

Metamorfoze Preservation Imaging Guidelines

draft

**Bureau Metamorfoze
Koninklijke Bibliotheek
National Library of the Netherlands
The Hague
June 2007
Draft**

Metamorfoze Preservation Imaging Guidelines

June 2007

Authors Hans van Dormolen and Robert Gillesse (technical guidelines), Henriette Reerink (procedures)

Editor Andrea Langendoen

Acknowledgements

Reinier Deinum, Barbara de Goederen, Dennis Schouten, Ingeborg Verheul (Koninklijke Bibliotheek); Peter Burns, Daniel Johnston, Don Williams, Dietmar Wueller (Image Engineering, Cologne).

Koninklijke Bibliotheek: National Library of the Netherlands

June 2007

Table of Contents

Preface 4

- This version of the Guidelines 4
- Background of the Metamorfoze programme 4
- History of the Guidelines 4
- Background of the Preservation Imaging Guidelines 5

1 Preservation imaging: procedures Under Construction 6

2. Preservation imaging: technical guidelines 7

- 2.1 Introduction 7*
- 2.2 Camera or scanner type 7*
- 2.3 Software requirements and settings 7*
 - 2.3.1 Image processing software 7
 - 2.3.2 Quality Monitoring Software 8
- 2.4 Recommended monitor settings 8*
- 2.5 Workspace recommendations 9*
- 2.6 Knowledge and skill requirements 10*
- 2.7 Quality criteria for preservation imaging 10*
 - 2.7.1 Tonal reproduction 10
 - 2.7.2 Noise 12
 - 2.7.3 Signal-to-noise ratio (SNR) 13
 - 2.7.4 Illumination 14
 - 2.7.5 Colour cast 14
 - 2.7.6 Colour accuracy 15
 - 2.7.7 Detail reproduction 15
 - 2.7.8 Geometric distortion 18
 - 2.7.9 Colour misregistration 19
 - 2.7.10 Image artefacts 19
 - 2.7.11 Other defects 19
- 2.8 Technical targets – image composition, frequency and file names 19*
- 2.9 Post-processing 21*
- 2.10 File format 21*
- 2.11 Colour space 21*
- 2.12 Technical metadata 21*
- 2.13 Technical assessment 21*

3 References 24

Appendix 1. Kodak Gray Scale: optical densities and corresponding pixel values per patch 25

Appendix 2: Glossary (in preparation) 27

Preface

This version of the Guidelines

This draft version of the *Metamorfoze Preservation Imaging Guidelines* sets out the requirements for *preservation images* commissioned for Metamorfoze. This draft version of the *Guidelines* is specifically intended to serve as the basis for pilot and test projects to be initiated as of June 2007. All criteria, technical targets and software may be slightly adjusted or changed in the course of this year. Besides serving as a basis for pilot and test projects, this draft version is also intended as a starting point for discussion with national and international experts in the field of *image science*. The final 1.0 version of the *Preservation Imaging Guidelines* is expected to be available in January 2008.

That final version should be regarded as setting the standard for *preservation imaging*. This means that all Metamorfoze *preservation imaging* projects must comply fully with these *Guidelines*. The images produced in this context must adhere to quality standards and retain a verifiable relation to the original in such a way that they can serve as a replacement of the original object, as the originals are withdrawn from use after preservation.

Background of the Metamorfoze programme

Metamorfoze, the Dutch national programme for the preservation of the paper heritage, started in 1997. The programme is financed by the Ministry of Education, Culture and Science, and co-ordinated jointly by the Koninklijke Bibliotheek (KB), The National Library of the Netherlands, and the National Archives (NA). The programme's aim is to preserve archives, books, newspapers and periodicals published before 1950 that are threatened by autonomous decay.

The approach chosen is to safeguard the content of these documents by capturing it in digital images. In addition, the original documents are securely packaged, put in long term storage, and withdrawn from use.

History of the Guidelines

When the Metamorfoze programme started in 1997, quality standards for analog conversion by way of *preservation microfilming* were formulated to ensure optimum quality of the microfilms produced as part of the programme. These standards were in keeping with the international standards for *preservation microfilming* in place at the time. During extensive practice in the following years, these standards have been repeatedly adjusted and elaborated, resulting in consecutive versions of the *Preservation Microfilming Guidelines*.

Now, more than ten years after the start of Metamorfoze, the national preservation programme offers organisations the option to preserve documents by way of digital conversion, in the form of *preservation imaging*.

Background of the Preservation Imaging Guidelines

Basic principles

Preservation imaging is based on the same principle as *preservation microfilming*: the surrogate, or *preservation copy*, must be an exact reproduction of the original. This means that all information visible in the original must also be visible in the *preservation copy*, as well as in the derivative images made from this copy. To achieve this, it is essential to ensure a verifiable relation between the preservation copy and the original document, based on objectively measurable quality criteria. These quality criteria are partly derived from internationally accepted standards and norms and partly on technical research carried out by KB.

Technical scope of these Guidelines

These *Guidelines* were formulated for digital capture of paper originals such as archives, books, newspapers and periodicals with a maximum optical density of 1.50. The KB quality managers can advise on capturing originals with a higher optical density or transparencies.

Structure of these Guidelines

These *Guidelines* consist of two parts: procedures and technical criteria. The first part is a summary of those sections of the *Metamorfoze Preservation Imaging Manual, version 1.0* (2008), to be published in January 2008, that describe the methods and workflow for *preservation imaging* in the context of a Metamorfoze project.

Quality criteria for preservation imaging

The core of these guidelines consists of the technical quality criteria set for digital images. The aim is to provide criteria for assessing the quality of images objectively, that is to say: based on measurable norms. This objective assessment is conducted with the aid of technical targets and software. Moreover, the Guidelines provide an understanding of the entire digitization workflow and the technical capabilities of various capturing devices.

The optical density and color of technical targets may be mutually divergent. At the moment we are investigating the variability and long term stability of technical targets. Insight and understanding of the variability of the technical targets is needed to perform objective assessment.

When assessing the individual quality criteria, the norm is not the maximum achievable, but a minimum limit set by Metamorfoze. The Metamorfoze quality managers have defined this minimum norm on the basis of research, in such a way that the quality of the preservation images is optimally guaranteed, while at the same time enabling a realistic workflow.

Questions and comments

Bureau Metamorfoze welcomes any comments on this draft version of the *Preservation Imaging Metamorfoze Guidelines*. For comments or questions regarding the technical guidelines, please contact the Metamorfoze quality managers: Hans van Dormolen, tel. +31(0)70-3140129, e-mail hans.vandormolen@kb.nl or Robert Gillesse, tel. +31(0)70-3140453, e-mail robert.gillesse@kb.nl
For comments and questions regarding the section on procedures, please contact:

Henriette Reerink, Metamorfoze project co-ordinator, tel.+31(0)70-3140319, e-mail henriette.reerink@kb.nl or Dennis Schouten, Metamorfoze programme manager, tel. +31(0)70-3140373, e-mail dennis.schouten@kb.nl.

1 Preservation imaging: procedures Under Construction

2. Preservation imaging: technical guidelines

2.1 Introduction

The core of this technical part of the *Guidelines* consists of ten quality criteria (see paragraph 2.7.1 to 2.7.10) preservation images must comply with. In addition to these quality criteria, guidelines for the use of technical targets, post-processing, file formats and technical quality monitoring are provided.

2.2 Camera or scanner type

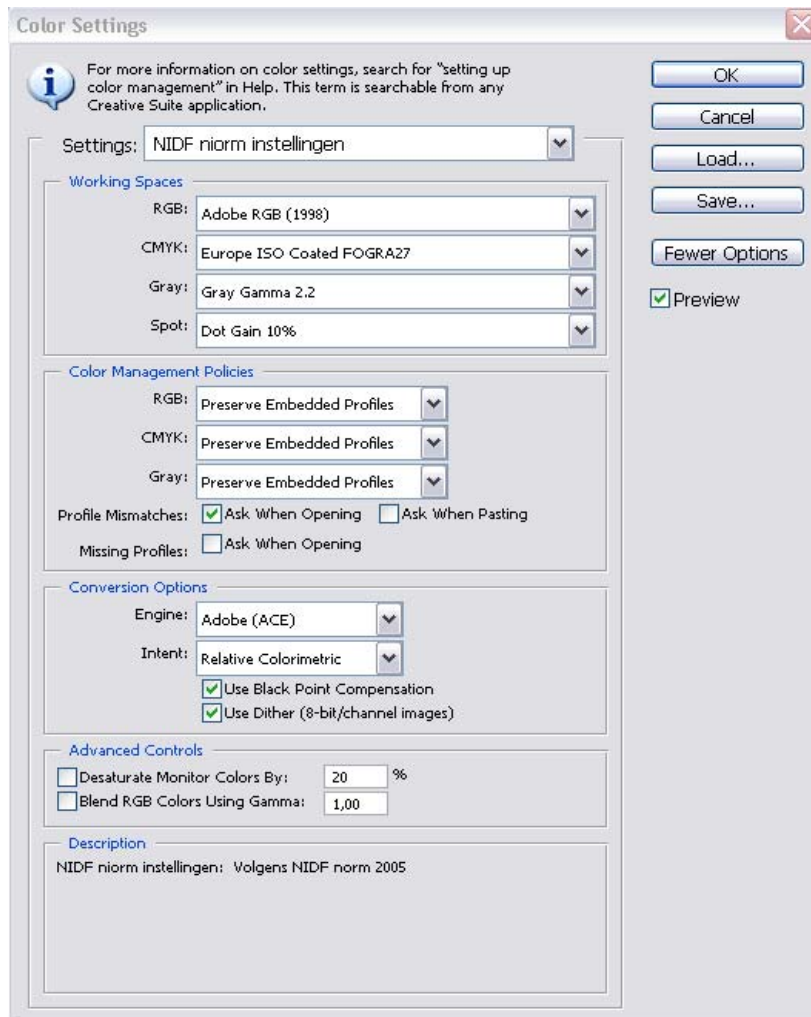
The equipment for *preservation imaging* is still very much under development. Not all equipment is suitable for *preservation imaging*. Selection of the appropriate hardware to meet these guidelines is the responsibility of the supplier. When required, the quality managers of Bureau Metamorfoze can provide advice.

2.3 Software requirements and settings

2.3.1 Image processing software

Use of the latest version of Adobe Photoshop (at the time of writing: CS2) is strongly recommended for assessing and, if necessary, processing the images. The following settings of Photoshop are recommended¹:

¹ Based on the NIDF norm (from the Dutch Institute for Digital Photography), p.5:
<http://www.pf-kunstbeeld.nl/NIDF/NIDFnorm3.pdf>



Screen dump from Adobe Photoshop CS2

2.3.2 Quality Monitoring Software

For quality monitoring the following two applications are required:

- ImCheck – to check detail reproduction and colour misrepresentation;
- IE Analyzer – to check colour reproduction.

Both applications can be obtained from the quality managers of Bureau Metamorfoze. In the future we aim to carry out all checks with the aid of just one application.

2.4 Recommended monitor settings

Appropriate monitor settings are very important when visually inspecting the images. The following recommendations are closely connected to the circumstances in the work place (see paragraph 2.5). The recommendations are mostly derived from the NIDF norm².

Recommended general settings for the monitor are:

² Ibidem, p. 4.

- White point 6500 K (using Adobe Gamma³)
- Gamma 2.2 (setting in Adobe Photoshop⁴)
- Set desktop background to grey, and as far as possible remove any colours from the user interface.

In addition to these basic settings the monitor must be calibrated and a monitor profile must be created. The most reliable method to create such a profile is with the aid of a measuring cell – which does just that: measure the screen – in combination with the corresponding software⁵. This applies to high end monitors such as Eizo, LaCie and Nec SpectraView⁶.

2.5 Workspace recommendations

The layout and illumination of the workspace determine how accurately images can be assessed. It is recommended to lay out the scanning area according to ISO standard 3664 or the more recent 12646 standard. The aim of these standards is to remove any effects interfering with the subjective, visual assessment of the images, and to support uniformity in assessment between supplier and client.

The following recommendations are derived from the standards mentioned above⁷:

- Ambient illumination shall be less than 64 lux and should be less than 32 lux.
- The colour temperature of the ambient illumination must be 5000 K.
- The workspace must be decorated in neutral colours, preferably grey.
- Ideally the walls, floors and furniture are grey, and free of posters, images and other objects that might interfere with the viewer's vision.
- All sources of glare should be avoided.
- Lights must be shielded or dimmed in such a way that they do not reflect in the working area or screen (a hood around the monitor is recommended).
- Daylight should be blocked out (the colour temperature or intensity of daylight will fluctuate during the day).

For the options for standard lighting, please refer to the NIDF-norm.

A problem when comparing an original with the digital reproduction is that the original should be viewed in clear lighting conditions, while the monitor gives the best results with little lighting. Ideally the viewing of digital image and original should take place in different rooms. This problem can be solved by using a viewing booth⁸.

³ In Windows XP accessible via the configuration screen.

⁴ Menu/edit/color settings.

⁵ Examples of measuring cells are given in the NIDF-norm, p. 4.

⁶ Exact types are given in the NIDF-norm, p. 4.

⁷ NIDF-norm, p. 3.

⁸ Gretag-Macbeth (<http://www.gretagmacbeth.com>) is one of the companies that manufacture these special 'viewing booths' in which objects can be viewed under various lighting conditions (daylight, tungsten, halogen, ultraviolet, etc.). Kenney and Rieger, *Moving Theory*, p. 69, specifically endnote 22.

2.6 Knowledge and skill requirements

To be able to apply these *Guidelines*, a certain level of knowledge is required of the operator and/or the manager. Knowledge and skills required are:

- Basic knowledge of sensitometry and of certain basic concepts of photography, such as density, pixel value, sharpness, colour theory, exposure, dynamic range.
- Basic knowledge of a number of concepts in digital photography, such as MTF, OECF, colour space, colour management, noise.
- Knowledge of hardware: the skill to assess the photographic capabilities of cameras and imaging systems, and to calibrate the equipment.
- General knowledge of computers and computer systems, especially regarding file management.
- Knowledge of file formats.

2.7 Quality criteria for preservation imaging

The following criteria and norm values will be substantiated by practical tests in the second half of 2007, whereby the price-quality ratio will also be taken into account.

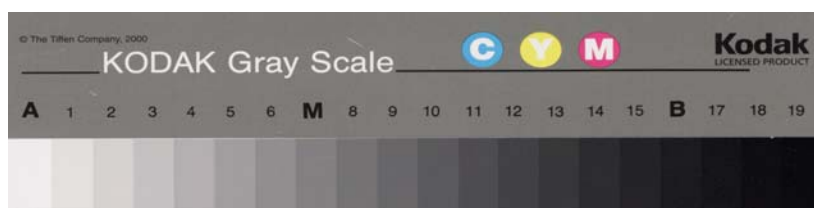
2.7.1 Tonal reproduction

The quality of the tonal reproduction of an image is one of the most important technical quality criteria. Therefore, this is always checked first. Just like in analog photography, the assessment is based on a comparison of the grayscale in the captured image with the original physical grayscale. For this purpose the Kodak Gray Scale Q-13 or Q-14 is used. (The Q-14 is slightly larger). The Kodak Gray Scale ranges from near white, which is the first patch, to near black in the last patch. There are twenty patches in all. The first patch (patch A) has an optical density of 0.05, the next patch is patch 1, with an optical density of 0.15. At the other end of the grayscale patch 19 has an optical density of 1.95. The difference in optical density between the patches (which we call steps) is consistently + 0.10 or -0.10, that is + of - $\frac{1}{3}$ stop. For assessment of the tonal reproduction, the entire range of the gray scale is measured. All twenty patches are important. However, to gain a quick insight in the quality of the tonal reproduction, our approach is to measure four steps only in the first stage of the assessment process. Once these four patches have been judged satisfactory, the other sixteen patches are assessed. The density margins (pixel values) are identical for all patches. It is the difference in density (pixel values) between patch A and patch 1 in the image, though, that is of essential importance. A norm value is set for the difference between these two patches. This difference is referred to as the *highlight gamma*. The next paragraph explains the term *highlight gamma* and how it is calculated. In addition, norm values are given for the density of all other steps in the Kodak Gray Scale that is included in the digital image.

Highlight gamma

The term gamma is used to indicate the contrast in a specific tonal range. For quality monitoring and description of preservation microfilms commissioned by Metamorfoze, the gamma has to comply with explicit norms. For analog film the gamma used to be calculated with the aid of the S-curve. For Metamorfoze preservation microfilms the gamma is calculated with the aid of the Kodak Gray Scale. For digital images the gamma, or contrast, plays an equally important role, and therefore has to adhere to specific criteria. To calculate the gamma of digital images

only the first step is used, from patch A to patch 1, and not, as in the case of microfilms, the first two or three steps. In other words, the gamma is calculated and described in the ‘high lights’, hence the term ‘*highlight gamma*.’



Kodak Gray Scale

Patch A must retain its minimal density in the captured image. Because the optical density of patch A is very low, only 0.05, the exposure margins during capture should also be low. The exposure margin allowed is 1/6 stop in total. This means 1/12 stop underexposure and 1/12 stop overexposure. Expressed in terms of optical density this is: 0.025 and 0.075.

With the aid of the reflection values the pixel values can be calculated.⁹ The pixel values are dependent on the colour profile that is used, on the bit depth, and on the monitor’s gamma setting. We assume the use of the Adobe RGB 1998 colour profile, a monitor gamma setting of 2.2 and a bit depth of 8. A density of 0.025 results in a pixel value of 248. A density of 0.075 results in a pixel value of 236. In the captured image the pixel value of patch A on the Kodak Gray Scale must therefore lie between pixel values 248 and 236 (see Table 1). Of course, the pixel values of patch 1 and all other patches must also remain within a margin of 1/6 stop. The pixel value of patch 1 must lie between 224 and 212.

The *real* or *theoretical* pixel values (without exposure margin!) of patch A and patch 1 are 242 and 218 respectively.

The *highlight gamma* is the quotient of the difference in pixel values between patch A and patch 1 measured in the captured imaged, and the *real* or *theoretical* pixel values. For example: the difference between measured pixel values in the image between patch A and patch 1 is 248 minus 220 = 28. The difference between the *real* or *theoretical* pixel values between patch A and patch 1 is 242 minus 218 = 24. The quotient of the difference in pixel values between patch A and patch 1 is 28:24 = 1.1. So, the *highlight gamma* is 1.1. The highlight-gamma may vary slightly. This depends on the quality of the capturing device used. For preservation imaging, the acceptable margins of the *highlight gamma* are set between 0.8 and 1.08.

As mentioned above, not only the first stretch of the curve, or grayscale, (that is to say: patch A en patch 1, the highlights) is important for the quality of an image, but also the reproduction of the grey and dark areas. To assess these, the patches 9 and 19 are measured. These, like all other patches, should remain within the same exposure margin of 1/12 stop overexposure and 1/12 stop underexposure. This means that the pixel values of patch 9 must lie between 97 and 92, and the pixel values of patch 19 must lie between 34 and 32 (see Table 1).

When the pixel value of patch 19 is lower, for instance 10, this means that the image has been processed, either by the software in inadequate capturing devices or faulty settings of the equipment. Alternatively, the image may have been processed

⁹ Pixel value = 255 (Reflection valueⁿ). ⁿ = 1/monitor gamma. This applies to Adobe RGB 1998, 8 bits.

manually. Image processing is allowed only for images derived from the master file, after technical assessment of that file. When the pixel value is higher than 34, say 45, the image was either captured with the wrong settings or subjected to post-processing.

The order in which the pixel values and the *highlight gamma* are measured and calculated is illustrated in Table 1, in the first column.

Table 1. Adobe RGB 1998, 8 bit, monitor gamma 2.2

1	Pixel value patch A	248 – 236
2	Pixel value patch 1	224 – 212
3	Highlight gamma	0.8 – 1.08
4	Pixel value patch 9	97 - 92
5	Pixel value patch 19	34 – 32

The norm values for all patches of the Kodak Grayscale are given in Appendix 1.

In addition to the norm values presented in this table, the so called *signal to noise ratio* also provides information about the tonal quality of the image (see paragraph 2.7).

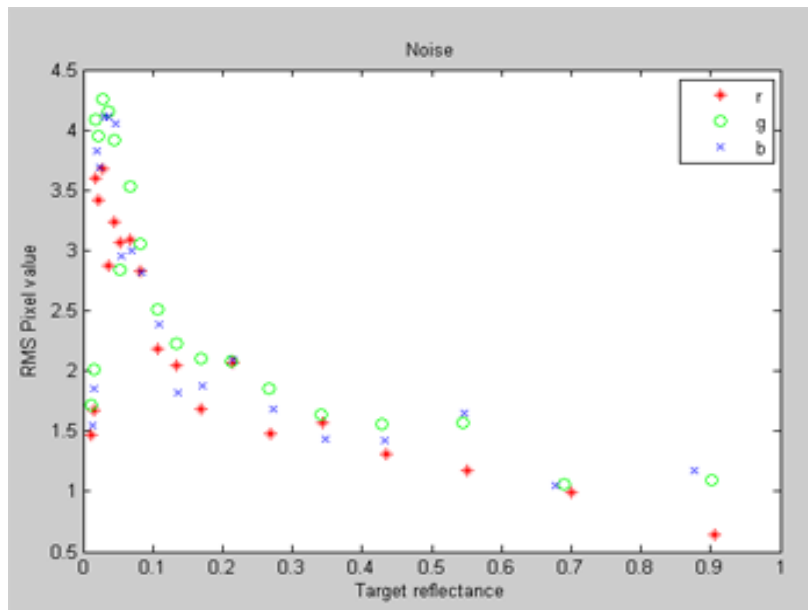
Measuring pixel values

The pixel values are measured in Photoshop with the *eyedropper tool*, with a pixel area setting of 5x5 pixels. The pixel values are displayed in the information screen. To measure the pixel values and calculate the *highlight gamma* (as shown in Table 1) in a colour image, the same colour channel must be used at all times. It is recommended to use the channel with the highest pixel values in patch A, since the allowed deviations in pixel values apply equally to all three colour channels. However, the Kodak Gray Scale is not suitable for establishing colour cast. To assess colour cast, the neutral patches of the *GretagMacbeth Color Checker CG* and the *Color Cast Chart Metamorfoze* must be used. For more information about colour cast, see par. 2.7.5.

2.7.2 Noise

The digital images should be as free from noise as possible. Noise can be described as unwanted light fluctuations in an image that are absent in the original. In general, noise can be perceived and measured easiest in high density areas. Noise can be either random or more fixed in character.

Noise is measured with the aid of the Kodak Gray Scale and the above mentioned ImCheck software. The software calculates the standard deviation (deviation of the average value) for every patch of the Gray Scale for all three RGB channels. The curve shown below is output by the ImCheck software. On the y-axis the standard deviation values are plotted, and on the x-axis the Gray Scale reflection values.



ImCheck software noise curve

Because every deviation in the target is measured as an actual deviation, it is absolutely necessary to work with an undamaged and stain and dust free Gray Scale. When a glass plate is used, this should also be clean and unscratched.

The maximum amount of noise allowed is a standard deviation of 4. This figure is based on the visibility of noise in the image¹⁰. The acceptable amount of noise in an image is related to the visual perception of an image. Noise should not (or barely) be visible, including in the darker areas.

2.7.3 Signal-to-noise ratio (SNR)

The SNR gives insight in the correlation between pixel values (*signal*) and *noise*. This correlation can simply be measured by dividing the pixel value of a random patch of the Kodak Gray Scale by its corresponding noise value or standard deviation. When, for instance, the pixel value of patch 19 is 33, and its noise value is 3, the SNR is $33:3=11$. This figure means that 1/11 part (or 9%) of patch 19 consists of noise. So, the higher the SNR, the better the correlation between noise and signal.

The SNR should not be 6 or lower for any pixel value for any randomly chosen patch of the Kodak Gray Scale. When an image consists for 1/6 part or more of noise, than the amount of noise in the image is so large as to exert a negative influence on the visual perception. The SNR and the corresponding optical density (input density) reflect the dynamic range of the scanner or camera system.

¹⁰ A measuring method is now available that focuses even more on noise visible to the human eye. This method, based on the fact that the human eye is most sensitive to noise in the luminance channel, is explained in Appendix C of the ISO 15739 standard. The company *Image Engineering* from Cologne has developed noise measuring software based on this method. This will be investigated more extensively.

2.7.4 Illumination

To ensure uniform illumination, a frame-filling white sheet of cardboard must be captured. The optical density of the white cardboard must be between 0.05 and 0.15. Centered at the bottom of the image a Kodak Gray Scale must be included. To assess illumination, the pixel values are measured in at least five points (with the Photoshop eyedropper tool, 5x5 pixels). Measurements are taken in the centre and at the four corners. In the case of doubt about the evenness of the illumination more points need to be measured. The difference between two random points in the image should never exceed the norm value given below.

The difference in pixel values between the centre and the corners, and between the corners themselves, must not exceed eight pixel values per colour channel. This equals a difference in optical density of 1/10 stop, or 0.03. The maximum pixel value must not exceed 248.

It is possible that the optical whiteners in the cardboard cause an incorrect or slightly deviating correlation between the pixel values of the three colour channels. Therefore, the cardboard is unsuitable to assess colour cast. The optical whiteners in the cardboard may also cause an incorrect or slightly deviating conversion of the reflection values to pixel values. Therefore we advise against comparing reflection values and pixel values one-to-one with the aid of white cardboard or paper containing optical whiteners. Likewise we advise against comparing pixel values of white cardboard or paper with optical whiteners one-to-one with the pixel values of the various technical targets such as the Q-13 and the *GretagMacbeth Color Checker CG*.

However, white cardboard and white paper do give a general idea of the quality of the illumination and of the presence of colour cast. This leads to the conclusion that the prescribed figure of eight pixel values should be applied with some leniency. Bureau Metamorfoze is still investigating the option to use cardboard without optical whiteners for measuring illumination and colour cast or, alternatively, the option to describe white cardboard or white paper with optical whiteners accurately with the aid of a spectrometer. This will enable accurate definition of pixel values and, consequently, acceptable deviations in pixel values.

Bureau Metamorfoze has designed a special technical target for accurate measurement of both illumination and the presence of colour cast. This target is expected to be available as of July 2007.

2.7.5 Colour cast

Like illumination, the presence of colour cast is measured and assessed in the centre and the corners of the frame. For this purpose Bureau Metamorfoze has designed a special technical target: the *Color Cast Chart Metamorfoze*. This is a small target (9x9 cm), which is to be positioned in the centre and the corners of the frame. The target contains six neutral grey patches with optical densities increasing from 0.05 to 1.50. The maximum allowed for colour cast is a difference of + 3 and - 3 in pixel values between the three colour channels for each gray patch. This norm applies to one individual target as well as between the five targets.

Illumination can also be measured with the aid of these targets. For this purpose the whitest patch, with optical density 0.05, must be used.

As the *Color Cast Chart Metamorfoze* will not be available until July 2007, for now white cardboard will have to be used to measure colour cast in the corners of the frame. In the centre of the frame, the *GretagMacbeth Color Checker CG* must be used. In the case of doubt about the presence of colour cast this target can be positioned in the corners as well.

2.7.6 Colour accuracy

To ensure colour accuracy, a colour target, the *GretagMacbeth Color Checker SG*, must be captured. This enables comparing the colours in the image with their reference values. This comparison is carried out with the aid of software.

Metamorfoze uses the application IE-Analyzer 3.0. The comparison is carried out in the LAB colour space and expressed in Delta E (ΔE). Colours are compared for three colour characteristics: hue, saturation and luminance. Norms are set for all three characteristics combined. What will be considered acceptable deviations is still under investigation. For now, Bureau Metamorfoze prescribes the following norm values:

- Excellent, and unreservedly acceptable: colour deviation in Delta E of 1 – 6.
- Still acceptable, but mediocre quality: colour deviation in Delta E of 6 – 10.
- Unacceptable: colour deviation in Delta E higher than 10.

Regarding the reproduction of paintings, for instance, the colour accuracy of the capturing device is of vital importance. In those cases the norms for acceptable colour deviation will need to be stricter.

2.7.7 Detail reproduction

1 mm six point letter ‘e’ as point of reference

The point of reference for measuring resolution is the 1 mm lower case letter ‘e’ (six point letter). The reason is that this is the smallest letter used in newspapers (in the stock market reports). When this letter is accurately reproduced, all six point letters, as well as larger fonts, will be easily legible.

‘Accurately reproduced’ means that:

- The open part of the letter has not filled up.
- All lines and details of the letter are distinctly visible.
- The lines of the letter are clearly distinct from the background.
- The letter is not frayed.

The smallest part of a six point letter is about 0.2 mm in size. Correct reproduction of a six point letter therefore ensures correct reproduction of all details of 0.2 mm or larger.

The minimum number of line pairs/mm and the capturing resolution required to reproduce a 1 mm six point letter

To reproduce a detail sized 0.2 mm (and consequently a 1 mm six point letter) a minimum of 5 lp/mm is required.¹¹ The half-sampling point¹² indicates that to achieve this the scanning resolution should be at least 250 ppi¹³. In most cases though, capturing at a higher resolution will be needed to yield the required 5 lp/mm. It is therefore recommended to capture at a minimum resolution of 300 ppi.

A higher resolution is justifiable only when details smaller than 0.2 mm have to be reproduced. For when the half-sampling point is approached, at 300 ppi, detail perception will be 5.9 lp/mm, ensuring a resolution of 0.16 mm details.

The larger the original, the more difficult it will be to adhere to the required number of lp/mm

For very large originals (A2+) the required number of lp/mm will generally have to be set lower, because 5 lp/mm will not be attainable at any resolution. This is permitted only in those cases where details are larger than the six point lowercase letter 'e'. Otherwise, the original will have to be captured in several overlapping images. For less finely detailed originals, the minimum norm for the number of lp/mm will be determined for each individual case, on the basis of the actual amount of detail in the original.

Assessing the number of lp/mm

The number of lp/mm is assessed by measuring MTF/SFR with the ISO standard slanted edge target QA-62.



Slanted edge-target Applied Image QA-62

¹¹ This calculation is based on the premise that at least one line pair is needed to properly resolve a detail. Thus, for a detail of 0.2 mm, five (1/0.2) lp/mm are needed.

¹² The half sampling point (or Nyquist theory) is the point indicating the maximum detail perception (expressed in lp/mm or cycles per millimeter, cy/mm) a scanner or camera can attain at a specific resolution. For different resolutions this is:

400 ppi = 7.9 lp/mm

300 ppi = 5.9 lp/mm

200 ppi = 3.9 lp/mm

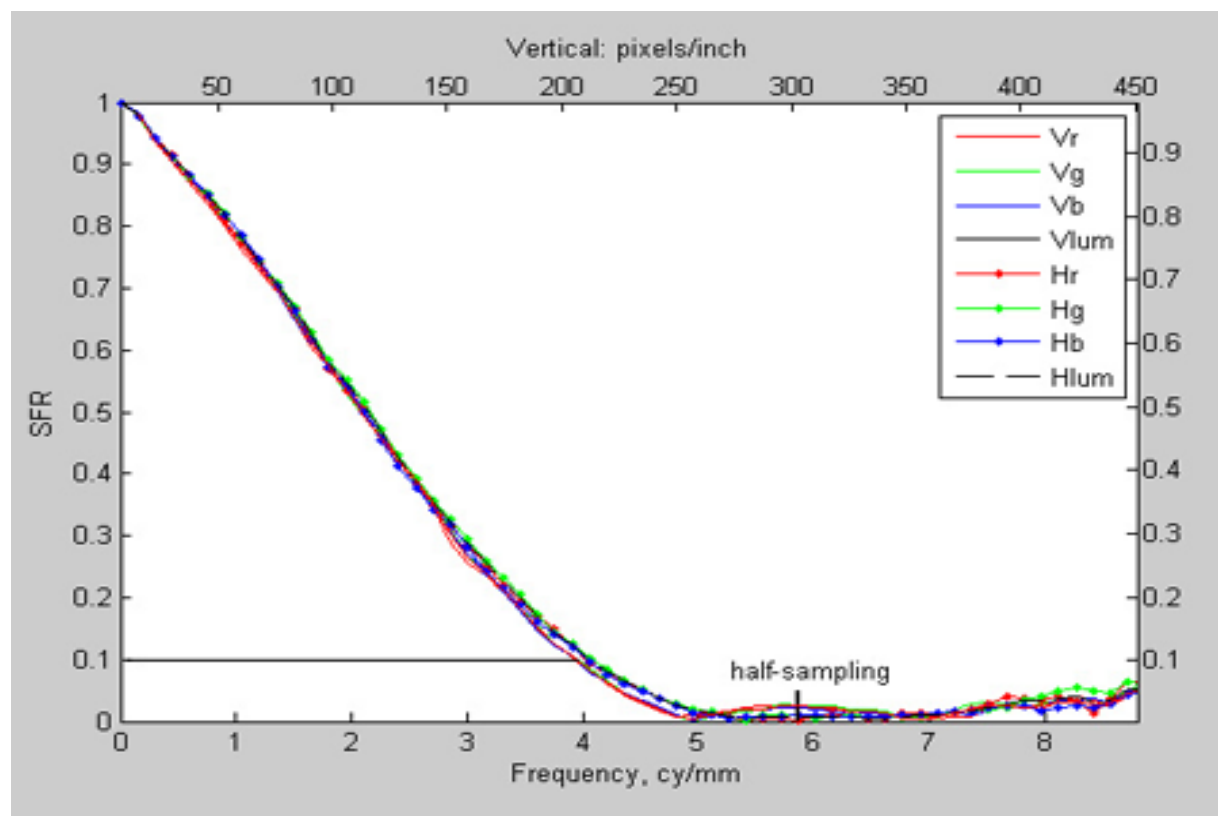
150 ppi = 2.9 lp/mm

Calculated as follows: $400 \text{ ppi} / 2.54 = 157,48 \text{ pp/cm} = 15,74 \text{ pp/mm} = 15,74/2 = \text{rounded off } 7,9 \text{ cp/mm}$.

¹³ 254 ppi to be precise.

The grey patches located around the slanted edge target can be used for an OECF test. When viewed under a microscope with 60x magnification, the slanted edge is still pinpoint-sharp.

The ImCheck software calculates the MTF for all three RGB channels, horizontally as well as vertically. The output is a curve: on the x-axis the MTF is plotted (transference of detail: 1 is 100% transference, 0 is 0% transference), and on the y-axis the number of lp/mm (or cy/mm, whereby cy = cycles, or frequency).



ImCheck software MTF-analysis output (detail)

Regarding this graph the following should be noted:

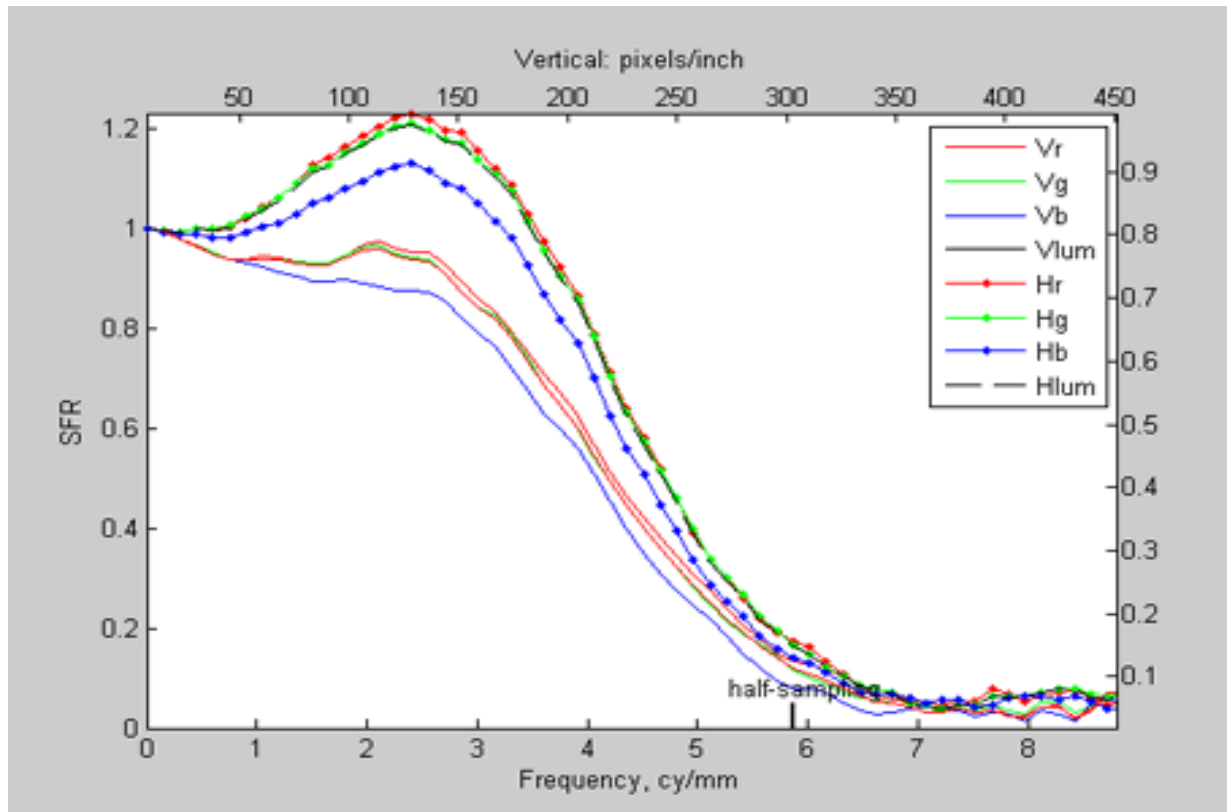
- The half-sampling point indicates the maximum attainable lp/mm for the corresponding resolution (in this case 5.9 lp/mm at a resolution of 300 ppi). All activity after this point is aliasing/noise.
- The 0.1 (or ten percent) MTF-point, also known as the Rayleigh criterion. This is the smallest point at which a detail can still be perceived. (In the wording of the ISO 3334 standard: where an impression is given of pairs of lines on the ISO resolution test chart no. 2¹⁴). In the example above, this point lies at 3.9 lp/mm, so quite a bit under the maximum attainable 5.9 lp/mm and the minimum of 5 lp/mm required in these Guidelines.¹⁵

¹⁴ ISO 3332. *Micrographics – ISO resolution test chart No. 2 – Description and use*. 1989. p. 3, paragraph 6.2.

¹⁵ From the number of lp/mm attained at the Rayleigh point the actual resolution can be deducted. The resolving power can be derived from the MTF curve as follows:
At the 0.1 Rayleigh point the number of cycles per mm is, for instance, 4.
4 cpm = 4 lpp/mm = 8 pixels per mm (pp/mm) (for each line pair at least 2 pixels are needed)
= 80 pp/cm = 203 ppi.

Sharpening

As a basic rule, sharpening is not allowed in the master file. However, as some digital cameras do not allow internal sharpening mechanisms to be disabled, a slight margin of sharpening is allowed. This margin is limited to 1.2 MTF and can be read from the MTF-curve. In the following example this is visible in the ‘bump’ in the peak of the curve. The image is sharpened horizontally to an MTF value of slightly over 1.2.



ImCheck software MTF-analysis output (detail)

2.7.8 Geometric distortion

Two types of geometric distortion may occur:

- Pillow-shaped distortion, whereby the sides of a square or rectangle are slightly concave.
- Barrel-shaped distortion, whereby the sides of a square or rectangle are slightly convex.

Both kinds of distortion alter the length and height in the centre of the original.

Research is still in progress into the extent of distortion occurring with different types of capturing devices. As a basic rule, the allowed deviation is a change in length or height of 1% at the most. The appropriate test target is also still under development.

Here the maximum attained resolution is 203 ppi (while the image may have been captured at 300 ppi!).

For now, to measure length and height in Photoshop, the *Image Evaluation Test Target (QA-2)* must be used. The size of this target is A3. To measure larger sizes, a larger test target must be used.

2.7.9 Colour misregistration

Colour misregistration occurs when the three RGB channels are not exactly synchronous. Consequently, around contrasty parts of the image a coloured border will be visible.

Colour misregistration is assessed with the aid of the slanted edge target *Applied Image QA-62 target* (see par. 2.7.7), and measured with the ImCheck software.

Colour misregistration can be determined separately for each channel, both horizontally and vertically.

The norm set by Metamorfoze is a maximum deviation of +/- 0.75 in both horizontal and vertical direction.

2.7.10 Image artefacts

Image artifacts is the term used for a variety of defects having in common that they can be detected only by visual inspection.

The following defects are not allowed:

- Horizontal and vertical stripes
- Pixel disturbances (usually caused by dirt and/or dust)
- Haloing
- Stair-step artifacts and other forms of distortion (such as undulations, curves etc.)

2.7.11 Other defects

When digitising bound originals, care should be taken to prevent letters disappearing in the gutter, or becoming illegible due to shadowing. When this seems inevitable, the Metamorfoze quality managers should be consulted.

2.8 Technical targets – image composition, frequency and file names

There are two kinds of technical targets: targets that must be captured with every individual image that is made from an original, and technical target sheets that must be captured for every batch (a specified number of images) or for a series of images made in a specified period of time (for instance one morning or afternoon).

For every batch or time span

Tonal reproduction, illumination, colour cast, colour accuracy and sharpness must be checked on a regular basis. The prescribed frequency is:

- At the start of every period of time utilized for digitisation, for instance one morning, afternoon, or evening.
- Once every 500 images.

Target sheet composition and sequence

- *First target sheet: tonal reproduction and illumination.* Both aspects are assessed with the aid of one single image, which is constructed as follows. A frame-filling white sheet of cardboard is captured. The optical density of the white cardboard must be between 0.05 and 0.15. A Kodak Gray Scale is centered at the bottom of the sheet. The distance between the sheet of white cardboard and the lens must be equal to the distance between the original and the lens. In other words: the reduction factor used for capturing the technical targets must be equal to the reduction factor used for capturing the originals. This applies equally to all other technical target sheets.
- *Second target sheet: colour cast and colour accuracy.* Both aspects are assessed with the aid of one single image, which is constructed as follows. A frame-filling sheet of white cardboard is captured. The optical density of the white cardboard must be between 0.05 and 0.15. A colour test target, the *GretagMacbeth Color Checker SG*, is positioned in the centre of the sheet, and a Kodak Gray Scale is centered at the bottom of the sheet. With regard to the reduction factor, the same applies as for the first test image.
- *Third target sheet: sharpness.* The image is constructed as follows: a frame-filling sheet of white cardboard is captured. The optical density of the white cardboard must be between 0.05 and 0.15. In the centre and in the corners of the image a sharpness test target, the QA-62 slanted edge target, is positioned. A Kodak Gray Scale is centered at the bottom of the sheet. With regard to the reduction factor, the same applies as for the first test image.
- *Fourth target sheet: optical distortion.* Guidelines are still under development.

For every individual image, it must be possible to assess tonal reproduction and colour accuracy in relation to the original. Therefore a Kodak Gray Scale Q-13 or Q-14 and a mini GretagMacbeth Color Checker Rendition Chart must be captured together with every single original. Both technical targets must be positioned side by side, and clearly visible, centered at the bottom of the frame.

How to enable assessment of colour cast for each individual image is still being investigated. A possible solution might be to use a target with a number of neutral grey patches, placed in a right angle. This target could be positioned in each corner, and captured with each image.

Naming of target files

First test:

- First image: MMKONB01_TARGETTEST0001_TONAL.TIF
- Second image: MMKONB01_TARGETTEST0001_COLOUR.TIF
- Third image: MMKONB01_TARGETTEST0001_SHARPNESS.TIF
- Fourth image: MMKONB01_TARGETTEST0001_DISTORTION.TIF

The target files must be saved in a separate directory named TARGETTEST_TEST0001

Xth test:

- First image: MMKONB01_TARGETTESTXXXX_TONAL.TIF
- Second image: MMKONB01_TARGETTESTXXXX_COLOUR.TIF
- Third image: MMKONB01_TARGETTESTXXXX_SHARPNESS.TIF

- Fourth image: MMKONB01_TARGETTESTXXXX_DISTORTION.TIF
- The target files must be saved in a separate directory named TARGETTEST_TESTXXXX

These directories are placed in a subdirectory called TARGETS

2.9 Post-processing

The only kind of post-processing allowed in the master file is rotating in Adobe Photoshop. If the master file is rotated this must be recorded in the technical metadata (see par. 2.12, NISO Z39.87 field 10.1.16). Any other kind of post-processing of the master file is not allowed. When there are urgent reasons for post-processing the master files, the quality manager of Bureau Metamorfoze must be consulted.

2.10 File format

TIFF IBM 6.0 uncompressed. The TIFF file must comply with the TIFF 6.0 specification: <http://partners.adobe.com/public/developer/en/tiff/TIFF6.pdf>

Compliance with the TIFF 6.0 specification can be checked with the JHOVE file header extraction tool: <http://hul.harvard.edu/jhove/>

2.11 Colour space

The files must be delivered with the Adobe RGB 1998 profile. Currently Bureau Metamorfoze is investigating the suitability of the L* RGB profile.

2.12 Technical metadata

The purpose of technical metadata is, firstly, to safeguard long term preservation of the file, and secondly to document the quality of the image.

For technical metadata the following NISO standard is available:

NISO Z39.87-2002: <http://www.niso.org/standards/resources/Z39-87-2006.pdf?CFID=46753226&CFTOKEN=45140661>).

Technical metadata (including the EXIF information produced by digital cameras) can, for the main part, be extracted per batch from the headers of the TIFF files with the JHOVE tool (<http://hul.harvard.edu/jhove/>).

2.13 Technical assessment

The master files are inspected twice:

- **First assessment**

The first check is performed by the supplier. All master files must be individually checked.

- **Second assessment**

The second check is performed by the quality manager digitisation of Bureau Metamorfoze. Depending on the size and complexity of the project this check can be performed on several batches. It is essential that an assessment is

performed shortly after the start of production. Thus, problems will be spotted at an early stage. Consequently, at least two assessments will be carried out: one at the start of production and one at the end.

General principles:

Assessment is based on a random sample survey. Of every batch 0,1% is checked. When more than 1% of the batch does not comply with the guidelines, the entire batch will be returned. All individual items in this batch must be re-checked, and when necessary, improved. If less than 1% of the batch is flawed, only the faulty images are returned and improved. After return of the improved batch, the images will be checked again.¹⁶

The size of the sample will be determined in accordance with the size and characteristics of the project, in mutual agreement by the institution commissioning the project, the supplier producing the images and the quality manager digitisation. The assessment can be conducted either on the premises of the supplier or at KB. However, the equipment and a workspace as outlined in par. 2.3 to 2.5 must be available for the assessment to be performed at the supplier's premises.

In the near future all quality assessments will be carried out with the aid of a software application developed by KB specifically for this purpose. Possibly this application can be installed at the supplier's premises as well.

The quality assessment will be conducted on the basis of the quality criteria described above, in par. 2.7 to 2.7.13. The sequence of these paragraphs is also the order in which the quality checks must be carried out:

- Tonal reproduction
- Noise and dynamic range
- Illumination
- Colour cast
- Colour accuracy
- Detail reproduction
- Geometric distortion
- Colour misregistration
- Image artifacts
- Technical targets
- Post-processing
- File format
- Technical metadata

Reporting

A report of the quality assessment will be produced, based on the following template (under development).

¹⁶ This procedure is derived in part from the guidelines of the National Archives and Records Administration: Steven Puglia ea, *NARA Guidelines for digitizing archival materials for Electronic Access*, 2004, p.65, 66 <http://www.archives.gov/research/arc/digitizing-archival-materials.html>

Report: Technical Assessment of Metamorfoze Preservation Images, by [name supplier]

Supplier:

Contact details:

Assessment date:

Report date:

Assessment status: [first assessment / progress assessment / final assessment]

Quality assessment performed by:

Source material:

Collection:

Scanner /camera system:

Results:

Initials:

3 References

- Daniel L. Johnston, *A Simplified Standard Method of Digital Image Tonal Capture for Archival Projects*, IS&T's 2002 PICS conference.
- Don Williams, Peter Burns, *Evaluating Digital Scanner and Camera Imaging Performance*, report tutorial IS&T Archiving 2006 conference.
- Don Williams, Franziska Frey, et.al., *Guides to Quality in Visual Resource Imaging*, 2002. <http://www.rlg.org/legacy/visguides/>
- Memory of the Netherlands Project Office, *Guidelines and Procedures for the Execution of Projects for Memory of the Netherlands*, May 2006. Specifically Appendix 9 and 11. [NB ENGELSE VERSIE NIET MEER BESCHIKBAAR VIA WEBSITE]
<http://www.kb.nl/coop/geheugen/richtlijnen/richtlijnen%20en%20procedures%20geheugen%20openbaar%204.1.pdf>
- ISO standards: ISO 15739 (Photography – Electronic still-picture imaging – Noise measurements), ISO 12233 (Photography – Electronic still-picture cameras – Resolution measurements), ISO 14524 (Photography – Electronic still-picture cameras – Methods for measuring opto-electronic conversion functions - OECFs)

Appendix 1. Kodak Gray Scale: optical densities and corresponding pixel values per patch

The values in this table are based on bit depth 8 and monitor gamma 2.2.
The optical density and color of technical targets may be mutually divergent. At the moment we are investigating the variability and long term stability of technical targets. Insight and understanding of the variability of the technical targets is needed to perform objective assessment.

Patch no	Optical density	Pixel value	Patch no	Optical density	Pixel value
	0.025	249		1.025	87
A	0.05	242	10	1.05	85
	0.075	236		1.075	83
	0.125	224		1.125	79
1	0.15	218	11	1.15	77
	0.175	212		1.175	74
	0.225	201		1.225	71
2	0.25	196	12	1.25	69
	0.275	191		1.275	67
	0.325	181		1.325	64
3	0.35	177	13	1.35	62
	0.375	172		1.375	60
	0.425	163		1.424	57
4	0.45	159	14	1.45	56
	0.475	155		1.475	54
	0.525	147		1.525	52
5	0.55	143	15	1.55	50
	0.575	140		1.575	49
	0.625	133		1.625	46
6	0.65	129	16	1.65	45
	0.675	126		1.675	44
	0.725	119		1.725	42
7	0.75	116	17	1.75	41
	0.775	113		1.775	40
	0.825	107		1.825	38
8	0.85	105	18	1.85	37
	0.875	102		1.875	36

	0.925	97		1.925	34
9	0.95	94	19	1.95	33
	0.975	92		1.975	31

Appendix 2: Glossary (in preparation)