IRD Printing White Paper

by

Larry Krummel

Edited by Dana Parker
First Edition April 2005

Executive Summary

Objective

This white paper will provide insight into the challenges and issues associated with printing Image Replacement Documents (IRD).

Target Audience

The primary audience for the paper will be organizations who are planning on developing their own custom IRD solution or are having issues with IRD printing solutions such as:

- Independent Software Vendors (ISVs)
- System Integrators
- Value Added Resellers

The secondary audience are any financial institution that is or will be involved with printing IRDs including:

- Banks
- Financial Institutions
- Bank Intermediaries

Summary

This paper will help to outline what is the Check 21 Act, what is an IRD and what are the standards associated with them. Included are examples of IRDs from the current standards and an overview of which standards are important to be acquainted with in order to print a valid IRD.

This paper will help demystify and summarize what is needed for a printed paper IRD. Also, this paper will help outline what minimum number of x9.37 specification fields are need to be populated in order to generate a valid printed IRD.

The differences between an original IRD and a subsequent IRD will be explained. In addition, many printing issues will be outlined since any printer can print IRDs, but not all printers can print a **valid** IRD. IRD validity is a major issue when it comes to incorporating Check 21 processes within a financial institution. For example, the calibration of a printer is needed to insure that the printer is set up correctly to print IRDs. Printing configuration will also be explored.

To have a deeper understanding of the check printing process it is best to understand the language used to print images and IRDs. The different printing languages will be outlined and the different issues associated with each including the speed and quality of the results.

Fonts, fusers, toners and magnetic ink can create a myriad of challenges in printing an accurate IRD and many of these challenges will be outlined. In addition, different paper has different effects on checks and IRD printing and paper can cause a number of unforeseen and difficult to troubleshoot problems.

Printing accurate IRDs require that all the printing hardware, software, and paper work in harmony. Operators need to be properly trained to oversee these processes. In addition, it is important that the printing technology is flexible enough to match different burster sorting orders.

Since one component of an IRD is an image, the challenges associated with scanning and imaging the checks will be explored including when dealing with image files the images can be quite large. According to the standard, DSTU X9.90–2004, Rev. A, there is no requirement as to the check image file format of the IRD as long as the "IRD's legibility and usability are maintained." Image quality challenges will be outlined since image quality metrics are used to help determine if an IRD is of high enough quality to be accepted.

Additional topics include bandwidth, security, image alignment and image anchoring.

Introduction

What is Check 21

The Check Clearing Act for the 21st Century or "Check 21" is the federal law that allows for the creation of a substitute check. The Check 21 Act was enacted on October 28, 2003, and became effective on October 28, 2004. The goal of the law was to facilitate check truncation by authorizing substitute checks, to foster innovation in the check collection system without mandating receipt of checks in electronic form, and to improve the overall efficiency of the Nation's payments system, and for other purposes.[1]

The basis of the law is to enable banks to create a substitute check or IRD, Image Replacement Document, with required check information that can be transferred from one bank to another the same way a paper check has in the past. There are many advantages to be able to truncate or delete the paper check and create a new form of the check. A few of those advantages are:

- **Cost savings**. It is estimated that banks will save an estimated $2 billion a year in transportation and processing costs
- **Quick check clearing times** – Check clearing time could be cut down from weeks to hours
- **Fast funds collection** – Banks will be able to collect funds on checks faster
- **Faster processing of return of unpaid checks**

What is an IRD

An Image Replacement Document (IRD) is defined, as a substitute machine-readable image copy of a check that may under certain legal arrangements be the practical and legal equivalent of the original check.[2] The DTSU X9.90-2004, Rev. A standard defines the allowable uses of an IRD which includes a substitute check as defined in the Check 21 Act. Therefore, in most respects IRD and substitute check are interchangeable. To simplify, we will be referring to IRD as the name for this printed negotiable instrument throughout the rest of this document.

An IRD is the legal equivalent of the original check if it has the following requirements:

- Must accurately represent all information on the front and back of the original check
- Contain the legend "This is a legal copy of your check. You can use it the same way you would use the original check."
- Must conform to industry standards applicable to the MICR line
- Must conform to the industry standard for the physical characteristics of checks (size, paper, etc.)

[1] H.R. 1474 – The Check 21 Act
[2] DSTU X9.37 - 2003

While the Law validates the creation of paper IRDs, it does not stipulate that banks must create IRDs or that they have to accept electronic checks. It does, require that once an IRD has been created that all parties must accept them as the legal equivalent. Checks in their electronic form and the transfer between banking institutions are not covered by the ACT but rather by agreements between the parties.

In addition, according to the Federal Reserve if an illegible IRD is created then the bank that created it may be liable for losses, up to the full amount of the check/IRD in the event of a claim.

What are the standards

There is two ANSI standards that directly control the generation of IRDs and the transmission of check images: ACS X9.100-140-2004 and ACS DSTU X9.37-2003. The first defines the layout and content of the IRD itself and the second the layout and content of files with check image data. In addition, the FSTC, Financial Services Technology Consortium, has published an Image Quality document that will help define image quality records in the X9.37 files.[3]

When the Check 21 Act refers to conformance to "industry standards" for creating a Substitute Check, it is referring to ACS X9.100-140-2004 "Specifications for an Image Replacement Document--IRD". (NOTE: This was originally published as DSTU X9.90.)

Although the Check 21 Act does not require image interchange, it is in reality the whole reason for the law. The ACS document for image interchange is ACS DSTU X9.37. The final version will be X9.100-180-2005. The Federal Reserve Board (FRB) has adopted DSTU X9.37 as its operating document , The FRB has issued companion documents to clarify issues within the DSTU.

In addition, there are many standards that support the printing of IRDs. IRD printing is supported by the following standards, but is not limited to this list:

- DSTU X9.37-2003 – Specifications for Electronic Exchange of Check and Image Data created by the Accredited Standards Committee X9, Inc.
- DSTU X9.90–2004, Rev. A, Specifications for an Image Replacement Document – IRD
- ANS X9.27 (2000) – Print and Testing Specification for Magnetic Ink Printing
- ANS X9.13 (2001) Specifications for Placement and Location of MICR Printing

There are many issues related to 9.37 files and IRD printing, which will be expanded on in a later chapter.

[3] http://www.fstc.org/projects/image-quality-phase-1/

Requirements of the standards

The X9.37-2003 standard outlines what data is required to be transferred between financial institutions. Currently the standard has a wide interpretation of what is required for an IRD, therefore, it is imperative that financial institutions either know the standard and understand all the implications of the standards or work with vendors that do.

The purpose of the Check 21 law is that the financial institution printing the IRD does not have to know anything about the institutions that will process the IRD, nor have any type of formal agreement between the institutions. In addition, since financial institutions or other entities are not required to accept an electronic document in place of a check, there will be the need to print out the IRDs for exchange with those entities.

The X9.90-2004 standard establishes the construction, layout, data elements, data content, and printing specifications for Image Replacement Documents (IRD).[4]

[4] DTSU X9.90-2004, Rev. A

IRD Examples

Here are examples of a Forward Original IRD from the DTSU X9.90-2004, Rev. A Standard. The examples provided contain check designs and security features that are for illustrative purposes only and are not part of this standard. In addition examples of check images are shown in grayscale for illustration purposes only. According to the standard check images may be captured and displayed in grayscale or black and white, but the Federal Reserve Bank is requiring all IRDs to be in binary, black and white[5]

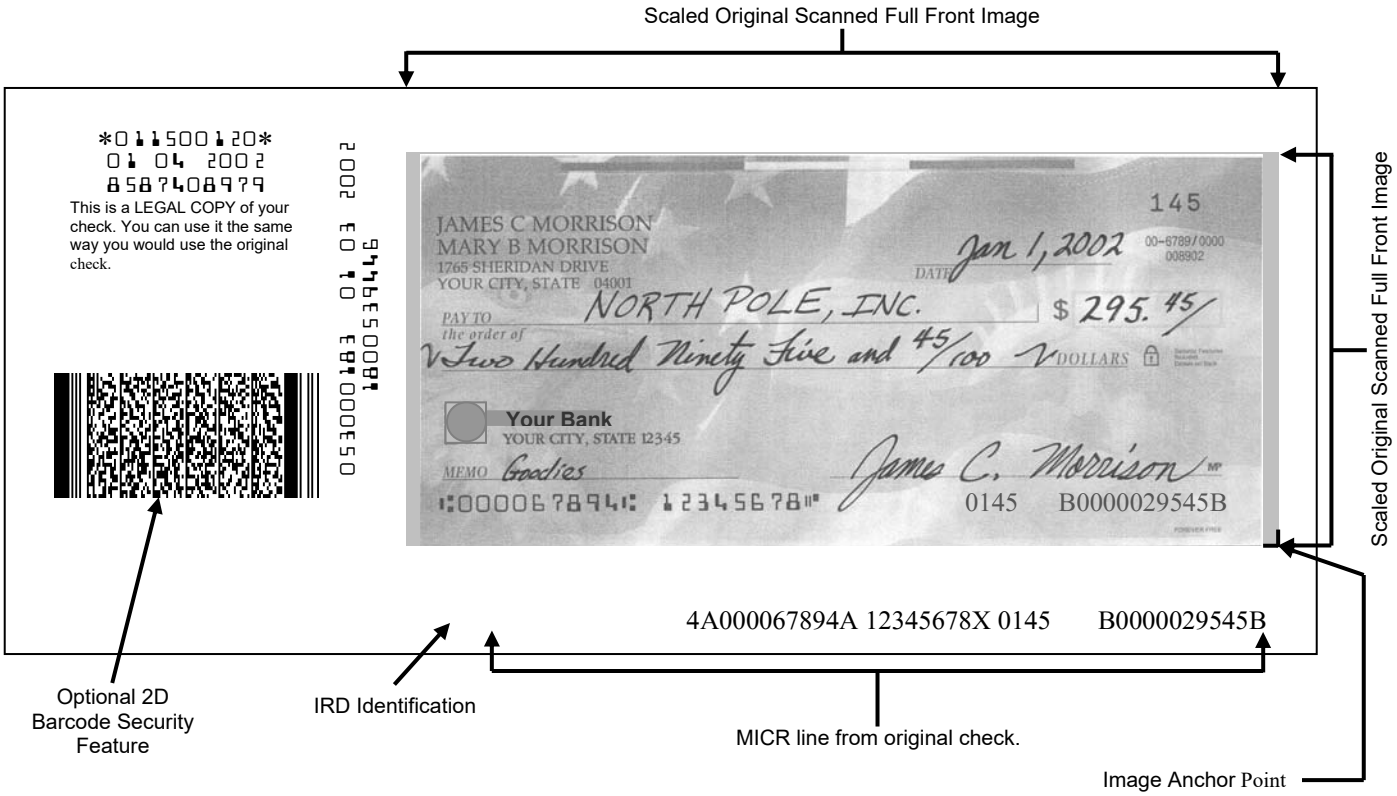


Figure 1: Forward Original IRD of Personal-Sized Check, Front[6]

(Not to scale)

[5] DTSU X9.90-2004, Rev. A
[6] DTSU X9.90-2004, Rev. A

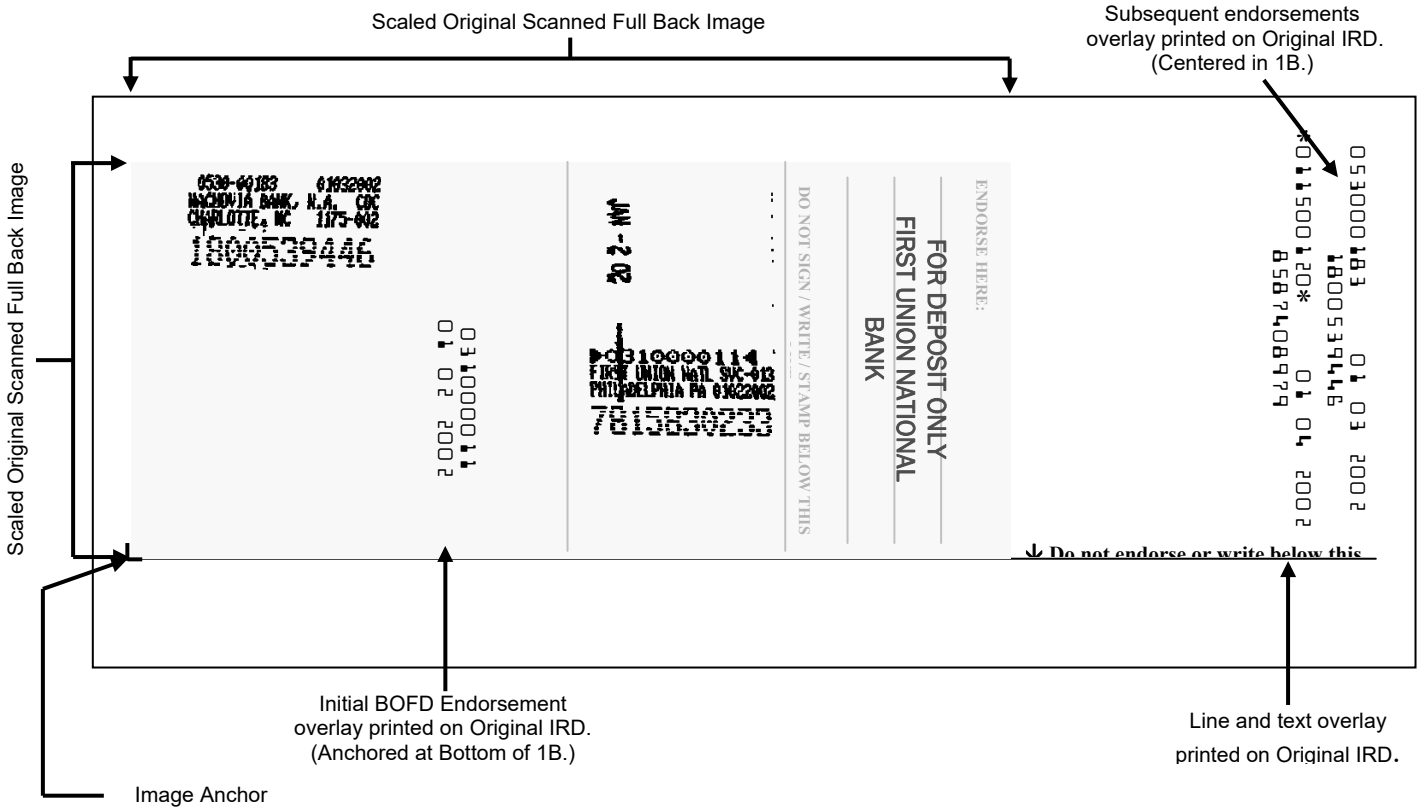


Figure 2: Forward Original IRD of Personal-Sized Check, Back[7]

(Not to scale)

[7] DTSU X9.90-2004, Rev. A

Valid IRDs for Printing

In order to print a valid IRD it is important to fully understand many document specifications including but not limited to DSTU X9.90–2004, Rev. A, Specifications for an Image Replacement Document – IRD and DSTU X9.37–2003, Specifications for Electronic Exchange of Check and Image Data. There are many details in these specifications as it relates to printing a valid IRD. To help demystify and summarize what is needed within the paper IRD, examples are outlined in the next few pages to include what information is needed on the IRD to be a valid printed IRD.

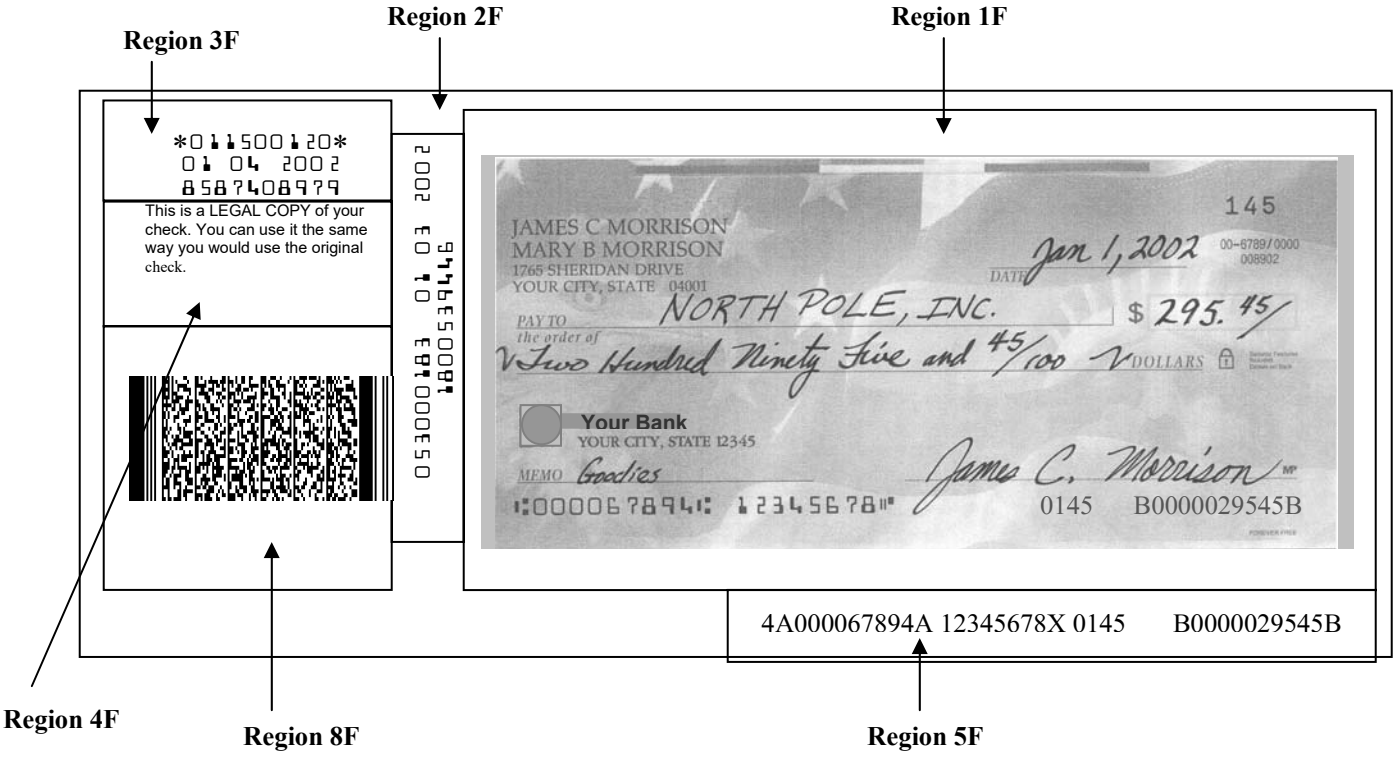


Figure 3: Forward Original IRD of Personal-Sized Check, Back[8]
(Not to scale)

[8] DTSU X9.90-2004, Rev. A

Region	
Region 1F	**Check image front** Includes scanned image of original check. The image is registered in the lower right corner of the region with scaling that maintains the aspect ratio. The image must meet generally accepted standards of image quality. For an original IRD or subsequent IRD this area may contain an image overlay for return reasons for example, "RETURN REASON – A NSF – NOT SUFFICIENT FUNDS" or "NOTICE IN LIEU OF RETURN". If the IRD being created is an original IRD, this text overlay shall be printed on the left half of Region 1F. If the IRD being created is a subsequent IRD, this text overlay shall be printed in the right half of Region 1F.
Region 2F	**Check Truncation Institution** This area needs to include the routing number, data and sequence number of the institution that imaged or scanned the check.
Region 3F	**IRD Printing Institution** This area includes the routing number, data and sequence number of the institution that printed the IRD.
Region 4F	**Legend** This area must include the legend, "This is a LEGAL COPY of your check. You can use it the same way you would use the original check." **This is the area for the legal copy legend. The legal copy legend is required for a legally defined IRD.**
Region 5F	**Required MICR Region** This area includes the MICR line as on the original check but with the following important differences: 1. The check image may not have the amount encoded, but region 5F must have it encoded. 2. The EPC field will be a 4 or a 5 to indicate it is an IRD. 3. Blanks may be added or subtracted from the check image line. 4. Dashes/ONUS/numeric codes that are present on the check must also be included in region 5F to be a valid IRD. ***Note:*** This is very important, since many bank databases do not include these characters. 5. Corrections are acceptable. For example, if the amount encoded on the check is incorrect, it may be corrected within this region.
Region 8F	**Optional Data** Region 8F is reserved for optional data. Typically this area contains a security 2D barcode but it may also contain text. This area may not contain a logo or other advertising or identification information.

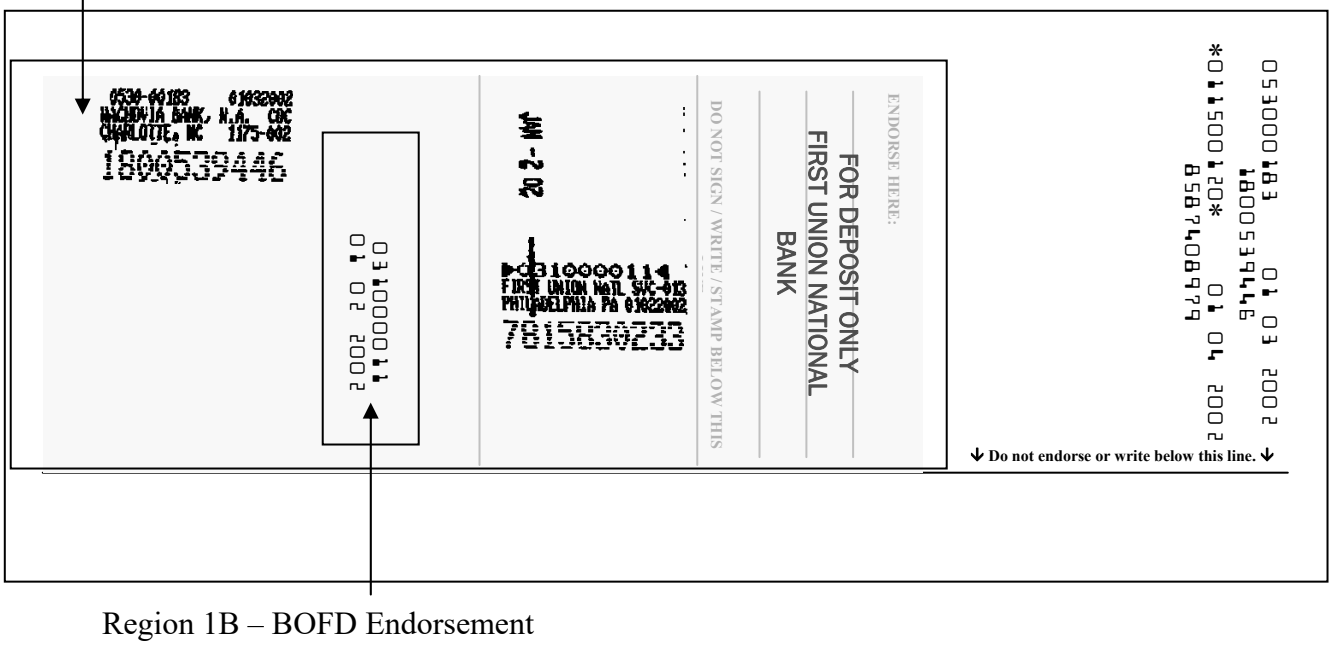


Figure 4: Regions on an Original Forward IRD - Back
(Not to scale)

Region	
Region 1B	**Check Image Back** The check image on the back of the IRD needs to be registered in the lower left corner of the region with scaling that maintains aspect ratio. The image must meet the generally accepted standards of image quality.
Region 1B	**Bank of First Deposit (BOFD) Endorsement** This field contains the routing number, data and sequence number of the BOFD.

IRD Printing as it Relates to the Standards

A minimum number of x9.37 specification fields need to be populated in order to generate a valid printed IRD. This minimum number of fields does not meet the current requirements for electronic transfer to the Federal Reserve, but is sufficient for printing IRDs for internal bank use. The following records and associated record fields are required for IRD printed files. For additional information on a complete list of requirements and records/fields, please review DSTU X9.37–2003, Specifications for Electronic Exchange of Check and Image Data.

> ***Note**: In the examples below, the record and the field are represented by a combination of their numbers. For example, Record 28, Field 6 is represented by 2806.*

Front or Back of IRD	Record	Required Fields	Notes
Check Front	25	2, 3, 4, 5, 6, 7, 8	
Check Front	28	3, 4, 5, 6, 10	1. The value for 2806 is 'Y'. 2. The value in 2810 has a width of 15. (The x9.37 specification currently has an error, and this is the correct value.)
Check Front	50	8	The value for the first 5008 field is '0' for the front of the check.
Check Back	50	8	The value for the second 5008 field is '1' for the back of the check.
Check Front	52	19	The value for the first 5219 is the front of the IRD file name.
Check Back	52	19	The value for the second 5219 is the back of the IRD file name.

Listed below is the name of each record and field.

Record	Field	
25	2	Auxiliary On-Us
25	3	External Processing Code
25	4	Payor Bank Routing Number
25	5	Payor Bank Routing Number Check Digit
25	6	On-Us
25	7	Itern Amount
25	8	ECE Institution Itern Sequence Number
28	3	Endorsing Bank Routing Number
28	4	Endorsing Bank Endorsement Date
28	5	Endorsing Bank Itern Sequence Number
28	6	Truncation Indicator
28	10	User Field
50	8	View Side Indicator
52	19	Image Data

A useful tool would be a viewer that can examine the content of these records and compare them to the check image.

Original IRD Versus Subsequent IRD

An original IRD is composed of a check image and the information contained within the check. A subsequent IRD starts with the image of an IRD and creates another IRD. Since this process can go on many times, it is important to understand how the images are preserved without being increasingly degraded.

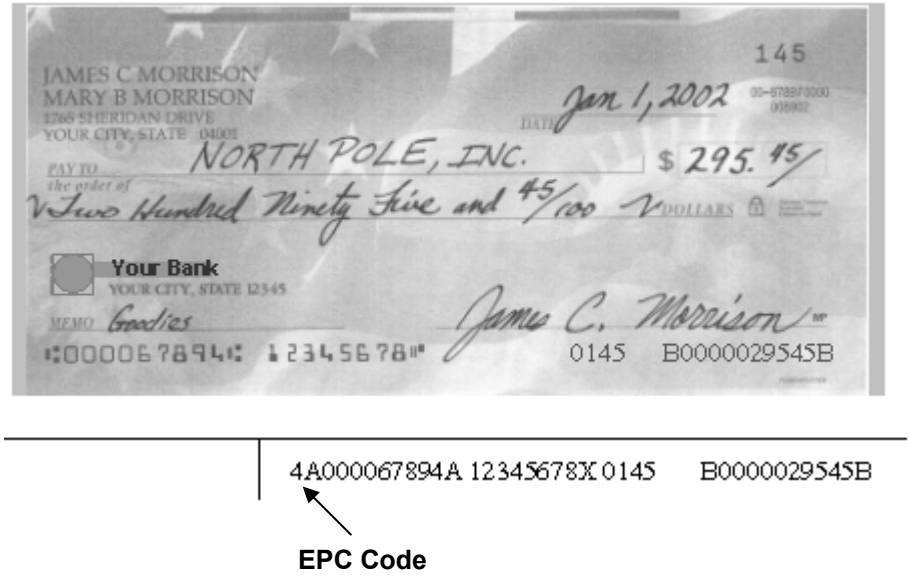


Figure 5 - EPC Code Example

The key is the EPC code of 4 or 5 is placed on the original IRD. This identifies the paper as an IRD and this indicates that the image must be processed differently than a check image. When a 4 or 5 is found on an image, the IRD process must NOT scale the check image but it must copy, as is, from the input IRD to the output IRD. In addition, the field 2F containing the Check Truncation institution is preserved as an image on the subsequent IRD. On the back of a subsequent IRD, the full back of the original IRD is copied. Hence a subsequent IRD will not lose image quality due to scaling. If an IRD does not have a 4 or 5 for the EPC code, then it will be processed incorrectly as a subsequent IRD and data will be lost.

IRD Validity Issues

IRD validity is a major issue when it comes to incorporating Check 21 processes within a financial institution. There are strategies that can be put in place to increase the confidence of a valid IRD.

- Data verification with reader/sorters - High speed MICR reader/sorters can be used to confirm the IRDs printed output is accurate. One way to confirm the printed output is to compare the MICR line of the printed IRD with the database information and the check image MICR data. If this data all matches, then you can have a level of confidence that the data is accurate and secure.
- Data verification with MICR OCR - In the current paper-based check environment, a single check gets read multiple times via check scanners and reader/sorters that verifies the information on the check as it goes through the check clearing process. When dealing with imaged checks the checks are scanned and the data is extracted from the checks once. This happens at the point when the checks are turned into images. When the images are scanned, data is extracted from the check and put into a file or a database that accompanies the check image. The question is, can the establishment that scanned the check be trusted to have extracted the accurate information? Once the check is scanned, there are usually no further processes to verify that the information from the first scan is correct. A high quality MICR OCR process performed on the check image done at the time of IRD printing can verify that the data that is on the scanned check matches data in the database for that check image.
- Data Integrity – The data integrity process can confirm if the data payer, MICR line, etc, are it being printed on the IRD correctly. Barcodes can provide an easy to automate the data integrity check for all IRDs. Banks and financial institutions can embed a 2 D barcode on the printed IRD. DTSU 9.90-2004 states that there is an optional area on the IRD that "may be used by the creating institution for data such as an automatically identifiable security feature or document control numbers.[9]" The barcode on the IRD may contain payee, amount, account number, routing #, etc to help verify the data integrity. Therefore, when the IRD is subsequently scanned, the barcode data can be easily verified against the data within the accompanied database. This 2 D barcode can provide a level of confidence that the printed IRD corresponds to what data is in the 9.37 or database accompanying the image file.

  An industry accepted 2D barcode is recommended so that any bar code reader can read the barcode. No special equipment is required for the financial institution. If encryption is used, then every financial institution that touches that IRD will need to have special equipment to be able to read that encryption.

[9] DTSU X9.90-2004, Rev. A

Challenges

Printer Issues

Any printer can print IRDs, but not all printers can print a **valid** IRD. If an IRD is not printed to the standards, then it may be rejected by the receiving institution, which would deny funds. Therefore, it is extremely important to employ technology that can ensure accurate printing of **valid** IRDs.

Calibration

Calibration of a printer is needed to insure that the printer is set up correctly to print IRDs. The checks need to be printed in the correct format and printed in accordance to the required tolerances that are outlined in the standards.

In addition, the checks need to be printed in the correct orientation. If the IRDs are printed landscape instead of portrait and this may not the optimal setting for the printer, then you run the risk of printing a non-valid or invalid IRD. In other words, if you print in the incorrect orientation for the printer, then you will print Non-Valid IRDs at some point over time.

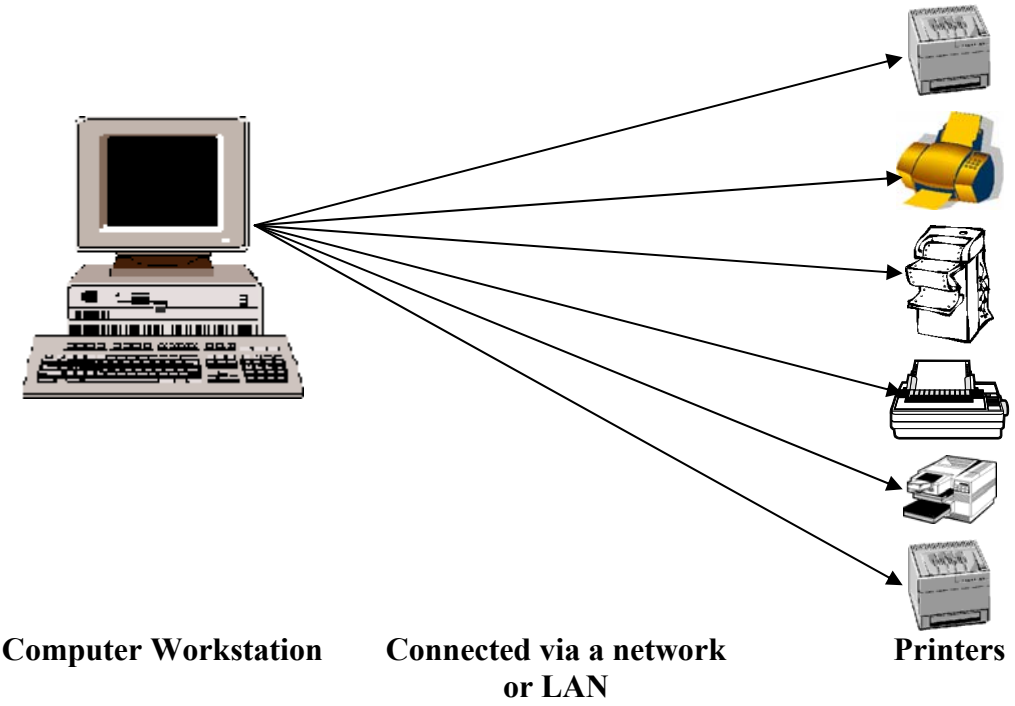
The problem is that most printers have a stepper motor to feed the paper in one direction and a laser in the other direction for portrait or landscape orientation printing. The paper motion is controlled by a stepper motor and gears and pulleys. The other direction is the laser direction and a high accuracy oscillator controls it. Not only will the paper motion vary from printer to printer, but over time it will wear and become increasing variant from other printers of exactly the same model.

When printing IRDs, each printer must be periodically calibrated and the output individualized for the printer. Some printers may print accurately when they are new, but over time the stepper motor will have wear and this will affect the accuracy of IRD printing. If your IRDs are not printed to the standard, then they are not **valid**.

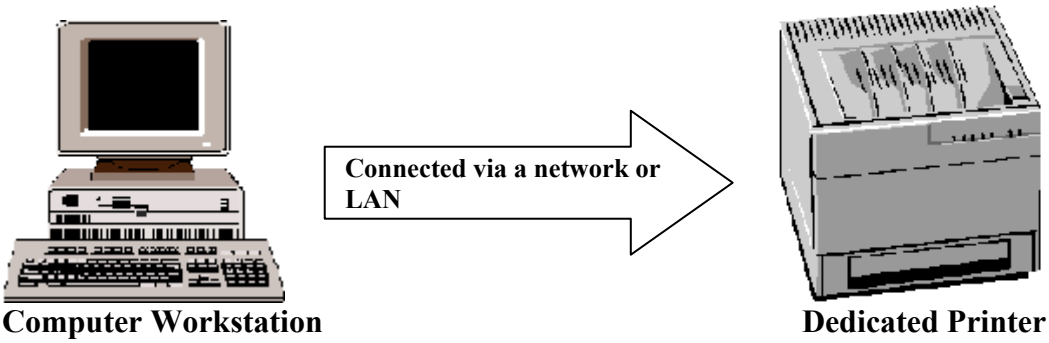
Printer Control

Print Server and Network Controlled Printers
When printing IRDs there are basically three recommended printer configurations that can be setup to control the actual printing. Each method has its own pros and cons associated with them.

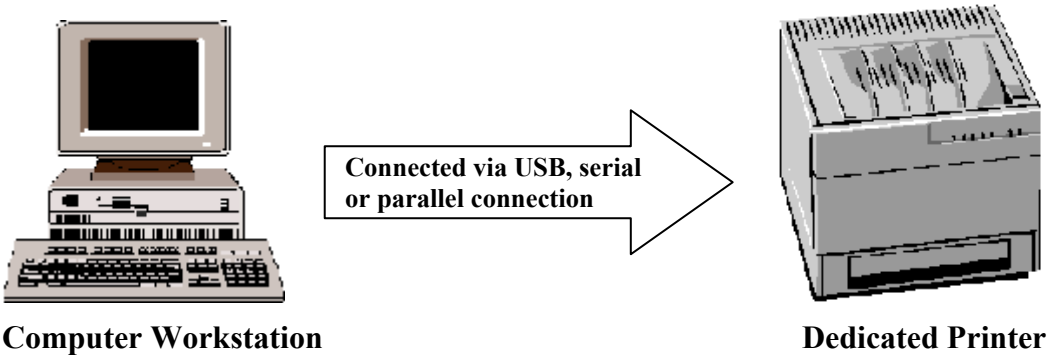
Example 1	Computer workstation connected to a printer or multiple printers via a network or LAN	Good performance
Example 2	Computer workstation connected to a dedicated printer directly via a network or LAN	Best performance
Example 3	Computer workstation connected to a printer directly via USB, serial or parallel connection	Bad performance – not recommended



Example 1 – Computer workstation connected to a printer or multiple printers via a network or LAN



Example 2 – Computer workstation connected to a dedicated printer directly



Example 3 – Computer workstation connected to a printer directly via USB, serial or parallel connection

The best performance possible for printing IRDs is to have the printer(s) controlled by a workstation through a dedicated LAN. Therefore, the workstation can be connected to the corporate LAN or network for receiving and sending data. But when it comes to printing, it is advantageous to have an additional network or LAN constructed between the IRD printing workstation and the IRD printer(s). The main advantage is that the corporate network will not be taxed with IRD printing loads and the printing speeds will be much faster and efficient.

Having the printer controlled by a workstation through a network or LAN can also result in good IRD printing performance. In this case, the workstation can print to any printer that is set up on the LAN or network. Therefore, a workstation can print to multiple printers based on speed and location of the printer. One must question security issues with the capability of printing on multiple printers.

Having a direct connection from the workstation to a printer via a serial, parallel or USB ports is not recommended, as these interfaces are very slow.

Printing Language and Page Composition--PDF versus IPCL

To have a deeper understanding of the check printing process it is best to understand the language used to print images and IRDs. With the correct printing language, the IRDs can be printed fast and accurate. To start out we need to have a few definitions including PDF, IPCL and PCL.

PDF (Portable Document Format) is an open file format specification that was invented by Adobe Systems over 10 years ago. A PDF file can contain fonts, images, printing instructions, keywords for searching and indexing, job tickets, interactive hyperlinks, movies, and is based on Adobe Postscript.

PCL (Printer Control Language) was originally conceived and devised by Hewlett Packard for HP's dot matrix and Inkjet printers and is now used in all of HP's laser printers. Now PCL is one of the most widely accepted printing language defacto standards. PCL commands use compact escape sequence codes that are embedded in the print job before being sent to the printer.

IPCL (Image Print Control Language) is an image centric printing language that is based on PCL. IPCL takes advantage of all of the printing aspects of PCL, but it optimizes printing for images. Images are sent to the printer compressed, which in effect allows the print jobs to be faster and more efficient. IPCL file can contain fonts, images and printing instructions.

Page Composition Overview

There are many ways to use PDF and IPCL. The speed and quality of the results will vary with the quality and experience of the programmer and environment. Given these variants, there are still underlying elements that dramatically effect the final result. When composing a PDF file for printing, the page is typically created within the application. Individual items such as fonts and images are retrieved, imaged, scaled, positioned and then a full-page image is created for the printer. The completed page is saved in a PDF file format. This file is then sent to the Print Spooler and converted into the native language of the printer (PCL or Postscript). This print data is then sent to the printer.

When composing with IPCL for printing, the elements of the page are identified and the position and sizing information are provided in the data stream to the Print Spooler. Only when the page is to be printed is the final image decompression, sizing and positioning completed.

Ramifications

Compression/Decompression Cycles

When composing with PDF, the typical application will first decompress the input image and then scale and position the image onto the composed page. In most cases, fonts will not be converted to bitmaps and will be treated as fonts. Once all the elements are placed on a page, the PDF file is generated. This will typically entail compressing the full page of image data. This file is then sent to the spooler where it will be decompressed and converted to the language of the printer. The result is the image data on the page is compressed/decompressed three times.

When composing with IPCL, the compressed image data remains intact and is sent to the spooler along with the IPCL commands for position and size. Only after the page is being sent to the printer is the image data decompressed. The tradeoff is three compress/decompress operations for PDF and one for IPCL. Therefore, IPCL provides a tremendous saving in computer computational power and bandwidth utilization. IPCL is much more efficient in printing IRDs and their associated images.

File Size

When dealing with image files the images can be quite large. For example a single 8.5 x 11 page scanned at 300 dpi black and white is roughly one megabyte of data. This same page at 600 dpi is four megabytes. A duplex page (front and back) in bitmap format would be eight megabytes before compression. If IPCL is used for printing this document, then the total data set for a duplex page is the size of the font data and the size of the individual original images. For a 3-up IRD page, front and back, there are six images at roughly 15k each for a total of 90k image data and a few thousands bytes for all the text.

This same document constructed in the PDF format file would start with eight megabytes before compression and will compress to 400k. So after a lot of work, the PDF IRD file size would be 400k per page and the IPCL IRD would be 90k with effectively no work. Therefore, if file size and efficiency is important, IPCL is a clear choice for printing IRDs.

Transfer to Printer and Printer Speed

With both languages[10], PDF and IPCL, the IRD data must be sent to the printer in the printer's native language. Printers usually require a resolution of 600 dpi for printing. For the PDF example at 600 DPI, eight megabytes of data must be sent per duplex page. In the case of IPCL, the image data can typically be sent at its native resolution, e.g. 200 DPI, and the printer will scale to the requested resolution for the page, e.g. 600 dpi. In the case of IPCL, the images can be sent to the printer much more effectively. In the case of IPCL printing, for a duplex 200 dpi IRD, this document would be approximately 0.4 megabyte. Therefore, the IPCL IRD would be 0.4 megabytes of data versus 8 megabytes of data for PDF that needs to be sent to the printer.

[10] (PDF is a file type, IPCL is a custom extension of a printer control language. These are two different methodologies used for printing IRDs or image files)

Printer Model

Both PDF and IPCL have a great deal of flexibility in order to image a page on a variety of printers. This flexibility handles many elements including page size, orientation and resolution. The PDF model for printing is that the page "looks the same" regardless of where it is printed. The need in printing IRDs is that the page "is the same" regardless of where it is printed. In particular the placement and size of the MICR data must "be the same" on all IRDs. It is for this reason that the font data and image data cannot be combined into one image at composition time. If this is done, the results will inherently be incorrect. Printing will likely work on one printer or even a printer line, but in general it is over time or with a new printer the IRD printing will fail. Both PDF and IPCL maintain separate data types for font and image to resolve this potential problem.

The real problem with the PDF printer model is that all printers within a printer line are treated as the same and they are not. The critical item is the direction of paper motion. The paper motion is controlled by a stepper motor and gears and pulleys. The other direction is the laser direction and a high accuracy oscillator controls it. Not only will the paper motion direction vary from printer to printer, over time it will wear and become increasing variant from other printers of exactly the same model. When printing IRDs, each printer must be periodically calibrated and the output individualized for the printer.

Fonts, Fusers, Toners and Magnetic Ink Issues

Fonts, fusers, toners and magnetic ink can create a myriad of challenges in printing an accurate IRD.

Fonts

Fonts are probably the one most important and least understood part of the printing process when it comes to printing IRDs. The ANSI x9.90 is the standard used when creating IRDs and it details the font type and font size printed on the IRDs.

There are many interrelated complex issues that are not apparent when considering resolution and fonts. The printer needs to be set a resolution for printing. For example, if you would like to print your IRDs at 300 dpi, then the specification states that for some areas of the check you will have 8 characters per inch, i.e. every character would utilize 37.5 dots i.e.300 dpi divided by 8 characters per inch = 37.3 dots per character. The question arises, how do you print a half a dot? In this case your printer or your software will make assumptions either adding or not adding the 0.5 dimension, and over time you will print invalid IRDs, once again running the risk of not being paid on those checks. This is a risk that is unacceptable. It is best to use printing software that takes this into consideration and prints at the optimal resolution for the printer and fonts installed.

Another issue with fonts is that some printing software downloads the fonts every time, while other software utilizes MICR fonts stored in the printer's DIMMS – Dual Inline Memory Modules. These DIMMS store special fonts that are specific for the printer and can be expensive. If the software used downloads the fonts at the time of printing, then the DIMMS may not needed for your printers.

It is best to utilize software that can load the font every time a print batch is run and unloaded each time the print batch is finished. If you already have fonts tuned for the printer, there is not reason to not use that font. But, the DIMMS are unnecessary if you have the right software.

Another challenge with printing IRDs as it relates to fonts is the OCR-A font. The DSTU X9.90–2004, Rev. A Standard references the TrueType 12-point OCR-A, from Bitstream to be used on IRDs when they are printed out. But, in reality, there is an old version of the Bitstream font that is available on the Internet that is incorrect. To print correct IRDs a special OCR-A font that meets the x9.90-2004 specification but is not an international standard font must be used. Therefore, when printing IRDs with MICR and OCR-A fonts it is important to have a printing solution provider that knows what the valid font are and what the correct revision of the font is. The solution vendor needs to understand the font nuances, because there are many. If the incorrect font is used, then it may not fit on the printed IRD and the IRD will be invalid.

MICR

All checks contain one MICR, Magnetic Ink Character Recognition, line embedded within the check. The MICR line(s) printed on the IRDs must conform to the existing MICR line of the check and if it does not, the receiving institution may reject it.

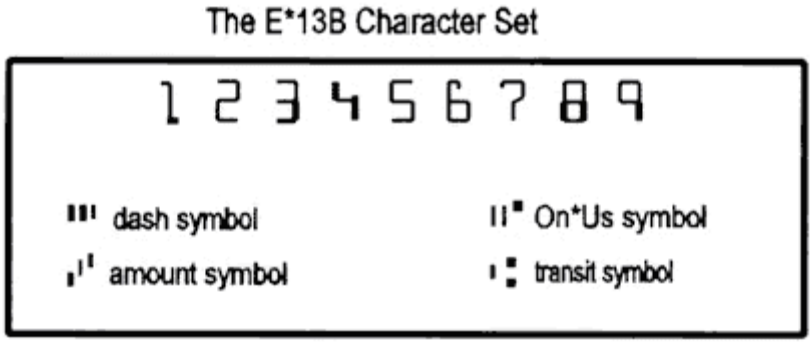


Figure 6 - Example of MICR Font

MICR characters are printed in magnetic ink or toner that when magnetized will emit a magnetic signal that identifies each unique character. The shape of the signal is developed from the character's horizontal and vertical attributes, and the amount and distribution of magnetic material in the ink or toner from which the character is formed. MICR check readers measure the strength of the magnetic signal emitted, and reject the check if the shape and/or magnetic properties of the characters do not meet the specified standard. Since the MICR font outline is a well-defined standard, the actual font creation and printing should be a simple process, but this is not the case. The fonts, fusers and toner need to work in harmony at the printer to create a valid MICR line.

Since some high-speed check reader/sorters can read over 2,000 checks a minute, the quality of the MICR characters is important. If a check cannot be read, it is sorted into an exception grouping and returned. In addition, the bank is charged a handling fee. Because of this, the MICR line on a check is tested for MICR character quality using a magnetic analyzer. A check printing system that does not generate correctly printed MICR lines on checks is simply unacceptable and can cause a multitude of problems, and added fees.

All of these MICR printing requirements will then apply to IRDs, because the IRDs should be processed through the same equipment and workflows as standard check.

On Us

The On Us field within the MICR line is optional and can contain the customer account and check serial number. This field can be up 19 characters long, and the bank on which the check is drawn (the "On Us" bank) is free to encode the customer's account number and the check serial number in a variety of ways. Some banks place the serial number first and the account number second, while others do just the opposite. There may be "dashes" and spaces as well. This field is flexible because only the "On Us" bank needs to process the item based on this information.

One challenge of the On Us section of the MICR line is dashes. Many banks print dashes within the MICR line of the check. But, the banks databases do not include the dashes, because this information is not needed for the inter-bank processing of checks. The issue arises when you start working with IRDs. The MICR line on the checks will include dashes, but the banks database will not have the dash information, and when the 9.37 file or IRD is constructed, it is constructed with the information from the banks database, i.e. no dashes. Therefore, the IRD will not match the MICR line of the check image. This would create an invalid IRD, since the Check 21 Act states that the substitute check "Must accurately represent all information on the front and back of the original check."

Therefore, before an IRD is printed, it is recommended that an OCR process is performed on the check image to verify that the MICR line on the check matches the information in the corresponding 9.37 file or database file used to compose the IRD.

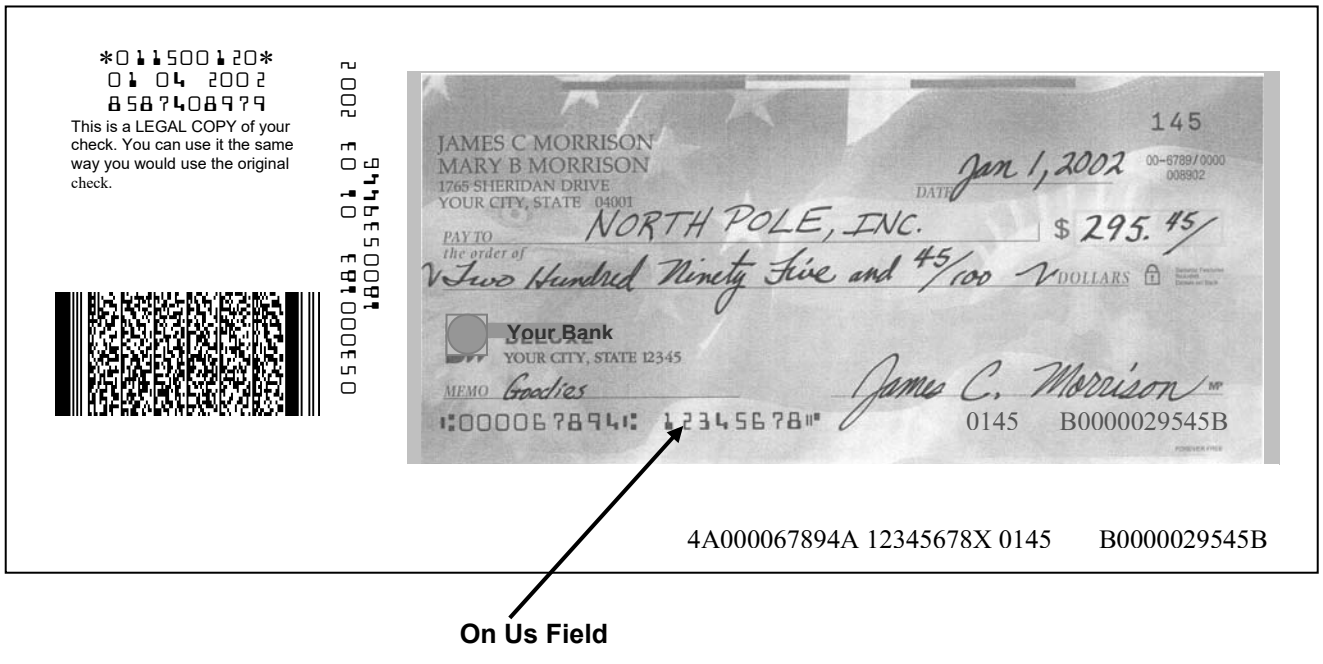


Figure 7 - On Us Field[11]

[11] DTSU X9.90-2004, Rev. A

Fusers & Toners

Laser printers use a fuser to fuse the toner to the paper. It will usually use a combination of heat and pressure to do this. The process will cause the toner to spread on the page in different amounts based on speed, paper, toner and fuser (printer brand). The printer manufacturer must also match the toner with the fuser. Magnetic ink is still another element in the mix and it too must be matched to the toner and the fuser. The result of all this is that the MICR font must integrate with the printer, toner, fuser, paper and magnetic ink to be printed to the specification.

In conclusion, it is imperative to employ a IRD printing technology provider that understands the printer, toner, fuser and magnetic ink issue when printing IRDs.

Paper Issues

Different paper has different effects on checks and IRD printing. Paper can cause a number of unforeseen and difficult to troubleshoot problems. Variables such as the type of paper absorption can make fonts wider or shorter, cause toner grip or toner adhesions issues. In order to have efficiency and accuracy in the IRD printing processes, the paper, printer, toner and bursters all need to work in harmony.

Double Printing Issues

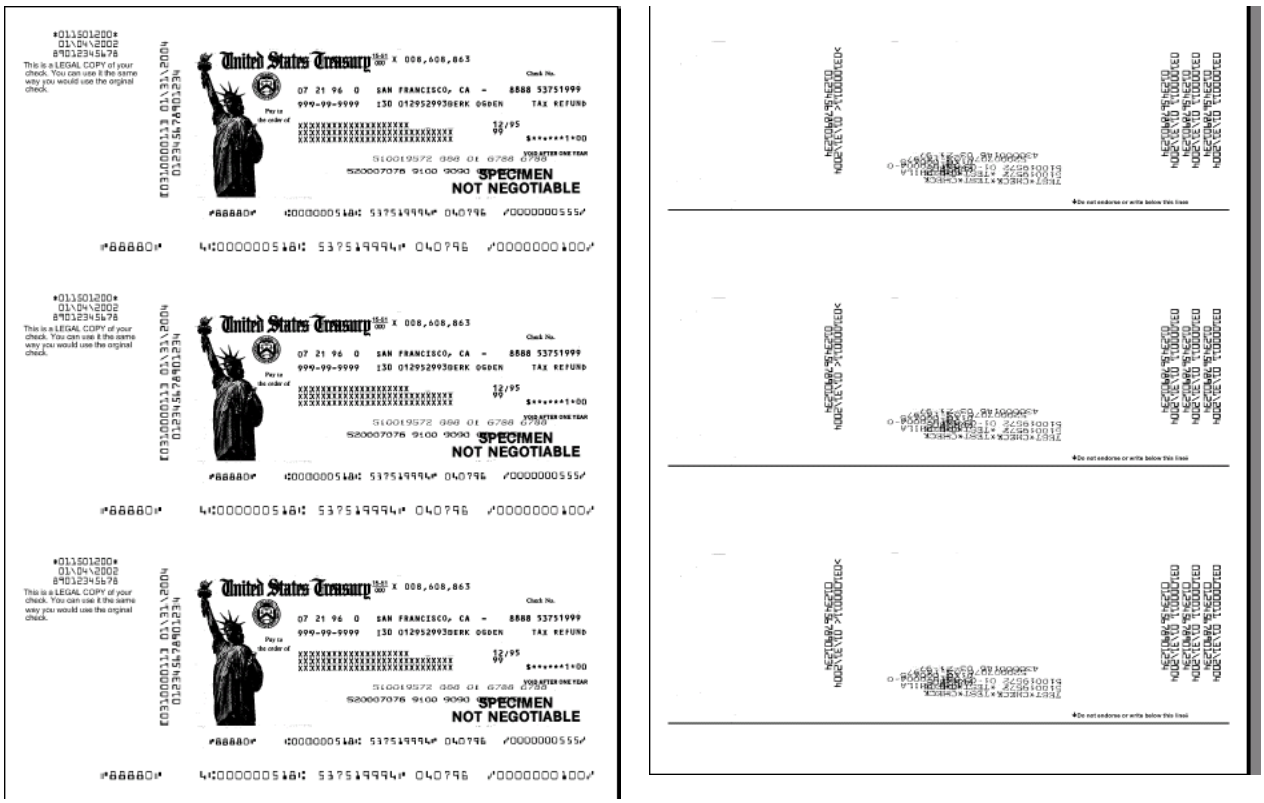
Printers inherently have complications at one time or another. There are printer jams, toner replacements, part replacements and power outages to name a few. When this happens, a standard printer will reprint the page it was printing before the problem. With an IRD this could be the cause of duplicate "valid" IRDs being printed. Therefore, it is imperative that a process is developed to verify the printed output is not inadvertently duplicated.

Operator training Issues

Printing accurate IRDs require that all the printing hardware, software, and paper work in harmony. Operators need to be properly trained to oversee these processes. Printers need to be calibrated and maintained, and the correct paper and toner needs to be used. Each IRD printing process will require a checklist for the operators for efficient printing. Therefore, the operators need to be trained to test and calibrate the IRD printer.

Bursting Issues

Bursters can be used for IRD printing to tear the IRDs at the defined perforations. IRDs can be printed two or three to a page and then sent through a burster for separating into single IRDs. It is important that the printing technology is flexible enough to match different burster sorting orders. For example, on three up checks, some bursters will tear the checks into 1,2,3, orders while other bursters will burst the checks, 3, 2, 1. The printing process needs to be flexible to accommodate this so that the IRDs are in the correct order for the bank. Some IRD printing solution providers will only print IRDs one up to get around this problem, but this could cause performance issues. Printing only one IRD at a time is not advised if you want to do high volumes.



Front Back

Figure 8: Sample of a three up IRD before bursting

If the checks are printed in the incorrect order and do not match the bursting process then it is very difficult to verify what checks have been printed and what checks have not. This is due to the fact that most Banks are printing IRDs with a Cash Letter. A Cash Letter lists all the checks/IRDs and their amount. A Cash Letter may have hundreds of IRDs or checks listed. After the IRDs are printed the bank workers need to verify that each IRD listed on the Cash Letter was printed. If the IRDs are printed out of order from the Cash Letter then this is very difficult to do.

Image Issues

Image Files

According to the standard, DSTU X9.90–2004, Rev. A, there is no requirement as to the check image file format of the IRD as long as the "IRD's legibility and usability are maintained." Image files can be black and white or can be color or grayscale to show more information. The DTSU 9.37-2003 standard references many different image file types but does not specify which file type and which implementation to use, they leave that up to the banks who will be sharing the files.

There are many different implementations of each image file type. The most popular black and white images are TIFF. TIFF images can employ CCITT Group 3, CCITT Group 4 or LZW compression algorithms. Grayscale images usually use JPEG or LZW compression algorithms. Most check imaging capture systems produce TIFF files. But, not all TIFF files are identical. There are dozens of versions and hundreds of incorrect implementations of the TIFF file format. The implications of this mean that in most cases the image can be viewed, since TIFF viewing software is fairly lenient in what they allow. But, these same TIFF images will not print properly. Therefore, it is important to work with a printing technology provider that can read incorrect TIFF image file formats and render them appropriately.

The Federal Reserve guidelines state that in order to send IRDs to the Federal Reserve the images must be a black and white image (not grayscale nor color.), TIFF 6 image format with CCITT G4 (200 DPI minimum resolution) with a maximum of 2 GB of file size.[12] Therefore, under agreement, banks can transfer basically any image file format they want, but if they would like to transfer X9.37 files to the Federal Reserve then they must follow the Federal Reserve's guidelines.

[12] Federal Reserve Adoption of DSTU X9.37- 2003, Image Cash Letter Customer Documentation, Version 1.3, October 5, 2004

Image Quality

Listed below are the Image Quality metrics based on the Financial Services Technology Consortium work on describing and expressing image quality and usability.[13] These metrics are used to help determine if an IRD is of high enough quality to be accepted. If an IRD contains any one of these attributes then it runs the risk being an invalid IRD.

- **Undersize Image** – This occurs when the image size is either too small in the horizontal or vertical direction. This can happen if there is an issue with scanning, or the image is torn or folded at scan time.
- **Folded or Torn Document Corners –** This occurs if the check corners are folded or torn at scan time, or the check could have torn edges before the scan of the check occurred.
- **Folded or Torn Document Edges** – The check can have folded or torn edges or this can happen at scan time.
- **Document Framing Error** – This occurs when an image has additional vertical and/or horizontal scan lines with no data present within those scan lines.
- **Excessive Document Skew** – If the check moves during the scan process then an excessive document skew will be the outcome.
- **Oversize Image** – This occurs when the scanned check image's width or height is too large. There are many reasons for an oversized image including but not limited to, scanning two documents at the same time, the scanner has an issue at the scan time and the image appears stretched, or a skewed document.
- **Piggyback Document –** This occurs when two images are scanned at one time and are "piggybacked" onto one another.
- **Image Too Light –** This occurs when the resulting check image is too light and it may be difficult to read the data on the check.
- **Image Too Dark** - This occurs when the resulting check image is too dark and it may be difficult to read the data on the check.
- **Horizontal Streaks Present in the Image** – When one or more black or white horizontal streaks are present in the image.
- **Below Minimum Compressed Image Size** – This is when the compressed image size is too small.
- **Above Maximum Compressed Image Size** – This is when the compressed image size is too large.

[13] FSTC Image Quality & Usability Assurance Project, Phase 1, Image Defect Metric Definitions, 8/23/04, http://www.fstc.org/projects/image-quality-phase-1/IQ&U_P1_Defects_Final_Report_v1.0.1.pdf

- **Excessive "Spot Noise" in Image** – This occurs when the background of the check creates "spots" or "spot noise" when it is scanned. When this occurs, it may be difficult to read the data on the check image.
- **Front-Rear Image Dimension Mismatch** – There is a difference is size between the front image of the check and the rear image of the check.
- **Carbon Strip Detected –** There are times when "carbonized band" is on the rear of the check and could interfere with the endorsement line.
- **Image Out of Focus –** If the scanner lens used to scan the checks is out of focus then an image that is out of focus will result causing this issue.

Additional Real World Issues

- **Void Line Touches MICR Line** – This occurs when the Void Line of the check touches the MICR line and may interfere with reading the MICR line and processing the check correctly.

Image Quality Examples

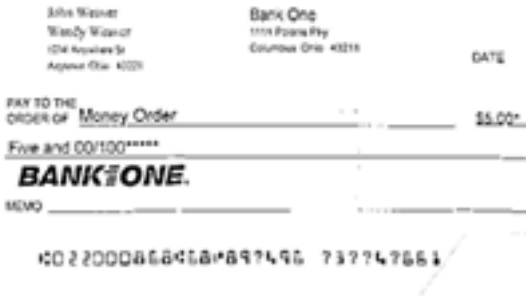


Figure 9: Undersize Image

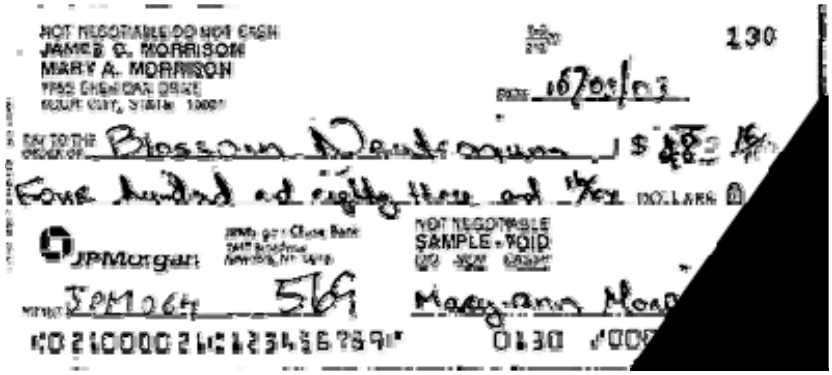


Figure 10: Folded or Torn Document Corners

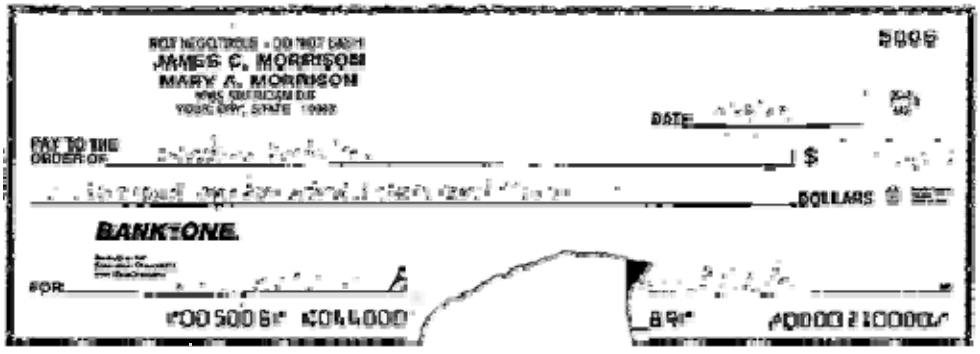


Figure 11: Folded or Torn Document Edges

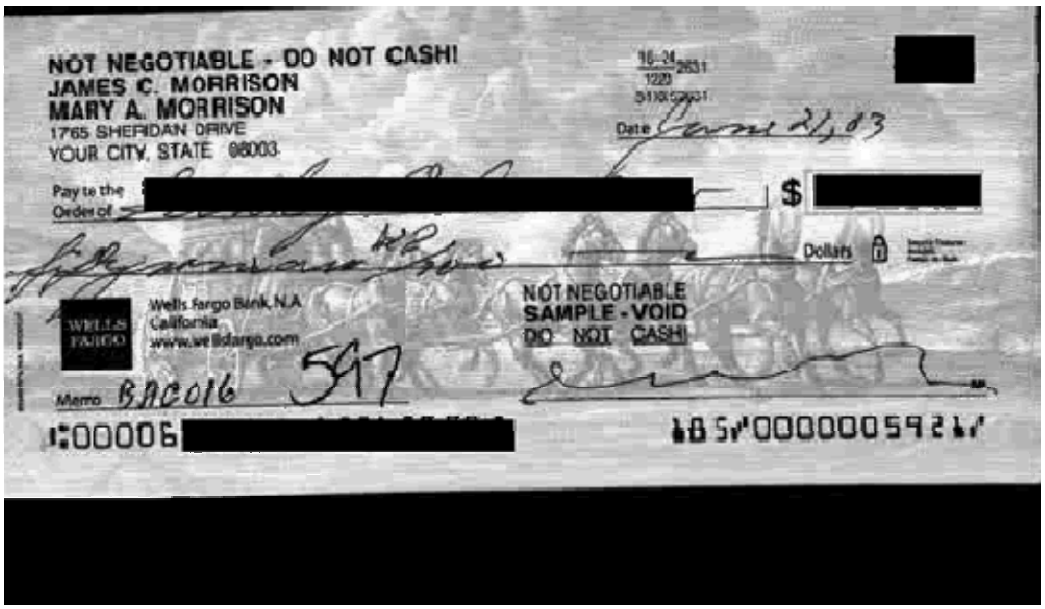


Figure 12: Document Framing Error

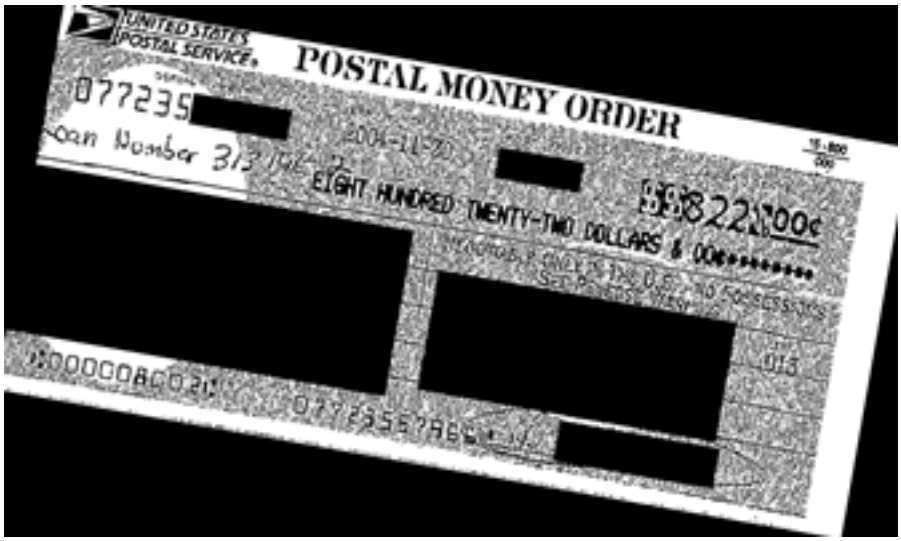


Figure 13: Excessive Document Skew

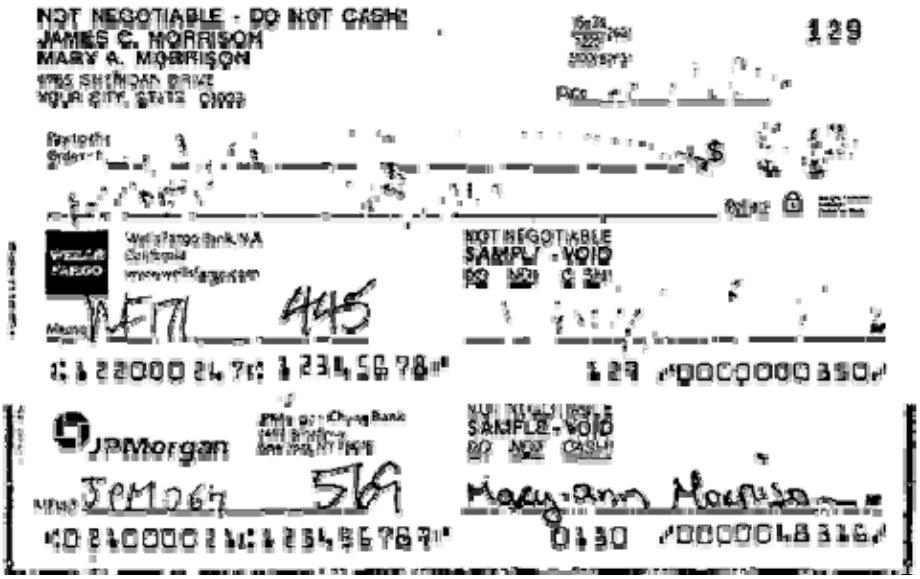


Figure 14: Oversize Image

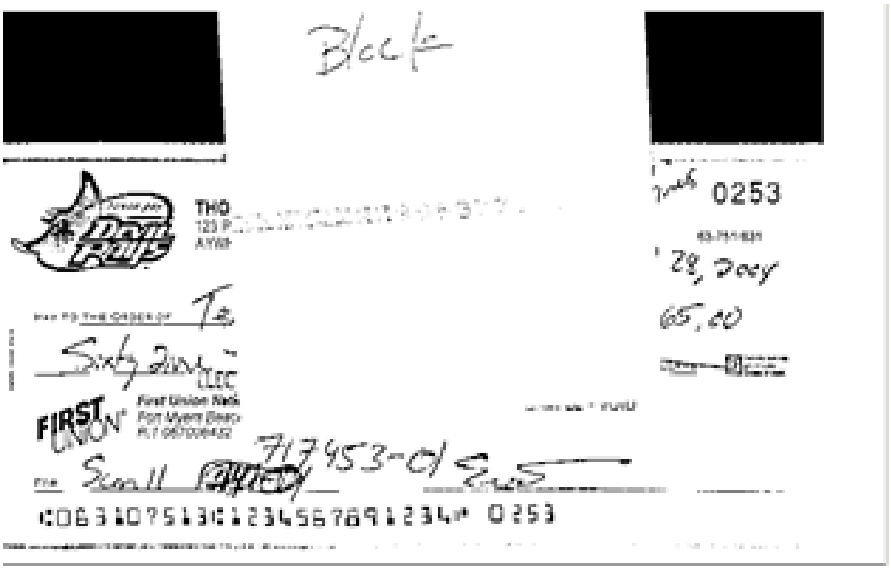


Figure 15: Piggyback Document

Figure 16: Image Too Light

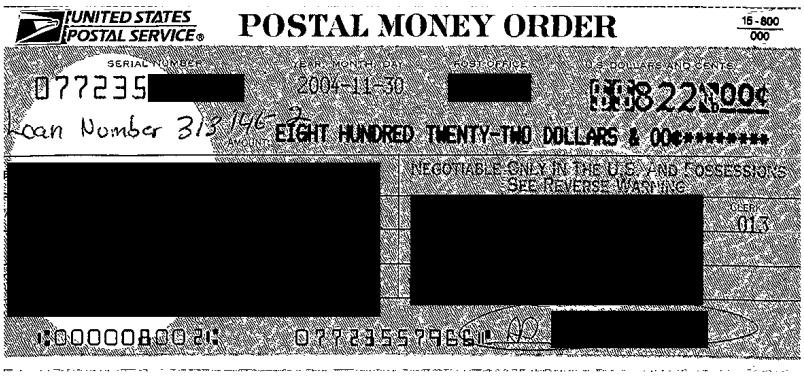


Figure 17: Image Too Dark

Figure 18: Horizontal Streaks Present in the Image

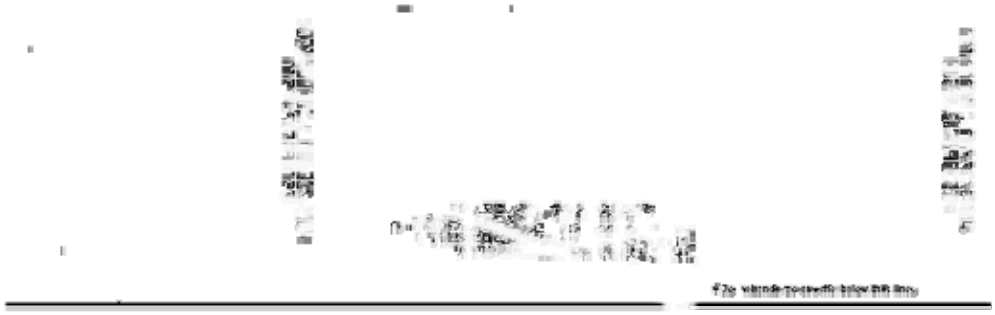


Figure 19: Below Minimum Compressed Image Size

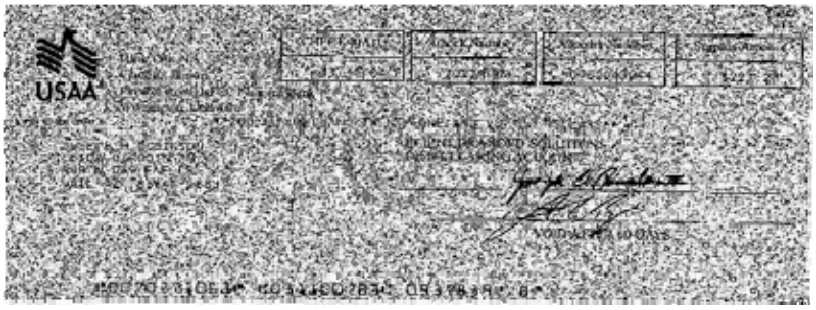


Figure 20: Above Maximum Compressed Image Size

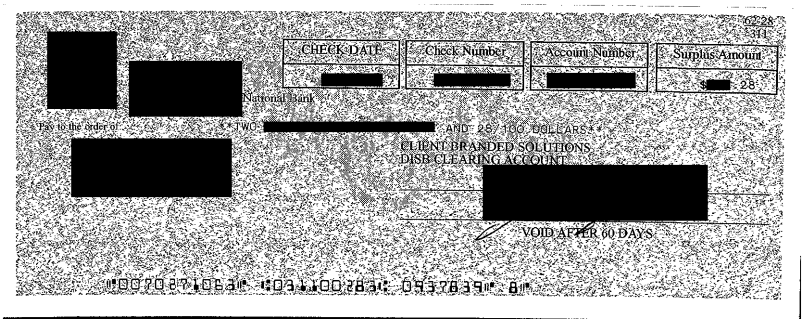


Figure 21: Excessive "Spot Noise" in Image

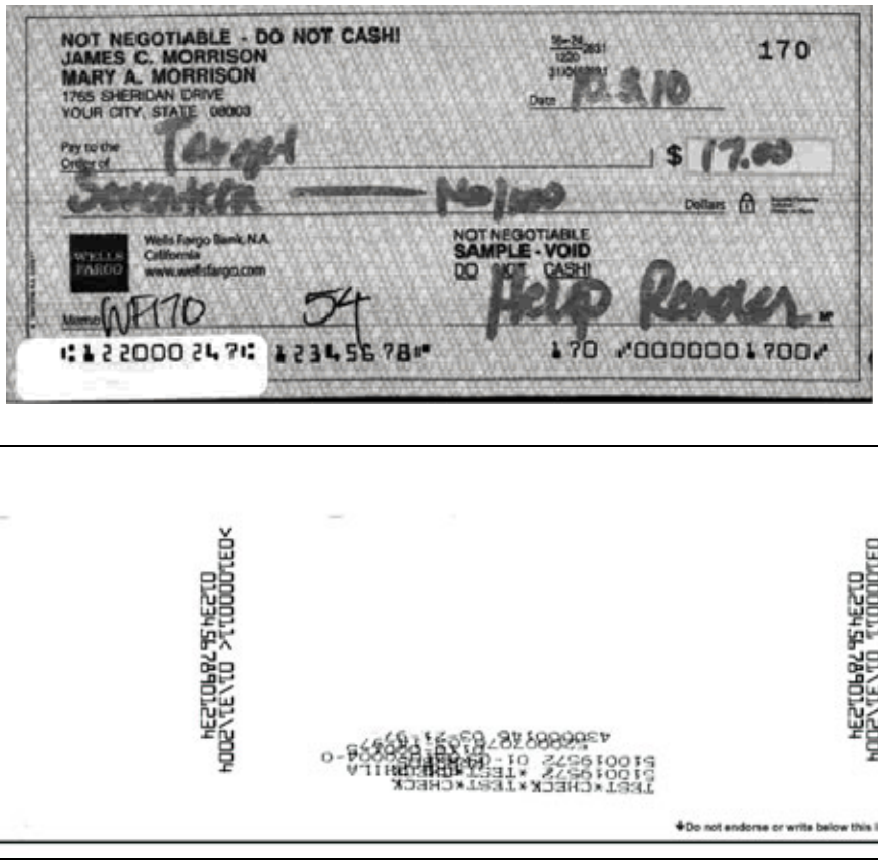


Figure 22: Front-Rear Image Dimension Mismatch

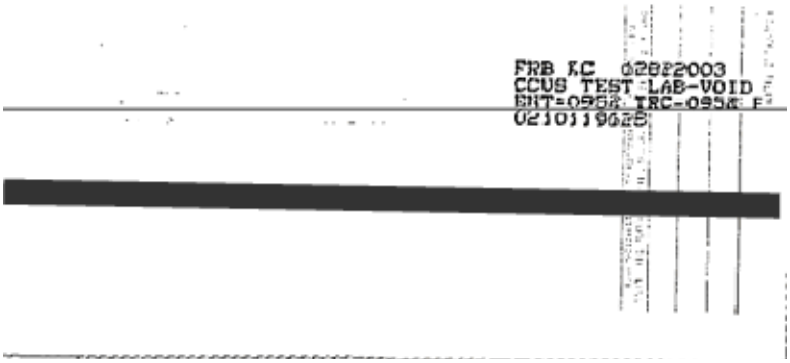


Figure 23: Carbon Strip Detected

Figure 24: Image Out of Focus

Additional Real World Issues Example

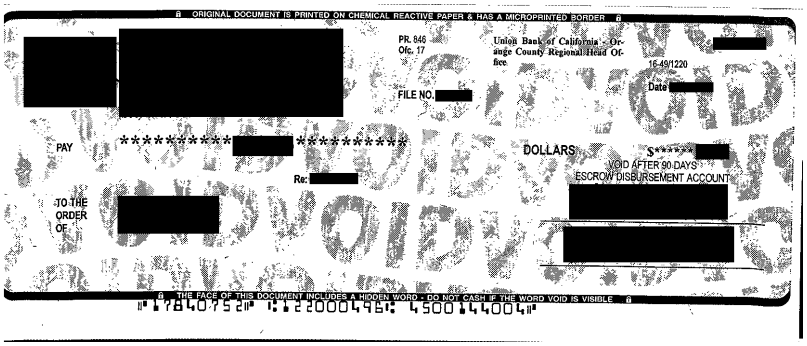


Figure 25: Void Line Touches MICR Line

It is important to employ IRD printing technology that can help identify files with images issues before they are printed and passed on to the next institution. If the IRD is passed on to the next institution with these issues, then a bank runs the risk of not being paid on the check and incurring an added fee. IRD printing software can check the quality of the image before an invalid IRD is printed. The software can either flag the image as an exception before it is printed or more advance software can automatically correct the check image to meet the minimum quality requirements.

Image Size

When printing IRDs it is also important to streamline your processes and to limit the amount of data that is sent over your internal network. Limiting the file size of your IRDs can allow you to print more checks per hour and will allow the network to run more efficiently.

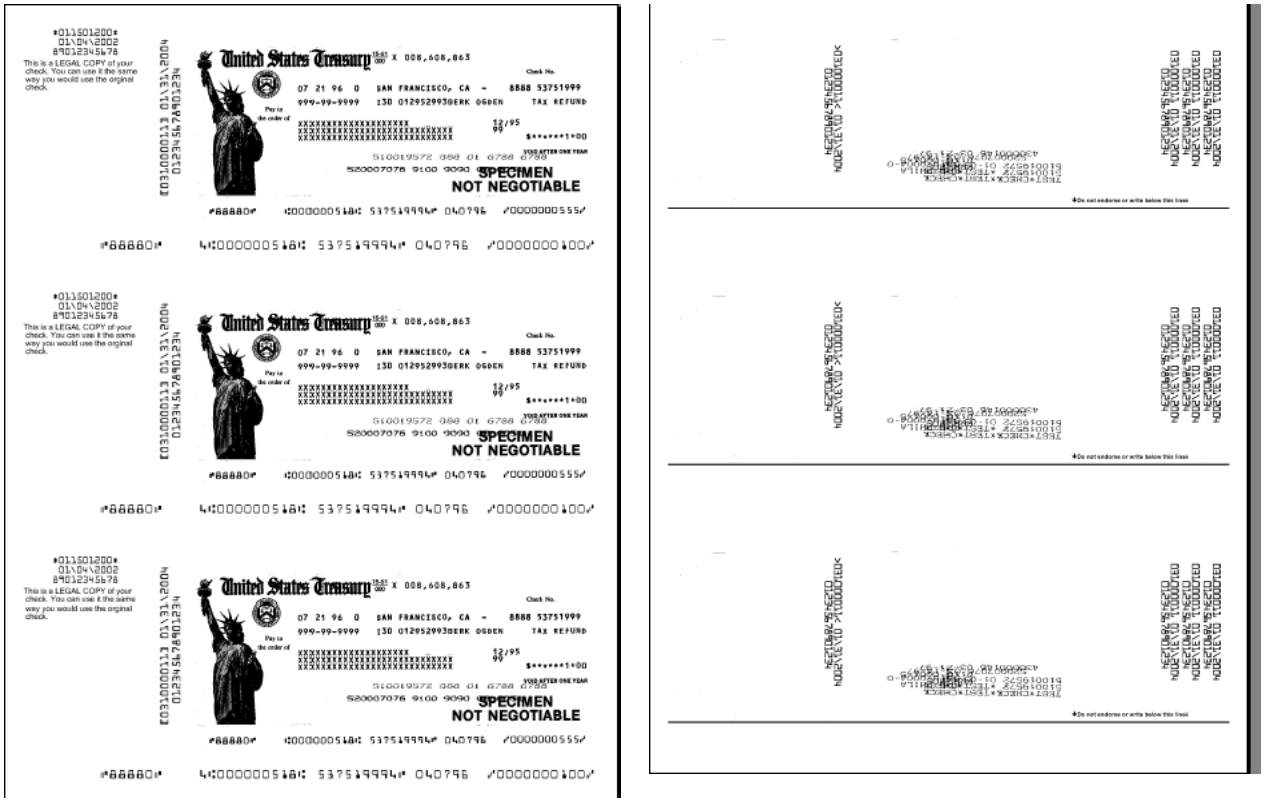
The software used to print IRDs needs to optimize the size of the image that is sent to the printer. If large files are sent to the printer, then you run the risk of performance issues on your printing job and performance issues on your network as a whole. For example if you plan to print IRDs at 600 dpi, that turns out to be 4 Megabytes of data for the front of the check and 4 Megabytes of data for the back of the check, for a total of 8 Megabytes per IRD! Smart software can optimize the data to only transfer 10-20 Kbytes of data per IRD without losing any data. Therefore, it is best to work with an IRD printing technology provider that optimizes the size of the IRD files.

Bandwidth

When printing large files or large batches of IRDs it is recommended to take bandwidth into consideration. IRDs including their images can be very large files, up to 8 Megabytes uncompressed. Printing solutions that are based on IPCL, Image Print Control Language, have very low bandwidth requirements, which will optimize data transferred over the network.

Image Alignment

In order to have accurate IRD printing, the check image has to be anchored in the lower right corner, and maintain its aspect ration. In addition, the standard requires that the front and back of the check image must be anchored to the same relative spot. Therefore, the check image on the back has to be justified to the lower left corner. If either of these is anchored to the incorrect placement, then the IRD and image associated with the IRD will be out of the specification tolerances and will be unacceptable. This is especially true when printing 2 or 3-up IRDs as seen in the following example. Therefore, it is very important to verify that the IRD printing solution you employ has taken this level of detail into consideration.



Front Back

Figure 26: Sample of a three up IRD

Security Issues

Security is an ongoing concern as it relates to IRD processing and printing. There are processes that can be employed to help increase the printing security of IRDs.

- Font protection – Fonts can be downloaded to the printer only for the specified IRD print job to secure printers from unauthorized printing of IRDs. There are specialized fonts that are needed to print IRDs. The preferred way to print IRDs is to utilize printing software that can load the fonts every time a print batch is run and unloaded each time the print batch is finished. In this way, the printers have an added level of security.
- Fraud prevention – To deter fraud, banks and financial institutions can embed a 2 D barcode on the printed IRD. DTSU 9.90-2004 states that there is an optional area on the IRD that "may be used by the creating institution for data such as an automatically identifiable security feature or document control numbers.[14]" The barcode on the IRD may contain payee, amount, account number, routing #, etc to help deter fraud. Therefore, when the IRD is subsequently scanned, the barcode data can be easily verified against the data within the accompanied database. This 2 D barcode can provide a level a security to prevent and catch fraudulent checks.

  An industry accepted 2 D barcode is recommended so that any bar code reader can read the barcode. No special equipment is required for the financial institution. If encryption is used, then every financial institution that touches that IRD will need to have special equipment to be able to read that encryption.
- Duplicate IRDs prevention – As with data verification, high speed MICR reader/sorters can be used to confirm that there are no duplicate IRDs that were printed. The MICR line can be read by the reader/sorters and compared against the database information to verify that only one IRD is printed for each database record.

[14] DTSU X9.90-2004, Rev. A

Conclusions

- Employ technology that can calibrate and ensure accurate printing of IRDs.
- IRDs need to be printed in the correct format and printed in accordance to the required tolerances that are outlined in the standards.
- IRD printing software needs to be able to calibrate the printer that it is interfacing with to print the IRDs.
- It is best to utilize software that can load the font every time a print batch is run and unloaded each time the print batch is finished.
- Work with a IRD printing technology provider that optimizes the size of the files within the printing process.
- It is imperative to employ an IRD vendor that understands the printer, toner, fuser and magnetic ink issue when printing MICR on IRDs.
- It is important to work with a IRD printing technology provider that can work with incorrect image file formats and print the correct information.
- It is important to employ an IRD printing technology provider that can help identify IRD images with issues before they are past on to the next institution.
- Work with a IRD printing technology vendor that understands and can fix image issues before the IRD is printed.
- It is important that the printing technology is flexible enough to match different burster sorting orders.

All My Papers Solutions

All My Papers products are used on millions of pages every day and are incorporated in many of the most popular paper capture solutions available today.

All My Papers has developed a set of software tools that will facilitate compliance with the Check 21 Law and automate check imaging. Financial institutions such as banks, credit unions, thrift associations and their corporate customers will need new software to view, image process, extract data, verify data.

AllMyPapers Check Image Tools

- **AmpLIB MICR OCR SDK** - a Window's™ DLL based Software Development Toolkit that finds, reads, repairs, and extracts MICR line data from check images.
- **IrdLIB SDK** - a COM Object Software Development Toolkit (SDK) for accurate and fast printing of Image Replacement Documents (IRDs) from X9.37 files and other sources. IRDLIB controls the forms, fonts and printers.
- **MicrBATCH** - a Windows application that runs in either command line or interactive mode that detects Magnetic Ink Character Recognition (MICR) fields, image processes and extracts MICR data from the scanned check Image.
- **X9.37 VIEWER -** a Windows application that allows the viewing of the content of X9.37 files such as the check images, item and record values. The licensed version includes viewing the contents of the fields and records and conformance analysis,

Table of Figures

Glossary

DSTU
Image Cash Letter File x9.37
ACS
FRB
FSTC
IRD
PDF (Portable Document Format)
Original IRD
Subsequent IRD
External Processing Code (EPC) field (ANS X9.13) - An optional, single digit field located to the left of the routing field on a check. The EPC field is used for special purposes as authorized by the Accredited Standards Committee X9B. Also known as position 44.