

**Law Enforcement/Emergency Services Video Association
LEVA**

**Guidelines for the Best Practice in the
Forensic Analysis of Video Evidence**

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1. Goal

The goal of this document is to provide a framework for the relevant concepts and issues in the scientific examination, comparison and/or evaluation of video in legal matters. This framework is designed within the acceptable practices of the forensic video analysis community.

2. Introduction

As video recording devices and Closed Circuit Television (CCTV) systems become a more affordable option in the private and public sectors, there is a corresponding increase in the frequency in which they are encountered in criminal investigations. The ability to obtain detailed information from video evidence has tremendous potential to assist with investigations. Care must be taken to make sure video evidence is accurately processed and presented in court.

Forensic video analysis is the scientific examination, comparison and/or evaluation of video in legal matters. Advancement of technology is bringing this field of science from the crime laboratories to the investigating agents. The benefits of this are twofold: First, results can be obtained more rapidly when the analysis is performed in the same city as the incident. Second, trained analysts available at the local level are able to work cases viewed as too minor to submit to the crime lab.

The best way to ensure the reliability of the video evidence is to have standard operating procedures (SOPs) in place. SOPs assist the forensic video analyst in maintaining proper records of the processes used to examine the evidence and that the processes are performed in a scientifically appropriate and uniformed manner. Records should be complete enough that a similarly experienced and trained individual, working with the same technology, could reproduce similar results.

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3. Scope

The scope of this document considers the recovery of video evidence, equipment for forensic analysis, process of forensic video analysis, output of video evidence, review of findings, and training considerations for analysts.

4. Recovery of Video Evidence

General principles for seizing and maintaining video evidence should be followed by law enforcement agencies. These general principles are:

1. **Rules of Evidence.** The same general rules of evidence should be applied to all video evidence just as it would to any other type of exhibit such as a knife at a homicide or fingerprints at a break-in..
2. **Chain of Custody.** Proper documentation of the chain of custody should be used and preserved to ensure the video evidence can be tendered in court as an exhibit.
3. **Evidence Preservation.** Upon seizing the video evidence, action should be taken to ensure the evidence is not changed:
 - a. For analog video evidence, the record tab needs to be removed or moved to a saved position.
 - b. For digital video evidence, write protection needs to be in place.
4. **Evidence Storage.** A climate-controlled room should be used to store video evidence.
5. **Custodian Responsibility.** Maintaining the evidentiary value of video evidence is the responsibility of the individual who has seized or signed for receipt of the evidence. The individual is responsible for all actions taken in respect to that item until it is formally transferred to another individual.

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5. Essential Equipment

All equipment used for forensic video analysis should be suitable for its purpose and maintained in a fully operational condition. The physical workspace of laboratories and investigative offices for the examination of video evidence should be designed and equipped for efficient, secure, safe, and effective use.

Equipment for forensic video analysis includes:

1. **Analog Video Monitor.** The analyst should have the ability to view the underscan area of the analog video signal with the monitor. The underscan area refers to that portion of the NTSC signal containing visual information that is generally not displayed on a consumer television. In simple terms, the NTSC image is larger than that which is displayed on a standard television. Without this type of monitor the underscan area must be available at some point during the video examination process.
2. **Video Playback Deck.** A real-time S-VHS deck with a built in frame synchronizer or Time Base Corrector (TBC) should be used to playback video evidence. Consideration should be given to adding a high-density time-lapse deck for projects where video is recorded in a high-density mode.
3. **Printer.** The analyst should have the ability to print images from video evidence. Consideration needs to be given to the type of printer chosen. Appendix B provides information on the variety of printers available.
4. **Digital Forensic Analysis System.** The minimum standards for a digital forensic analysis system include:
 - a. The ability to digitize the complete NTSC signal (International Telecommunication Union Radiocommunication Sector Recommendation BT.601 (ITU-R 601)).

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- b. The ability to view consecutive images at the field level.
- c. The ability to digitize and process video using a lossless compression scheme. Lossy compression schemes, such as that inherent in the DV format, discard original information and can add artifacts to achieve smaller file sizes. If the purchasing decision comes down to either a lossy compression system or no digital forensic analysis system at all, a lossy compression system may be acceptable. The analyst must recognize the limits of a lossy compression scheme compared to a lossless compression scheme.
- d. The ability to process video without the addition of artifacts.
- e. General acceptance by the forensic video analysis community.

6. Process of Forensic Analysis

The practitioners of forensic video analysis should adhere to established scientific principals. When establishing a process of forensic analysis for video evidence, analysts should take into account:

1. **Prior to Examination.** Consideration should be given to the following before commencing any examination of video evidence:
 - a. **Examination Priority.** Priority should be given to other forensic examinations (fingerprints analysis, trace evidence analysis, etc.) before any forensic video analysis proceeds. The minimum precautions must be identified and implemented.
 - b. **Integrity of Evidence.** Video evidence submitted for forensic video analysis should first be reviewed for its integrity. Any deficiency (damage, write

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protections not in place, etc.) should be documented and resolved before any forensic video analysis proceeds.

- c. **Protection of Evidence.** At all times, precautions should be taken to ensure video evidence is protected from external factors (magnetic fields, static electric charges, electrical hazards, etc.) that may cause damage to the media or to the recorded signal contained on the media.

2. Image Processing Techniques. Forensic video analysis may employ several techniques of image processing during examinations. Consideration should be given to the following before using any image processing tools:

- a. **Image Processing Applications.** A number of tools are available that may be utilized for image processing during forensic video analysis. Several computer software applications contain a variety of tools useful for image processing. A comparison performed by the analyst of the capabilities of different programs will ensure the benefits and limitations of each program are understood.

- b. **Image Formats.** There are a vast number of image formats available for image processing. A format that allows for no compression or lossless compression should be used. The Tagged Image File Format (TIFF or .tif format) is widely used and recommended for the processing of images.

3. Standard Operating Procedures (SOPs). Analysts should establish SOPs for the analysis of video evidence. The overall plan for the analysis of video evidence should include the following:

- a. **Record Keeping.** SOPs should assist the forensic video analyst in maintaining proper records of the processes used to obtain the evidence.

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Output provided should represent the following:

1. **Proper aspect ratio.** If the digital forensic analysis system follows the ITU-R 601 standard, any images obtained for print purposes must be corrected for the transfer of non-square to square pixel matrixes.
2. **Uncompressed video output.** Any video or image files produced using further compression schemes for smaller file sizes should be used for demonstrative purposes only. Further compressed files are generally inappropriate for evidentiary purposes.

8. Analysis Review

All work undertaken in forensic video analysis may be subjected to a technical and administrative review.

1. **Technical Review.** A qualified forensic video analyst should conduct a technical review on a sample of completed cases (e.g., a set percentage of all casework or a randomly chosen case during a set period). The sample of completed cases could vary depending on the situation (new forensic video analyst vs. experienced forensic video analyst). Technical review should include consideration of the validity of all processes used and the critical analysis findings. A written record of the technical review should be made and retained with the case management system.
2. **Administrative Review.** An administrative review should be performed on every completed case. It is used to check for consistency with established SOPs and for editorial correctness. The author of the report or other personnel may perform this review. The Technical Review and the Administrative Review are topics that should be detailed in the SOP and adhered to.

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9. Training

The discipline of forensic video analysis is a particularly technical one. New products for the recording and storage of video information mean new types of video evidence. New tools and procedures for the examination and analysis of video evidence are also developed on a regular basis. For this reason, it is not practical to view training as a one-time event but rather as an on-going process.

It is important to keep pace with technological advances, new techniques, changes in the law that relate to forensic video analysis. Sources for training include:

1. **Professional Organizations and Educational Meetings.** Organizations such as LEVA, the International Association for Identification (IAI), and the National Technical Investigators Association (NATIA) provide regular courses and seminars on forensic video analysis.
2. **Vendor Training.** Courses and seminars provided by companies that provide digital forensic analysis systems and image processing tools.
3. **Seminars.** Provided by government agencies, government forensic laboratories, as well as commercial enterprises and seminars allow analysts to compare and review processing techniques.
4. **College Level Courses.** Universities, colleges, and technical schools that provide course work in forensic video analysis, video engineering, and image processing.

Additionally, LEVA provides a Forensic Video Analysis Certification Program that outlines a training plan in forensic video analysis.

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10. APPENDIX A

Definitions

Artifact	Any visible feature or distortion in a recorded image or output image that is NOT present in the corresponding imaged object or input image.
Aspect Ratio	The ratio of width to height of the picture. For example, ITU-R 601 NTSC video, the aspect ratio is 720 X 486 or 1.48:1.
Compression	The translation of data (video, audio, digital or a combination) using a variety of techniques to reduce the amount of data required to represent the content.
Digitization:	The process of transferring an analog (signal based) video image into a digital (data based) image capable of being processed on a computer.
Field	One half of complete video frame, consisting of every other analog scan line.
Frame	A complete image in video or film recording. A video frame consists of two interlaced fields of either 525 lines (NTSC) or 625 lines (PAL/SECAM) running at 30 frames per second (NTSC) or 25 frames per second (PAL/SECAM)
ITU-R 601	A basis for digital coding standards for video in countries using the 525-line system as well as in those using the 625-line system. ITU-R 601 defines the sampling systems, matrix values and filter characteristics for Y, Cr, Cb and RGB component digital television. It establishes a 4:2:2 sampling scheme at 13.5 MHz for the luminance channel and 6.75 MHz for the chrominance channels with eight-bit digitizing for each channel, providing a total signal bandwidth of 168 Mbps. The term 4:2:2 refers to the ratio of the number of luminance channel samples to the number of chrominance channel samples; for every four luminance samples, the chrominance channels are each sampled twice.
NTSC	National Television Standards Committee
VHS	Officially stands for Video Home System but initially stood for Vertical Helical Scan, after the relative head/tape scan technique. Some early reports claimed that the initials originally stood for Victor (Company) Helical Scan system. This is an analog composite video format wherein luminance and chrominance values are contained in the same channel. Uses a control track for synchronization with 240 lines of horizontal resolution.
S-VHS:	Super-Video Home System (also known as Y/C) is an analog video format offering a higher quality signal than composite video, but a lower quality than RGB and component video. This mid-level format divides the signal into two channels - luminance and chrominance. Uses a control track for synchronization with 400 lines of horizontal resolution.

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11. APPENDIX B Printing Considerations

Forensic video analysis requires that an accurate representation of the image be reproduced for print purposes. There are three main categories of printers available for images: dye sublimation, laser, and inkjet. The advantages and disadvantages of each printer type should be considered before inclusion to forensic video analysis.

Ink jet Printers

Ink jet technology is available in two forms: thermal and piezo-electric. Thermal ink jet printers use tiny heating elements to shoot microscopic droplets of ink through an ultra-fine print head nozzle. This is done in continuous passes across the page while the paper is advanced. Printers that use Epson's proprietary piezo-electric technology apply an electric current to change the shape of the piezo element that houses the print head nozzle. As a result, ink is being forced out of the nozzle onto the paper when the crystalline element shrinks slightly.

Many ink jet printers will preserve the image integrity if they are capable of printing at least twice the image density. For example, video frames of a nominal 72 pixels per inch (PPI) require an ink jet printer that can print at least 144 dots per inch (DPI). Scanned images or images from digital cameras that produce images of higher pixel density would require a printer capable of higher dot density. While the current movement in the computer industry strives for ever-higher printer densities, anything more than 2 times the image density simply slows the printing process, uses more ink, and produces no significant improvement in image quality.

In addition to the technical specifications, it is important to find an inkjet printer that uses good quality, archival grade ink. Most ink jet printers use water-soluble inks that are unsuitable for forensic work. These inks can be damaged by any contact with water.

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Archival inks are solvent based, therefore they are waterproof and can last up to 70 years without fading regardless of the type of paper used.

Laser Printers

A laser printer utilizes a laser beam to produce an image on a drum. The light of the laser alters the electrical charge on the drum. The drum is then rolled through a reservoir of toner, which is picked up by the charged portions of the drum. Finally, the toner is transferred to the paper through a combination of heat and pressure.

Traditionally, laser printers are known for their low operating costs, high quality prints and large handling capacities. Many laser printers will preserve the image integrity if they are capable of printing at least twice the image density.

Dye Sublimation Printers

Dye-sublimation printers use heated layers of a color film roll to produce photo-quality prints. A heating element first heats the color film to vapor and then diffuses it onto the surface of the specially treated paper. This is done for each of the four colors to form the complete image. The varying temperature of the heating element controls color intensity.

While many laboratories use Dye-sublimation (Dye Sub) printers, they may not be the best choice for forensic work. Dye Sub printers are expensive, require regular maintenance, and use costly expendables. In addition, the printing process intentionally blurs the image pixels to produce a softer, more pleasing image.