SWGDE Guideline for the Use of Infrared Radiation (IR) in Forensic Photography

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1. Purpose

The purpose of this document is to provide an understanding of how infrared radiation (IR) photography can be used to document and examine evidence.

2. Scope

This document will provide a basic understanding of the principles of fluorescence and reflectance as it pertains to IR, the equipment needed for IR photography, its use when documenting and examining evidence, and procedures for capturing images. This covers an advanced photography technique and does not address basic principles of photography.

3. Limitations

- Depending on the camera's imaging sensor, near IR (NIR) ~1100 nanometers (nm) may only be detected versus the full IR spectrum.
- Not all substrates and surface materials will create contrast when exposed to IR.

4. Equipment

Please reference *SWGDE Photographic Equipment and Infrastructure Recommendations* prior to implementation of new equipment or procedures.

A. IR capable digital camera or system.

A full spectrum camera or a camera that has been professionally modified to allow for the capture of images in the IR spectrum.

- Full spectrum cameras are sensitive to wavelengths of energy from ultraviolet (UV), visible, and IR.
- Professional modified cameras with an IR filter installed will often only sensitive to IR. When using a professionally modified camera, you will need to select the filter conversion that best serves the agency's needs.
- IR focuses at a different point than visible light and each lens may have a different focus shift. It is important to test the camera with the lens prior to use.
- For comparative analysis photography, a fixed focal length macro lens is recommended.
- For documentation photography, a variable focal length lens may be utilized; however, this may cause or create distortion of the image.

B. Filters

- Visible band pass filter (if using a full spectrum camera to capture natural light images)

- IR transmission filters (blocks visible light and allows IR to pass through)

C. Variety of light sources

- Reflectance - Dedicated IR source or a light which emits in the IR spectrum (e.g. tungsten light bulb, detachable flash, floodlight, flashlight)

D. Fluorescence - Alternate light source (ALS) typically in the blue/green wavelengths (~450-550 nm) Remote shutter release

E. Sturdy tripod or copy stand capable of various angles and positions

F. Digital storage media

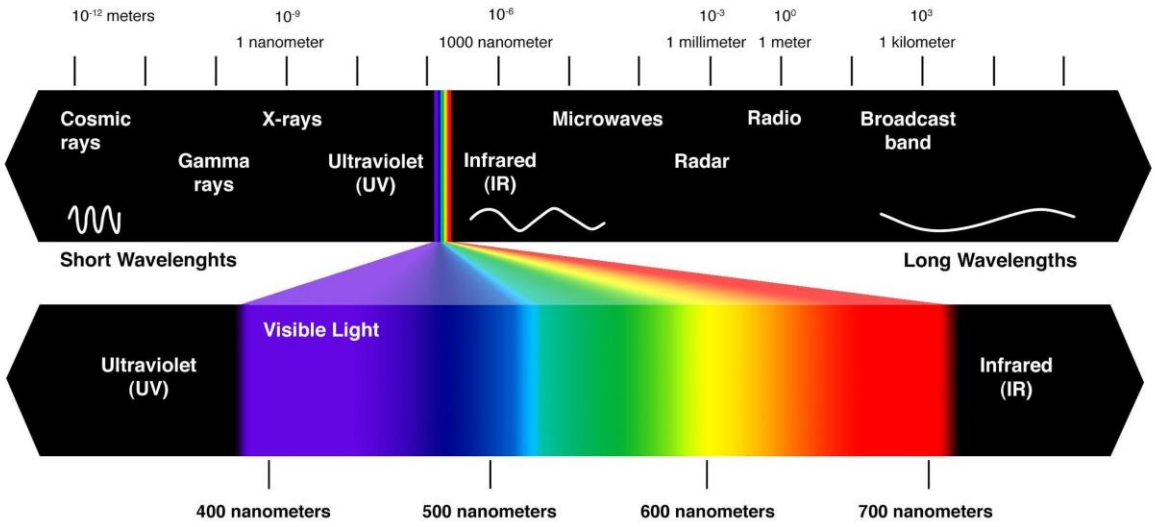
G. Standardized scales of various sizes

H. Appropriate Personal Protective Equipment (PPE)

5. Basic Principles Behind IR Photography

The visible portion of the electromagnetic spectrum (Figure 1) includes wavelengths of approximately 400-700 nm. IR is outside the visible spectrum of light. In general, the NIR range from 700 to 900 nanometers has the most practical application for forensic photography.

Figure 1. Electromagnetic Spectrum



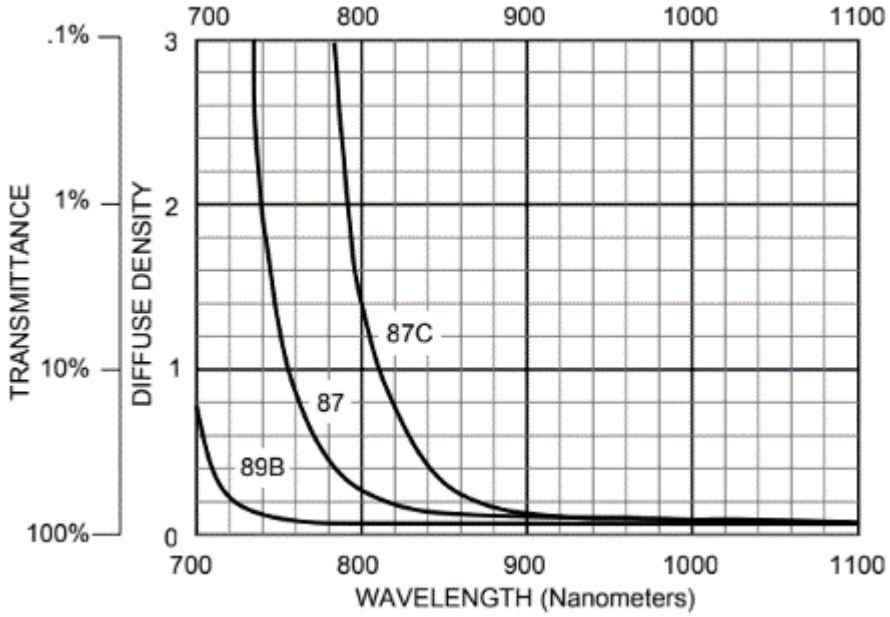
IR photography takes advantage of a camera sensor's ability to capture wavelengths that are outside the visible spectrum. IR reflectance photography is a technique that captures IR energy. IR fluorescence photography captures IR emitted by a subject that has been excited by a light source of a lower wavelength, typically in the blue/green range (450-550 nm). In these techniques, subjects that emit IR will appear lighter in appearance.

This technique is beneficial when an item of evidence and its background are the same tone under visible light but react differently to IR. Documentation of evidence such as blood or

gunshot residue on dark clothing, injuries or tattooing on skin, and questioned documents may benefit from the use of IR photography.

IR transmission filters are designed to allow IR wavelengths to pass through the camera lens to the sensor while blocking the visible light wavelengths. The filters allow for additional contrast to be created. Different filters are available to control which wavelengths are transmitted to the camera sensor.

Figure 2. Example of three IR transmission filters and the wavelengths which are transmitted[1]



Note: The examples of IR transmission filters in Figure 2 are provided in Wratten numbers. Below is a chart of several filter manufacturers and their equivalents to the Wratten numbers; the chart is not inclusive of all possible filters or manufactures. The use of Wratten number identified filters or the manufacturers listed in the chart should not be construed as an endorsement.

Blocks Wavelengths Below	Wratten	Schott	B+W	Helio	Hoya	PECA
580nm	25	OG 590	90	1025/125	25A	716/721
600nm	29	RG 630	91	1029/129		723
645nm	70	RG 665				902
680nm	89b	RG 695	92	5695/569	R72	914
700nm	88					
720nm	88a	RG 715		5715/571		912
740nm	87	RG 780		5780/578		904

[1] KODAK PROFESSIONAL High-Speed Infrared Film KODAK Publication No. F-13; December 2002, page 2, https://125px.com/techdocs/kodak/ (Accessed June 4, 2019).

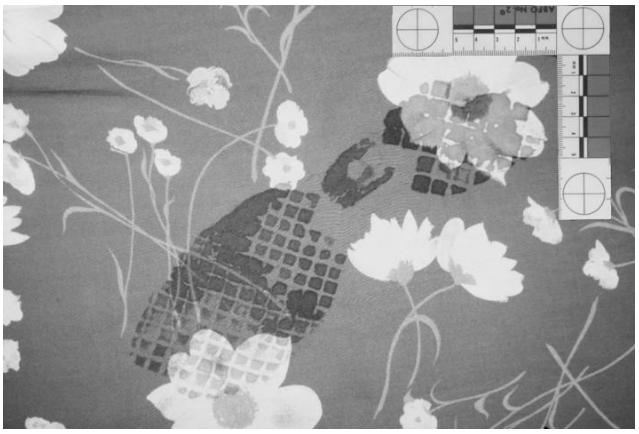
790nm	87c	RG 830	93	5830/583		910
820nm	87b	RG 850		5850/585	RM90	908
880nm	87a	RG 1000	94	5100/510	RM100	906

6. Examples of IR Photography

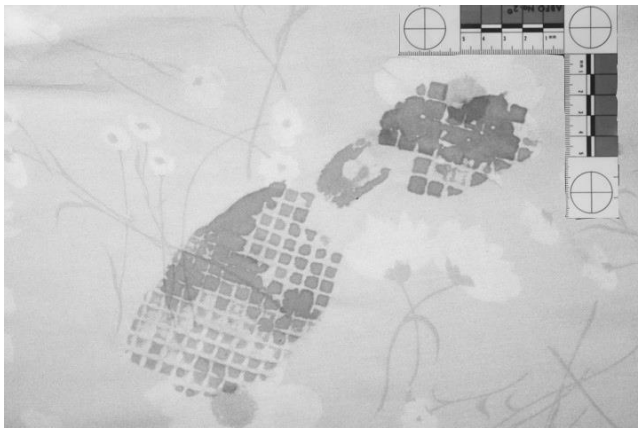
6.1 Blood on fabric

Visible Light

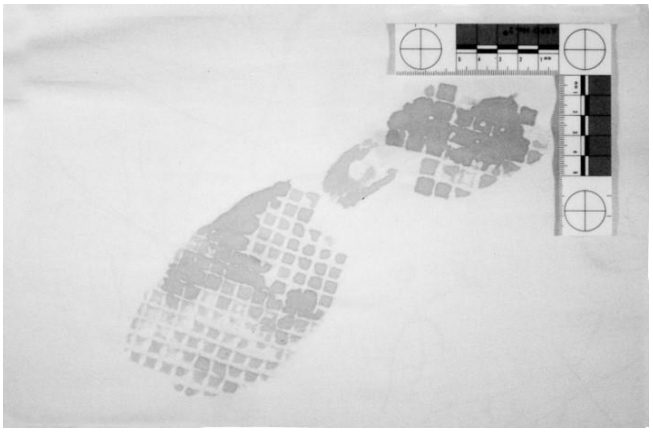
Reflected IR with 70 Filter



Reflected IR with 88A Filter

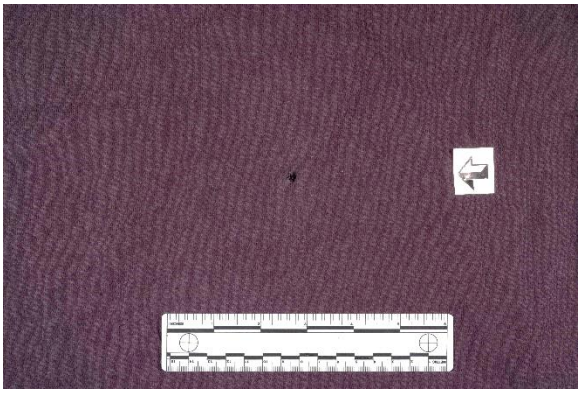


Reflected IR with 87C Filter

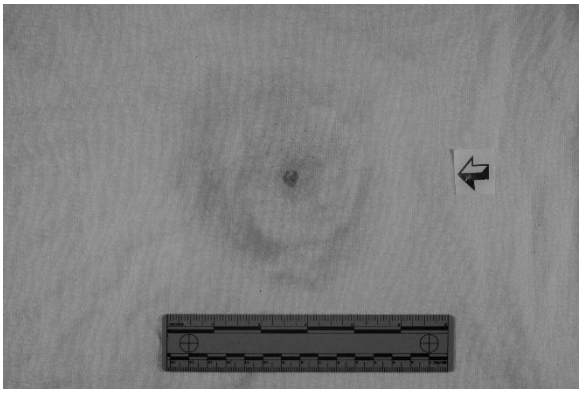


6.2 Gunshot residue (GSR) on fabric

Visible Light



Reflected IR with 87 Filter



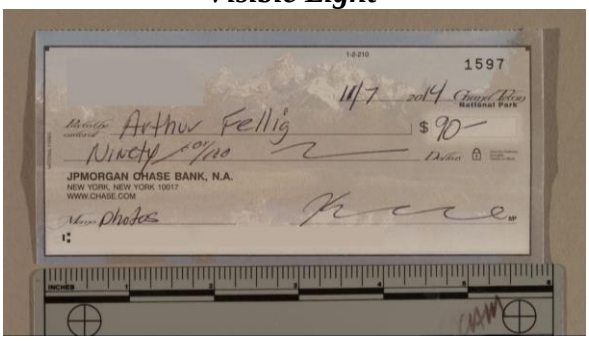
6.3 Tattoo on the skin

Visible Light

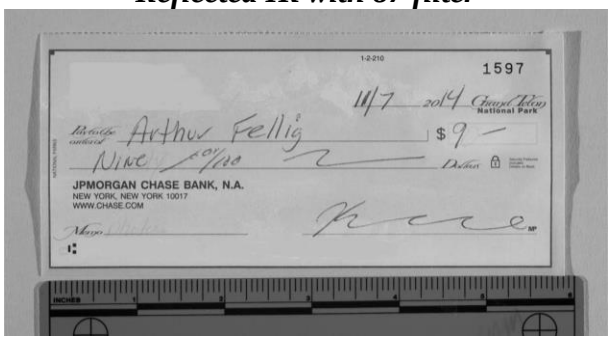
Reflected IR with 87 Filter

6.4 Ink

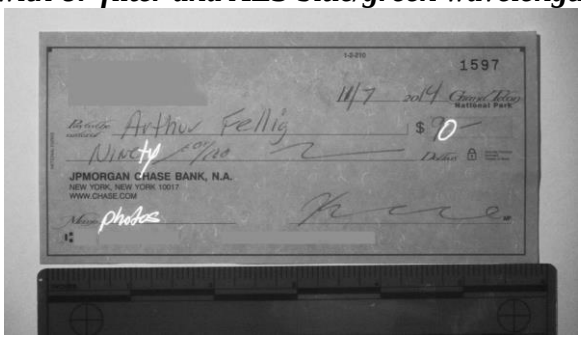
Visible Light



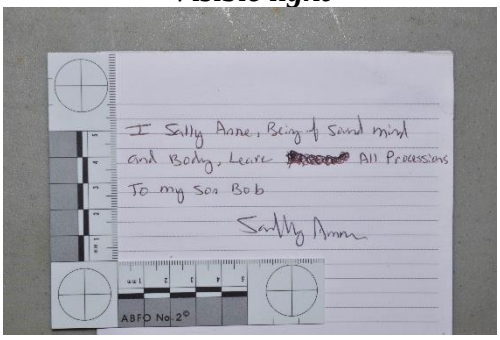
Reflected IR with 87 filter



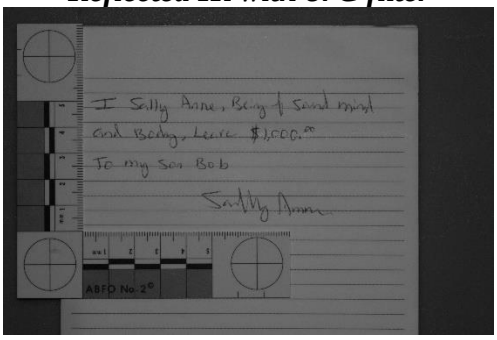
IR Fluorescence with 87 filter and ALS blue/green wavelengths (~450-550 nm)



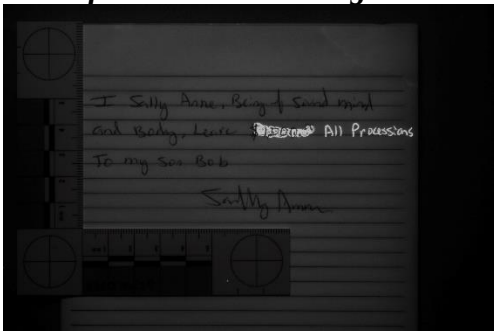
Visible light



Reflected IR with 87C filter



IR Fluorescence with 87 filter and ALS blue/green wavelengths (~540 nm)

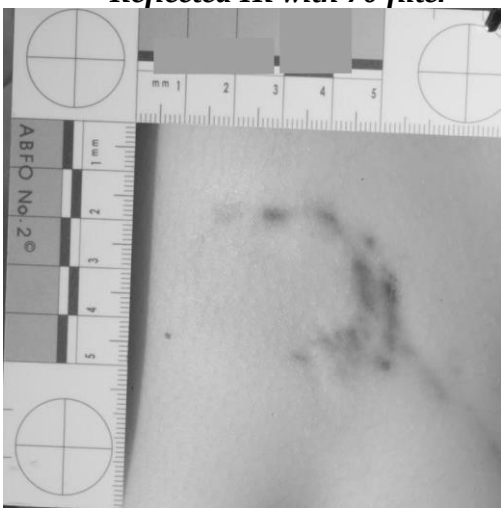


Note: Depending on the formulation of the ink, they will react different to IR: some will fluoresce under IR some will reflect, and some will absorb.

6.5 Bite mark(s)/bruising

Visible light

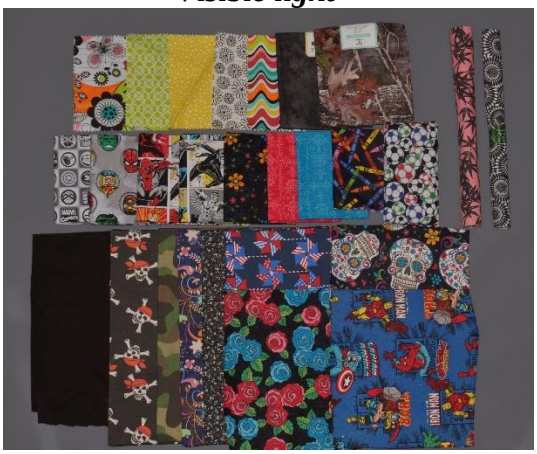
Reflected IR with 70 filter



Note: IR penetrates the skin showing deeper bruising. However, it may not be the best technique to use if the bruising is superficial.

6.6 Fabrics/Textiles

Visible light



Reflected IR with 87C filter

Note: The IR photography technique could be used to document clothing for possible comparison against an IR video image. Different fabrics, patterns and blends will absorb IR light in different ways depending on the manufacturing. (e.g. a black t-shirt could appear light gray under IR or logos/branding can look different or components completely lost during capture).

7. Procedures for IR Photography

These procedures are written for a full spectrum camera; however, if you are using an IR converted camera, then skip steps 6 - 8. It is suggested that the subject also be documented using visible light photography. If utilizing a preconfigured system, refer to the appropriate user manuals.

7.1 Procedure for reflected IR photography

1 Mount the camera to a tripod, copy stand or another sturdy device
2 Set camera to the lowest ISO for the lighting conditions
3 Set the camera to manual mode
4 Set the file format to RAW
5 Compose the subject so that it is perpendicular to the camera - place a scale and label on the same plane as the subject
6 Apply even and direct lighting (do not diffuse) to the subject
7 Place a visible bandpass filter on the camera and focus
8 Meter for visible light, capture an image, review, and adjust as necessary
9 Using the same light source, or another high in IR output apply even illumination to the subject
10 Remove visible bandpass filter
11 Place the IR filter on the camera and focus - for a non-calibrated lens use either live view (if equipped) or adjust for maximum depth of field
12 Capture an image, review, and adjust as necessary
Note: Use of different filters may be necessary to achieve the desired results.

7.2 Procedure for Fluorescence IR

1 Mount the camera to a tripod, copy stand or another sturdy device
2 Set camera to the lowest ISO for the lighting conditions
3 Set the camera to manual mode
4 Set the file format to RAW
5 Compose the subject so that it is perpendicular to the camera - place a scale and label on the same plane as the subject.
6 Apply even and direct visible lighting to the subject
7 Place a visible bandpass filter on the camera and focus
8 Meter for visible light, capture an image, review, and adjust as necessary
9 Replace the visible light with a light source of approximately 450nm to 550nm (blue/green) do not diffuse.
10 Place the IR filter on the camera and focus - for a non-calibrated lens use either live view (if equipped) or adjust for maximum depth of field

11 For best results, it is recommended to capture the image in a dark environment

12 Capture an image, review, and adjust as necessary

Note: Use of different filters may be necessary to achieve the desired results.

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History

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