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Section 4

Recommendations and Guidelines for Using Closed-Circuit Television Security Systems in Commercial Institutions

1. Purpose

The purpose of this document is to provide recommendations and guidelines for the use of closed-circuit television (CCTV) security systems in commercial institutions, such as banks and convenience stores. For the purpose of this document, stationary unattended cameras and on-site recording devices will be discussed. The basic principles and recommendations can, in most cases, be applied to any system using closed-circuit television cameras and video recorders. This document addresses analog and digital video systems. The intent of these recommendations and guidelines is to optimize image quality to facilitate the identification of unknown people and objects depicted therein.

This document does not specifically address employee theft or other internal security issues, although some of the recommendations can be applied to those problems. Likewise, this document does not address live monitored surveillance systems. References that address such systems are included in Appendix A, CCTV References.

Furthermore, these guidelines are not intended to replace or take precedence over other regulatory requirements in the specific jurisdiction of the facility to which these guidelines will be applied.

2. Position

The use of closed-circuit television systems and the recording of security images is an accepted practice in commercial institutions, such as banks, convenience stores, and other facilities. In addition to deterring crime, this practice can often facilitate the apprehension and conviction of people involved in criminal activity. It is the position of the Scientific Working Group on Imaging Technology that in order to optimize the use of these systems, the following criteria should be met:

- Recordings that depict criminal activity must be preserved in a manner that permits law enforcement officials to recover the original images with a documented chain of custody. (Chain of custody is the chronological documentation of the movement, location, and possession of evidence.)

- The number, placement, and type of cameras should be sufficient to provide adequate coverage and detail in the monitored area.

- There should be adequate, balanced lighting in the monitored area.

- Institutions should establish and follow a program of regular system maintenance.

- Institutions should have documented procedures to ensure that employees know

what to do in the event of a criminal incident.

This document addresses electronic closed-circuit television security recording systems only. It does not address the use of film-based or digital-still cameras. This document is not intended to suggest removing film surveillance systems or digital-still cameras from the affected facilities. Due to the fact that images recorded using film and digital-still cameras are usually of higher quality than video images, the continued use of such systems, where existing, is strongly encouraged.

3. Introduction

A closed-circuit television security system may include a single camera or multiple cameras. Coverage can include checkout areas, walk-up or drive-up automated teller machines, public-service areas, entrance or exit doors, work areas, interior corridors or common building hallways, and exterior or interior parking areas.

A camera system may include cameras, a monitor to view the camera images, a recording device to capture selected images, and software or a switching system to control the method of selecting and storing images. Depending on the location and situation, video-camera systems may use an analog videocassette recorder (VCR), a digital video recorder (DVR), or a PC-based digital recording capture station to record images from the cameras. Finally, a means of retrieving and storing images must be incorporated into the system.

This document addresses closed-circuit television systems in the following seven areas:

- System Design (Section 5)
- Recording Systems (Section 6)
- Cameras (Section 7)
- Media (Section 8)
- System Maintenance (Section 9)
- Retention of Recordings (Section 10)
- Evidence Handling (Section 11)

4. Functional Requirements

The purpose of these requirements is to increase the likelihood that images recovered from closed-circuit television systems are sufficient to enable law enforcement officials to identify the people and objects of interest depicted therein.

In order to identify a person, specific individual features on a person, such as the detailed shape of the eyes, ears, nose, mouth, and chin, must be distinguished. Identification is facilitated if the ability to distinguish smaller features such as moles, scars, tattoos, and

freckle patterns, as well as the ability to derive measurements of these features, is possible. (Closed-circuit television systems that were designed for automated facial recognition may not meet the minimum standards specified in this document.) Likewise, identifying a vehicle requires that the license plate numbers or other identifying characteristics be distinguished.

In Figure 1, the images on the left are more likely to allow for personal identification than the images on the right. The lower part of the figure shows the head of the subject from each image after it has been enhanced.

Figure 1(a). A closed-circuit television image likely to be suitable for personal identification.

Figure 1(b). A closed-circuit television image not likely to be suitable for personal identification.

Figure 1(c). Cropped, enlarged, and enhanced image processed from Figure 1(a).

Figure 1(d). Cropped, enlarged, and enhanced image processed from Figure 1(b).

5. System Design

The ability of a closed-circuit television system to record images that will be of greatest assistance to law enforcement depends on multiple factors including the choice and placement of cameras and lenses, recorders, storage space, and compression schemes. These factors are not independent of one another but must be coordinated with one another. As an example, adding cameras to an existing system may require adjustments

to the amount of storage or the rate at which images from each camera are recorded.

A careful survey of the facility in which the system will be installed must be completed and analyzed as an integral part of the total system-design process. A site plan documenting the location and field-of-view of each camera in the facility should be included as a part of this survey. Finally, upon installation, the system must be tested to confirm that images produced by the system as output (i.e., those that would be provided to law enforcement in the event of a criminal investigation) are of sufficient quality to maximize the likelihood of identifying people or objects depicted therein.

5.1. System Components

Closed-circuit television systems should include the following components, at a minimum: a camera or cameras, moveable and/or fixed; a monitor; and a recording device, including the means by which the recording may be extracted from the device. Consideration should also be given to any need for recording audio with the video from one or more cameras and any legal problems unique to audio recording. Guidelines for recording devices are addressed in the following subsections and in Section 6, whereas cameras are addressed in the following subsections and in Section 7.

5.1.1. Monitors

A monitor should be included with every closed-circuit television system so that system operation may be checked on a daily basis (see Section 8). Monitors capable of operating in an under-scan mode are strongly recommended because this capability permits the viewer to observe the entire field-of-view being recorded.

5.2. Number and Placement of Cameras

The number of cameras needed for an institution will vary depending on a variety of factors, including the specific security needs of the institution and the monitored area(s). Care should also be exercised to ensure that cameras are not located in places where they may be subject to tampering or accidental adjustments. Camera disabling and tampering can be minimized by using components that feature concealed wiring and protection of the camera and lens assembly from weather and/or physical damage.

The cameras' fields-of-view should not be obstructed, nor should cameras be pointed directly at bright light sources, such as picture windows and spot lights. If bright areas cannot be avoided in a scene, cameras with backlight illumination or compensation adjustments are preferred to optimize the resulting image.

As a minimum, there must be at least one camera for every exit. These exit cameras should be aimed toward the interior of the facility, and each one should be located where it can obtain an unobstructed frontal view of the head and shoulders of everyone exiting the facility. The lenses on exit cameras should be configured to have a depth-of-field that extends from three feet to at least ten feet from the camera in order to provide images of exiting people which are in focus. Exit cameras that have a depth-of-field extending from three feet to beyond ten feet will have the added benefit of providing overviews of the interior and head-to-foot views of people as they enter and exit the facility.

Cameras should be placed where they can record images with unobstructed views at each point of customer transactions, such as teller windows (walk-up and drive-through), cash registers, automated teller machines, or customer-service stations. There must be at least one camera at each point-of-customer transaction. Cameras should be adjusted to ensure that they are in focus at the location where a customer can be expected to stand. If a window or other security barrier is present, care must be taken to position the camera in a manner that minimizes reflection, glare, and other obstructions that can interfere with a clear view of the persons or objects being recorded.

Figure 1(a) illustrates a head and shoulders image that is preferable for the exit and transaction cameras. The camera lenses needed to achieve the fields-of-view are discussed in Section 7.

Cameras that provide overviews of the interior and exterior portions of a facility can be useful in an investigation but cannot be relied on to provide images suitable for identification purposes. Therefore, in these guidelines they are considered to be of reduced importance. However, if the combination of the exit and customer-transaction cameras do not provide complete coverage of the interior of the facility, then it is recommended that additional cameras be included for this purpose.

If deemed necessary, exterior cameras intended to record images of vehicles should be placed to provide direct views of the vehicle so that the license plate is clearly visible and legible. Additional exterior cameras covering wider fields-of-view can provide additional vehicle information.

Finally in some instances, commercial institutions may find it useful to include monitored cameras as a part of their overall security strategy. The views from such cameras are not intended to be recorded but provide employees with a means to view areas in a facility that would otherwise be out of employees' sight. Moveable dome and pan/tilt cameras can be used to provide additional room coverage through automatic alarm presetting and parking. Motion detection or door contact alarms can automatically initiate a camera preset providing a high-resolution view of the alarmed scene. This provides unmanned, additional target coverage. After a predetermined time, the camera can return to a preset parked position or to a scanning pattern to cover site locations not viewed by the fixed devices.

If the system contains a matrix switch with a joystick controller, a guard or observer can manually track a suspect giving a tightly zoomed, high-resolution image of the suspect. Variable speed control and automatic focus are recommended to facilitate smooth target tracking. When in the parked position, the unit can serve as an additional fixed camera.

Specific information regarding camera types and lenses is provided in Section 7.

5.3. Lighting

Poor lighting is the most common factor that degrades the quality of video images. Adequate, balanced lighting should be provided in areas viewed by the cameras. Particular care must be taken to ensure that the dynamic range present in a scene does not exceed the capability of the camera to record it.

Strong backlighting or high-contrast lighting may cause the face of a subject to be obscured in shadow, making identification of a suspect from the image difficult or impossible. Likewise, spotlights can create both shadows and highlights on faces, making it difficult to determine if observed tonal variations represent actual features, such as facial hair, or are merely a product of the lighting. The use of noninfrared, high-dynamic range cameras and those capable of operating in low light conditions should be considered to help improve the image quality.

As an example, ceiling-mounted fluorescent lighting that is well distributed throughout interior spaces would be preferred to the use of track-mounted spotlights.

Finally, different light sources have different color temperatures that will affect the apparent color of objects in a scene. Tungsten lamps impart a reddish tint to objects in a scene, whereas fluorescent bulbs can impart a greenish tint. Likewise, sodium lamps can make objects appear more yellow than they actually are. Most color video cameras can be adjusted to compensate for this, and many perform this function automatically.

A color video camera is considered balanced for a particular reference white when a neutral white card is placed in the camera's field-of-view under normal illumination conditions and the red, green, and blue channels provide equal output levels. Therefore, interior color cameras should be balanced for white on installation and rebalanced if the type of lighting used is changed. However, because many commercial institutions will operate under conditions in which lighting is variable, white balance may not be possible at all times.

Infrared lighting can be used to provide improved low light performance for monochrome cameras. Infrared lighting is not supported by standard color cameras as they filter out the infrared spectrum. If an infrared sensitive video camera is used, law enforcement officers should be made aware of this because an infrared sensitive video camera often reproduces clothing that appears to be dramatically differently when compared to images of the same clothing that were recorded with a video camera that is not sensitive to infrared.

A more complete set of technical guidelines for lighting is provided in Appendix B.

5.4. Electrical Power

Closed-circuit television systems must be provided with adequate power. Backup power sources and surge protection should be included in the system design to ensure that recordings are preserved in the event of a power loss. Systems that require electrical power to preserve their recordings should have backup power sources sufficient to last for at least 30 minutes, until either the system power is restored or the system is shut down in a manner that preserves the recording. Video processors such as digital video recorders should also automatically restart in a preprogrammed operation mode on power-up from extended power outages.

When a videocassette recorder or digital video recorder with automatic restart is used,

there must be an ON-OFF switch on the front of the recorder. This is to ensure that no data is lost following an incident that led to the recorder being purposely turned off to preserve the recording of the event.

Closed-circuit television systems should be placed on isolated circuits that are properly grounded to reduce interference and signal degradation. If the system is on a long power run, outdoors, or in an area prone to electrical storms, special protection devices to control power surges and nearby lighting strikes are strongly recommended.

5.5. Bandwidth

The bandwidth provided for transmitting the video signal must be compatible with, and sufficient to meet, the resolution requirements listed below for the system's recording device. Although bandwidth minimum standards do not guarantee acceptable video image quality, they do play an important part. To improve the likelihood of acceptable image acquisition, video cameras should have a signal bandwidth of at least 7MHz.

5.5.1. Signal-to-noise ratio

One major problem with picture clarity is noise. Electronic noise is present to some extent in all video signals. Noise manifests itself as snow or graininess over the whole picture on the monitor and subsequently on recordings. There are several sources of noise: poor circuit design, heat, overamplification, external influences, automatic gain control, and transmission systems. Some video signal noise cannot be overcome in a reasonable manner. However, to improve the likelihood of acceptable image acquisition, video cameras should have a signal –to-noise ratio of at least 48dB. Further, the line loss between each camera and the multiplexer or recorder that the camera is connected to shall not cause the signal to fall below 45dB.

5.6. Recorder Security

Steps must be taken to ensure the physical security and integrity of the system's recording device. Placement of the recording device in a restricted access location, such as a locked cabinet or room, is strongly recommended. Note that proper environmental controls must be implemented according to the manufacturer’s specifications. For example, videocassette recorders require adequate airflow to prevent overheating.

Policies should be in place to ensure that law enforcement can gain immediate access to the recorded images when necessary.

5.7. Recordings of Associated Text Information

Both analog and digital closed-circuit television systems include the capability to associate text information, such as time, date, and camera identification, with the images recorded by the system. In some cases, transaction or personal information may also be recorded in association with image data. This is often accomplished by superimposing the text directly on the images.

Time, date, and camera information is useful in investigations and should be preserved. However, text that obstructs the view of subjects’ faces or vehicles’ license plates may hinder investigations and should be placed to minimize its effect on image content. Test

recordings should be performed to ensure that this requirement is being met and that the information being recorded is accurate.

The Scientific Working Group on Imaging Technology strongly recommends that digital closed-circuit television systems be configured so that associated text information is unalterable and preserved as data records or files that are linked to the respective images. In such cases where time and date, transaction, or personal information is recorded in digital systems along with the image stream, it must be possible for law enforcement to recover the images separate from this information.

For analog closed-circuit television systems in which it is not possible to separate personal or transaction data from the images, systems must be configured to record this information for one second or less for each instance (e.g., transaction) in which such data is required. If the text information is visible on the recorded video, then the text characters must be as small as possible while still being legible, and it must be possible to position the text anywhere on the screen to minimize the effect.

Each individual image and transaction data packet should have a time/date stamp associated with it. Whenever possible the time/date stamp should be generated as close to the image source as possible. For example, when a camera is directly wired to the digital recording device at the same site, then time synchronizing the recorder is sufficient. However, when the camera is located remotely (in another city) and connected to the recorder by a wide-area network (WAN), then the image may be delayed in transit. In those cases, it is highly desirable to associate the time stamp with the image at the source sensor (the camera) instead of at the recorder. A time-tag image file is then transferred over the wide-area network to the recorder. The trend toward using Internet-protocol (IP) cameras will facilitate this process where the Internet-protocol camera is capable of accepting time synchronization input.

The industry accepted standard for time synchronizing computers and all digital data devices is the network-time protocol (NTP). It is an open standard sponsored by the Internet Engineering Task Force (IETF) and is defined by RFC1305. This standard specifies an accuracy level of the time synchronizing device called the Stratum level. The simple network-time protocol (SNTP) is another such standard. With the proliferation of global positioning satellite (GPS)-based timing equipment, these time references are readily available for low cost. The use of an industry standard time-synchronization protocol is recommended.

6. Recording Systems

Recording systems used in closed-circuit television systems should adhere to the following minimum standards.

6.1. Recording Resolution for Analog Recording Systems

Analog videocassette recorders must record each image at a minimum line resolution of 240 visible lines. This resolution is typical of most VHS videocassette recorders. The use of videocassette recorders with higher line resolutions (e.g., S-VHS videocassette recorders and tapes) is strongly encouraged because this improves image

quality.

6.2. Recording Resolution for Digital Video Recorders

The minimum resolution requirements for digital video recorders will vary depending on the media used to record the images. Some manufacturers quote digital resolution (pixels) in analog lines of resolution. For rough comparative purposes, a minimum digital resolution of 450 lines can be used for digital video recorders using digital video tape. Digital video recorders using a hard disk or optical disk for storage must record each frame at a minimum resolution of 640 pixels in the horizontal direction and 480 pixels in the vertical direction. (Differences in the units used to describe these resolution recommendations are due to the differences in the industry standards used to describe these media.) If images are recorded in field mode, then each field must be recorded at a minimum resolution of 640 by 240.

The Scientific Working Group on Imaging Technology strongly encourages the use of higher resolutions than those described above whenever possible.

6.3. Compression

Compression is a process in which the size of a digital file is reduced. Due to the large amount of information present in each second of video, most digital video systems use compression to reduce storage and transmission requirements.

Compression may be lossless or lossy. In lossless compression information is not lost. In lossy compression, information is lost. If a file has only been saved using lossy compression, then it is not possible to recover all of the information in the original file.

In the event of an alarm-triggered mode (see Section 6.8), it is recommended that lossless compression be used to record the sequence of interest, if possible. If a system is incapable of lossless compression during the alarm mode (as well as at all other times), then in order to maximize the amount of information available to law enforcement, it is strongly recommended that the lowest possible amount of compression be used in recording files.

Some manufacturers use proprietary compression formats that require the use of proprietary software in order to view the video sequences or images. Use of such software can prevent or hinder law enforcement from viewing or otherwise accessing these images. If such software is used, then steps must be taken to ensure that law enforcement will be able to access them when needed. See Section 11, Evidence Handling, for more guidance.

6.4. Time-Lapse Recordings

NTSC (National Television Systems Committee) video records images at a rate of approximately 30 frames per second. Each frame consists of two fields or images, producing an actual rate of 60 images per second.

Analog videotapes are usually recorded in one of three speeds: SP (standard play), LP (long play), or EP/SLP (extended play/super-long play). A T-120 tape recording at standard play speed will record for a period of two hours, whereas a T-120 tape recording

at long play speed will record for a period of four hours, and a T-120 tape recording at extended play/super-long play speed will record for a period of six hours. Changing the recording speed from standard play to long play to extended play/super-long play does not change the rate at which images are recorded, it remains 60 images (fields) per second. Any recording made at a rate of 60 fields per second is commonly referred to as a real-time recording.

Time-lapse recorders are capable of recording video at rates that are much lower than 60 images per second. This enables the recording of images over a longer period of time. For example, using T-120 tapes, a videocassette recorder set in standard play mode will record 30 frames (60 images) per second for two hours. With a time-lapse setting of 24-hours, a T-120 tape will run for 12 times the normal two-hour tape length, and the videocassette recorder will record no more than five images per second. Table 1 provides the image-recording rate for a variety of common time-lapse settings under normal recording conditions.

Table 1. Typical Image Recording Rate for Different Time-Lapse Modes

Time-lapse mode (in hours)	2	12	24	48	72	120	240
Number of fields (images) per second	60	10	5	2.5 (5 every 2 s)	1.67 (5 every 3 s)	1	0.5 (1 every 2 s)

(Based on an approximate real-time rate of 60 fields per second.)

Some analog time-lapse video recorders manufactured specifically for closed-circuit television security applications are designed to record a higher number of fields per second in different time-lapse modes than those reported in Table 1. For example, some high-density video recorders can achieve record rates of more than 20 fields per second in 24-hour time-lapse mode. Likewise, digital video recorders may also be capable of recording at higher rates.

In order to meet the Scientific Working Group on Imaging Technology guidelines, closed-circuit television systems must capture and record at least one complete field per camera per second. Any rate lower than this may result in inadequate temporal coverage of events in the scene.

6.5. Switchers/Multiplexers

Facilities with more than one camera may choose to use a device that enables the recording of images from all of the cameras to a single recorder. The two most common devices used to do this are switchers and multiplexers.

Switchers, as the name implies, alternate among multiple cameras so that the output of the switcher at any one time is the signal from a single camera. Systems in which the

output of a switcher serves as the input to the recording device will record images from each camera in succession. The time that it takes for a switcher to return to the same camera is called the camera interval. The reciprocal of this interval is referred to as the camera refresh rate. Therefore, a camera interval of one-half second would correspond to a camera refresh rate of two times per second.

A multiplexer takes the outputs from multiple cameras and adds an encoded signal that allows a picture from each camera to be viewed in succession (as with switchers) or simultaneously. The encoded signal is almost always vendor-proprietary, making it difficult to recover the recorded images without the proper hardware and software.

Switchers, multiplexers, and similar devices are frequently used to generate multiimage displays. Multiimage displays consist of a split screen that allows for the viewing of more than one camera image on the screen simultaneously. Recording images in this mode, however, significantly decreases the individual camera's image size and quality. Many brands of duplex multiplexers will allow the user to view multiple camera images simultaneously, while still recording full-sized images from each camera.

In order to meet the Scientific Working Group on Imaging Technology guidelines, closed-circuit television systems must not record in multiimage modes.

Given the requirement in Section 6.4 that recordings capture at least one complete field per camera per second, this will restrict the refresh rate for each camera in a system with one recorder. As a reference, Table 2 relates the number of images per second per camera for given time-lapse recording modes.

Table 2. Images Recorded per Second by Each Camera in a Switched System for Different Time-Lapse Modes

Images (Fields) Recorded per Second by Each Camera							
		Time-Lapse Recording Mode (in hours)					
		2	12	24	48	72	120
Cameras	1	60	10	5	2.5	1.67	1*
	2	30	5	2.5	1.75	^	^
	4	15	2.5	1.25	^	^	^
	8	7.5	1.25	^	^	^	^
	16	3.75	^	^	^	^	^
	32	1.875	^	^	^	^	^
	60	1*	^	^	^	^	^

* Indicates limits fixed by the Scientific Working Group on Imaging Technology requirement of one image per camera per second.

^ Indicates this cannot meet the Scientific Working Group on Imaging Technology requirement of one image per camera per second.

The values reported in Table 2 assume a nominal real-time recording rate of 60 fields per second. As described in Section 6.4, some closed-circuit television security system video recorders designed specifically for time-lapse applications are capable of exceeding the values reported in this table. Under such circumstances, it will be possible to record images from more cameras while still meeting the Scientific Working Group on Imaging technology requirement of one image per camera per second.

6.6. Triggers / Incident Recorders

In some situations, systems may include triggers that lead to the recording of images at a rate, or in a sequence, that differs from the normal operating mode. An example of this would be to change from time-lapse mode to real-time mode when triggered by an alarm button. Another example would be to include an otherwise inactive camera in the recorded sequence if motion was detected in the field-of-view of that camera.

If such a device is used, its use must not conflict with the recommendation in Section 6.4 (i.e., one field per second from every camera in the system must continue to be recorded at a minimum).

Furthermore, test recordings should be made to ensure that activation of the trigger and subsequent operation of the incident recorder does not have a deleterious effect on the quality of the recorded images.

6.7. Remote Recording

Some closed-circuit television systems transmit the system signal(images and other information) to a remote site for recording.

The images transmitted this way are usually compressed significantly in order to meet bandwidth restrictions. As noted in Section 6.3, excessive compression severely degrades image quality.

In those situations in which remote monitoring is practiced, the Scientific Working Group on Imaging Technology strongly recommends that recording devices also be installed at each monitored location so that images may be stored with a minimum of image compression, when necessary.

In some cases, a remote facility recording video signals from multiple off-site locations may also have the capability to control recording devices installed at each off-site location. It is important to ensure that this capability be tested on a regularly scheduled basis. Procedures must be established that define the response by personnel at the remote facility in the event of an incident at one of the off-site locations. Steps should be taken to preserve the recorded video at both the remote facility, as well as the off-site facility.

6.8. Alarm-Triggered Digital Buffers

In an alarm-activation event, law enforcement will seek to have the highest possible image quality. This includes recording images using lossless compression.

Therefore, in order to meet the Scientific Working Group on Imaging Technology guidelines, closed-circuit television systems that record images using lossy compression must have an alarm-mode included in their system.

Furthermore, in the event of an alarm trigger in order to meet the Scientific Working

Group on Imaging Technology guidelines, the following system settings are required for the alarm sequence:

- Lossless compression
- The recorder must have a buffer capable of retaining the five minutes of data prior to the alarm-trigger using lossless compression.
- The system records at a rate of 60 fields per second, while maintaining the same rate at which the system switches between cameras (i.e., more pictures per camera each second if time-lapse mode is normally used).
- Once triggered, the system should continue to record in a lossless manner until manually stopped by an authorized agent, according to the facility's policies and procedures. (Systems should be configured to stop recording in the event that the recorder runs out of memory or storage space prior to user intervention in order to retain the existing images.) This period of time should extend for at least five minutes after the completion of the crime or event that led to the alarm. The recorder shall have sufficient storage to be capable of recording in this mode for a minimum of 30 minutes.
- All alarm data may be stored as black-and-white images.

Currently installed systems that are incapable of lossless compression should be configured to record the alarm sequence at the lowest possible compression ratio.

6.9. Digital Recorder Output Devices

Digital recording systems that do not use removable media for day-to-day storage must be capable of exporting exact duplicates of their recordings to removable media in a standard commercial format. This is necessary so that law enforcement officials can obtain copies of the recorded digital files that are a bit-for-bit copy of the files stored on the system.

In order to meet the Scientific Working Group on Imaging Technology guidelines, closed-circuit television systems using digital recorders must be configured to permit output to write-once storage devices including CD-WORM (compact disc-write once read many times). It is strongly recommended that systems also be configured to permit output to DVD (digital versatile disk). This latter recommendation is based on the observation that the recording of any alarm-triggered event will be over ten minutes in length (five minutes before the alarm, plus the duration of the event, plus five minutes after the event). The greater storage capability of DVDs will reduce the number of disks needed to store the recording on removable media. Systems designed to output to DVD should not use standard compression techniques used in the production of consumer DVDs (that is typically on the order of 5:1) but should be capable of making bit-for-bit copies of files recorded on the system hard drive(s).

6.10. Output File Types

Digital recording systems must be capable of exporting exact duplicates of their digital

image files to removable media. If a system uses a proprietary format to store images, then steps must be taken to ensure that law enforcement can extract an exact copy of each image in the recording in a lossless and open file format capable of fully supporting the recorded data. The current preferred file format for such applications is TIFF.

Furthermore, in order to assist law enforcement in the expeditious dissemination of still images immediately after an event, digital recording systems must be capable of directly exporting still images at the highest quality setting in one of the following industry standard formats: TIFF, BMP, or JFIF (which commonly uses the JPG extension). The ability to export to an uncompressed, nonproprietary AVI (audio-video interleave) file and the native video file format, in addition to one of the previously mentioned still image formats, is desirable as well. All output formats must maintain accurate aspect ratios consistent with the original recording.

See Section 11 for further information regarding guidelines for output in the event of a criminal incident.

7. Cameras

Cameras used in closed-circuit television systems should adhere to the following recommendations:

7.1. Black-and-White Versus Color Cameras

Although black-and-white video cameras may provide better image resolution than color cameras, the information available in color images may provide important investigative information. Therefore, the choice of cameras is left to the commercial institution, dependant on the intended use of the recorded images.

7.2. Camera Detector Size

Video and digital cameras use detectors that come in a variety of sizes. Typical sizes are 1/4, 1/3, and 1/2 inches. The size of the detector will have a direct impact on the focal length of the camera lens. See Section 7.5 for further information.

7.3. Camera Resolution

In order to meet the Scientific Working Group on Imaging Technology guidelines, analog video cameras must have an output resolution of at least 400 horizontal lines. Digital video cameras must have an output resolution of at least 480 horizontal lines. Cameras that have higher resolutions are strongly recommended.

7.4. Camera Infrared Characteristics

The detectors used in black-and-white video cameras may be sensitive to a part of the infrared spectrum that is outside of the normal range of human visual perception. This can improve the ability of the camera to record in low-light situations.

Due to the fact that images acquired by infrared-sensitive cameras can make some dark clothing and other objects appear to be lighter than they actually are, it is recommended that infrared-sensitive cameras not be used to record scenes that are well-illuminated.

Many cameras are equipped with filters that can mitigate this effect. This does not apply to most color cameras that normally contain an infrared barrier filter to block infrared light.

The use of infrared-sensitive cameras should be noted in the system documentation (see Section 9.1).

7.5. Lens, Focal Length, and Field-of-View

The selection of lenses will be dictated by the field-of-view to be covered by each camera, as well as by the size of the camera's detector.

For cameras placed to record images at a point-of-customer transactions, such as a teller window (See Section 5.3), the area of interest (e.g., face, license plate) should cover approximately 15 percent or more of the camera's field-of-view (based on the recommended minimum resolution found in Section 7.3). For an average human head that is six-inches wide, a three-foot-wide field-of-view will meet this guideline. For a license plate width of approximately 12 inches, a six-foot-wide field-of-view is sufficient.

The focal length necessary to achieve an approximately three-foot-wide field-of-view for a given detector size and camera-to-subject distance is provided in Table 3. The camera must be in focus at the position of this subject.

Table 3. Approximate Focal Length (in mm) Needed for Three-Foot-Wide Field-of-View

	Distance to subject (in feet)	2’	5’	10’	15’	20’	30’
Detector size (inches)	1/4”	2.3	5.9	11.7	17.6	23.5	35.2
	1/3”	3.1	7.8	15.7	23.5	31.3	47.0
	1/2”	4.0	10.1	20.2	30.3	40.4	60.7

(Differences in the units used to describe these resolution recommendations are due to the differences in the industry standards used to describe these media.)

Cameras that provide overviews of interior and exterior locations should have their focal lengths selected so as to meet the field-of-view requirements of the facility. However, exit cameras should have sufficient depth-of-field to be in focus at distances of three feet and beyond to ensure that subjects exiting the facility will be in focus.

7.6. Exposure Control

Cameras should be equipped with automatic mechanisms to ensure proper exposure under varying lighting conditions. Such mechanisms include, but are not limited to, automatic gain circuitry, day/night sensor switching, and lenses with automatic iris functions.

7.7. Camera Housings

Cameras may require coverings and environmental controls to protect them from the elements or tampering. Clear coverings placed in front of camera lenses will reduce image quality; therefore, unless there are specific environmental or security concerns that require camera housings, it is recommended that they not be used.

8. Media

Media, including analog videotapes, compact discs, digital video tapes, and digital versatile disks, should be of high quality and meet equipment manufacturers' specifications. Low-quality media can result in damaged equipment and poor images.

9. System Maintenance

Closed-circuit television systems should be maintained in a manner that ensures their proper function over their entire lifetime. Therefore, the following recommendations should be adhered to:

9.1. System Documentation

Institutions should maintain documentation regarding their closed-circuit television systems that includes the following information:

- Make and model of all system components, including recorders, cameras, lenses, and multiplexer/switcher. For digital systems, this information should include software and hardware information, including software version. If infrared-sensitive cameras are in use, their location should be documented. An example of a system information sheet is included in Appendix C. If possible, a photocopy of the maintenance record should be included.

- Adequate system documentation should be included at the site. This includes instructions for downloading and outputting recordings.

- Point-of-contact information for system installer and/or system maintenance organization, to include at least two names and telephone numbers.

- Site plan showing all equipment placement (including recorders), as well as field-of-view for each camera. Appendix C includes an example of a site plan.

This information should be verified monthly and made available to responding law enforcement officials on their arrival at the scene.

9.2. System Validation and Maintenance

Prior to use, systems must be validated to meet the requirements of Section 4. The systems must be capable of acquiring, recording, and producing output images that are of sufficient quality to enable law enforcement officials to identify the people and objects depicted therein. Revalidation of these requirements must occur every time the system is altered.

A variety of system checks and maintenance are necessary at different times. If system errors are found, steps to correct them should be implemented.

A maintenance log must be maintained to document all system validation activities, checks, and maintenance activities.

Table 4 provides a calendar for these checks and maintenance items that should be recorded on a maintenance log.

Table 4. System Checks and Maintenance Schedule

	Check / Activity	Procedure
Daily	Is the system operating?	Play back 30 seconds of recorded video and confirm that all cameras are being recorded.
	Are the cameras aimed properly, in focus, and not obstructed?	Review live images from each camera to ensure this.
	Are the time and date correct?	This is dependent on the system design.
	Is the removable recording media (i.e., tape) properly installed and in the record mode?	Check that the record indicator is active and that the tape counter is advancing.
	Is the system secured?	Check physical locks on cabinet and/or doors.
Monthly	Clean lenses and camera housings. (Care must be taken to avoid damage and misalignment.) More frequent cleaning may be necessary depending on environmental conditions.	Follow manufacturer's specifications.
	For systems using removable media (i.e., tape), recording mechanisms should be cleaned.	Follow manufacturer's specifications.
	Check environmental controls (temperature and humidity) to ensure that they meet manufacturer's specifications for all system components.	Follow manufacturer's specifications.
Annually	Complete system preventative maintenance check.	A qualified closed-circuit television technician should perform this check.
	For digital systems using hard drives for storage, a check for bad clusters and other disk errors should be performed.	Refer to manufacturer's instructions and specifications.
	Ensure written policies and procedures regarding system operation are up to date.	Review existing policies and procedures and revise as needed.
	Ensure employee competence in system operations, including alarm-mode response.	Conduct operator training.
	Ensure system output to compact disc meets law enforcement needs.	Write sample images from system to removable media and review images on separate computer system.
	Ensure that reusable media is replaced.	A system operator should perform this check.

9.3. Maintenance of Recording Media

Institutional requirements will dictate the length of time for which recorded images must be archived.

All recording media has an expected usable life span. Based on that life span, policies should be developed to ensure that media is replaced before this period expires. For example, it is recommended that VHS video tapes be reused no more than 12 times and that they be replaced on an annual basis. This use of extended time-lapse mode may drastically shorten the life span.

For digital recording devices, manufacturer's recommendations for maintenance and the device service-life replacement schedule should be observed. A regular ongoing (automated) inspection of hard drives should be conducted to ensure that the disk(s) is/are functioning properly and that there are no bad sectors or other hardware errors that could result in a loss of data. Other reusable media must be recertified no less frequently than the manufacturer's guarantee period.

Institutions should establish policies regarding the marking of removable media so that the most recent date of recording will be documented.

10. Retention of Recordings

It is recommended that analog videotapes be retained for a minimum of 31 days before being reused. This coincides with the 12-time use recommendation. For ease of retrieval, each videotape should be sequentially numbered, and the dates and times recorded on each tape should be written on a label on the videotape.

Due to the nature of digital recordings, the Scientific Working Group on Imaging Technology recommends that recordings be retained for the longest time possible (minimum of 10 days) with the least amount of compression available in the system's capabilities. Storage capacity to meet these needs must be considered.

11. Evidence-Handling Procedures

This section addresses procedures to follow when law enforcement response is necessary. This may be in response to a robbery, or it may be related to other criminal investigation.

11.1. Documentation for Law Enforcement

The system documentation, as described in Section 9.1, including equipment information, site plan, contact information, and maintenance log, should be made available to responding law enforcement officials. Any additional pertinent information regarding the recording or the incident itself should be noted, such as incident time, record mode, and discrepancies between actual time and recorder time. Appendix C includes an example of documentation.

11.2. Handling Evidentiary Recordings

Following an incident involving immediate law enforcement response, it is necessary to ensure that the recorded images are secured. Unless the possibility exists that the images may be overrecorded or overwritten, the recording should not be stopped until law enforcement officials arrive.

11.2.1. Video-cassette tape systems

Upon terminating a recording, the tape should be removed from the recording device and the recording tab immediately removed or shifted to the record-disabled setting. The tape should not be played again prior to the arrival of law enforcement officials. The name of the institution and identity of the person performing this function should be marked on the exterior of the cassette housing, along with the time and date of removal.

Prior to transfer to law enforcement officials, steps must be taken to ensure that the tape is not mishandled or damaged. This includes keeping the tape away from magnetic fields, such as those generated by televisions, radios, and speakers. The tape should be maintained at room temperature and out of direct sunlight. Tapes should not be stored in vehicles for an extended period of time.

Personnel qualified to assist law enforcement in recovering images from the tape should be identified and made available prior to the arrival of law enforcement officials.

11.2.2. Digital video systems

The following steps should be followed:

1. Upon terminating a recording, personnel qualified to assist law enforcement in recovering images from the closed-circuit television system should be identified and made available (in person or by telephone) to offer technical assistance.

2. Law enforcement officials will coordinate with appropriate personnel to view and retrieve the best image(s) prior to the officials' departure from the crime scene. When immediate transmission of images is necessary to expedite distribution from the crime scene, the images should be transmitted by network, e-mail, compact disc, or other available means. Images shall be provided to law enforcement in the TIFF, BMP, or JFIF (JPG) formats. If the facility uses a remote location for the storage of recorded images, then the facility will provide the images to an address designated by the law enforcement officials.

3. The facility's security personnel will produce at least two copies of the relevant images and video on compact disc (CD) or digital versatile disk (DVD) (nonrewritable) in the nonproprietary formats as well as the original native format.

4. In the event of alarm-trigger incidents as described in Section 6.8, law enforcement would like all video and relevant data that were recorded five minutes before the alarm-trigger, the entire incident, and five minutes after the incident. This is barring any outside circumstances when it is required to save a longer period of time (e.g., casing of the bank).

5. If additional retrieval of video recording is warranted, law enforcement officials will notify the facility's security personnel to secure the hard drive or retrieve additional video and data. The facility will be required to maintain all recorded video and data on a rolling ten-day period from the event of a crime. This means that at the date of the crime, law enforcement officials would be able to review all video for ten days prior to the crime. As an example, two days after the crime, law enforcement officials would be able to review all video for eight days prior to the crime and so on.

6. When the relevant video, images, and data have been copied, each shal be labeled with the name of the institution and identity of the person performing this function, along with the time and date of removal. This information should not be written directly on the media but preferably on a label that is affixed to a protective container, such as a jewel case, sleeve, or clamshell enclosure.

APPENDIX A – CCTV References

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Appendix B: Technical Guidelines for Lighting

In this document, illuminance is measured in Lux. Some older documents and references may refer to the measurement in foot candles (one foot candle is approximately equal to 11Lux).

To provide good-quality camera images, a minimum of 275 to 333Lux of illumination should be provided in the customer areas, office areas, hallways, stairways, and exits where there is camera coverage.

Exterior self-service facilities, such as automated teller machine vestibules or drive-up lanes, should have a minimum of 110Lux of illumination 24-hours daily to ensure good image quality.

Exterior areas, such as sidewalks, entrances, night depository areas, that have camera coverage should have a minimum of 55Lux of illumination.

Parking lots with camera coverage should have a minimum of 11Lux of illumination at ground level.

Supplementary surface lighting may be necessary for adequate illumination for the face of anyone using an automated teller machine or other self-service resource.

Appendix C: System Documentation and Site Plan Examples

System Equipment Information

Recorder make and model _____

Multiplexer make and model _____

Camera/s make and model _____

Are any cameras infrared-sensitive and if so identify _____

Video format (circle) VHS SVHS digital video recorder PC
Other _____

If digital video recorder or PC-based:
Hardware manufacturer _____
Software name and version _____

Is a copy of the most current maintenance/service log attached? (circle) YES NO

Does the system record multiple cameras? (circle) YES NO
If yes, how many? _____

Contact Information

Recording system point of contact _____ Telephone: _____

Institution point of contact _____Telephone: _____

If the system records multiple cameras, note the camera location and angle view. Use the following diagrams as examples.

Include the following additional information in the event of a law enforcement response:

What record mode was the system? (circle) 2 hour, 6 hour, 12 hour, 24 hour, 48 hour, 72 hour,
Other _____ Unknown

Does the recorded date/time accurately represent the time of day? (circle) YES NO

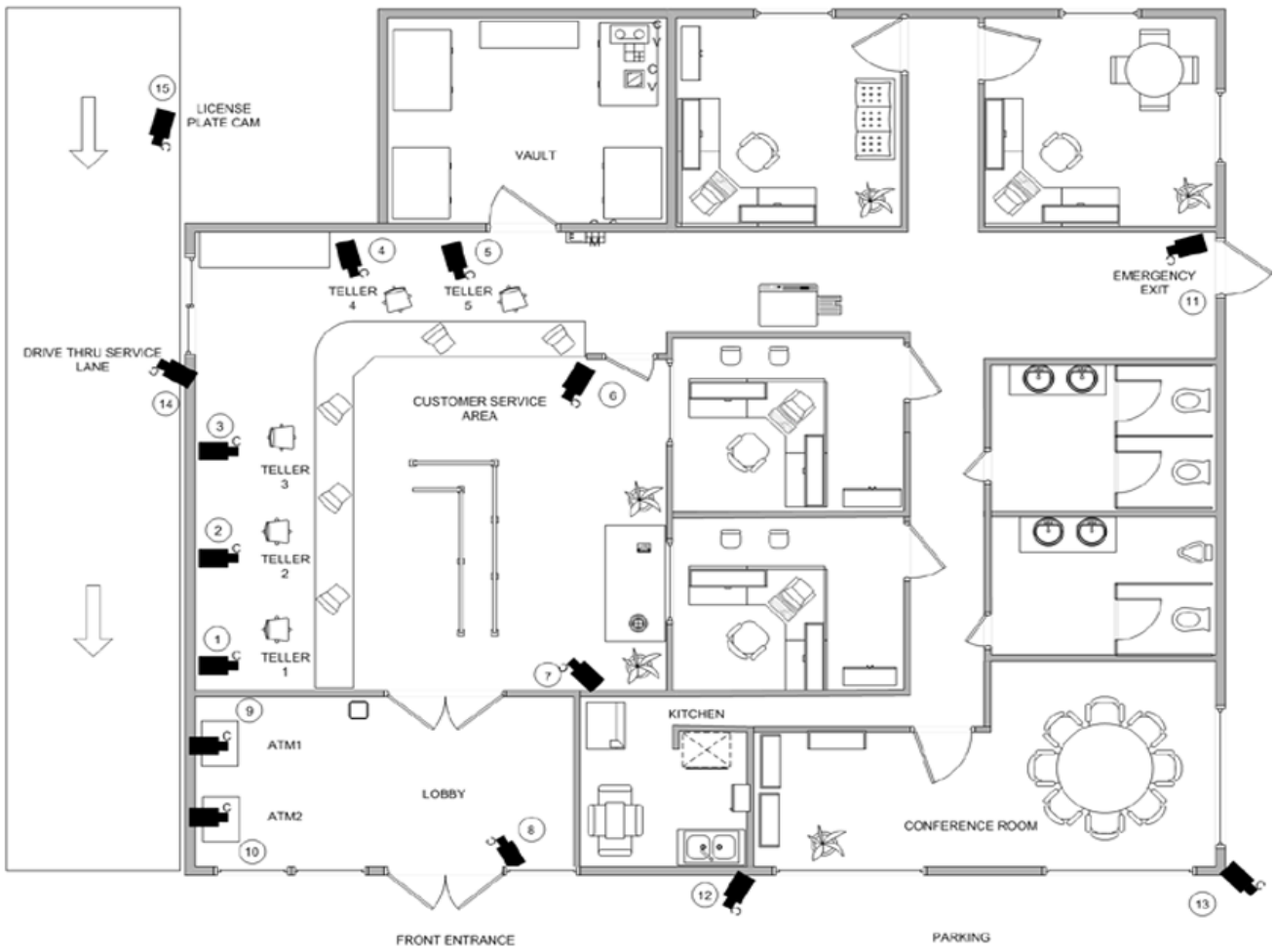
Date and time of incident _____

Date and time of incident on tape _____

Date and time recording removed from equipment_____

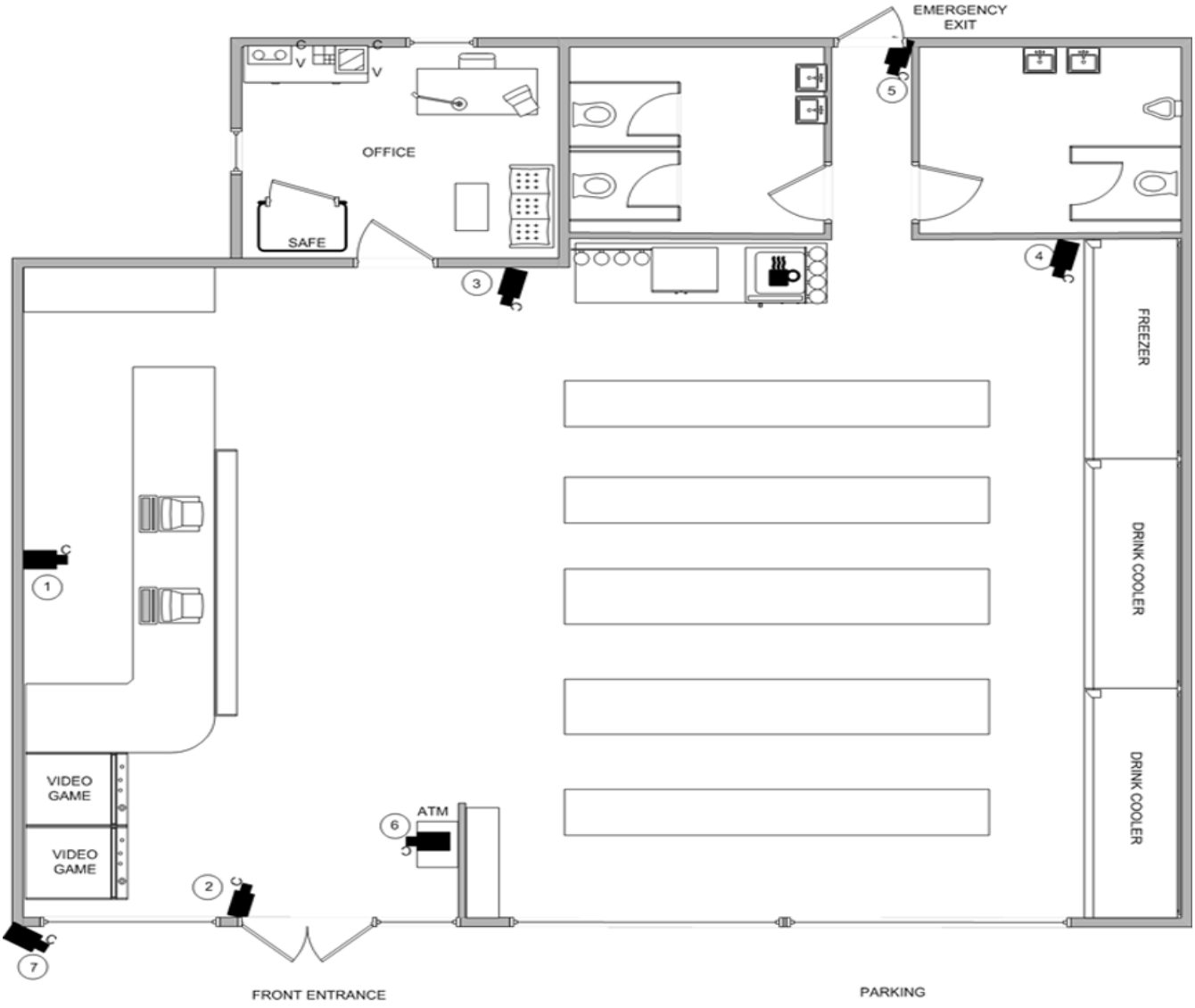
Other Information:_____
_____
_____

EXAMPLE OF SITE PLAN FOR
SMALL BANK



Camera 1: Teller one, facing east
Camera 2: Teller two, facing east
Camera 3: Teller three, facing east
Camera 4: Teller four, facing south
Camera 5: Teller five, facing south
Camera 6: Customer-service area, facing south-west
Camera 7: Customer-service area, facing north-west
Camera 8: Lobby, facing north-west
Camera 9: Lobby automated teller machine one
Camera 10: Lobby automated teller machine two
Camera 11: Emergency exit, facing west
Camera 12: Parking lot, south side of building
Camera 13: Parking lot, south-east corner of building
Camera 14: Drive-through service lane, facing west
Camera 15: Drive-through service lane, facing south

EXAMPLE OF SITE PLAN FOR
CONVENIENCE STORE



Camera 1: Clerk and check-out area, facing east
Camera 2: Front door entrance, facing north
Camera 3: Outside of office, facing south
Camera 4: Freezer area, facing south
Camera 5: Emergency exit, facing south
Camera 6: Automated teller machine, facing west
Camera 7: Parking lot, facing south-east

Reference List

SWGIT and SWGIT/SWGDE documents can be found at:
http://www.theiai.org/swgit/index.html

Section	Title
Section 1	Overview of SWGIT and the Use of Imaging Technology in the Criminal Justice System
Section 2	Considerations for Managers Migrating to Digital Imaging Technology
Section 3	Guidelines for Field Applications of Imaging Technologies in the Criminal Justice System
Section 4	Recommendations and Guidelines for Using Closed-Circuit Television Security Systems in Commercial Institutions
Section 5	Recommendations and Guidelines for the Use of Digital Image Processing in the Criminal Justice System
Section 6	Guidelines and Recommendations for Training in Imaging Technologies in the Criminal Justice System
Section 7	Recommendations and Guidelines for the Use of Forensic Video Processing in the Criminal Justice System
Section 8	General Guidelines for Capturing Latent Impressions Using a Digital Camera
Section 9	General Guidelines for Photographing Tire Impressions
Section 10	General Guidelines for Photographing Footwear Impressions
Section 11	Best Practices for Documenting Image Enhancement
Section 12	Best Practices for Forensic Image Analysis
Section 13	Best Practices for Maintaining the Integrity of Digital Images and Digital Video
Section 14	Best Practices for Image Authentication
Section 15	Best Practices for Archiving Digital and Multimedia Evidence (DME) in the Criminal Justice System
SWGIT/SWGDE	Proficiency Test Program Guidelines
SWGIT/SWGDE	Guidelines and Recommendations for Training in Digital and Multimedia Evidence
SWGIT/SWGDE	Recommended Guidelines for Developing Standard Operating Procedures
SWGIT/SWGDE	Glossary of Terms