Scientific Working Group on Digital Evidence

Core Competencies for Forensic Audio

10-A-001-3.3

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1. Purpose

This document provides an outline of the knowledge and abilities practitioners of forensic audio should possess. The following elements provide a basis for training and testing programs. This basis is suitable for certification, competency, and proficiency testing.

2. Scope

These competencies are sufficient for a technician performing basic forensic audio functions such as equipment configuration, handling of evidence, format conversion, basic media repairs, and reporting of results as outlined in *SWGDE 08-A-001-2.5 Best Practices for Forensic Audio* [1].

In a given organization, the role of a technician might include some or all of the functions detailed below. A technician must possess the knowledge and abilities for the tasks performed.

Other procedures, such as enhancement, complex media repairs, or signal analysis require additional skill sets specific to the content or phenomena under test. Refer to *SWGDE 10-Q-002-3.0 Guidelines & Recommendations for Training in Digital & Multimedia Evidence* for general training requirements of forensic practitioners.

Audio evidence is typically submitted in digital, file-based formats, with physical media (analog or digital) encountered less frequently. Core competencies in the handling and repairing of physical media are included below for practitioners who are appropriately trained in these processes.

3. Core Competencies

A forensic audio technician must be able to hear and shall track their acuity regularly. A hearing assessment shall also be performed after an acute event that results in hearing loss is experienced (e.g., trauma, illness).

A forensic audio technician must understand audio technology and forensic methodologies, and shall remain current in the discipline through such means as scientific and legal literature, professional organizations, and other continuing education.

A forensic audio technician must be trained on their laboratory's specific standard operating procedures which should be based on best practices, such as *SWGDE 08-A-001-2.5 Best Practices for Forensic Audio* [1].

A forensic audio technician shall have an understanding of ethics and the requirements for integrity and neutrality in scientific processes. This includes an understanding of human cognitive biases and ways to mitigate the influence of biases in judgment and decision making.

A forensic audio technician shall have the ability to apply the principles of quality management such as those defined in *SWGDE 10-Q-001-1.0 Minimum Requirements for Quality Assurance in the Processing of Digital and Multimedia Evidence* [2].

3.1 Audio Laboratory Configuration

- Knowledge of computer workstation hardware, configuration, software and connection of peripheral storage devices.
- Ability to operate task specific forensic audio processing equipment and software and know their capabilities and limitations.
- Ability to run test signals through individual devices and through an interconnected laboratory system to verify connectivity and performance is as expected. Calibrated test signal generators or validated test media should be used for this purpose.
- Ability to test audio processing software using known audio data to verify it is performing as expected.
- Ability to identify equipment that requires calibration, identify when that equipment is out of calibration, understand why it is out of calibration, and what steps must be taken to re-calibrate.
- Ability to maintain equipment and perform basic maintenance functions including cleaning and demagnetizing electronic heads, defragmenting hard drives, and updating operating system, forensic, and antivirus software.
- Ability to identify and mitigate environmental noise that interferes with hearing evidence recordings within the laboratory (speech, HVAC, equipment fans, vibration).
- Ability to identify and mitigate sources of electromagnetic interference (EMI) such as AC, ground loops, stray electrical and magnetic fields, RF equipment (e.g., cell phones, radios, etc.), and CRTs.
- Knowledge of the proper temperature, humidity, and ventilation requirements of audio equipment.
- Knowledge of various cable and connector types and the impact of their construction and distance on signal quality, impedance, and interconnection issues.
- Ability to design signal paths to mitigate noise and distortion and to keep signal levels within an appropriate range.

3.2 Advising the Submitter

- Ability to advise submitters regarding best practices for identifying and seizing audio evidence for subsequent laboratory examination, evidence preservation, packaging, transport, and storage.

3.3 Evidence Retrieval

- Ability to identify physical media of the source and determine the appropriate playback equipment.

- Ability to research unfamiliar audio recording devices and systems to best collect audio and associated data.

3.4 Submission of Request

- Ability to determine whether a request is within the scope of an individual's or the laboratory's services.
- Ability to assess the risks to audio evidence posed by processes from other forensic science disciplines.
- Ability to assess the risks to non-audio evidence posed by forensic audio processes.
- Ability to determine an appropriate sequence of interdisciplinary forensic analyses, given the risks that exist.

3.5 Audio Evidence Handling

- Knowledge of physical media formats and how to protect them from overwrite and environmental damage.
- Ability to identify physical damage which may impact the proper function of the media or device.
- Ability to safeguard recorded evidence (write protection and physical, magnetic, and environmental protection).
- Ability to properly pack, seal, and ship media exhibits without damaging the physical media or the recorded evidence.
- Ability to properly label media exhibits for identification without damaging evidence.
- Knowledge of how duplication processes can have adverse effects on signal quality and intelligibility.
- Ability to explain the limitations of duplicated recordings and the importance of original recordings.

3.6 Preliminary Examination

- Ability to perform spectral analysis and knowledge of its application and limitations, to include an understanding of how settings can affect time domain to frequency domain transformations (e.g., Fourier transforms) and introduce measurement uncertainty.
- Ability to perform amplitude analysis to identify and evaluate signal characteristics such as DC offset, clipping, and dynamic range. This includes an understanding of how decibel scales (e.g., dBFS, dBV, dBSPL) are derived logarithmically from amplitude values.
- Ability to perform critical listening to identify signals and events of interest and the suitability for analysis.

- Ability to estimate signal bandwidth.
- Ability to estimate number of independent channels and channel phase difference.
- Ability to select an appropriate output format with sufficient channels, sampling rate, and bit depth to represent the desired signal to the desired accuracy.
- Ability to adjust the playback gain, amplification, and capture devices to minimize distortion and prevent clipping while preventing the loss of low energy signals.
- Knowledge of widely supported audio formats.
- Ability to check digital media for viruses.
- Ability to evaluate a digital source signal to determine the native bit depth, sampling rate, dynamic range, encoding scheme, and number of channels.
- Ability to identify audio file formats and determine the appropriate software to access, play back, or convert audio data.
- Ability to recover and interpret metadata from file formats.
- Ability to attach, configure, and use write protection hardware and software to ensure original data integrity.
- Knowledge of file and data hashing processes and the ability to compute and verify them. This should include an understanding of the statistical probability for collision underlying chosen algorithms (e.g., SHA-2, SHA-3).

3.7 Analog Playback

- Ability to determine a recording's track configuration and speed and select an appropriate playback device.
- Ability to adjust playback equipment to produce an optimal output signal.
- Ability to use the frequency response and channel separation of the audio signal to adjust playback head height and azimuth to optimize the output signal bandwidth, track separation, and level.

3.8 Repair and Recovery

- Knowledge of the production and assembly of audio media, the materials from which they are made, the physical properties of those materials, and how the media are designed to function.
- Ability to evaluate media damage to determine whether it may affect access, playback, or recovery of the recording.
- Ability to disassemble and reassemble media housings and replace damaged components as necessary.
- Ability to clean magnetic tape without damaging it.
- Ability to clean optical discs without damaging them.

- Ability to identify the following in magnetic tape reels: sticky-shed, binding, pack slip, torn or wrinkled tape, and damage to the tape reel.
- Ability to determine if data has been written to a recordable optical disc.
- Ability to splice magnetic tape.

3.9 Results

- Ability to provide effective written and verbal communication.
- Ability to communicate effectively the capabilities and limitations of processes and results.
- Ability to assess the needs of the submitter to provide the appropriate output medium and format.
- Ability to record examination notes that document how exhibits were handled and what processes were performed with enough detail to allow a comparably trained examiner to explain the results or derive similar conclusions.
- Ability to write a report containing all of the relevant information in a clear and concise manner using standardized terminology, such as *ASTM E2916 Standard Terminology for Digital and Multimedia Evidence* [3].

3.10 Legal – Courts, Testimony, Law

- Knowledge of fundamental jurisdictional case law pertaining to forensic audio and speech.
- Knowledge of rules of evidence in civil and criminal procedure pertinent to admissibility and authentication in the relevant jurisdiction.
- Knowledge of rules of evidence in civil and criminal procedure pertinent to expert witness testimony in the relevant jurisdiction.
- Ability to successfully provide testimony in court under direct and cross examinations and in depositions.
- Ability to present complex technical information and conclusions in a clear and concise manner to a general audience.

4. References

[1] Scientific Working Group on Digital Evidence. *SWGDE Best Practices for Forensic Audio.* SWGDE 08-A-001-2.5. *SWGDE*, 22 Jun. 2022, https://www.swgde.org/08-a-001/.

[2] Scientific Working Group on Digital Evidence. *Minimum Requirements for Quality Assurance in the Processing of Digital and Multimedia Evidence*. SWGDE 10-Q-001-1.0. *SWGDE*, 15 May 2010, https://www.swgde.org/10-q-001/.

[3] ASTM International, *Standard Terminology for Digital and Multimedia Evidence Examination.* ASTM E2916-19e1. *ASTM*, 2022.

5. Additional Resources

- Scientific Working Group on Digital Evidence. *Guidelines & Recommendations for Training in Digital & Multimedia Evidence*. SWGDE 10-Q-002-3.0, SWGDE, 15 Mar. 2024, https://www.swgde.org/10-q-002/.

6. History

Revision	Issue Date	History
1.0 DRAFT	5/20/2010	Initial draft for public comment.
1.0 DRAFT	9/16/2010	Formatted and technical edits performed for release as a Draft for Public Comment.
1.0	9/15/2011	No public comments received. SWGDE voted to approve as a Final Approved Document.
1.0	9/27/2014	Updated document per current SWGDE Policy with new disclaimer. No changes to content and no version/publication date change.
2.0 DRAFT	9/15/2016	Updated document to synchronize with *SWGDE Best Practices for Forensic Audio version 2.2*. SWGDE voted to release as a Draft for Public Comment.
2.0 DRAFT	1/12/2017	Comments received and updated sections 1 through 3 to allow for differences in technician roles in different agencies. SWGDE voted for release as a Draft for Public Comment.
2.0 DRAFT	2/21/2017	Formatted and published as a Draft for Public Comment.
2.0	6/20/2017	Updated document in response to comments received (Sections 3.1, 3.6, 3.7, and 3.10). SWGDE voted to approve as a Final Approved document.
2.0	7/18/2017	Formatted and published as a Final Approved Document.
3.0 DRAFT	6/15/2023	Updated document format and numbering.
3.1 DRAFT	5/15/2024	Added sentence to Section 3: "Core Competencies: This includes an understanding of human cognitive biases and ways to mitigate the influence of biases in judgment and decision making."
3.2 DRAFT	9/19/2024	Changes made to multiple sections.

		Scope: Paragraph added: “Audio evidence is typically submitted in digital, file-based formats, with physical media (analog or digital) encountered less frequently. Core competencies in the handling and repairing of physical media are included below for practitioners who are appropriately trained in these processes.” Section 3: Changed various “must” statements to “shall,” revised the second sentence of the first paragraph, deleted the word "classes." Section 3.1: Sentence added: "Calibrated test signal generators or validated test media should be used for this purpose," deleted the word "analog," and deleted the sentence regarding signal formats. SWGDE voted for release as a Draft for Public Comment. Formatted as a Draft for Public Comment.
3.3	1/15/2025	Revisions made to Sections 3.1, 3.6, and 3.10 in response to public comments. Updated references.
3.3	2/21/2025	SWGDE voted to approve as a Final Approved Document.
3.3	2/25/2025	Formatted for release as a Final Approved Document.