The Financial Services
Technology Consortium

~ IMAGE DEFECT METRICS ~

IMAGE QUALITY AND USABILITY ASSURANCE: PHASE I PROJECT

Version 1.0.1

August 23, 2004

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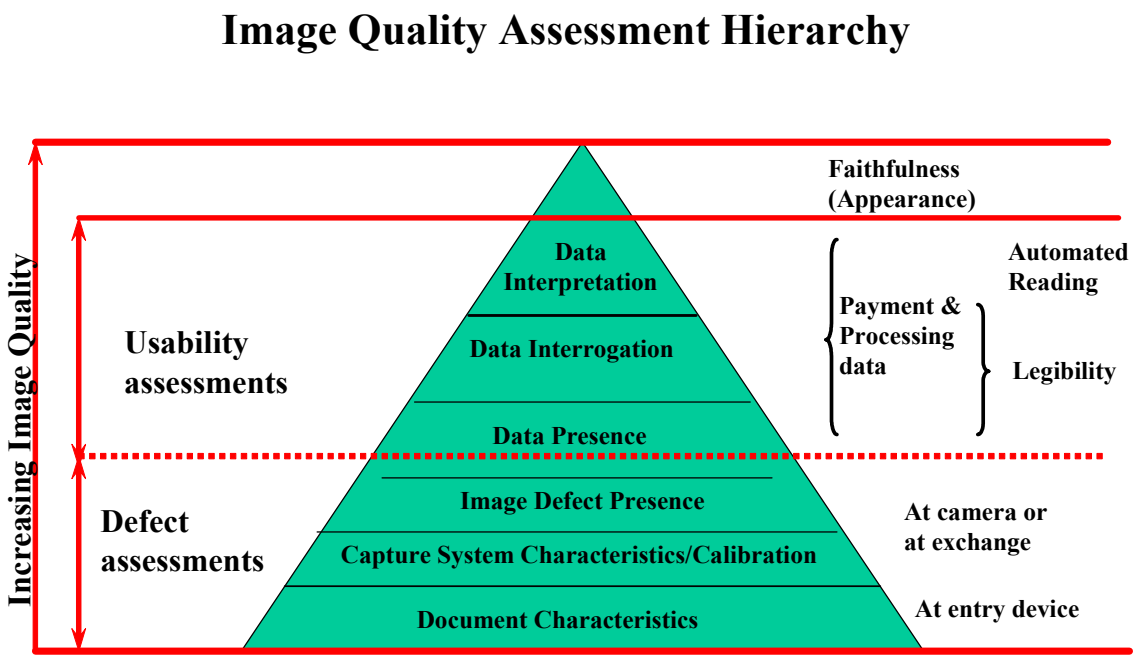
Introduction

The *Image Defect Metrics* defined in this document represent objectively measurable check image quality defects—deviations from a perfectly complete and accurate image that can be assessed by standard technical measurements that do not involve subjective judgments (e.g., by a human examining the image) or semantic analysis.[1]

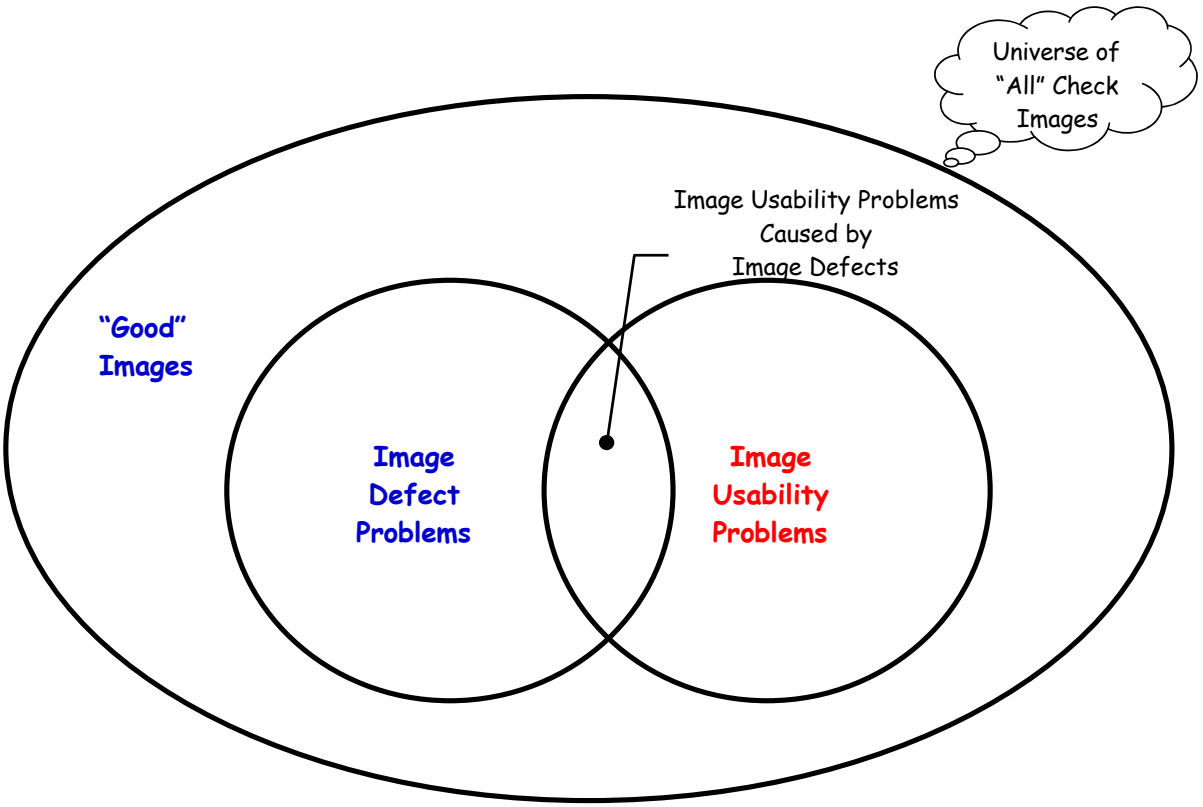
In the context of the *Image Quality Assessment Hierarchy* adopted as the reference model for Image Quality Assurance (see figure below), the check image defect metrics defined here constitute the basis for *defect assessments*.



Source: Dexter Holt of the Federal Reserve Bank submitted to the ASC[2] X9B-WG15

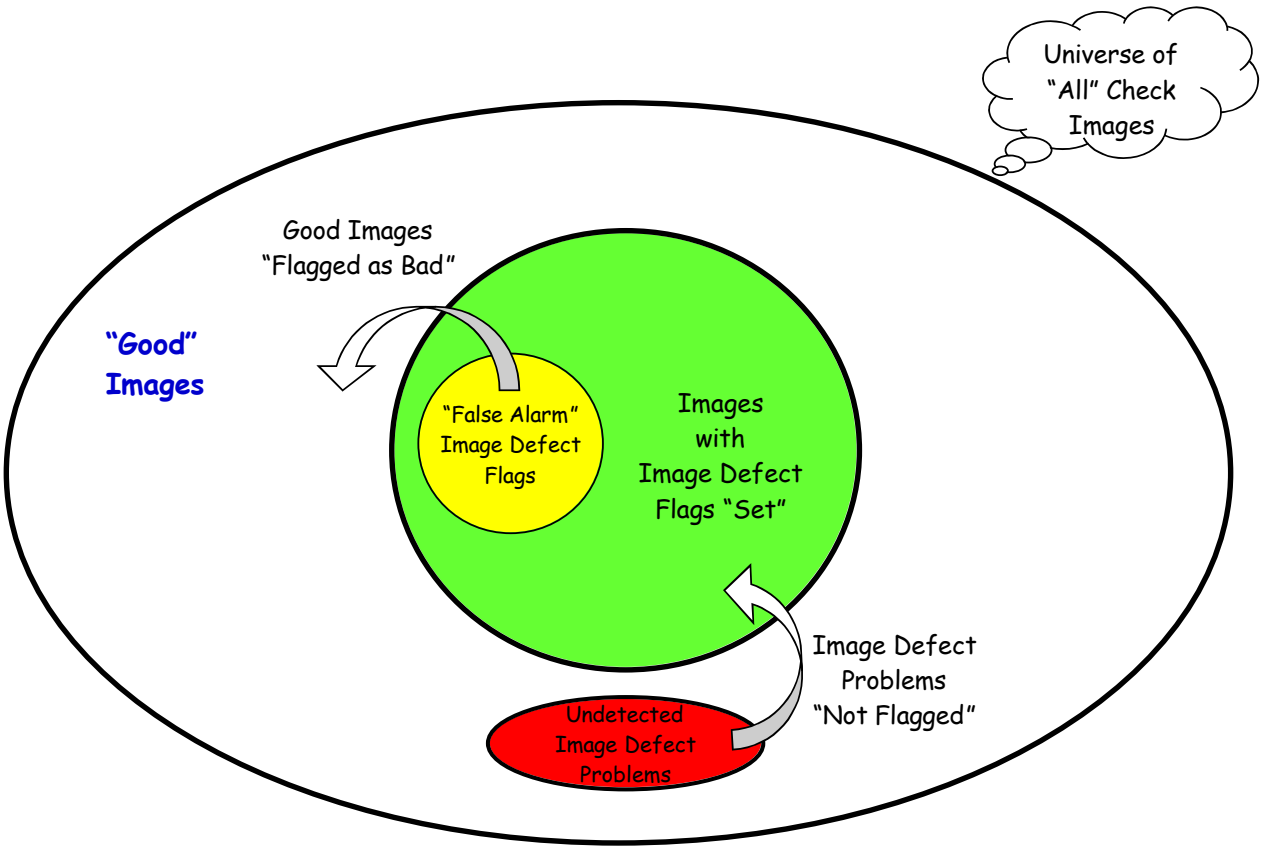
Defects in a check image may or may not affect the usability of the image for some or all purposes; a defect measurement therefore provides essential data for usability analysis, but does not *in and by itself* represent a definitive answer to questions such as whether or not specific data elements are legible, or whether the image can be successfully processed by an automated recognition engine. This relationship between defect assessment and usability assessment can be illustrated graphically by the Venn diagram in the following figure:

[1] These Image Defect Metric Definitions are the product of Phase I of the FSTC Image Quality & Usability Assurance Initiative, and are best understood in the context of the *Final Report* of that project.
[2] Accredited Standards Committee



Source: Unisys Corporation submitted to the ASC X9B-WG15

At the level of defect assessment, the principal concern is to determine, based on well-defined standard criteria that can be applied uniformly to all measurement circumstances, whether or not a particular defect is present. This determination involves both a quantitative measurement of an image attribute (e.g., "image height") and a qualitative assertion about the presence of a defect (e.g., "undersize image"). Quantitative measurements—metrics—are defined for each of the possible check image defects listed in this document. The corresponding qualitative assertions depend on establishing thresholds for each metric (or combination of metrics) that strike an effective and practical balance between correctly identifying defects that might affect usability (avoiding "escapes") and incorrectly identifying defects that won't affect usability ("false positives"). These defect assessment objectives are illustrated by the following Venn diagram:



Source: Unisys Corporation submitted to the ASC X9B-WG15

The measurement thresholds for the defects defined in this document are represented by parameters (e.g., "minimum image width threshold"), rather than specific numeric values. Further analysis of experimental and other data concerning the "real world" frequency with which each defect occurs, and the way in which each defect affects image usability, is required to set these thresholds to specific numeric values.

An important assumption of the image quality assessment model is that defect analysis begins with a structurally complete and readable (uncorrupted) image file, the header of which has been checked for the presence and adequacy of basic image parameters (e.g., resolution, number of scan lines, pixels per scan line, and compression type). Such a file is considered to be the expected output of the image capture process that precedes image quality assessment. Detecting (and correcting) poor image resolution, for example, is assumed to take place before IQA begins, wherefore "poor image resolution" does not appear in this list of image defect metric definitions.

It is also important to note that this document compiles an intentionally generous list of image defects, casting a wide net to identify as many potentially consequential defects as possible. Further analysis may show that it is not necessary to measure all of these defects in order to provide useful and adequate information for usability assessment.

1. Undersize Image

Definition:

A defect due to the document image rendition's width or height being below the minimum image size based on the minimum check size and tolerances associated with the image capture platform.

Measurement and Units:

For each image a tri-state "flag" will be provided indicating whether the "undersize image" condition was tested for and the result of the test.

- Undersize Image Flag = 0, if the condition is not tested
- Undersize Image Flag = 1, if the condition is tested, and the defect is present
- Undersize Image Flag = 2, if the condition is tested, and the defect is NOT present

In addition to the tri-state flag, the following metrics for the defect will be provided:

- Image width in tenths of inches, e.g., 65 = 6.5 inches.
- Image height in tenths of inches, e.g., 31 = 3.1 inches.

Criteria for Defect Present:

The defect will be assumed to be present if one or more of the conditions below occur:

- Image width < *Minimum Image Width Threshold*
- Image height < *Minimum Image Height Threshold*

Possible Source(s) of the Defect:

- Torn document. An image where a significant portion of the original source document is absent (top missing, right side missing, bottom missing, or left side missing).
- Folded document. An image where a significant portion of the original source document is folded (top edge folded, right edge folded, bottom edge folded, or left edge folded).
- Improperly framed document, e.g., image capture begins too late, or ends too early. An image where the leading or trailing edge of the document has been truncated due to a camera synchronization error during the image capture process.

Defect Illustrations:

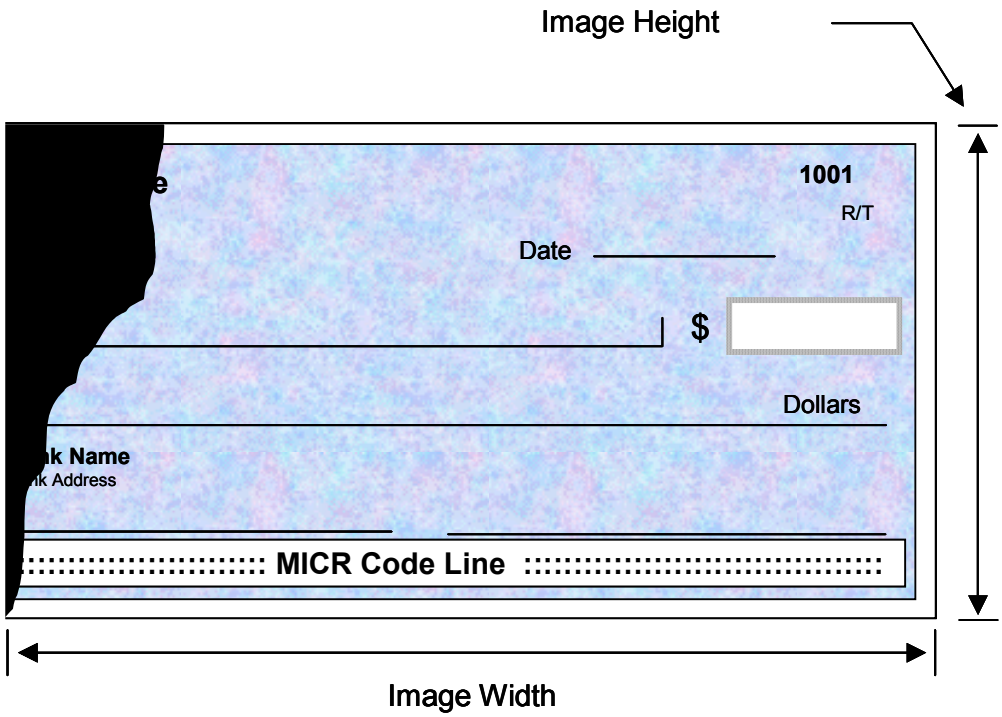


Figure 1A – Large Tear Present on the Left Edge of the Source Document

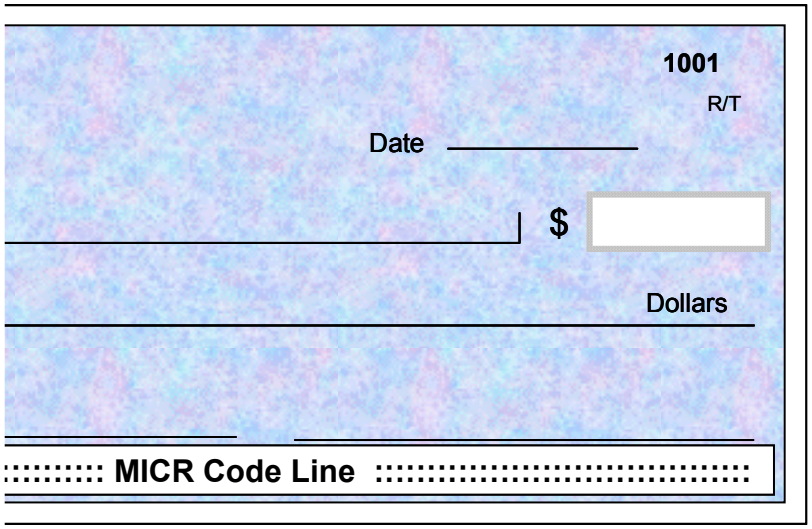
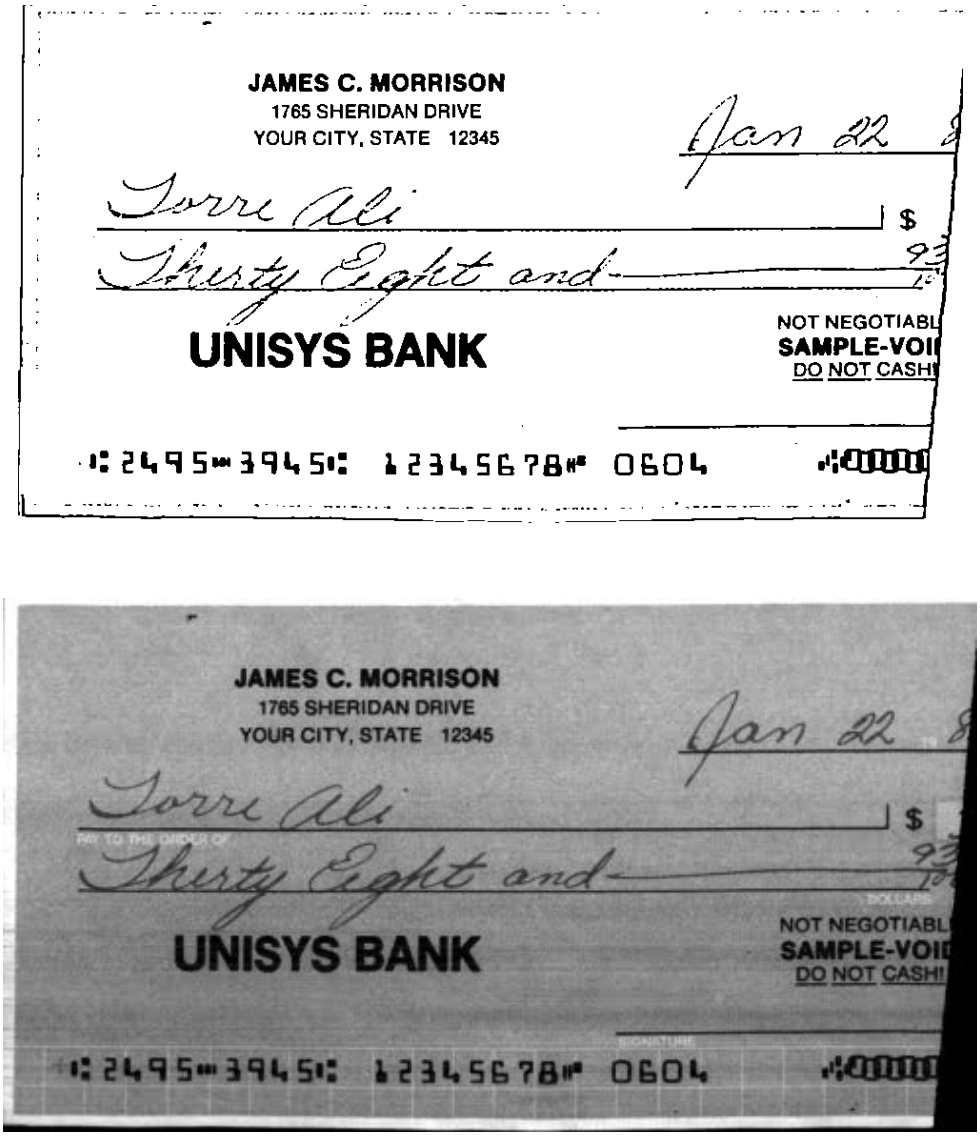
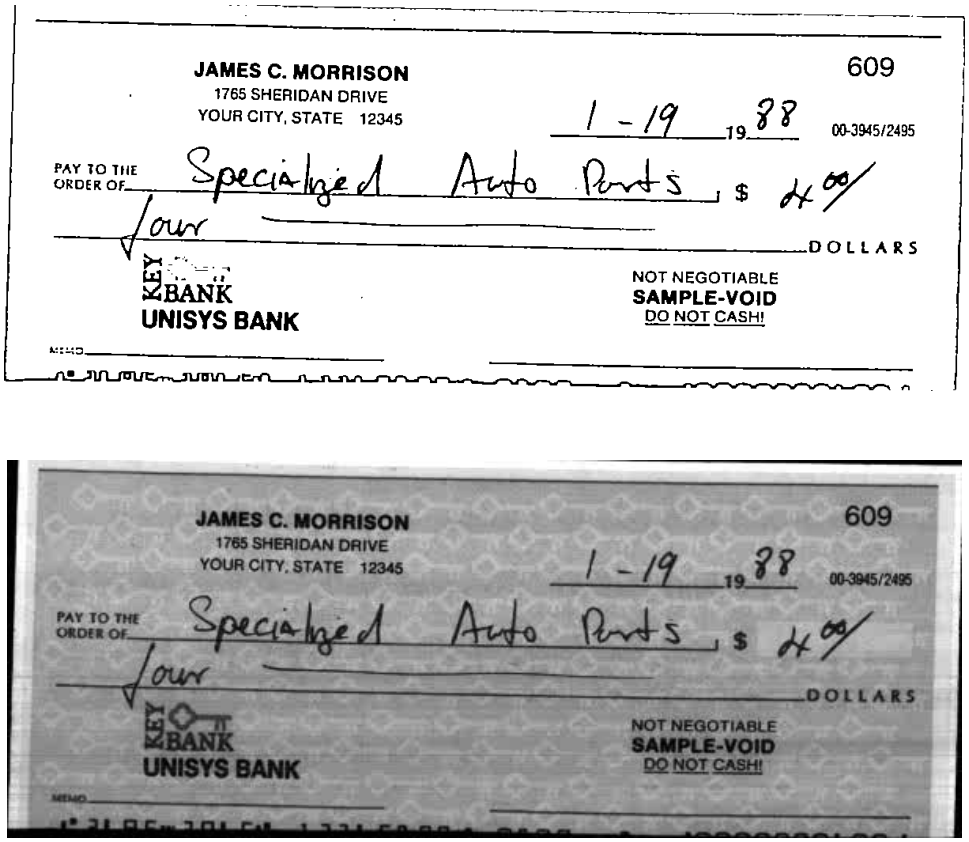


Figure 1B – Image Capture Framing Error



Figures 1C – Large Fold Present on Right Edge of the Source Document



Figures 1D – Large Fold Present on the Bottom of the Source Document

Possible Business Impacts:

In general, the presence of an "undersize image" could cause one or more key data fields, present on the source document to be missing and/or obscured on the check image. Other business impacts include the following:

- Inability to create a complete substitute check.
- Financial losses due to missing/obscured information in one or more key data fields.
- Missing information in customer statements (Day 2 processing impact).
- Missing information in CD-ROM delivery.
- Missing information during on-line access.
- General customer service issues.
- May require document re-scan (work flow and labor expense impact)

Recoverability:

This defect may be recoverable if the source document can be unfolded and re-imaged. There is no recovery for severely torn documents, since the information has been lost on the source document.

2. Folded or Torn Document Corners

Definition:

A defect due to the corner of the source document being either missing and/or folded in the document image rendition.

Measurement and Units:

For each image a tri-state "flag" will be provided indicating whether the "folded or torn document corners" condition was tested for and the result of the test.

- Folded/Torn Corners Flag = 0, if the condition is not tested
- Folded/Torn Corners Flag = 1, if the condition is tested, and the defect is present
- Folded/Torn Corners Flag = 2, if the condition is tested, and the defect is NOT present

In addition to the tri-state flag, the following metrics for the defect will be provided:

For each corner of the document (upper left, upper right, lower left, lower right), the dimensions of a circumscribing rectangle enclosing the missing corner area will be provided as described below:

- Width of the circumscribing rectangle in tenths of inches, e.g., 10 = 1.0 inches
- Height of the circumscribing rectangle in tenths of inches, e.g., 5 = 0.5 inches

If no corner fold or tear is detected in the document, the tri-state flag will be set to a value of two (2), and the four pairs of width/height values will be set to a value of zero. If one or more folded or torn corners are detected, the width and height values will be set to the dimensions of the circumscribing rectangle enclosing any missing corner area.

Criteria for Defect Present:

The defect will be assumed to be present if both of the conditions below occur:

- Fold/tear corner width > *Maximum Corner Fold/Tear Width Threshold*
- Fold/tear corner height > *Maximum Corner Fold/Tear Height Threshold*

Independent fold/tear corner width and height thresholds will be defined for each corner of the document, i.e., four separate sets of width and height thresholds.

Possible Source(s) of the Defect:

- Folded document corners. An image defect identified when a corner (upper left, upper right, lower left, lower right) of the source document has been folded, causing an area of the document image to be missing and obscured.
- Torn document corners. An image defect identified as a missing corner (upper left, upper right, lower left, lower right) in the source document, resulting in an area of the document image to be missing.

Defect Illustrations:

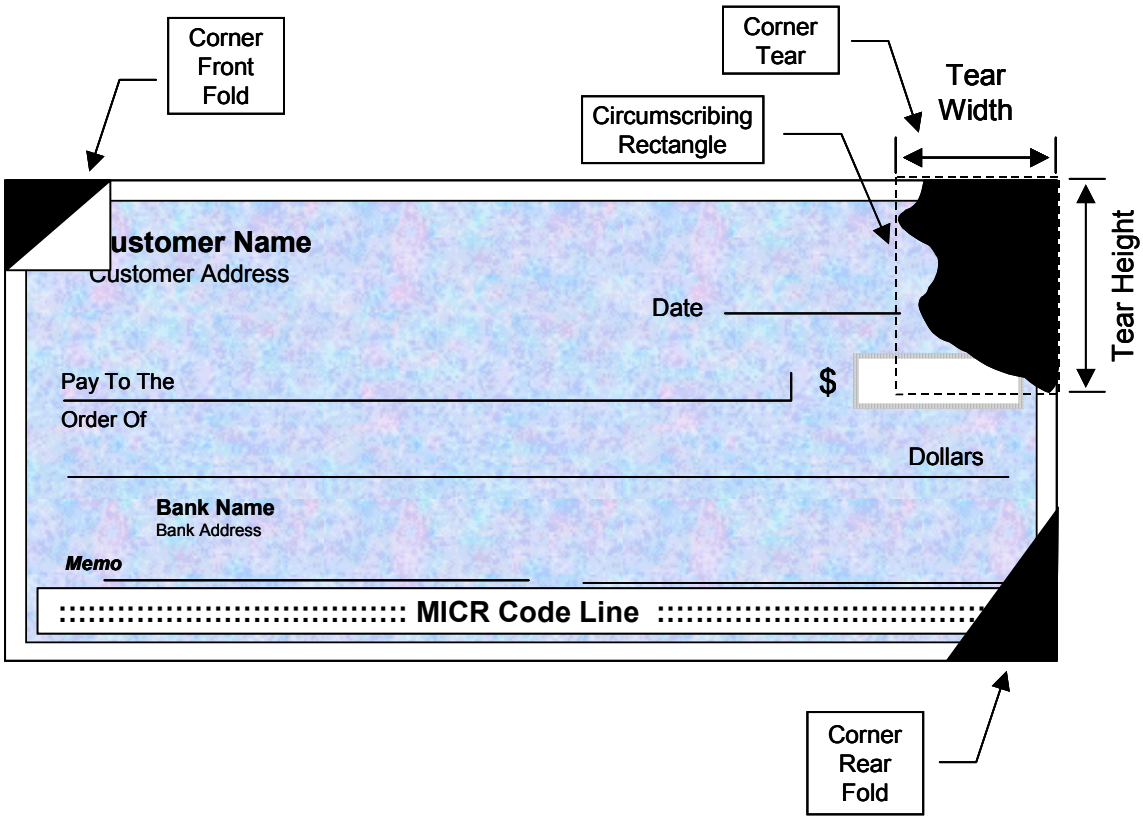
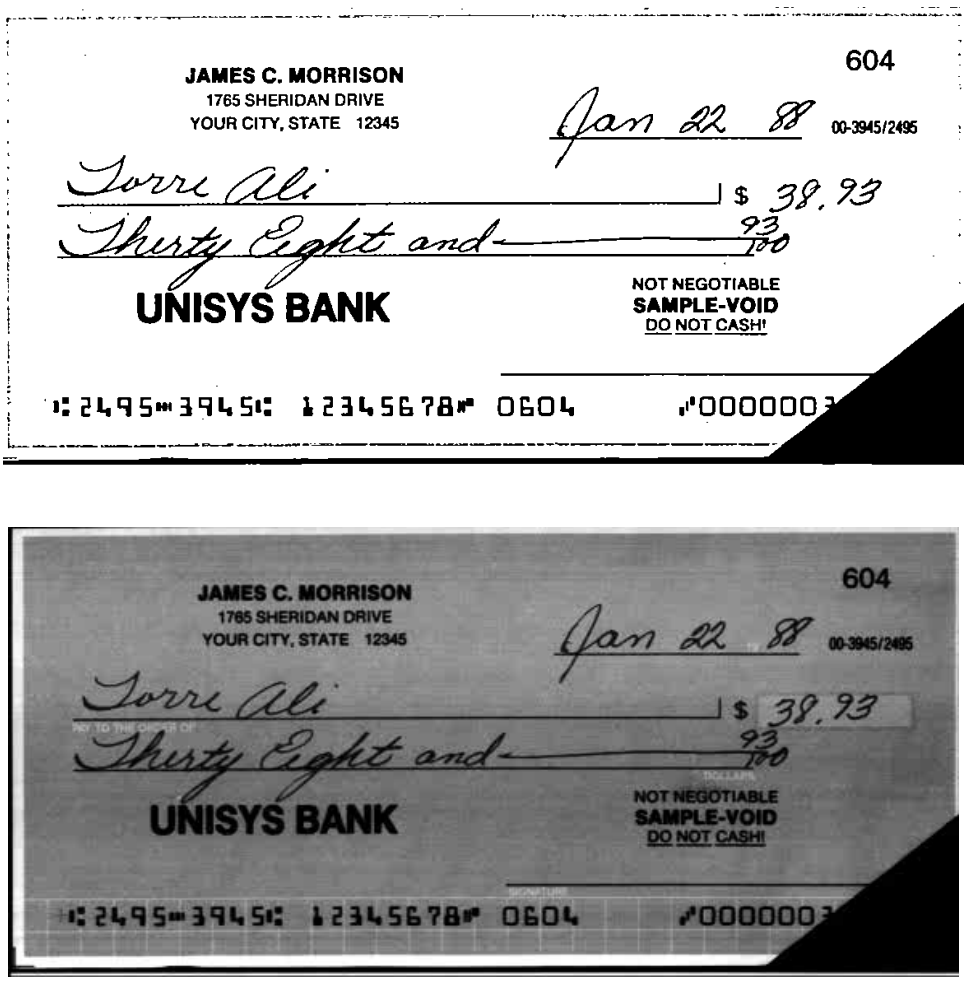


Figure 2A - Torn/Folded Document Corner and Edge Defects



Figures 2B – Corner Fold on the Right Bottom of the Source Document

Possible Business Impacts:

In general, the presence of a "folded/torn document corner" could cause one or more key data fields, present on the source document to be missing and/or obscured on the image rendition of the document. Other business impacts include the following:

- Inability to create a complete substitute check.
- Financial losses due to missing/obscured information in one or more key data fields.
- Missing information in customer statements (Day 2 processing impact).
- Missing information in CD-ROM delivery.
- Missing information during on-line access.
- General customer service issues.
- May require that some documents will need to be rescanned (work flow and labor expense impact)

Recoverability:

This defect may be recoverable if the source document can be unfolded and re-imaged. There is no recovery for severely torn documents, since the information has been lost on the source document.

3. Folded or Torn Document Edges

Definition:

A defect due to the edge of the source document being either missing and/or folded in the document image rendition.

Measurement and Units:

For each image a tri-state "flag" will be provided indicating whether the "folded or torn document edge" condition was tested for and the result of the test.

- Folded/Torn Edge Flag = 0, if the condition is not tested
- Folded/Torn Edge Flag = 1, if the condition is tested, and the defect is present
- Folded/Torn Edge Flag = 2, if the condition is tested, and the defect is NOT present

In addition to the tri-state flag, the following metrics for the defect will be provided:

For each edge of the document (left, right, top, bottom), the dimensions of a circumscribing rectangle enclosing the missing edge area will be provided as described below:

- Width of the circumscribing rectangle in tenths of inches, e.g., 10 = 1.0 inches
- Height of the circumscribing rectangle in tenths of inches, e.g., 5 = 0.5 inches

If no edge fold or tear is detected in the document, the tri-state flag will be set to a value of two (2), and the four pairs of width/height values will be set to a value of zero. If an edge fold/tear is present, the width and height values will be set to the dimensions of the circumscribing rectangle for that edge.

If multiple missing areas are present on the edge of the document, the values associated with the largest missing area on the edge will be reported, i.e., only one missing area will be reported for each edge of the document.

Criteria for Defect Present:

The defect will be assumed to be present if both of the conditions below occur:

- Folded/torn edge width > *Maximum Edge Fold/Tear Width Threshold*
- Folded/torn edge height > *Maximum Edge Fold/Tear Height Threshold*

Independent folded/torn edge width and height thresholds will be defined for each edge of the document, i.e., four separate sets of width and height thresholds.

Possible Source(s) of the Defect:

- Torn and/or folded document edge. An image defect identified when an edge (top, bottom, left, right) of the source document has been torn and/or folded, causing an area of the document image to be missing and obscured.

Defect Illustrations:

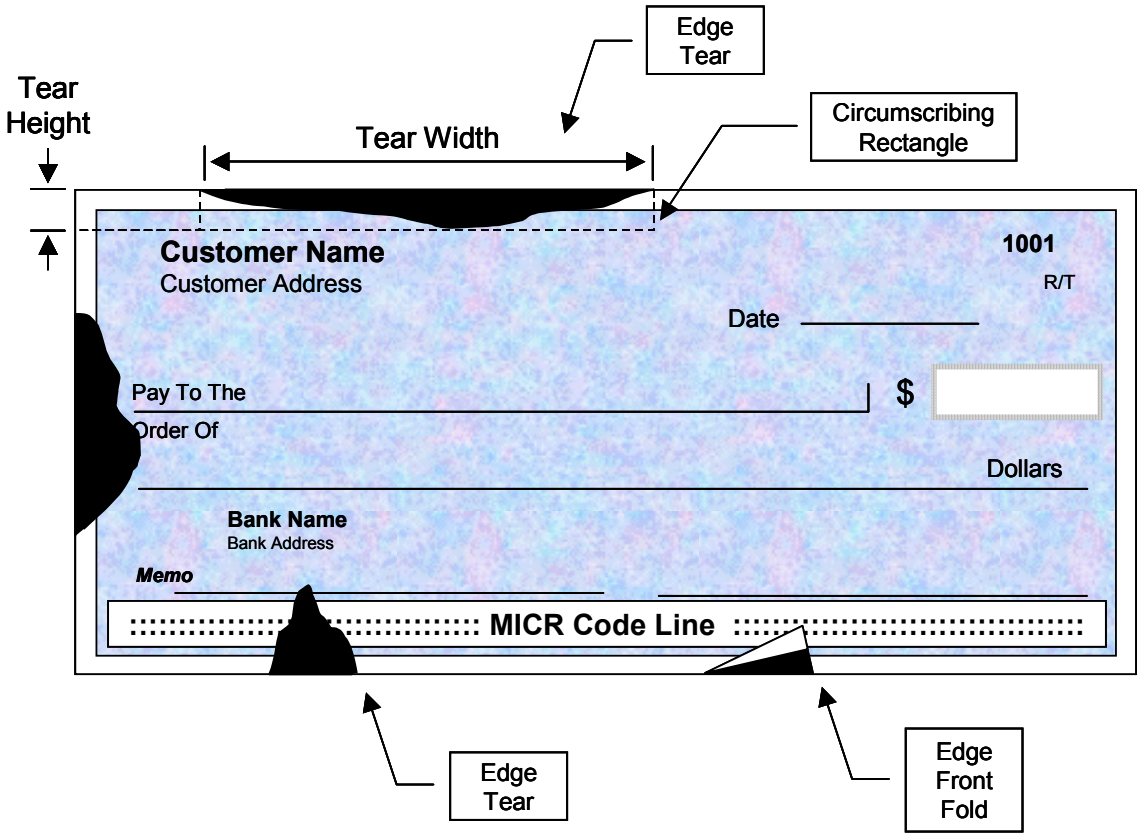


Figure 3A - Torn/Folded Document Edge Defects

Figures 3B – Large Edge Tear Present on the Bottom of the Source Document

Possible Business Impacts:

In general, the presence of a "folded/torn document edge" could cause one or more key data fields, present on the source document to be missing and/or obscured on the image rendition of the document. Other business impacts include the following:

- Inability to create a complete substitute check.
- Financial losses due to missing/obscured information in one or more key data fields.
- Missing information in customer statements (Day 2 processing impact).
- Missing information in CD-ROM delivery.
- Missing information during on-line access.
- General customer service issues.
- May require that some documents will need to be rescanned (work flow and labor expense impact)

Recoverability:

This defect may be recoverable if the source document can be unfolded and re-imaged. There is no recovery for severely torn documents, since the information has been lost on the source document.

4. Document Framing Error

Definition:

An image defect that is due to the inclusion of additional vertical and/or horizontal scan lines, within the document image, that contain no document pixel data.

Measurement and Units:

For each image a tri-state "flag" will be provided indicating whether the "document framing error" condition was tested for and the result of the test.

- Framing Error Flag = 0, if the condition is not tested
- Framing Error Flag = 1, if the condition is tested, and the defect is present
- Framing Error Flag = 2, if the condition is tested, and the defect is NOT present

In addition to the tri-state flag, the following metrics for the defect will be provided:

- Width in tenths of inches of the additional scan lines present to the left of the left edge of the document, e.g., 15 = 1.5 inches.
- Width in tenths of inches of the additional scan lines present to the right of the right edge of the document, e.g., 11 = 1.1 inches.
- Height in tenths of inches of the additional scan lines present above the top edge of the document, e.g., 17 = 1.7 inches.
- Height in tenths of inches of the additional scan lines present below the bottom edge of the document, e.g., 3 = 0.3 inches.

Criteria for Defect Present:

The defect will be assumed to be present if one or more of the conditions below occur:

- Width of additional left edge vertical scan lines > *Maximum Left Edge Over scan Threshold*
- Width of additional right edge vertical scan lines > *Maximum Right Edge Over scan Threshold*
- Width of additional top edge horizontal scan lines > *Maximum Top Edge Over scan Threshold*
- Width of additional bottom edge horizontal scan lines > *Maximum Bottom Edge Over scan Threshold*

Possible Source(s) of the Defect:

- The presence additional scan lines prior to the left (or prior to the right) edge of the document in the document image. This condition can be the result of the image camera system not being able to properly detect the right or left edge of the document during the image capture process.
- The presence of additional scan lines below the bottom (or above the top) edge of the document in the document image. This condition can be the result of the image camera system not being able to properly detect the bottom or top edge of the document during the image capture process.

Defect Illustrations:

Figure 4A - Document Framing Defect - Additional Vertical Scan Lines

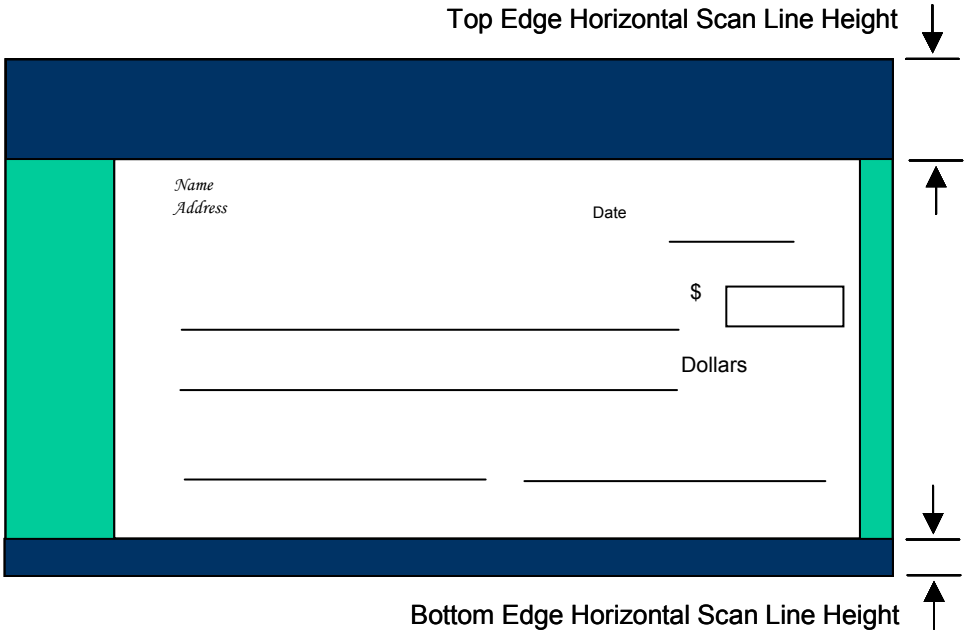
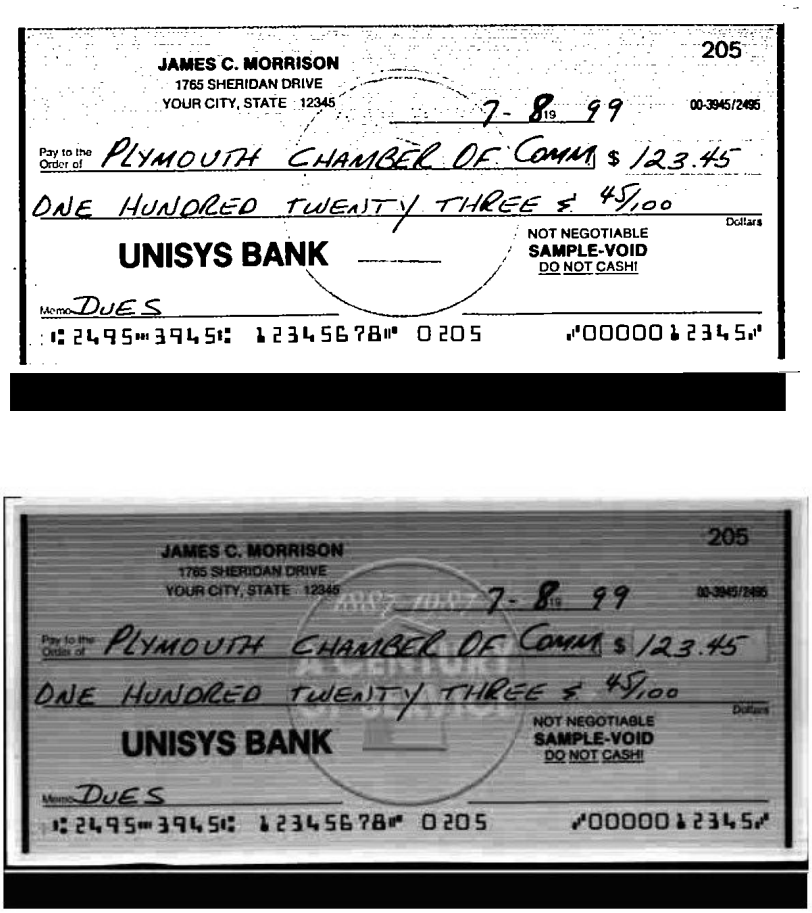
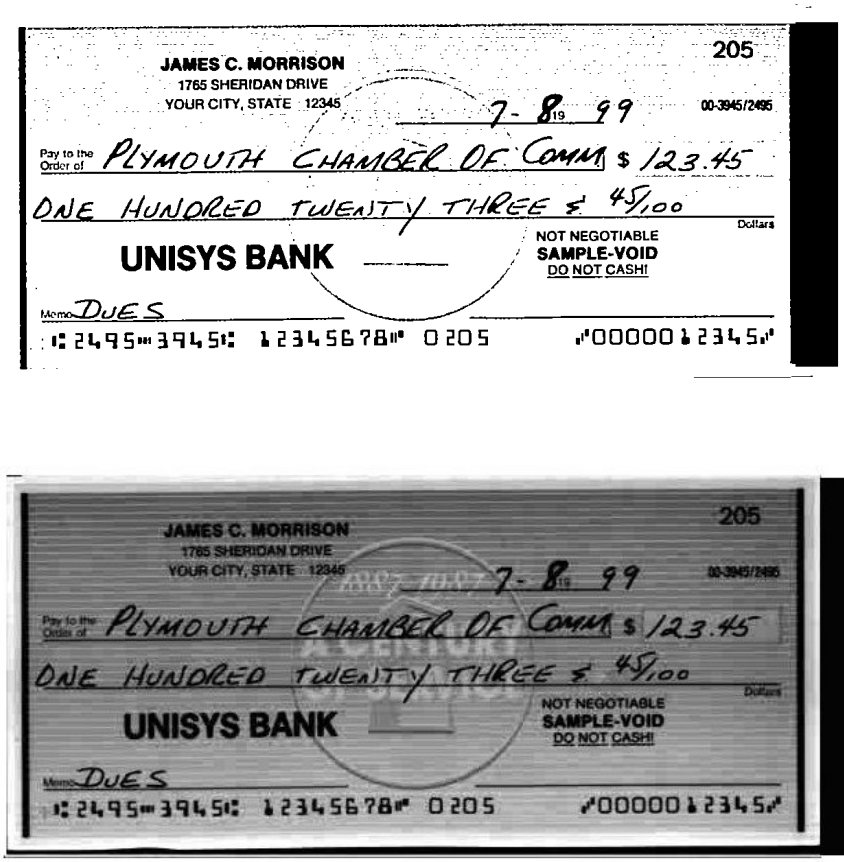


Figure 4B - Document Framing Defect - Additional Horizontal Scan Lines



Figures 4C – Additional Horizontal Scan Lines on the Bottom Edge of the Image



Figures 4D – Additional Vertical Scan Lines on the Right Edge of the Image

Possible Business Impacts:

In general, "document framing defects" may not directly create any image legibility or usability issues. However, two possible operational impacts resulting from document framing defects are listed below:

- Improper document framing can create esthetic artifacts with the document image that could create issues for image statement print applications and/or customer acceptance.
- The presence of additional vertical and/or horizontal scan lines can negatively impact image print legibility, if the image must be scaled to a constant size for the image print process, e.g., image statement print or substitute check generation.

Recoverability:

This defect may be recoverable if the source document can be re-imaged, possibly on an alternate document processor or scanner.

5. Excessive Document Skew

Definition:

A defect caused by the imaged document not being in proper alignment with the image camera sensor.

Measurement and Units:

For each image a tri-state "flag" will be provided indicating whether the "excessive document skew" condition was tested for and the result of the test.

- Document Skew Flag = 0, if the condition is not tested
- Document Skew Flag = 1, if the condition is tested, and the defect is present
- Document Skew Flag = 2, if the condition is tested, and the defect is NOT present

In addition to the tri-state flag, the following metrics for the defect will be provided:

Document skew is the angle formed in the image between the lower edge of the document and the lower edge of the image.

- Document Skew Angle (in tenths of degrees, e.g. 15 = 1.5 degrees of skew, -20 = -2.0 degrees of skew)
- Angle range (-90 degrees to +90 degrees)

Rotating the check clockwise creates negative skew angles. Rotating the check counter-clockwise creates positive skew angles.

It is recognized that in many cases, the sign of the skew angle will be opposite between the front and rear image renditions of the document because a clockwise rotation of the front of the check corresponds to a counter-clockwise rotation of the rear of the check.

Criteria for Defect Present:

The defect will be assumed to be present if one or more of the conditions below occur:

- Document Skew Angle < *Negative Skew Angle Threshold*
- Document Skew Angle > *Positive Skew Angle Threshold*

Possible Source(s) of the Defect:

- Paper handling problems in the document transport, e.g. document feeder, transport belts/rollers. Documents may not be properly aligned in the transport track, resulting in the document being skewed as it imaged by the camera subsystem.
- Improper alignment of the document on a flatbed scanner. If the document is being imaged using a flatbed scanner, improper alignment of the document on the scanner window will result in a skewed document image.

Defect Illustrations:

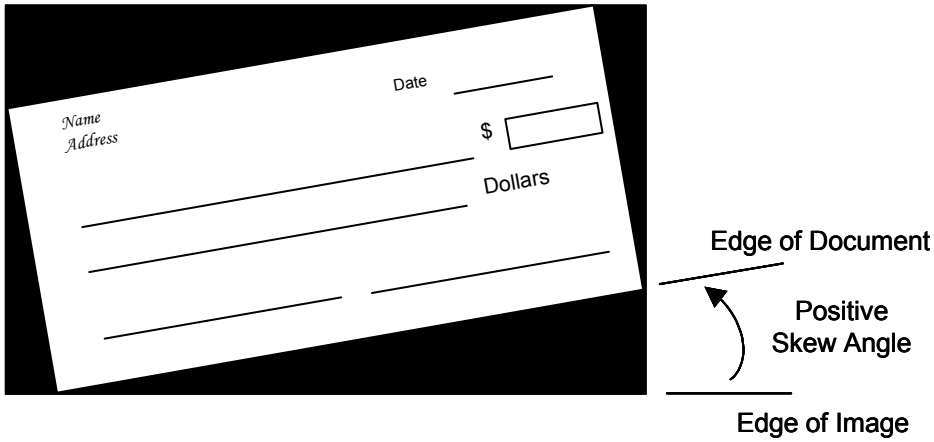


Figure 5A – Example of Positive Document Skew

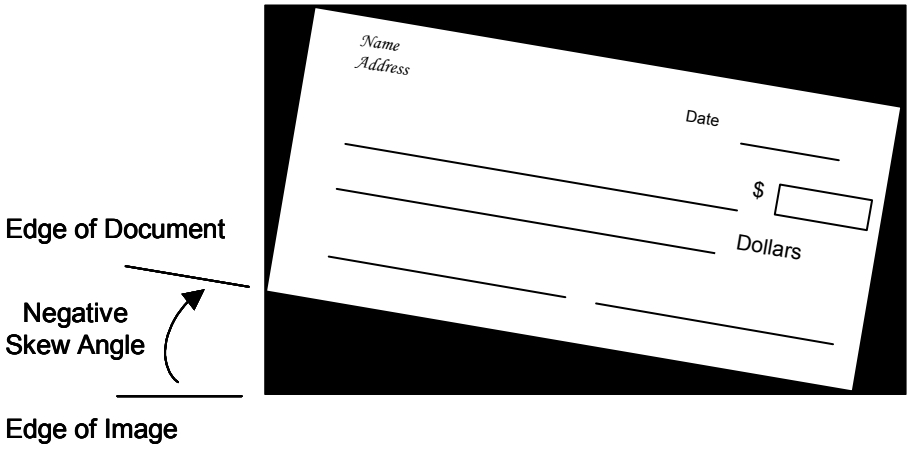
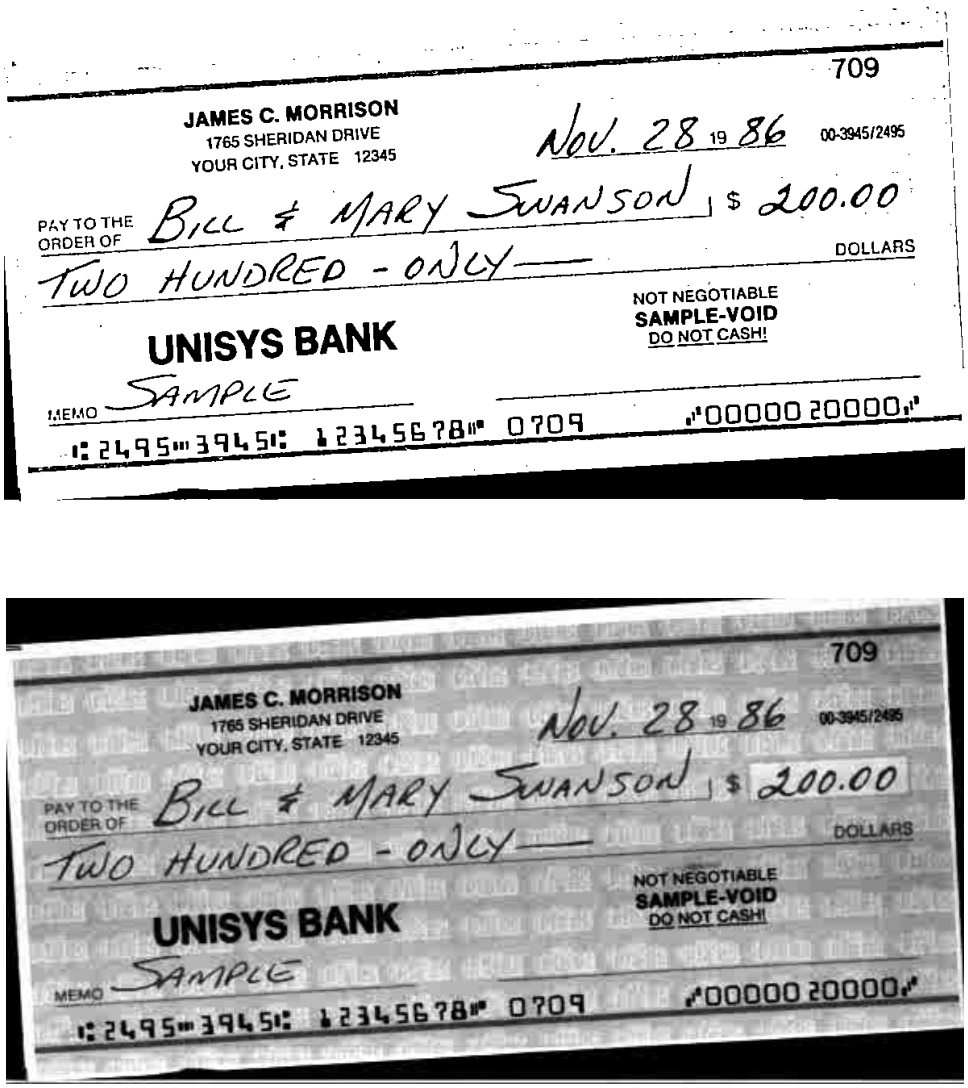


Figure 5B – Example of Negative Document Skew



Figures 5C – Excessive Document Skew

Possible Business Impacts:

- Excessive document skew can create "partial image", e.g., clipping or truncating, defects, if the document is rotated out of the image cameras field-of-view.
- Document skew can create esthetic artifacts with the document image that could create issues for image statement print applications and/or customer acceptance, e.g., triangular shaped wedges on the perimeter of the document that may be white, black or a striped pattern.
- Small skew angles can seriously impact MICR and OCR. A skew angle of 2 to 3 degrees on a typical length document can move the MICR characters outside the ANSI specified band. Similar skew angles can cause degradation of CAR/LAR.

Other business impacts include the following:

- Inability to create a complete substitute check.
- Financial losses due to missing/obscured information in one or more key data fields.
- Missing information in customer statements (Day 2 processing impact).
- Missing information in CD-ROM delivery.
- Missing information during on-line access.
- General customer service issues.
- May require that some documents will need to be rescanned (work flow and labor expense impact)

Recoverability:

This defect may be recoverable if the source document can be re-imaged, possibly on an alternate document processor or scanner.

6. Oversize Image

Definition:

A defect due to the document image rendition's width or height being above the maximum image size based on a maximum check size and tolerances associated with the image capture platform.

Measurement and Units:

For each image a tri-state "flag" will be provided indicating whether the "oversize image" condition was tested for and the result of the test.

- Oversize Image Flag = 0, if the condition is not tested
- Oversize Image Flag = 1, if the condition is tested, and the defect is present
- Oversize Image Flag = 2, if the condition is tested, and the defect is NOT present

In addition to the tri-state flag, the following metrics for the defect will be provided:

- Image width in tenths of inches, e.g., 90 = 9.0 inches.
- Image height in tenths of inches, e.g., 45 = 4.5 inches.

Criteria for Defect Present:

The defect will be assumed to be present if one or more of the conditions below occur:

- Image width > *Maximum Image Width Threshold*
- Image height > *Maximum Image Height Threshold*

Possible Source(s) of the Defect:

- Overlapped (piggybacked) documents. An image containing two or more documents that are overlapped as they pass the image camera.
- Under-spaced documents. An image containing two or more documents that are separated by only a small distance (or end-to-end), resulting in two documents being captured as a single image.
- Skewed documents. Excessively skewed documents may cause the maximum image height to be exceeded.

Defect Illustrations:

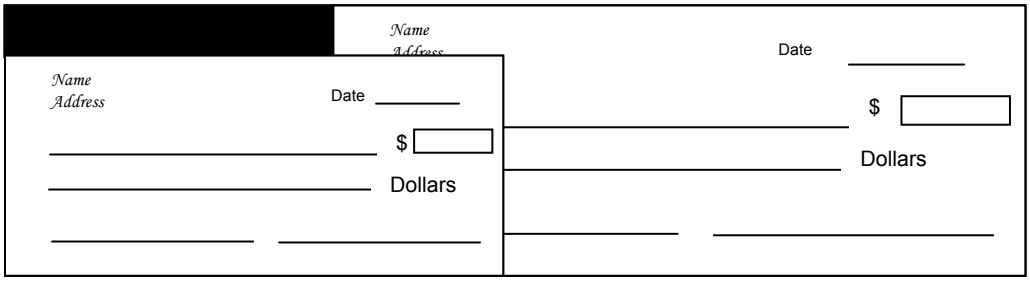


Figure 6A – Oversize Image (due to Piggyback Items)

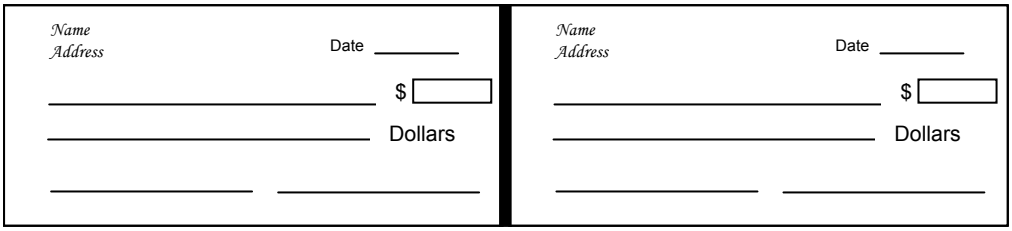


Figure 6B – Oversize Image (due to Document Spacing)

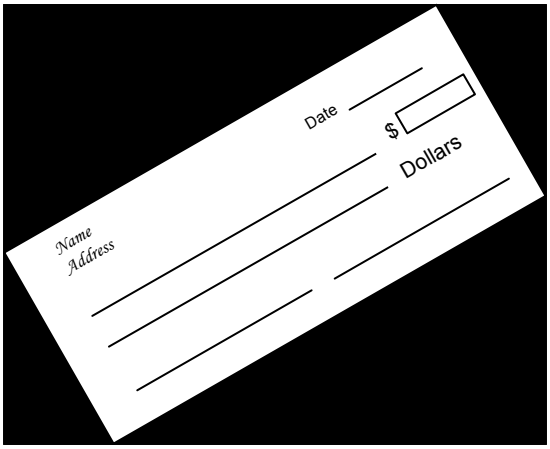
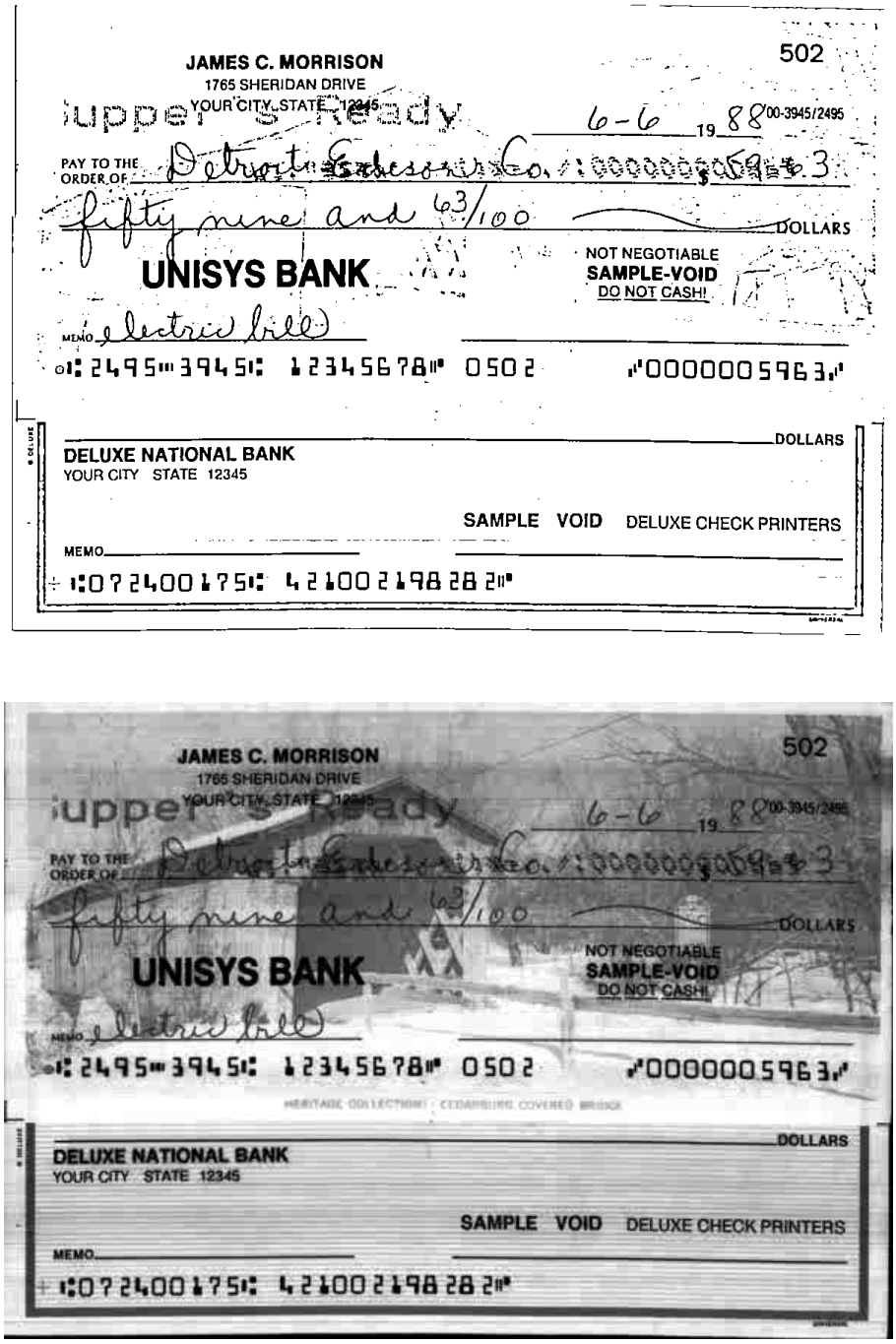


Figure 6C – Oversize Image (due to Excessive Skew)



Figures 6D – Oversize Image (Too High)

Possible Business Impacts:

- When two or more documents are overlapped, during image capture, information in one or more data fields, e.g., courtesy amount, MICR code line, Pay to, or endorsement, can be obscured by the overlapping document.
- Piggyback documents can cause legibility and usability problems depending on the degree of document overlap.
- Under-spaced documents generally create a missing image/document during the image capture process.

Other business impacts include the following:

- Reconciling outages.
- Differences from transit items dispatched "free".
- Increased adjustment rate affecting downstream partners.
- Potential losses due to lost information.
- Potential for missing/extra items in customer statements (Day 2 impact).
- Creating a missing item charge.
    - The piggybacked item will not be charged to either an on us account or out the door as a transit item.
- No information on the piggybacked item (item behind) since the only part you can see on film is the back.
- If the item information can be obtained either from the system or the depositor, and it is a transit item, a collection letter will need to be sent to verify if the item has been paid.
- If the original item has not been paid you will need to send a substitute documentary draft to collect the funds.

Recoverability:

This defect may be recoverable if the source document(s) can be re-imaged, possibly on an alternate document processor or scanner.

7. Piggyback Document

Definition:

A piggyback image defect occurs when two or more documents are present and overlapped within the document image.

Measurement and Units:

For each image a tri-state "flag" will be provided indicating whether the "piggyback document" condition was tested for and the result of the test.

- Piggyback Document Flag = 0, if the condition is not tested
- Piggyback Document Flag = 1, if the condition is tested, and the defect is present
- Piggyback Document Flag = 2, if the condition is tested, and the defect is NOT present

Sample Criteria for Defect Present:

Specific measurements and detection criteria associated with this defect are not defined and are dependent upon specific vendor implementation methodology. Although each vendor will determine how to set the piggyback flag, examples of possible approaches are presented below.

- Presence of document transport signaling information ("feed check", double document detection, etc.).
    - Items identified as possible piggyback or "double document" by the capture hardware or capture software.
- Document images with more than one document.
    - Two or more items overlap as they travel through the capture hardware transport. An item is attached to the back of another item and processed without ever being separated from the first item. Items are partially or completely stacked behind another item.
- Portion of the MICR code line, endorsement, or customer name/address obscured on the image.
- Detected multiple document heights within the document image.
    - More than one item aligned at the bottom, but different heights. More than one item not aligned at bottom
- Detected multiple MICR code lines.
- Detected multiple "data fields" on within the document image.
    - More than one "Pay to the Order of" words. More than one courtesy amount. More than one "memo" or "for" words.
- Problems reading the documents MICR code line.
    - MICR line capture may or may not be affected depending on where on the sorter track the overlapping occurs.
- Endorsement (present on the rear of the document) does not match the information on the front (face) of the document. If an item is completely piggybacked it may still be recognized if the endorsement information doesn't match the front of the item.

Possible Source(s) of the Defect:

Overlapped (piggybacked) documents. Generally due to:

- Poor document quality.
- Poor document work preparation prior to sorting.
- Mechanical handling and control problems within the document transport feeder or track.

Defect Illustrations:

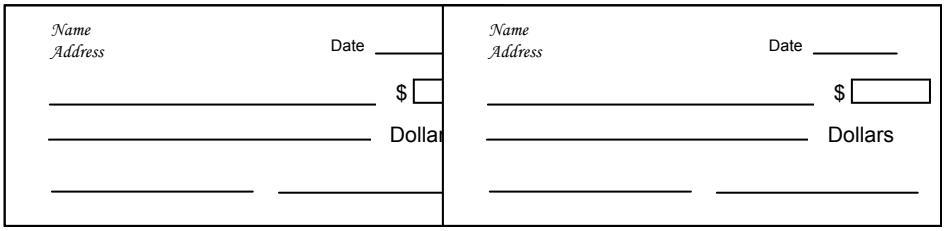


Figure 7A – Piggyback Documents (same size)

Figure 7B – Piggyback Documents (different size and skewed)

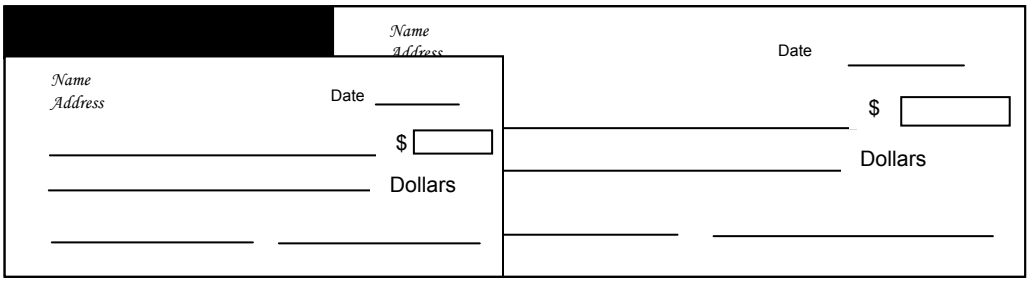
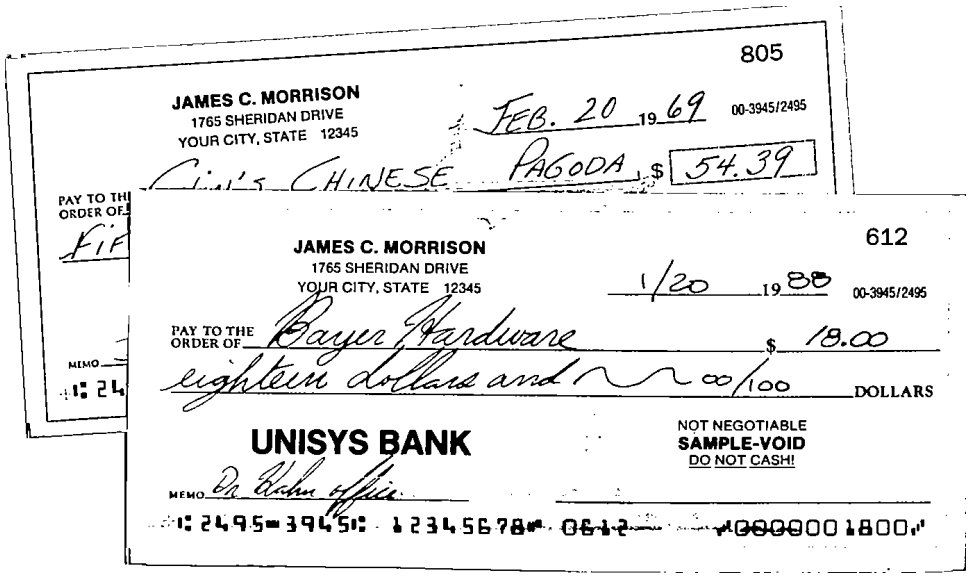
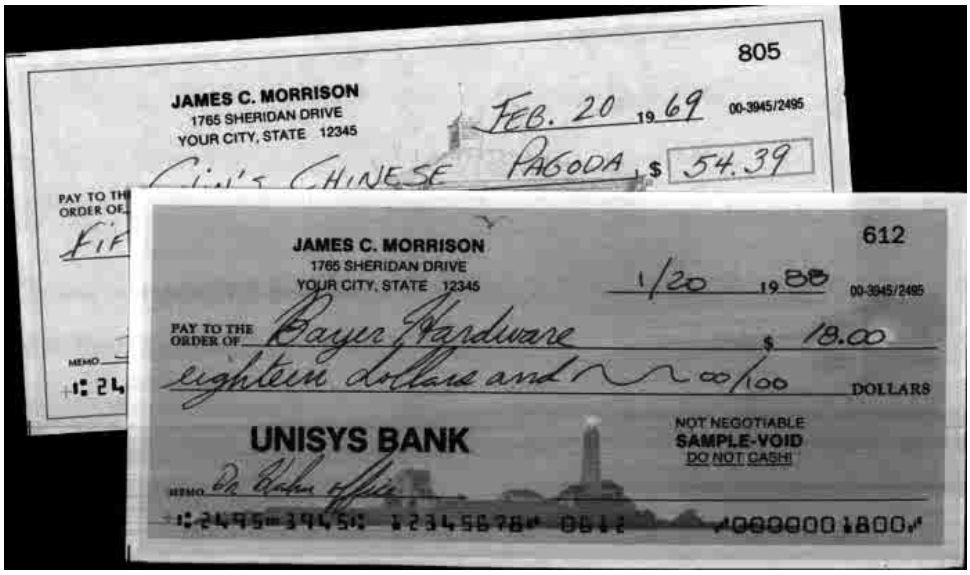


Figure 7C – Piggyback Documents (different size)

Figures 7D – Piggyback Documents





Figures 7E – Piggyback Documents

Possible Business Impacts:

- When two or more documents are overlapped, during image capture, information in one or more data fields, e.g., courtesy amount, MICR code line, Pay to, or endorsement, can be obscured by the overlapping document.
- Piggyback documents can cause legibility and usability problems depending on the degree of document overlap.
- Piggyback documents are an indicator that a document is missing in the image capture process.

Other business impacts include the following:

- Reconciling outages.
- Differences from transit items dispatched "free".
- Increased adjustment rate affecting downstream partners.
- Potential losses due to lost information.
- Potential for missing/extra items in customer statements (Day 2 impact).
- Creating a missing item charge.
    - The piggybacked item will not be charged to either an on us account or out the door as a transit item.
- The piggybacked item will not be charged to either an on us account or out the door as a transit item.
- If this is not a power-scanned item by the branch listing the transit routing number along with the dollar amount we will have to depend on the depositor for assistance which can place us in a loss position as we do not always receive a response from the depositor.
- No information on the piggybacked item (item behind) since the only part you can see on film is the back.
- If it is not possible to obtain the information on the piggybacked item, this will be a loss to the bank.
- If the item information can be obtained either from the system or the depositor, and it is a transit item, a collection letter will need to be sent to verify if the item has been paid.
- If the original item has not been paid you will need to send a substitute documentary draft to collect the funds.

Recoverability:

This defect may be recoverable if the source document can be re-imaged, possibly on an alternate document processor or scanner.

8. Image Too Light

Definition:

For a bi-tonal image, a defect due to the image not having a sufficient number of "black" pixels.

For a gray level image, a defect due to the image having sufficient "brightness", but insufficient "contrast".

Measurement and Units:

For each image a tri-state "flag" will be provided indicating whether the "image too light" condition was tested for and the result of the test.

- Image Too Light Flag = 0, if the condition is not tested
- Image Too Light Flag = 1, if the condition is tested, and the defect is present
- Image Too Light Flag = 2, if the condition is tested, and the defect is NOT present

In addition to the tri-state flag, the following metrics for the defect will be provided:

For Bi-tonal Images:

- Percentage of black pixels in the image in units of 0.1 percent, e.g., 20 = 2% of the image pixels are black.

Note:

- *Percent black pixels in the image is defined as:*

$$\text{Percent Black Pixels} = \frac{\text{(Number of Black Pixels in the Image)}}{\text{(Total Pixels in the Image)}} * 100$$

For Gray Level and Color Images:

- Percent image brightness in units of 0.1 percent, e.g., 782 = 78.2% brightness.
- Percent image contrast in units of 0.1 percent, e.g., 550 = 55.0% contrast.

Note:

- *Percent image brightness is defined as the average of the brightest "N" pixels in the image divided by the whitest gray level pixel value possible, e.g., 255, times 100. It is suggested that "N" represent 75-90% of the lightest gray level pixels present in the entire image (computed from the image gray level histogram).*

$$\text{\% Average Brightness} = \frac{\text{(Avg. of the "N" Whitest Pixels)}}{\text{(Maximum White Value Possible)}} * 100$$

- *Percent image contrast is defined as the contrast between the "N" brightest and "M" darkest pixels in the image, expressed as a percentage. It is suggested that "N" represent 75-90% of the lightest gray level pixels present in the entire image (computed from the image gray level histogram), and that "M" represent the remaining 10-25% of the darkest gray level pixels present in the entire image.*

$$\text{\% Average Contrast} = \frac{\text{((Avg. of the "N" Whitest Pixels) – (Avg. of the "M" Blackest Pixels))}}{\text{(Maximum White Value Possible)}} * 100$$

Note: Metric computations as defined above for both bi-tonal and gray level image renditions will exclude the image pixels that are located in the margin surrounding the document image. The size of the top, bottom, right and left margins will be determined in a future FSTC investigation. As a starting point for defining the size of the margin to be excluded from the document image, refer to ANSI X9.13, regarding the printing/placement of non-magnetic pre-printed borders on personal and business checks.

Criteria for Defect Present:

For Bi-tonal Images:

The defect will be assumed to be present if the condition below occurs:

- Percentage of black pixels < *Minimum Percentage of Black Pixels Threshold.*

For Gray Level and Color Images:

The defect will be assumed to be present if both of the conditions below occur:

- % Average Brightness > *Maximum Percent Brightness Threshold*
- % Average Contrast < *Minimum Percent Contrast Threshold*

Possible Source(s) of the Defect:

This defect can be due to one or more of the following problems:

- Poor printing/writing contrast on the source document.
- Improper thresholding of the document background.
- Illumination problems with the image capture subsystem.
- Image camera calibration problems.

Defect Illustrations:

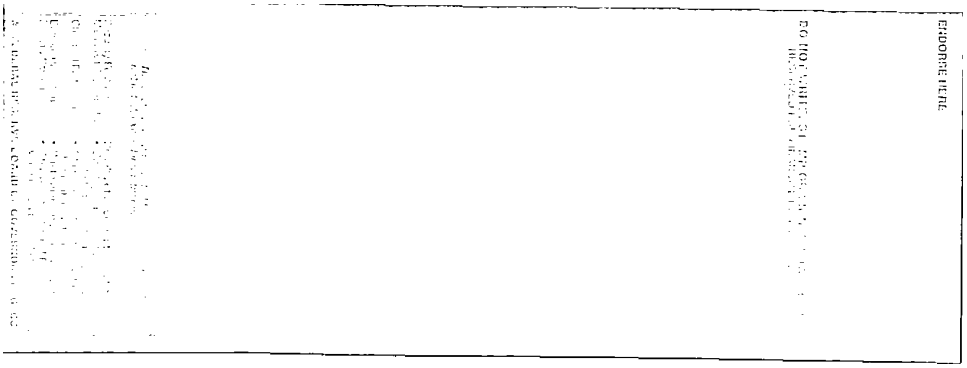


Figure 8A – Bi-tonal Rear Image Too Light

Possible Business Impacts:

For bi-tonal images, having insufficient black pixels in the document image indicates that there is very little writing or printing present, creating a potential image usability/legibility issue.

For gray level or color images, having insufficient contrast in the document image creates an image rendition that looks "washed out", creating a potential image usability/legibility issue.

Other business impacts include the following:

- Inability to create a legible substitute check.
- Financial losses due to information being eliminated/obscured in one or more key data fields.
- Information missing/obscured in customer statements (Day 2 processing impact).
- Information missing/obscured in CD-ROM delivery.
- Information missing/obscured during on-line access.
- General customer service issues (document image fidelity).
- May require that some documents will need to be rescanned (work flow and labor expense impact)

Recoverability:

This defect may be recoverable if the source document can be re-imaged using an alternate threshold setting (for bi-tonal image renditions) or an alternate document scanner.

9. Image Too Dark

Definition:

For a bi-tonal image, a defect due to the image having too many "black" pixels.

For a gray level image, a defect due to the image having insufficient "brightness".

Measurement and Units:

For each image a tri-state "flag" will be provided indicating whether the "image too dark" condition was tested for and the result of the test.

- Image Too Dark Flag = 0, if the condition is not tested
- Image Too Dark Flag = 1, if the condition is tested, and the defect is present
- Image Too Dark Flag = 2, if the condition is tested, and the defect is NOT present

In addition to the tri-state flag, the following metrics for the defect will be provided:

For Bi-tonal Images:

- Percentage of black pixels in the image in units of 0.1 percent, e.g., 20 = 2% of the image pixels are black.

- *Percent black pixels in the image is defined as:*

$$\text{Percent Black Pixels} = \frac{\text{(Number of Black Pixels in the Image)}}{\text{(Total Pixels in the Image)}} * 100$$

For Gray Level and Color Images:

- Percent average image brightness in units of 0.1 percent, e.g. 782 = 78.2% brightness.

Note:

- *Percent image brightness is defined as the average of the brightest "N" pixels in the image divided by the whitest gray level pixel value possible, e.g., 255, times 100. It is suggested that "N" represent 75-90% of the lightest gray level pixels present in the entire image (computed from the image gray level histogram).*

$$\text{\% Average Brightness} = \frac{\text{(Avg. of the "N" Whitest Pixels)}}{\text{(Maximum White Value Possible)}} * 100$$

Note: Metric computations as defined above for both bi-tonal and gray level image renditions will exclude the image pixels that are located in the margin surrounding the document image. The size of the top, bottom, right and left margins will be determined in a future FSTC investigation. As a starting point for defining the size of the margin to be excluded from the document image, refer to ANSI X9.13, regarding the printing/placement of non-magnetic pre-printed borders on personal and business checks.

Criteria for Defect Present:

For Bi-tonal Images:

The defect will be assumed to be present if the condition below occurs:

- Percentage of black pixels > *Maximum Percentage of Black Pixels Threshold.*

For Gray Level and Color Images:

The defect will be assumed to be present if the condition below occurs:

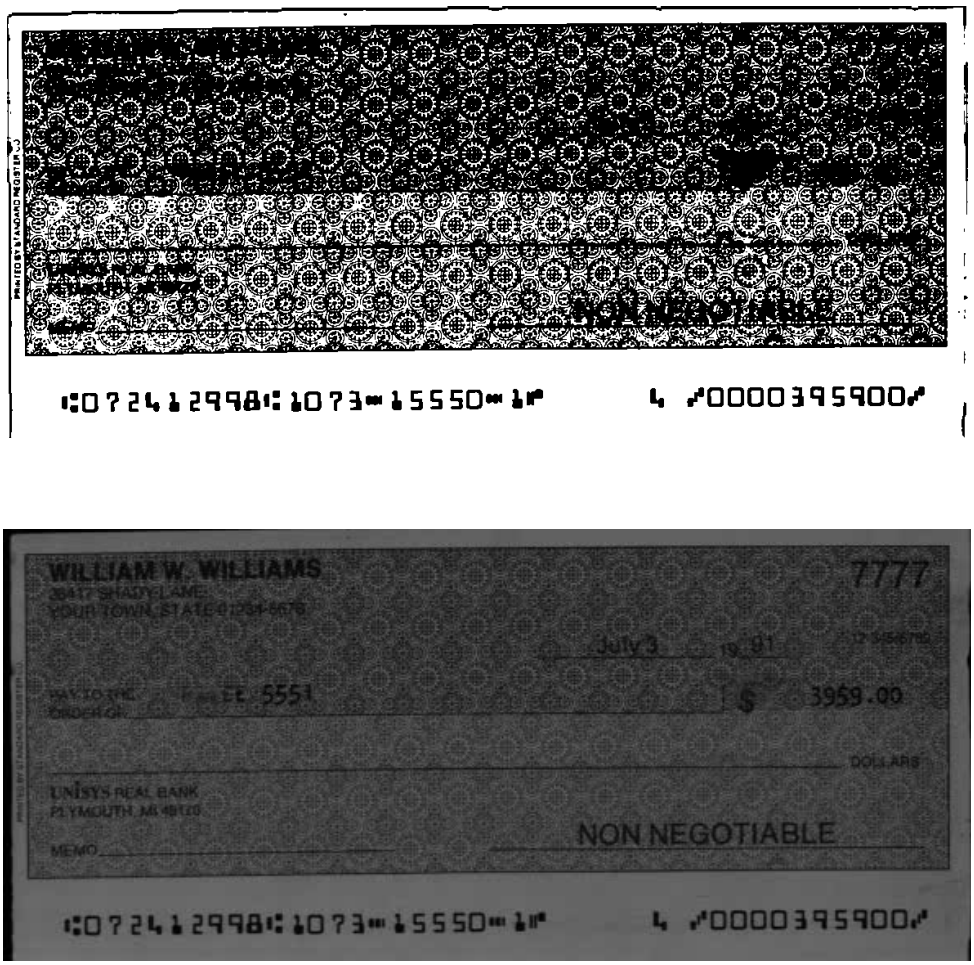
- % Average Brightness < *Minimum Percent Brightness Threshold*

Possible Source(s) of the Defect:

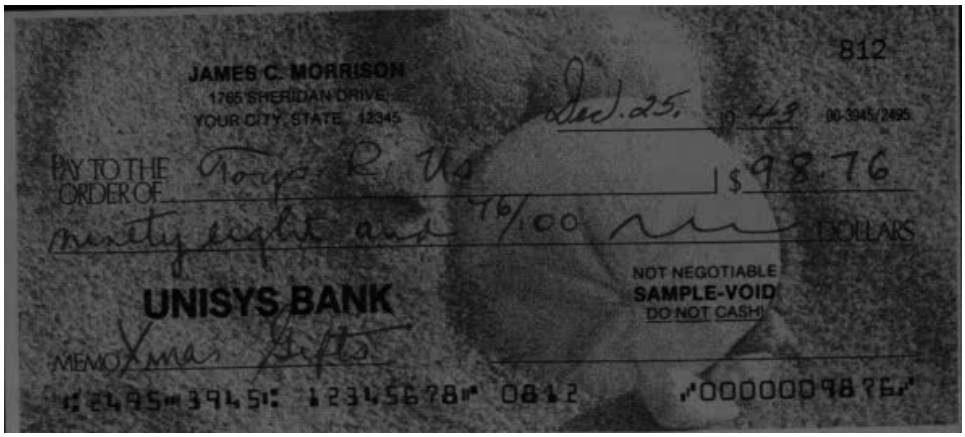
This defect could be an indicator of one of the following problems:

- Excessive printing/writing on the source document.
- Improper thresholding of the document background.
- Large amounts of black pixel "noise" present in the image.
- Illumination problems with the image capture subsystem.
- Image camera calibration problems.

Defect Illustrations:



Figures 9A – Image Too Dark



Figures 9B – Image Too Dark

Possible Business Impacts:

For bi-tonal images, having too many black pixels in the document image indicates that there is either a large amount of writing or printing present or a significant portion of the document background has been retained possibly obscuring the writing/printing, creating a potential image usability/legibility issue.

Other business impacts include the following:

- Inability to create a legible substitute check.
- Financial losses due to information being eliminated/obscured in one or more key data fields.
- Information missing/obscured in customer statements (Day 2 processing impact).
- Information missing/obscured in CD-ROM delivery.
- Information missing/obscured during on-line access.
- General customer service issues (document image fidelity).
- May require that some documents will need to be rescanned (work flow and labor expense impact)

Recoverability:

This defect may be recoverable if the source document can be re-imaged using an alternate threshold setting (for bi-tonal image renditions) or an alternate document scanner.

10. Horizontal Streaks Present in the Image

Definition:

A defect due to the image containing one or more "dark" (for all images) or "light" (for gray level and color images) horizontal streaks that extend horizontally across the majority of the entire document image.

Measurement and Units:

For each image a tri-state "flag" will be provided indicating whether the "horizontal streaks in the image" condition was tested for and the result of the test.

- Horizontal Streaks Flag = 0, if the condition is not tested
- Horizontal Streaks Flag = 1, if the condition is tested, and the defect is present
- Horizontal Streaks Flag = 2, if the condition is tested, and the defect is NOT present

In addition to the tri-state flag, the following metrics for the defect will be provided:

For Bi-tonal Images:

- A count of the number of horizontal "black" streaks present in the image, e.g., 10 = ten horizontal streaks detected.
- The height of the largest horizontal "black" streak present in the image, in units of pixels, e.g., 4 = the maximum black streak height detected is four pixels high.

Note: There is no provision for detecting "white" streaks in a bi-tonal image, only black streaks.

A horizontal streak in a bi-tonal image will be characterized by two attributes:

- A horizontal scan line that is composed almost entirely of black pixels.
- A height which is a measure of the number of contiguous scan lines that appear to be nearly all black.

Note: Streak height is defined as:

The number of contiguous horizontal scan lines for which the horizontal scan line black pixel percentage > *Black Streak Percentage Threshold.*

Parameters associated with the bi-tonal "horizontal streak" definition are as follows:

- *Black Streak Percentage Threshold is defin*ed as the percentage of black pixels per horizontal scan line, in units of 0.1 percent, e.g. 990 = 99.0 % or more of the pixels in a horizontal scan line must be black in order to be considered part of a streak.
- *Maximum Streak Height To Be Detected Threshold is defin*ed as the maximum streak height to be detected, in units of contiguous horizontal black scan lines, e.g., 7 = the maximum streak height to be detected (only streaks that are 7 or fewer pixels in height will be included in the count of horizontal black streaks present in the image).

For Gray Level and Color Images:

- A count of the number of horizontal "gray level" streaks present in the image, e.g., 10 = ten horizontal streaks detected.
- The height of the largest horizontal "gray level" streak present in the image, in units of pixels, e.g., 4 = the maximum gray level streak height detected is four pixels high.

A horizontal streak in a gray level or color image will be characterized by two attributes:

- A horizontal scan line whose average gray level is significantly "lighter" or "darker" than the neighboring horizontal scan lines.
- A height which is a measure of the number of contiguous gray level scan lines that appear to be have nearly the same average gray level value.

Note: Streak height is defined as:

Streak height =

Number of contiguous horizontal scan lines for which the average horizontal scan line contrast > *Streak Contrast Threshold.*

Parameters associated with the gray level or color "horizontal streak" definition are as follows:

- *Streak Contrast Threshold* is defined as the percent change in the vertical gray level contrast, in units of 0.1 percent., e.g. 250 = a 25.0 % change in contrast between a horizontal scan line (or group of scan lines) and adjacent horizontal scan lines will be required before the scan line is considered the starting/ending boundary of a gray level streak.
- *Maximum Streak Height To Be Detected Threshold* is the maximum streak height to be detected, in units of contiguous horizontal gray level scan lines, e.g., 7 = the maximum streak height to be detected (only streaks that are 7 or fewer pixels in height will be included in the count of horizontal gray level streaks present in the image).

Note: Metric computations as defined above for both bi-tonal and gray level image renditions will exclude the image pixels that are located in a top and bottom margin of the document image. The size of the top and bottom margins will be determined in a future FSTC investigation. As a starting point for defining the size of the margins to be excluded from the document image, refer to ANSI X9.13, regarding the printing/placement of non-magnetic pre-printed borders on personal and business checks.

Criteria for Defect Present:

For Bi-tonal Images:

The defect will be assumed to be present if either of the conditions below occurs:

- Largest black streak height > *Maximum Black Streak Height Threshold*
- Number of black streaks > *Maximum Black Streak Count Threshold*

For Gray Level and Color Images:

The defect will be assumed to be present if either of the conditions below occurs:

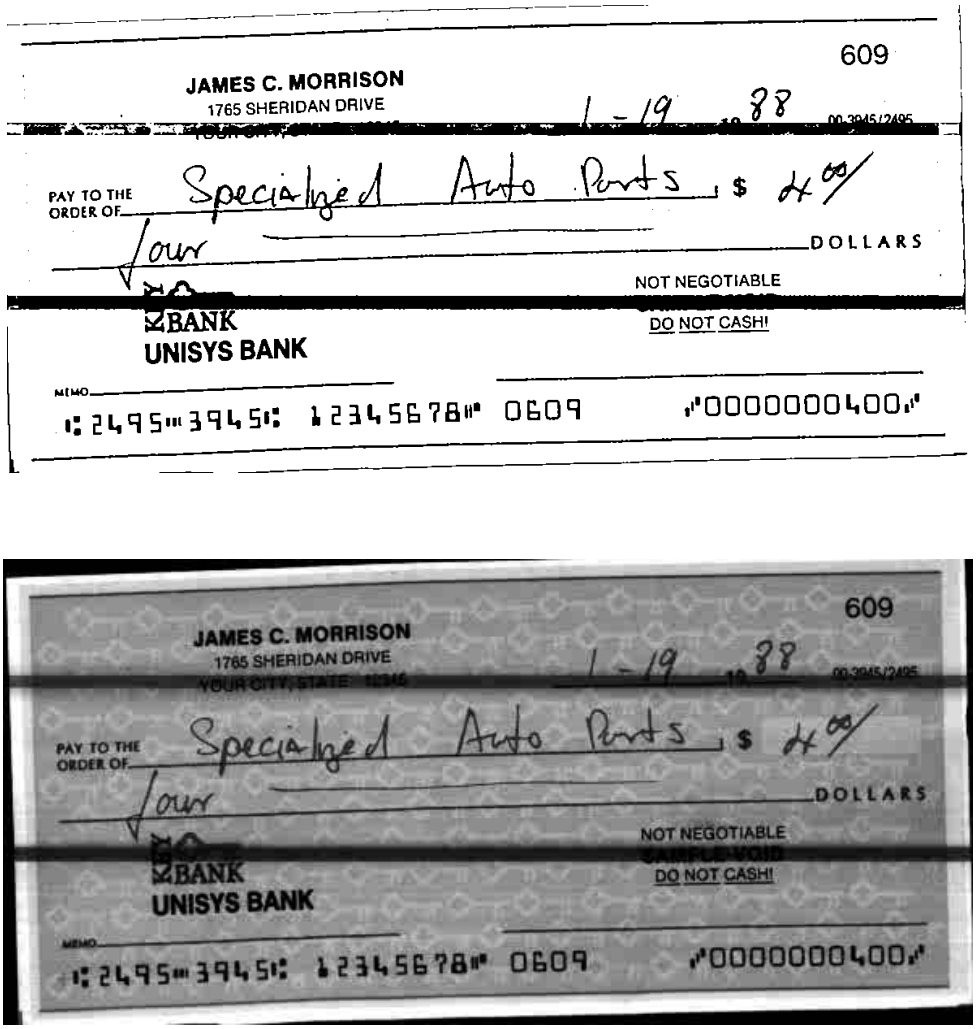
- Largest gray level streak height > *Maximum Gray Level Streak Height Threshold*
- Number of gray level streaks > *Maximum Gray Level Streak Count Threshold*

Possible Source(s) of the Defect:

Dark streaks can be caused by a number of factors during the image capture process. Possible sources of dark streaks include the following:

1. Dirt and/or ink that can adhere to either the image capture scan window or camera lens commonly present in most high, medium or low-speed document transport imaging systems.
2. A scratch or irregularity present on the image scan window or camera lens – top or bottom.
3. Dirt or debris on camera calibration targets, i.e., white reference targets.
4. Failure of the image camera CCD sensor or electronics.

Defect Illustrations:



Figures 10A – Horizontal Streaks in the Image

Possible Business Impacts:

- Dark streaks can result in the illegibility and/or potential non-usability of a required field within an image representation of an item.
- The appearance of "white streaks" may lead to image capture suspects and/or non-usability.
- Either light or dark streaks and/or bands will affect image capture suspect rates, for both are treated somewhat equally during the image quality suspect routine.

Other business impacts include the following:

- Critical component obscurity on the face of an item (maker name, courtesy amount, legal amount, signature line, payee name, etc.)
- Platform-applied audit data (back of item)
- Endorsement annihilation
- Substitute check creation
- Collectibility
- Legal equivalency
- Customer dispute
- Counterfeit detection automation
- Due to the nature of the causes of streaks and/or bands, without proper detection/prevention methods during the point of capture, there could be a large sequence of items rendered useless causing significant risk of loss.

Recoverability:

This defect may be recoverable if the source document can be re-imaged after cleaning the document scan window, re-imaged using an alternate document scanner or re-imaged after the image camera is re-calibrated.

11. Below Minimum Compressed Image Size

Definition:

The compressed image size is too low.

Note: The compressed image is defined as the compressed image raster data, exclusive of any image header.

Measurement and Units:

For each image a tri-state "flag" will be provided indicating whether the "below minimum compressed image size" condition was tested for and the result of the test.

- Below Compressed Size Flag = 0, if the condition is not tested
- Below Compressed Size Flag = 1, if the condition is tested, and the defect is present
- Below Compressed Size Flag = 2, if the condition is tested, and the defect is NOT present

In addition to the tri-state flag, the following metrics for the defect will be provided:

For both bi-tonal and gray level images:

- Compressed Image Size in bytes, e.g., 15,323 bytes.

Criteria for Defect Present:

The defect will be assumed to be present if the condition below occurs:

For bi-tonal images:

- Compressed Image Size < *Minimum Bi-tonal Compressed Image Size Threshold*

For gray level and color images:

- Compressed Image Size < *Minimum Gray Level Compressed Image Size Threshold*

Minimum compressed image size thresholds will be independently established for the front and rear image of the document and will be dependent on the image compression method utilized, e.g., CCITT, JPEG, JBIG, ABIC or JPEG 2000.

Possible Source(s) of the Defect:

This defect could be an indicator of one of the following problems:

- Improper suppression (thresholding) of the document background.
- Image camera calibration problems.
- Inappropriate JPEG compression parameters/settings, yielding an image with a high level of distortion.
- A white document with very little writing or printing, e.g., the rear of a check with a small endorsement.

Defect Illustrations:

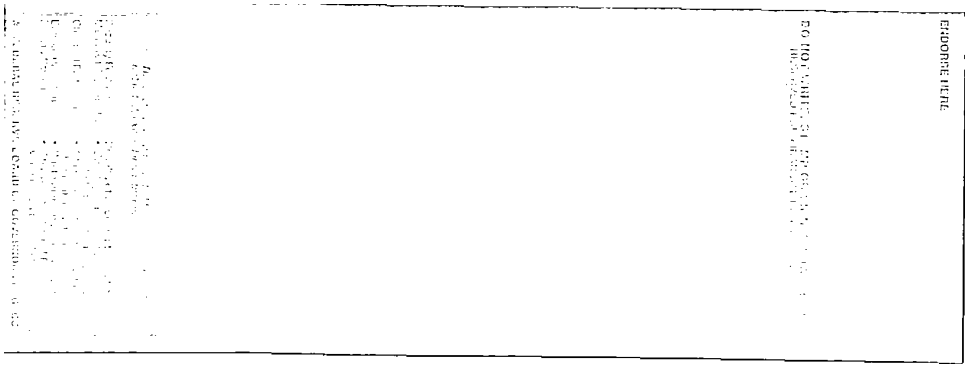


Figure 11A – Bi-tonal Rear Image Below Minimum Compressed Image Size

Possible Business Impacts:

- A small compressed image packet size could be the indicator of a check image with very little information content, e.g., writing or printing.
- In the case of a bi-tonal image rendition, a small compressed image packet size could indicate that the check image is nearly all white or all black.
- In the case of a gray level image rendition, a small compressed image packet size could indicate that the JPEG compressed check image has very low "visual" image fidelity/quality, e.g., high distortion.

Other business impacts include the following:

- Inability to create a legible substitute check.
- Financial losses due to information being eliminated in one or more key data fields.
- Information missing in customer statements (Day 2 processing impact).
- Information missing in CD-ROM delivery.
- Information missing during on-line access.
- General customer service issues (document image fidelity).
- May require that some documents will need to be rescanned (work flow and labor expense impact)

Recoverability:

This defect may be recoverable if the source document can be re-imaged using an alternate threshold setting (for bi-tonal image renditions), an alternate JPEG compression setting, or an alternate document scanner.

12. Above Maximum Compressed Image Size

Definition:

The compressed image size is too high.

Note: The compressed image is defined as the compressed image raster data, exclusive of any image header.

Measurement and Units:

For each image a tri-state "flag" will be provided indicating whether the "above maximum compressed image size" condition was tested for and the result of the test.

- Above Compressed Size Flag = 0, if the condition is not tested
- Above Compressed Size Flag = 1, if the condition is tested, and the defect is present
- Above Compressed Size Flag = 2, if the condition is tested, and the defect is NOT present

In addition to the tri-state flag, the following metrics for the defect will be provided:

For both bi-tonal and gray level images:

- Compressed Image Size in bytes, e.g., 15,323 bytes

Criteria for Defect Present:

The defect will be assumed to be present if the condition below occurs:

For bi-tonal images:

- Compressed Image Size > *Maximum Bi-tonal Compressed Image Size Threshold*

For gray level and color images:

- Compressed Image Size > *Maximum Gray Level Compressed Image Size Threshold*

Maximum compressed image size thresholds will be independently established for the front and rear image of the document and will be dependent on the image compression method utilized, e.g., CCITT, JPEG, JBIG, ABIC or JPEG 2000.

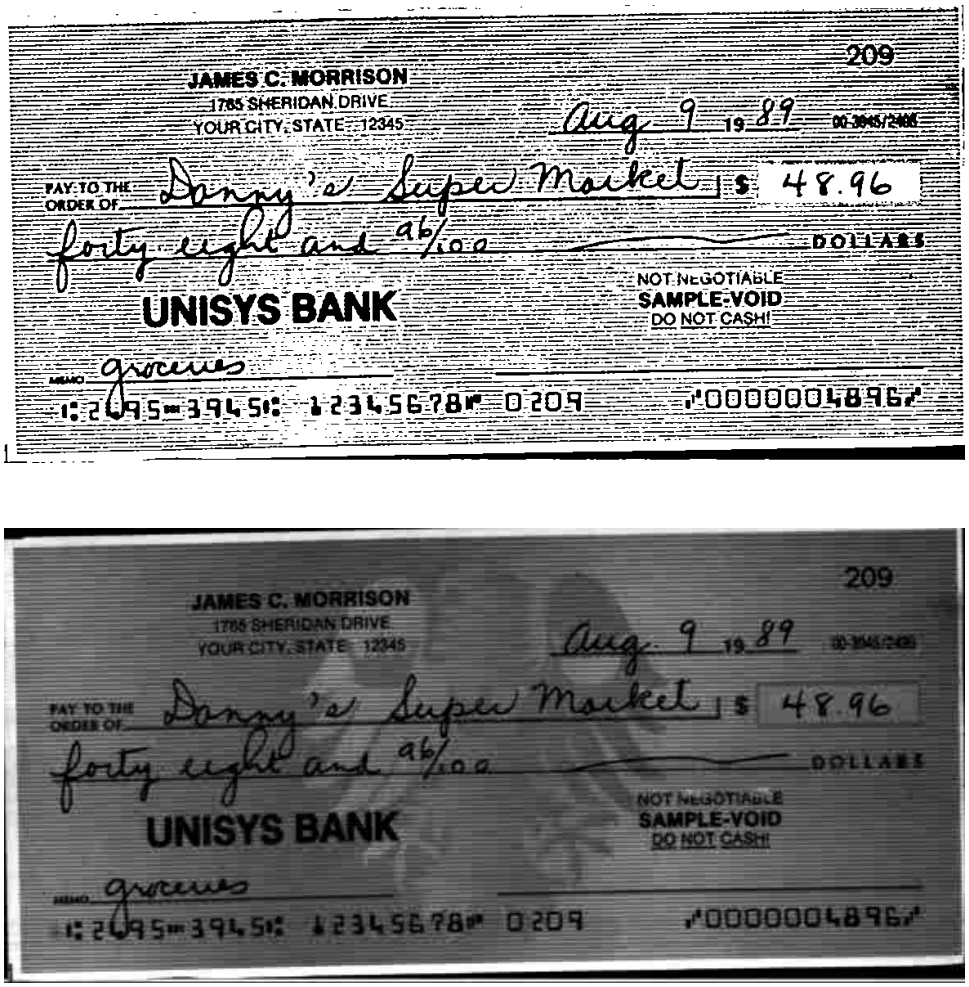
Possible Source(s) of the Defect:

A large compressed image packet size is generally an indicator of a check image with a high information content, e.g., lots of writing or printing or high contrast background patterns.

In the case of a bi-tonal image rendition, a large compressed image packet size occurs when the check image contains a lot of black/white pixel transitions. This could be an indicator that the bi-tonal image has the following attributes:

- a significant amount of image "noise" present in the check image
- a large amount of written/printed data present in the check image
- a significant amount of the check background pattern/scene has been retained during the creation of the bi-tonal rendition

Defect Illustrations:



Figures 12A – Image Above Maximum Compressed Image Size

Possible Business Impacts:

All of the above could be an indicator of possible usability and/or legibility problems in the check image.

- May not be able to view printed or handwritten information due to excessive noise or black blobs

Other business impacts include the following:

- Inability to create a legible substitute check.
- Financial losses due to information being eliminated/obscured in one or more key data fields.
- Information obscured in customer statements (Day 2 processing impact).
- Information obscured in CD-ROM delivery.
- Information obscured during on-line access.
- General customer service issues (document image fidelity).
- May require that some documents will need to be rescanned (work flow and labor expense impact)

Recoverability:

This defect may be recoverable if the source document can be re-imaged using an alternate threshold setting (for bi-tonal image renditions), an alternate JPEG compression setting, or an alternate document scanner.

13. Excessive "Spot Noise" in the Image

Definition:

For a Bi-tonal Image:

An image defect due to a bi-tonal image containing "excessive occurrences" (greater than some defined count) of "spot noise" in the image rendition.

"Spot noise" is defined as an isolated "small grouping" of connected black pixels surrounded on all sides by white pixels.

For a Gray Level Image:

Not defined.

Measurement and Units:

For each image a tri-state "flag" will be provided indicating whether the "excessive spot noise in the image" condition was tested for and the result of the test.

- Spot Noise Flag = 0, if the condition is not tested
- Spot Noise Flag = 1, if the condition is tested, and the defect is present
- Spot Noise Flag = 2, if the condition is tested, and the defect is NOT present

In addition to the tri-state flag, the following metrics for the defect will be provided:

For Bi-tonal Images:

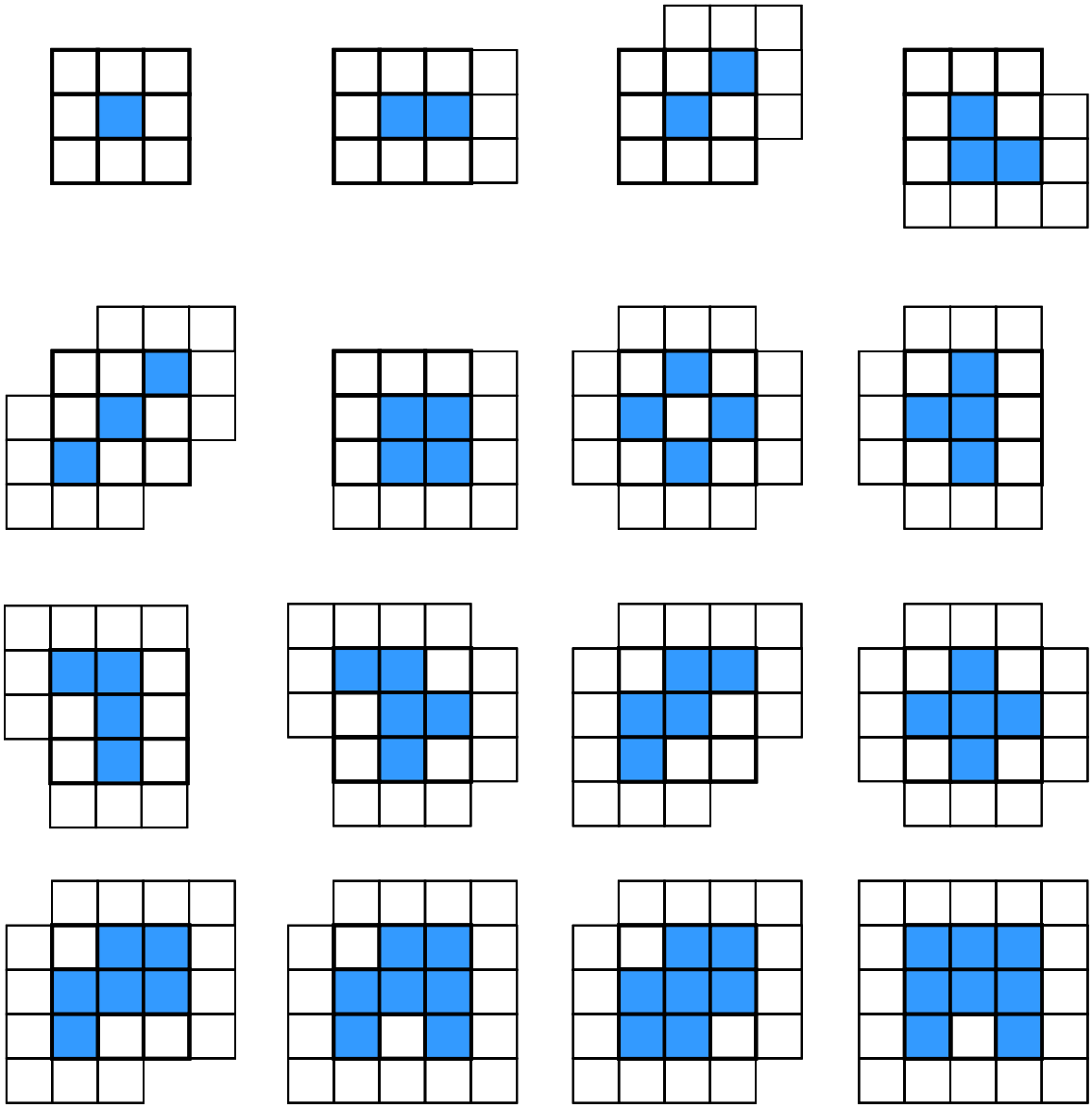
- The count "N" of the average number of "spot noise" groupings per square inch of the image, e.g., 541 groups of "spot noise" per square inch.

Note: The maximum size/area of the "spot noise" groupings will range from a single black pixel (1x1) up to a 3x3 pixel grouping of connected black pixels. The only requirement is that the pixel grouping be surrounded on all sides by at least one "white" pixel, i.e., no connectivity to other black pixels in the immediate vicinity. Although larger "spot noise" geometries are possible, it is assumed that if spot noise is present in an image, a large number of 1x1 to 3x3 spots will be present. See Figure 13A for examples of "spot noise" using this definition.

For Gray Level and Color Images:

Not applicable. At present there is no definition of "spot noise" for a gray level or color image.

Note: Metric computations as defined above for both bi-tonal and gray level image renditions will exclude the image pixels that are located in the margin surrounding the document image. The size of the top, bottom, right and left margins will be determined in a future FSTC investigation. As a starting point for defining the size of the margin to be excluded from the document image, refer to ANSI X9.13, regarding the printing/placement of non-magnetic pre-printed borders on personal and business checks.



13A – Examples of “Spot Noise” Constrained Up To a 3x3 Pixel Area

Criteria for Defect Present:

The defect will be assumed to be present if the condition below occurs:

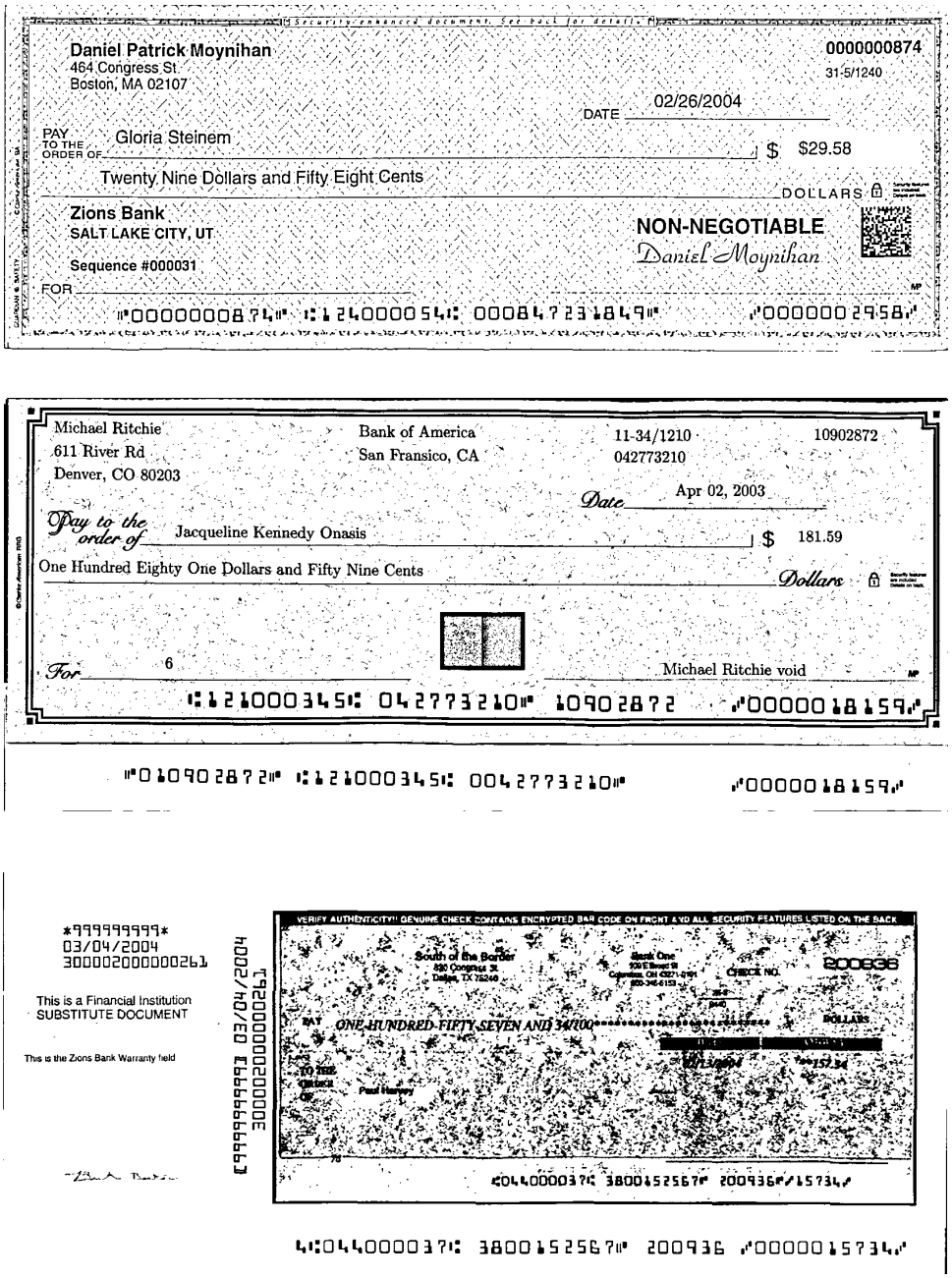
- Average spot noise count per square inch > *Maximum Spot Noise Count Threshold Per Square Inch*

Possible Source(s) of the Defect:

Noise in a bi-tonal image can be caused by one or more of factors:

- The scanned document may have a "cluttered" background such as a complex high contrast image. When imaged and thresholded, this type of background can result in many small dark regions or noise.
- Noise can result from a document that has very low contrast. In this case the threshold algorithm may produce many isolated dark regions as it struggles to differentiate between what is dark and what is bright. This can happen if the original grayscale image is bright or dark.
- Low contrast and subsequent noise can also occur if there is a problem with the scanning system such as improper illumination.
- Noise could be the result of physical defects on the document being scanned.
- The surface of an item may contain actual dark regions resulting from dirt or other contaminants that will result in a noisy image.

Defect Illustrations:



Figures 13A – Bit-tonal Images with Excessive Spot Noise

Possible Business Impacts:

- The distribution of the noise may negatively impact legibility and usability of the image for subsequent processing.
- Presence of "spot noise" in the image generally leads to increased image file sizes since images containing "spot noise" negatively impact data compression of the image pixel data. This will negatively impact operational requirements associated with check image storage and transmission bandwidth.

Recoverability:

This defect may be recoverable if the source document can be re-imaged using an alternate threshold setting (for bi-tonal image renditions) or an alternate document scanner.

14. Front-Rear Image Dimension Mismatch

Definition:

An image defect that is due to a dimensional (width and/or height) mismatch between the front and rear images of the source document.

This type of defect indicates that the image height and width do not match between the front and rear images of the source document.

Measurement and Units:

For each image a tri-state "flag" will be provided indicating whether the "front-rear image dimension mismatch" condition was tested for and the result of the test.

- Front-Rear Dimension Mismatch Flag = 0, if the condition is not tested
- Front-Rear Dimension Mismatch Flag = 1, if the condition is tested, and the defect is present
- Front-Rear Dimension Mismatch Flag = 2, if the condition is tested, and the defect is NOT present

In addition to the tri-state flag, the following metrics for the defect will be provided:

- Absolute Value of the Image Width Difference, between front and rear images (in tenths of inches, e.g. 4 = 0.4)

- Absolute Value of the Image Height Difference, between front and rear images (in tenths of inches, e.g. 3 = 0.3)

Criteria for Defect Present:

The defect will be assumed to be present if either of the conditions below occurs:

- Absolute Value of the Image Width Difference > *Maximum Image Width Difference*
- Absolute Value of the Image Height Difference > *Maximum Image Height Difference*

Possible Source(s) of the Defect:

- The front image of document "n" being matched up with the rear image of document "n-1".
- Differences in document framing for the front and rear image renditions of the document.

Defect Illustrations:

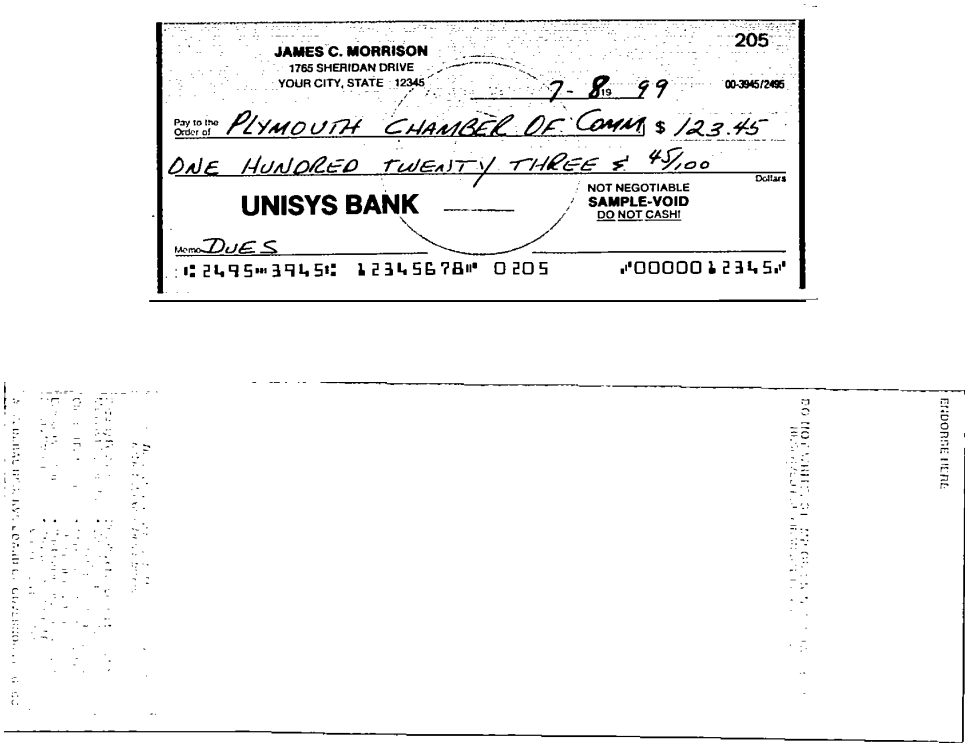


Figure 14A – Front and Rear Image Dimensional Mismatch

Possible Business Impacts:

- Matching of the front image from document "n" and the rear image from document "n-1" will create an image rendition that has the wrong endorsement data or pay to information associated with the check image.
- This defect might be recoverable by re-imaging the source document(s).

Recoverability:

This defect may be recoverable if the source document can be re-imaged, assuming the problem is either due to an "image out-of-sequence" condition or a "document framing" error for either the front or rear image rendition.

15. Carbon Strip Detected

Definition:

A defect due to the presence of a "carbonized band", that typically extends from the leading edge to trailing edge on the rear of the check, that can potentially interfere with the legibility of endorsements.

Measurement and Units:

For each image a tri-state "flag" will be provided indicating whether the "carbon strip detected" condition was tested and the result of the test.

- Carbon Strip Flag = 0, if the condition is not tested
- Carbon Strip Flag = 1, if the condition is tested, and the defect is present
- Carbon Strip Flag = 2, if the condition is tested, and the defect is NOT present

Parameters associated with this defect are as follows:

- *Minimum Carbon Strip Height,* is defined to be the minimum height of a carbon strip, in units of tenths of inches, e.g. 2 = a 0.20 inch minimum carbon strip height.

Criteria for Defect Present:

The defect will be assumed to be present when the conditions below occur:

- A black band is present on the rear of the document image that meets the size and location requirements for a carbonized band as defined in ANS X9.100-111 2004
- The black band height exceeds the *Minimum Carbon Strip Height* parameter setting.

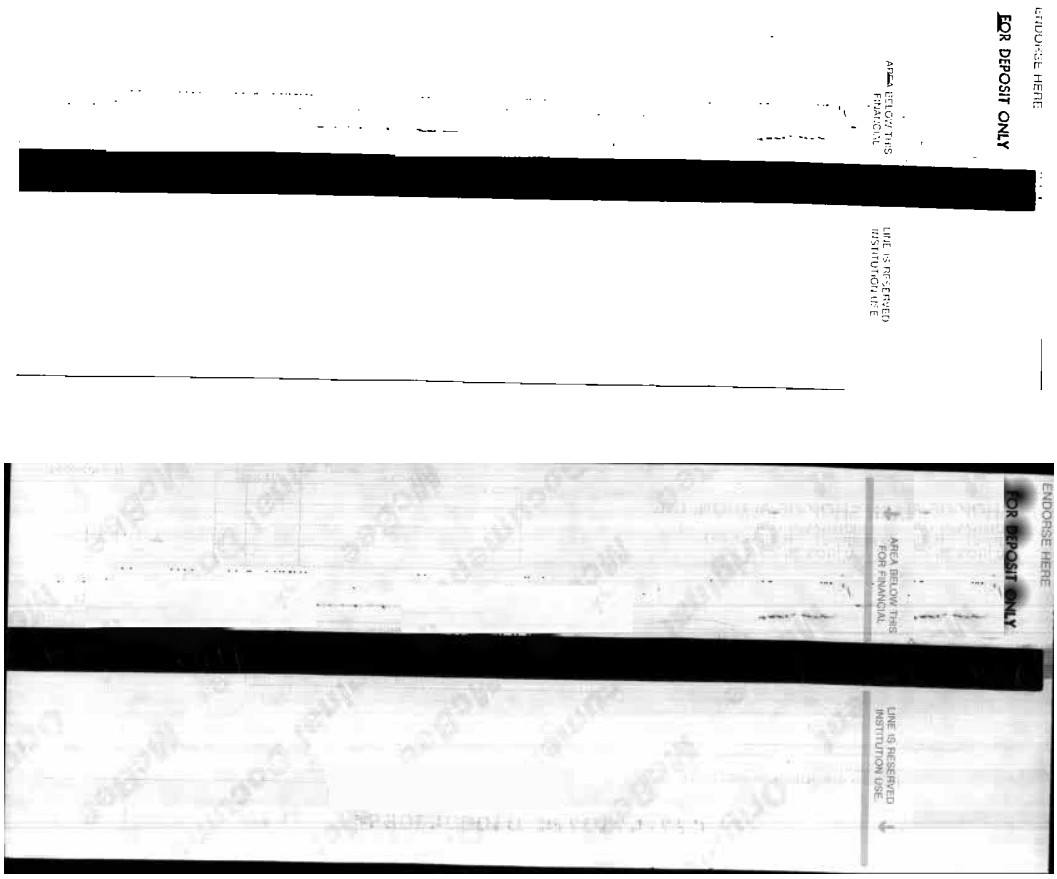
Note: As specified in ANS X9.100-111 2004, the width of the carbon band is restricted to a maximum vertical height of 0.40 inches and a maximum width of 8.75 inches, i.e. the full length of the check. Per ANS X9.100-111 2004, the carbon band is located 1.40 to 1.90 inches (1.4375 inches on average) above the aligning (bottom) edge of the check or occasionally placed on the top edge of the check at a distance of 2.80 inches or more from the bottom edge of the check. Refer to ANS X9.100-111 2004 for additional information.

Possible Source(s) of the Defect:

- The presence of a black/blue carbon strip printed on the rear of a check that facilitates the transfer of information from the check to another document, i.e., general ledger sheet or earnings record card. This type of check is a component part of a "One-Write Check System".
- One-Write Check Systems that use carbon in only the stub area would not interfere with the endorsement.
- Within the industry, both carbon and carbonless strips are used for "One-Write Check Systems".

The continued use of carbon has been driven by customer preference for the higher transfer capability and readability it provides.

Defect Illustrations:



Figures 15A – Image with Carbon Strip on Rear of Document

Possible Business Impacts:

- Full or partial obstruction of the endorsement area on the rear of the check.

Recoverability:

The presence of a carbonized strip on the rear of a check may or may not interfere with check endorsements. However, the only way to verify that a check endorsement is not being obscured by the carbon band is to have the image of the check visually reviewed by a human operator.

16. Image "Out of Focus"

Definition:

An image defect due to the image camera subsystem being "out of focus" resulting in blurred image renditions of the document.

Measurement and Units:

For each image a tri-state "flag" will be provided indicating whether the "image out of focus" condition was tested for and the result of the test.

- Out of Focus Flag = 0, if the condition is not tested
- Out of Focus Flag = 1, if the condition is tested, and the defect is present
- Out of Focus Flag = 2, if the condition is tested, and the defect is NOT present

In addition to the tri-state flag, the following metrics for the defect will be provided:

For bi-tonal images:

Not applicable.

For gray level images:

The focus measure is the ratio of maximum video gradient between adjacent pixels, measured over the entire image and normalized with respect to image's gray level dynamic range and "pixel pitch". The formula for computing image focus is provided below.

$$\text{Image Focus Score} = \frac{\text{(Maximum Video Gradient)}}{\text{(Gray Level Dynamic Range)*(Pixel Pitch)}}$$

Where,

Video Gradient = ABS [(Gray level for pixel "i") – (Gray level for pixel "i+1")]

Gray Level Dynamic Range = [(Average of the "N" Lightest Pixels) – (Average of the "N" Darkest Pixels)]

Pixel Pitch = [1 / Image Resolution (in dpi)]

Notes:

1. *A horizontal video gradient is computed at each pixel in the image by computing the absolute value difference in gray level between the pixel (i) and the pixel located to it's right (i+1). A vertical video gradient is also computed for each pixel in the image by computing the absolute value difference in gray level between the pixel (j) and the pixel located below (j+1). The maximum video gradient is determined by recording the largest gradient value computed (either horizontal or vertical) measured over the entire image.*
2. *The gray level dynamic range for the image is computed by taking the difference between the average of the "N" lightest pixels and the average of the "N" darkest pixels in the image.*
3. *Pixel pitch is computed by taking the inverse of the image resolution expressed in dots or pixels-per-inch.*

Criteria for Defect Present:

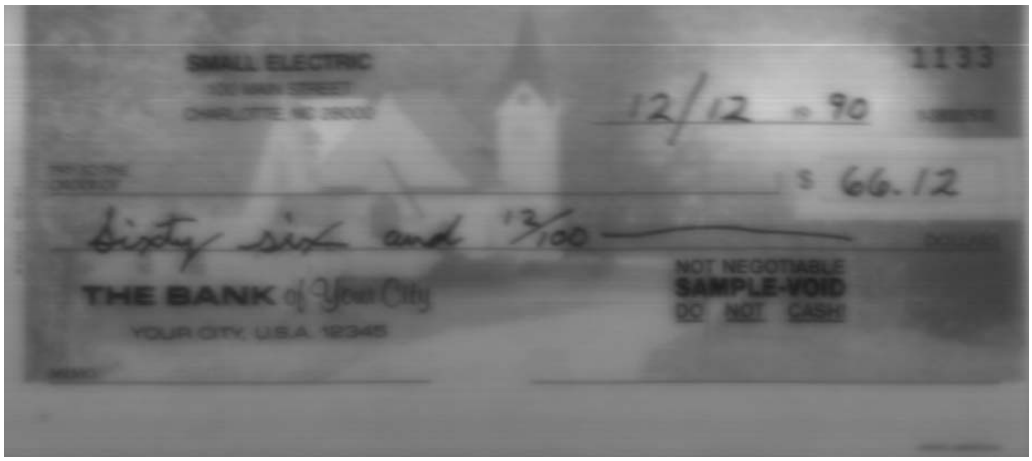
The defect will be assumed to be present when the condition below occurs:

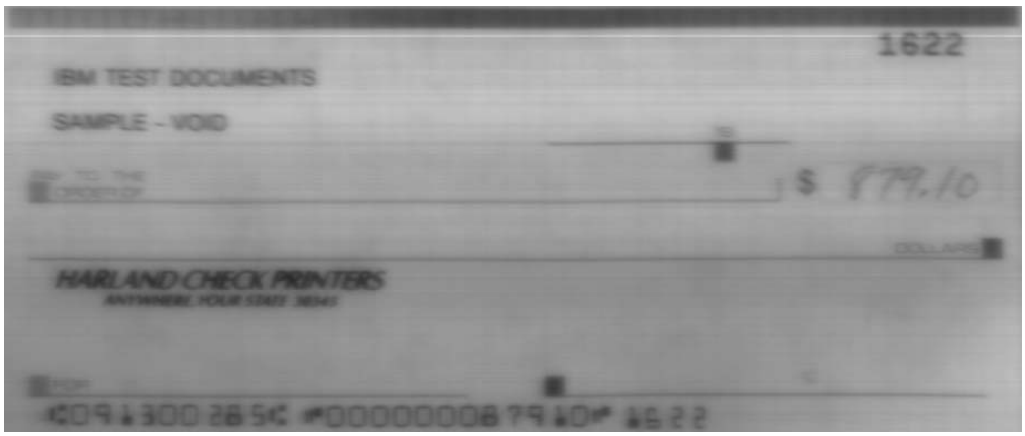
- Image Focus Score < *Minimum Focus Threshold*

Possible Source(s) of the Defect:

- An image camera that was not properly manufactured to the vendor's specifications.
- A change in the image camera's optical-mechanical setting(s) after being installed/used at a client site.
- Imaging of a document that is not positioned within the image camera's "depth of focus".

Defect Illustrations:





Figures 16A – Images Out of Focus

Possible Business Impacts:

- Inability to read pre-printed and written information that is present on the source document, e.g., pay to line, legal amount, courtesy amount, etc. due to the image being blurred.

Recoverability:

This defect may be recoverable if the source document can be re-imaged using an alternate document scanner.

Terminology

Term	Definition
Bi-tonal Image	A document image containing only black and white pixel values.
Brightness	A measurement of the gray level intensity associated with an individual pixel or region of the image.
Compressed Image Size	The compressed image data stream (normally measured in bytes) that contains the compressed rendition of the document image. The compressed image size includes any required compression parameter data defined by the image compression algorithm, e.g., JPEG or CCITT parameters, but excludes any image file header/parameter data. Compressed Image Size in expressed in units of bytes.
Contrast	A measurement of the difference in brightness between two regions (or pixels) of an image, which is generally normalized with respect to the brightest region.
Document Framing	The process of locating the top/bottom and left/right boundaries of the source document in the document image rendition.
Document Image	A digital image representation of the original paper check/document.
Document Height	The vertical dimension of the source document. The document height is normally measured in units of inches.
Document Width	The horizontal dimension of the source document. The document width is normally measured in units of inches.
dpi	Dots per inch. A measure of spatial resolution of the compressed document image, e.g., 200 dpi.
Front Image	The digital image representation of the paper check that contains the MICR code line, e.g., the front side of the check.
Front Fold (Corner or Edge)	The folded portion (corner or edge) of the paper check that covers an area located on the front side of the source document.
Gray Level Dynamic Range	A measure of the difference (in gray levels) between the lightest and the darkest pixel values in the image.
Gray Level Image (Gray Scale Image)	A document image rendition containing pixels that can take on a range of gray level values, typically between 0 and 255 (0 being pure black, 255 being pure white, with values in between representing an intermediate shade of gray).
Hole	A missing area of the original check, located in the interior of the source document.

Term	Definition
Image Area	The area of the digital image (or sub-area) computed by multiplying the pixel width and pixel height of the area of interest. Image area is normally measured in units of pixels, e.g., 100 pixels wide by 200 pixels high = an area of 20,000 pixels. Combined with the image resolution (dpi) the image area can be computed in units of square inches.
Image File Size	The size in bytes of a data file containing both the compressed image data stream, e.g., the JPEG or CCITT compressed image data, and image header/parameter data typically carried with the compressed image data, e.g., the TIFF or IOCA image file structure/wrapper. In other words, the sum of the compressed image data and the image file header/parameters. In general, the Image File Size is equal to or greater than the Compressed Image Size. Image File Size is expressed in units of bytes.
Image Height	The vertical length of the document image. The image height is normally measured in units of pixels. Combined with the image resolution (dpi), the height of the image can be computed in units of inches.
Image Rendition	A description of the document image digital representation, i.e., bi-tonal, gray level, color, etc.
Image Width	The horizontal length of the document image. The image width is normally measured in units of pixels. Combined with the image resolution (dpi), the width of the image can be computed in units of inches.
Metric	A standard unit of measurement.
Partial Document Image	A document image where a portion of the source document is either missing and/or obscured in the image rendition.
Partial Image	A document image where a portion of the source document has been "clipped" or "truncated" during the creation of the image (i.e. the source document was not entirely scanned).
Pixel	Picture Element. A single digitized sample in an image.
Pixel Pitch	The inverse of the image spatial resolution expressed in dots per inch (dpi), e.g., for a 200 dpi image rendition the pixel pitch is 1/200.
Rear Image	The digital image representation of the source document that contains the endorsement, e.g., the back of the check.
Rear Fold (Corner or Edge)	The folded portion (corner or edge) of the paper check that covers an area located on the rear side of the source document.
Scan line	A sequence of pixel values in the digital image rendition of the document that spans either the width or height of the image. Scan lines can be either oriented horizontally (across the width of the image) or vertically (across the height of the image). A collection of vertical or horizontal scan lines defines the entire area of the document image.
Source Document	The original paper check.

Term	Definition
Spot Noise	The presence of "numerous" small black pixel spots covering the entire (or a portion of) document image. This is sometimes referred to as "salt and pepper" noise, due to the fact that it appears someone has sprinkled dark specs over the entire image.
Tear (Corner or Edge)	A missing area of the original paper check, located on the corner or edge of the source document.
Threshold	A value below (above) which a metric indicates the presence of a defect.
Video gradient	The change or difference in gray level between two adjacent image pixels.

Credits

FSTC gratefully acknowledges the project contributions of the team of volunteers who helped develop the image defect metric definitions.

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