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Digital Camera Guidance for EPA Civil Inspections and Investigations



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USE OF DIGITAL CAMERAS FOR CIVIL INSPECTIONS AND INVESTIGATIONS

STATEMENT OF GUIDANCE

EPA has determined it is acceptable to use digital cameras/photographs for documenting civil inspections and investigations provided certain requirements are met. This document is for guidance purposes only. Photographs recorded, maintained, or reproduced in a manner other than as described in the recommended steps may nevertheless be used as evidence in developing or going forward with an agency action. However, the person responsible for such photographs should consult with EPA counsel on the appropriate use, handling, and documentation of such photographs. This document is intended for the guidance of EPA staff. It does not set forth requirements that are binding on EPA staff or on third parties or courts. The fact that a particular requirement set forth in this document is not satisfied shall not be relevant to the admissibility or legal force of a particular digital photograph.

INTRODUCTION

EPA inspectors often include photographs taken during the inspection in the inspection report to support their observations. Generally, EPA inspection manuals for specific programs address the use of photographs. In recent years, inspectors have begun to use digital cameras. The use of digital images presents somewhat different issues related to the use of these electronic images as evidence. To be effective, the image should be of sufficient clarity and detail to support the observations, and should represent what the inspector saw with the appropriate level of detail. Credibility of the digital image (as well as any photographic image whether digital or film) and acceptability in court (i.e. evidence) depends on the ability of the photographer (or the witness who was present when the photograph was taken) to authenticate the photograph by answering the simple question: Is this a fair and accurate representation of what you saw? To address potential concerns, this document sets forth EPA's guidance on the use of digital photographs and identifies requirements necessary to ensure the integrity of the pictures.

The document addresses image capturing, storage, and handling. In addition, this document provides an overview of digital camera technology, peripheral equipment, and recommended steps found in Appendix A. Credibility of digital images in court usually depend on reliability, reproducibility, and security. It is acceptable to make changes to digital images such as cropping, enlarging, or making it lighter/darker to improve the sharpness provided the inspector does all the following:

- Records how, when, and where the picture was taken;
- Logs the steps used in processing the image when they include techniques other than those used in a traditional photographic darkroom;

- Complies with a written SOP that includes the recommended steps set forth in this document; and
- Ensures the preservation of the original digital image.

RECOMMENDED PROCEDURES

Inspectors should take precautions to ensure the integrity of the digital image and resulting photographs because these are easy to manipulate. Appendix B of this document provides technical information and considerations related to digital camera use. Inspectors should ensure they meet the following minimum requirements when using digital photographs to document EPA civil inspections and investigations:

- A. The integrity of the digital image should be preserved:
1. When inspectors use digital photographs as evidence, the person testifying should be able to verify the authenticity of the printed image. This includes knowledge on how the image was acquired, its relevance to the case, and how it corroborates testimony as to issues which may be disputed in the case.
 2. The quality of the photograph should be good enough to show details, objects, and relevant information.
- B. Inspectors using a digital camera for inspections should be able to capture, store, print, and handle digital images properly:
1. Inspectors should have equipment which will allow the secure use and storage of the digital images such as storage media, printer, and computer. (The Basic Technical Information Section, Appendix B, provides further details on equipment).
 2. The inspector should follow the recommended steps for handling the digital image. Each Regional office with inspection authority using digital cameras should develop recommended steps governing their use. Appendix A of this document contains a model of the recommended steps.
 3. The inspector should not delete any digital images while conducting an inspection regardless of whether they are of poor quality.
 4. A record of any copies of the digital images given to a facility should be kept in EPA's inspection file. The record should identify and describe the digital images and can be noted in the field notes, on a Photo-Log, or as a separate list.
 5. Protect CBI. Digital photos which may contain Confidential Business Information (CBI) should not be sent via e-mail. When taking, storing, using, or transferring

digital photos which contain CBI data inspectors should follow standard CBI procedures regarding use of computers and electronic storage media at all times.

C. Inspectors should maintain an Archival Copy of all images taken:

1. Inspector/photographer should create an archival copy¹ of all original images taken during the inspection as soon as practical after image capture. Inspectors should NOT delete any photographs taken. This archival copy should be labeled and maintained in the inspection file in a secure location. Any enhancements needed on the image should be made only to a working copy.² (NEVER EDIT THE ORIGINAL IMAGES OR ARCHIVAL COPY). Ideally unalterable storage media such as a read-only Compact Disk (CD-R) should be used to create the archival copy. If this option is not available, other storage media (including alterable) may be used for the archival copy, provided the images can be verified and Chain-of-Custody procedures are followed to prevent tampering. When using an alterable storage media, cyclic redundancy check³ software can be used to verify the images.
2. When mailing the archival copy via postal mail, inspectors should place the storage media in a protective jacket, pouch, or equivalent with a custody seal and follow the procedures used for mailing samples to ensure its integrity.
3. If digital images are CBI, CD's containing there images should be stored following appropriate CBI procedures.

D. The inspector should keep a Photo-Log in the inspection file of all the photographs taken including the printed images referenced in the inspection report:

1. The Photo-log is a record of the archival copy, which includes all the photographs taken during the inspections.
2. The record should include: identity of the photographer, date, time, location, [including information identifying the location such as EPA Identification numbers, latitude, and longitude], and a brief description of the pictures, (including anything

¹An archival copy is an unchanged, unedited copy of the original images that will be used as the permanent record. It is the functional equivalent to the "negatives" in film photography.

²The working copy is the "back-up" copy of the original images which may be used to make minor enhancements or edits such as cropping and improving contrast.

³Cyclic Redundancy Check (CRC) is a technique to obtain data reliability. It is used to protect blocks of data called Frames. The CRC performs a mathematical calculation on a block of data and returns a number that represents the content and organization of that data, a checksum. By comparing the checksum of one block of data to another, it can be determined whether they match.

worthy of special note). This record may be a list of the photos noted as part of the field notes, may be a separate photo list, or a separate Photo-Log.

3. For working copies, If images are transferred from one storage media to another or changes are made to an image, EPA should keep a record in the inspection file of the identity of the person making the transfer/change and the date of transfer or change. The record should include the type of change. Minor edits can be made to the working copy such as cropping, reduction, enlargement, or contrast improvement. Each change should be saved as a separate image file and documented so that all enhancements can be reconstructed, if necessary.
4. The inspection report should contain printed copies of the digital photos referenced in the report. The printed images should be initialed by the inspector and dated when the photo was taken (unless the photo is already imprinted with the date taken).

REFERENCES/ADDITIONAL INFORMATION
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12. TSCA Confidential Business Information Security Manual, Office of Pollution Prevention and Toxics, April 1995.

Websites:

1. www.digital-camerastore.com/digitalinfor2.htm - good basic info and lists of cameras/prices.

2. www.cliffshade.com/dpfwiw/advice.htm – “Advice for first-time digital camera users”, – good overview of digital camera use with links to more information.

3. www.cooking-italian-food.com/photography.htm – “Digital Camera Guide - Photography Definitions and Terminology”, - discussion of resolution, optical/digital zoom, ISO, storage media, and other basic terminology.

4. “An Introduction to Image Compression”, - www.debugmode.com/imagecmp/.

5. “Resolution, File Size & Image Quality”, - www.haroldphoto.com/digital.asp.

6. “Frequently Asked Questions on Digital Photography”, - www.photodrive.ru/faq6_e.htm.

7. Maresware Forensic and Analysis Software - a list of commercial forensic software, including cyclic redundancy check. www.dmares.com/maresware/DOCS/press_release.htm.

8. “Error Detection and Correction”, - description of Cyclic Redundancy Check - www.linktionary.com/e/error.html.

9. “Understanding Cyclic Redundancy Check”, - <http://4d.com/acidoc/CMU/CMU79909.htm>. a description of how the CRC error detection system algorithm works.

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APPENDIX A**Recommended Steps for the Use of Digital Cameras****A. Creating Digital Pictures**

1. Camera Use

The Inspector should be familiar with the camera's features before using it during inspections. He/she should read appropriate manuals and practice using the camera before an inspection. In addition, the inspector should know the following:

- How to store an image;
- The capacity of the storage media being used;
- How to transfer images from one storage media to another;
- How and what is needed to print good quality images;
- How to use the different settings (resolution choice, digital zoom, close-up, flash, etc.); and
- The camera's limitations (weather, zooming, lighting).

2. Preparing to Take Pictures

Before taking pictures, the inspector should:

- Ensure that the camera and supporting equipment are appropriate to the task. The camera should possess appropriate resolution and capacity for the type of photo required, including close-up or distance photos, if needed;
- Ensure that the camera is in working order;
- Check the settings – make sure the date/time settings are properly set;
- Make sure there is adequate storage media for the projected number of photos needed; and
- Make sure that fresh and back-up batteries are available.

B. Photo Image Storage/Handling and Security.

1. Storing/Handling Images.

The inspector should use the following procedures when storing/handling digital images:

- Number each Storage Media (storage card, smart media, or other card) sequentially and label it with the name of the facility and date taken. Indicate what pictures from the inspection are contained on each.
- Store each incident/inspection's images on one storage media card, if possible, clearly identifying pictures captured for each inspection.

- Images from one incident/inspection should not be split between two electronic storage cards unless the storage media does not have enough memory to store all the images from one inspection/incident.
 - Before each inspection create an “end-card” image label and photograph it.
 - If images from more than one incident/inspection need to be captured on a single storage card, insert a “blank” image after the “end card” image.
 - Ensure that there is adequate space on your hard drive, and as soon as possible after each incident/inspection, download the images from the camera’s storage media to the hard drive of the computer, verifying that the images have been successfully transferred. (DO NOT CHANGE THE IMAGES IN ANY WAY).
 - Using the downloaded images, copy them to a CD-R or other permanent storage media to create the archival copy. (Do not edit or change the image).
 - Label the archival copy with the time, date, name of facility/site, and “Archival Copy”.
 - File the archival copy with inspection report in a secure location. If the archival copy is on alterable storage media, file it with a Chain of Custody form.
 - Once an archival copy is securely filed, the original storage media may be erased and re-used.
 - Create a second copy (“Working Images”) from the downloaded images to use for enhancements such as cropping or contrast. Label this “Working Images”.
 - If any images are changed, save each change as a separate file so that it can be replicated, if necessary.
 - Note any image changes and record the file numbers on the Photo-Log or photo record and include it with the Inspection Report.
 - Once the archival copy and a working copy have been made, the images may be removed from the hard drive to free up memory, if needed.
2. Image Security.

The original images and/or archival copy should be stored either with the inspection file, in a locked file cabinet, or in an other secure location. If any of the information is CBI, all CBI procedures should be followed, including use of secure computers, storage media, data handling, and transmission. See your local Document Control Officer if you have any questions regarding proper CBI procedures.

- If the archival copy is kept on alterable storage media (such as USB), each archival copy should have a Chain of Custody form to document access to the images.

The Chain of Custody form should include:

1. The identity of the photographer;
2. The date and location where the photos were taken;
3. The file identification numbers of the photos in the set; and
4. A log to record the identity, signature, date, and time of any person having access to the photos/images.

- If the archival copy is stored on alterable media:
 1. Each person viewing or using the archival copy should sign the Chain of Custody Log; and
 2. To send via postal mail to another location, place it in a jacket, pouch, or equivalent holder with a custody seal and the Chain of Custody form (follow the same procedures used when mailing samples).

- The Region should have a file management procedure in place mandated by EPA Records Schedule 211 and EPA Records Management Regulations which can be found at: <http://www.epa.gov/records/policy/schedule/sched/211.htm>.

- Inspector should be careful when handling images and avoid extreme temperatures, electricity, x-rays (airports), power surges, or other similar events, which might cause electrostatic interference and thus impact the image quality.

APPENDIX B

Basic Technical Information Section Related to Digital Camera Use

Digital and film photography share many similarities. Both create an image through the use of a light-sensitive medium. In the case of digital cameras, light falls on a grid of detectors known as a charge coupled device, CCD, and produces a pattern of electrical charges that are measured, converted to numbers, and stored. Each value in the grid corresponds to a picture element, (also known as a pixel) in the digital image.⁴ The electrical output of the CCD is sent to a converter that changes the image to a digital output which is then stored in the camera as a computer data file with each file representing a different photograph.⁵ The following information includes a discussion of some important factors relevant to digital camera use.

Resolution

Digital camera resolution is the amount of sharpness or detail in the image and is dependent on the number of pixels in the image. This is generally determined by the number of pixels across the width and height of the CCD. Pixel count is established by multiplying these numbers. Therefore, it is important to know the maximum CCD resolution (total number of pixels in a camera's sensor) in order to know the film equivalent capability of the digital camera. This is generally stated as "x" Mega Pixels. For example, 1280 x 960 pixels would give the film resolution of a 5" x 7" print and 1600 x 1200 pixels would give the film resolution of a 8" x 10" print.

For higher quality, multi-purpose use, CCD resolution in the 3.1+ mega pixel range is needed. Higher mega pixel levels allows creation of a greater number of images with a high level of detail that will not be lost if the image should be enlarged. This is important where larger photos may be necessary and/or where greater detail is important. It is also important if more than a few high resolution pictures are going to be needed during an inspection.

The quality of a printed photo is only partially dependent on the camera resolution. Printer resolution capability is also an important factor when printing photos.

Photo Storage and Printing

Storage and printing are other important considerations for the use of digital cameras. The computer is most often the mechanism used to store and print digital photos. To transfer images from the digital camera's memory to the computer, the camera is connected to the computer using a Universal Serial Bus (USB) port. Most computers have a USB port that simply

⁴Erik C. Berg, "Legal Ramifications of Digital Imaging in Law Enforcement", *Forensic Science Communications*, October 2000.

⁵Penney Azcarate, "Digital Imaging Technology and the Prosecutor", *Prosecutor*, January/February 2000.

connects to the camera with a plug-in cable and images can be downloaded to the hard drive. If a USB port is not available, a card reader can be connected to the printer port to transfer images to the computer and the images then can be stored on the computer's hard drive. However, if the hard drive were to fail the images could be lost so back-up storage is necessary. Some cameras are also equipped to transfer the images directly from the camera to the computer. The disadvantage of this system is that if the transfer is interrupted some images could be lost.

Images can be printed at the same time they are downloaded, or printed as needed. For truly photographic quality prints, a commercial developer is recommended, particularly if large pictures are required. (Commercial developers have access to a different process that can provide better color and resolution than that afforded by in-house processing). For in-house viewing or most general purposes, a good quality color ink-jet printer using archival inks is recommended, particularly if the photos will be stored for a long period of time. For high quality images, premium glossy photo paper will give a great degree of color accuracy, even under magnification. For general purposes plain paper, photo quality ink-jet paper, premium photo paper, etc. can be selected depending on the necessary quality outcome.

Storage Media/Memory

A digital camera uses and/or contains random access memory (RAM) to store the images. When RAM is used up, it should be restored in order to take more pictures. There are currently several types of storage media used to record digital photos. The most common ones are Smart Media, Compact Flash, and Stick Memory. Also available is another card-sized storage media, an IBM "Microdrive", which fits the Compact Flash Type II card slot and can store up to 1 gigabyte of data when used with a compatible camera. Regardless of the storage media used by the camera, pictures can be downloaded and stored either on the computer's hard drive or on a compact disk (CD) if the computer is equipped with a CD "burner".

The number of photos which can be taken per session is a function of the resolution selected and the amount of memory required. This is somewhat dependent on the file format used. Most digital cameras use a file format which "compresses" the image so that more pictures can be stored on the storage media. There are two file types used to store the digital images on the storage media. A "lossless" file is one where no data is lost. Two file format types frequently used by digital cameras to capture "lossless" images are TIFF (Tagged Image File Format) and RAW (that has not been altered, processed or manipulated in any way). Lossless files or lossless compressed files tend to be quite large. Because these images require so much memory, to store more than one or two digital images in this format requires a very high capacity (and expensive) storage media, so this is primarily used only by professional photographers using high-end equipment.

Another file type in which some data may be lost is known as a "lossy" file. Images stored this way take up less much less room but may lose some data or image quality. However, the resultant "loss" may not be significant to over-all picture quality. One type of "lossy" file format that is currently used by most digital cameras is a standard file format known as JPEG (Joint Photographic Experts Group). This file format is designed to address the known limitations of the human eye and was named for the committee that devised and wrote the standard. At the

highest JPEG resolution, even though there may be some small loss of image quality, it would not be obvious to the human eye. (This is less true for pictures of things like signs or other very hard-edged objects). When the camera saves files in the JPEG format, the amount of compression (image quality) must be decided upon. Most cameras give you the option in the setup menu to choose the JPEG image quality: fine (1:4 compression ratio), normal (1:8 compression ratio), and basic (1:16 compression ratio). The decision is always a compromise between image quality and the number of files that can be fit on a memory card. Unless many images need to be crammed onto the card, or the final quality is not that crucial, it is recommended to always use the camera setting that delivers the highest quality (lowest compression level). In most cases, a high-quality compression setting (fine) produces excellent image quality and generates compact file sizes that will allow many images to be fit onto a storage card. Generally, a 3.1 Mega Pixel (MP) camera using a 16 Mega Byte (MB) storage medium at high resolution could store approximately only two TIFF files, but could store at least 12 JPEG photos with no noticeable image loss.

Most digital cameras come with built-in picture file identifier (which assigns a unique number to each picture), date, and time stamps. This is an important feature which can be helpful for record-keeping purposes.

Power Supply

Because they are electronic, digital cameras require significantly more power than other types. As a result, batteries can drain quickly. This can be true even when batteries are left in the camera and are not in use. Repeated viewing of images through the camera's liquid crystal display (LCD) screen can also rapidly deplete batteries. This is particularly significant for digital cameras because battery depletion can cause the camera settings to be lost, in addition to being problematic if the power suddenly disappears when needed during use.

Most digital cameras use nickel metal hydride (NiMH rechargeable batteries) others use nickel cadmium (NiCd, rechargeable), lithium (non-rechargeable), and of course, alkaline (non-rechargeable). Of these, the NiMH batteries are the most economical because of their basic cost, rechargeability, length of charge, and long service life. (They are also environmentally preferable to the nickel cadmium batteries which are gradually being phased out). The lithium batteries are useful as cold-weather back-ups. Having extra battery sets is essential when using digital cameras for anything more than a few quick shots.

Optical Zoom

Another factor affecting picture quality, particularly for close-ups or distance, is optical zoom. Optical zoom is "true zoom" or telephoto, which makes the image appear closer without losing detail (a 2x optical zoom is roughly equivalent to a 35-70 mm zoom on a film camera). Digital zoom is really just built in image enlargement with some resulting loss of photo detail. Cameras with a higher degree of optical zoom allow for a greater degree of flexibility in use without loss of image quality.

Computer Requirements

If a computer is equipped with a CD “burner”, the images can be stored on a read-only CD (CD-R). This has several advantages. Images stored to a CD-R are created by permanently altering the disc with a laser light beam. CD writers cannot delete laser marks, so the images can be stored without alteration and any alteration would be detectable. This is only true for CD-R, not CD-RW (read-write). The “original” images could be stored this way to form an unalterable archive and it is feasible to store large numbers of images in a small amount of space (a typical CD can store hundreds of images). Once the images are archived to a CD-R, copies of the unaltered “originals” can be made from the CD-R and any necessary enhancements, such as improving contrast or “cropping” can be done on the copies and properly noted in a Photo-Log for future reference. Each change should be saved as a separate image file and documented so that all enhancements can be reconstructed, if necessary.

An alternative to using the CD-R is to store the images on a USB Flash Drive or computer hard drive and use commercially available software to perform a “Cyclic Redundancy Check” (CRC) on the stored images. The software performs a calculation that generates a unique number which can be checked later against the stored data to ensure that they match, indicating that the data also matches.

A computer has two types of memory, hard disk storage and Random Access Memory (RAM). The computer’s hard disk drive is the memory used to store the digital images before transferring them to another storage medium, such as a CD-R. A high-capacity hard drive is needed if many digital images will be downloaded at one time. A hard disk drive should not be filled to more than 70% of its maximum capacity in order to not cause performance deterioration. A computer with at least a 10 gigabyte hard drive is recommended at a minimum, but the amount of hard drive memory needed will depend on what other programs are resident which use memory, and how many pictures will be downloaded from the camera’s storage media before being transferred to CD-R or other permanent storage.

Computer speed is another consideration. Speed is normally measured in millions of cycles per second or MHz. Speed affects how fast the digital images can be downloaded or edited. A speed of at least 233 MHz is recommended, although computers are now available at speeds of 2000 MHz (2Ghz).