

1. Banding which is a common image quality defect of the hard copy output in a printer or a copying machine is added as one of the image quality attributes of a large area graphic image.
2. Conformance test charts and the goal values for measurement system qualification are specified to three character and line image attributes and seven large area graphic image attributes.
3. The fundamental resolution of the scanner for measurement was increased from 600 spi to 1200 spi to reduce the measurement variation.
4. Nearly all of the image quality attributes defined in ISO/IEC 13660 have been redefined in ISO/IEC 24790 to eliminate intermingling physical measures and psychophysical factors.
5. In order to improve the correspondence between image quality attributes and subjective evaluations, an image quality attribute verification experiment was conducted on seven items of image quality attributes to select prediction algorithms for image quality attributes that have the highest correlation with subjective evaluation. The verification experiment was conducted by five countries including Japan, U.S.A, China, South Korea, and the Netherlands.

Verification of the goal values specified in this Technical Specification is under development.

Information technology — Office equipment — Measurement of image quality attributes for hardcopy output — Monochrome text and graphic images

1 Scope

This Technical Specification specifies device-independent image quality attributes, measurement methods, and analytical procedures to describe the quality of output images from hardcopy devices. This Technical Specification is applicable to human-readable monochrome documents produced from printers and copiers.

The attributes, methods and procedures rely on measurable properties of printed text and graphic images. Special targets or reference images are not required, but image elements must meet some minimal requirements, e.g. on size or number present, in order to be useful for adequate measurements. The Technical Specification is not applicable to images on media other than hardcopy (e.g. images on a VDT) or to images that are intended to be machine readable only (e.g. bar codes).

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 5-1:2009, *Photography and graphic technology — Density measurements — Part 1: Geometry and functional notation*

ISO 5-3:2009, *Photography and graphic technology — Density measurements — Part 3: Spectral conditions*

ISO 5-4:2009, *Photography and graphic technology — Density measurements — Part 4: Geometric conditions for reflection density*

ISO 2470-1:2009, *Paper, board and pulps — Measurement of diffuse blue reflectance factor — Part 1: Indoor daylight conditions (ISO brightness)*

ISO 14524:2009, *Photography — Electronic still-picture cameras — Methods for measuring opto-electronic conversion functions (OECFs)*

ISO 21550:2004, *Photography — Electronic scanners for photographic images — Dynamic range measurements*

3 Terms and definitions

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

3.1

background area

region outside the edge of any image element