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Scientific Working Group for Forensic Toxicology (SWGTOX) Standard for Laboratory Personnel

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This standard has been adopted by the Scientific Working Group for Forensic Toxicology (SWGTOX) and is intended to reflect a minimum standard of practice. Laboratories choosing to meet this practice must decide on an implementation plan that is conducive to the operation, resources and means of the laboratory.

1. Introduction

1.1. Scope

1.1.1. This standard delineates the minimum requirements for educational qualifications, training, competency, experience, continuing education and professional development, and certification. This standard applies to laboratory personnel performing forensic toxicology activities in sub-disciplines specified in the SWGTOX bylaws. Standards for breath alcohol personnel are contained in "Scientific Working Group for Forensic Toxicology (SWGTOX) Standard for Breath Alcohol Personnel".

1.1.2. Laboratory personnel that perform administrative or non-technical duties are outside the scope of this document.

1.1.3. Existing regulations, codes, and rules may need to be modified to conform to this standard. SWGTOX develops and disseminates consensus standards for the practice of forensic toxicology, but has no legal authority to enforce these standards.

1.1.4. The minimum requirements for laboratory personnel are categorized at the level of *Technician*, *Analyst*, *Toxicologist*, and *Technical Director*. Each category of employment builds on the requirements of the previous category.

2. Definitions

2.1. *Analyst* – An individual (however named) who conducts, directs or reviews the analysis of forensic toxicology samples; evaluates data[1] and reaches conclusions;[2] may sign a report for court or investigative purposes as a consequence of such examinations. This person does not provide interpretive opinions related to the results of toxicological tests.

2.2. *Certification* – The recognition by an independent certifying body that an individual has acquired and demonstrated specialized knowledge, skills, and abilities.

2.3. *Competency* – The application of knowledge, skills, and abilities appropriate to the job function.

2.4. *Continuing Education* – Ongoing training whereby personnel remain current, or advance to a higher level of expertise, specialization, or responsibility.

2.5. *Course* – An officially recognized program of instruction that is taught through an accredited college or university program in which the student's successful completion is documented by an official record of the institution.

2.6. *Credential* – A formal recognition of a professional's knowledge, skills, and abilities (e.g., diploma, license).

2.7. *Education* – Formal coursework at an accredited college or university.

2.8. *Experience* – Direct observation of and participation in the practice of a discipline.

2.9. *Laboratory Personnel* – Individuals who perform analytical or laboratory-based functions of a technical nature. This excludes administrative or non-technical support staff.

2.10. *Methodology* – The analytical processes and procedures used to support forensic toxicology (e.g., chromatography, spectroscopy or immunoassay).

2.11. *Professional Development* – The education and training that contributes to career advancement and succession planning (e.g., administration, leadership, management and fiscal responsibility).

2.12. *Qualifications* – The combined education, training, and experience of an individual.

2.13. *Reference Material* – A material or substance, sufficiently homogenous, stable, and of known concentration with respect to one or more specified properties, which has been established to be fit for its intended use in a measurement process.

2.14. *Technical Director* – An individual (however named) who is responsible for the technical oversight of the toxicology laboratory.

[1]Evaluate data refers to the evaluation of scientific data to meet reporting criteria.
[2]Reach conclusions refers to the decision to report the substance as detected/not detected and submit those findings for review.

2.15. *Technician* – An individual (however named) who performs basic analytical functions but does not evaluate data, reach conclusions or sign a report for court or investigative purposes.

2.16. *Toxicologist* – An individual (however named) who provides interpretive opinions related to the results of toxicological tests for court or investigative purposes. This standard further divides this role between Toxicologist (General) and Toxicologist (Alcohol) as described in Appendix A.

2.17. *Training* – The formal, structured process of teaching and assessment, through which personnel reach a level of scientific knowledge and expertise required to perform specific tasks.

3. Educational Qualifications

3.1. Overview

3.1.1. One indication of professional standing is educational qualifications. Diplomas and formal academic transcripts are required as proof of academic credentials.

3.1.2. Minimum standards for education, training, experience and continuing education are summarized in Appendix A for each category of employment. Core scientific topics are listed in Appendix B.

3.2. Technician

3.2.1. Associate's degree in natural science (e.g., biology, chemistry, biochemistry) or applied science (e.g., forensic science, medical sciences) from an accredited institution.

3.3. Analyst

3.3.1. Bachelor's degree in natural science (e.g., biology, chemistry, toxicology, biochemistry) or applied science (e.g., medical sciences, forensic science) from an accredited institution; successful completion of general and organic chemistry with associated laboratory classes (minimum 16 semester hours); a course in statistics; at least two (2) college-level courses from either Column A or Column B located in Appendix B.

3.4. Toxicologist (Alcohol-only)

3.4.1. Bachelor's degree in natural science (e.g., biology, chemistry, toxicology, biochemistry) or applied science (e.g., medical sciences, forensic science) from an accredited institution; successful completion of general and organic chemistry with associated laboratory classes (minimum 16 semester hours); a course in statistics; at least one (1) college-level course from Column A and one (1) from Column B located in Appendix B.

3.5. Toxicologist (General)

3.5.1. Bachelor's degree in natural science (e.g., biology, chemistry, toxicology, biochemistry) or applied science (e.g., forensic science) from an accredited institution; successful completion of general and organic chemistry with associated laboratory classes (minimum 16 semester hours); a course in statistics; at least one (1) college-level course from Column A and two (2) from Column B located in Appendix B.

3.6. Technical Director (General)

3.6.1. Master's degree in natural science (e.g., biology, chemistry, toxicology, biochemistry) or applied science (e.g., forensic science) from an accredited institution; successful completion of general and organic chemistry with associated laboratory classes (minimum 16 semester hours); a course in statistics; at least one (1) college-level course from Column A and two (2) from Column B located in Appendix B.

4. Training

4.1. Purpose

4.1.1. Personnel require training to build competency. The length of the initial training provided to the individual will depend upon the scope of work to be performed, as well as the qualifications of the individual. The depth of training will be appropriate to the job function(s).

4.1.2. Regardless of qualifications all technical personnel will be provided training to ensure competency in all assigned areas detailed in the training elements section.

4.1.3. Prior to assuming independent responsibility, personnel must have successfully demonstrated competency in their job function(s).

4.2. Source of Training

4.2.1. The source of training can be internal and/or external to the forensic laboratory. Training partnerships are valuable because they provide broad perspectives and facilitate consistency of professional practice. Sources include government agencies, academic institutions, training academies or institutions, private sector organizations, manufacturers, professional societies, and mentors.

4.3. Training Program

4.3.1. The laboratory shall have a documented training program. It must address both theoretical and practical knowledge, skills and abilities necessary to perform job functions.

4.3.2. A training plan shall define training methodologies, performance standards and assessment methods (e.g., written and/or oral examinations, critical reviews, analysis of unknown samples and mock casework applicable to the sub-discipline).

4.3.3. Documentation of completion of the elements of the training program will be retained.

4.3.4. The relevance and content of the training program shall be evaluated by the organization annually.

4.4. Training Elements

4.4.1. Specific training elements shall include the following areas where applicable for the specific job duties as summarized in Appendix A.

4.4.2. Administrative and Laboratory Policies

4.4.2.1. Accreditation

4.4.2.2. Document and record control

4.4.2.3. Method validation

4.4.2.4. Quality management

4.4.2.5. Safety and security

4.4.2.5.1. Biological, chemical, and physical hazards (e.g., storage, handling, disposal)

4.4.2.5.2. Security (e.g., facility)

4.4.2.6. Standard operating procedures

4.4.3. Analytical Methodology

4.4.3.1. Aliquoting

4.4.3.2. Isolation techniques

4.4.3.3. Qualitative analysis

4.4.3.4. Quantitative analysis

4.4.3.5. Theory

4.4.4. Communication

4.4.4.1. Report writing

4.4.4.2. Verbal and nonverbal skills

4.4.4.2.1. Non-technical

4.4.4.2.2. Technical

4.4.5. Evidence

4.4.5.1. Chain of custody

4.4.5.2. Collection

4.4.5.3. Concepts

4.4.5.4. Preservation

4.4.5.5. Retention

4.4.6. Instructional development

4.4.6.1. Adult learning principles

4.4.6.2. Knowledge and/or development of curriculum

4.4.6.3. Use of assigned multi-media equipment

4.4.7. Instrumentation

4.4.7.1. Limitations

4.4.7.2. Maintenance and troubleshooting

4.4.7.3. Operation

4.4.7.4. Theory

4.4.8. Legal Aspects

4.4.8.1. Case law

4.4.8.2. Terminology

4.4.8.3. Testimony

4.4.8.3.1. Courtroom procedure

4.4.8.3.2. Deposition and courtroom

4.4.9. Quality Control

4.4.9.1. Reference Material

4.4.9.1.1. Limitations

4.4.9.1.2. Preparation

4.4.9.1.3. Traceability

4.4.9.1.4. Uses

4.4.9.2. Theory

4.4.10. Standards of Conduct

4.4.10.1. Ethics

4.4.10.2. Professionalism

4.4.11. Statistical Analysis

4.4.11.1. Calculations

4.4.11.2. Control charts and/or trending

4.4.11.3. Measurement assurance

4.4.11.4. Measurement uncertainty

4.4.11.5. Terminology

4.4.12. Toxicology

4.4.12.1. Interpretation

4.4.12.2. Pharmacodynamics

4.4.12.3. Pharmacokinetics

4.4.12.4. Physiology

5. Competency

5.1. Initial Competency

5.1.1. Regardless of academic qualifications or past work experience, all individuals shall satisfactorily complete a competency assessment prior to assuming independent responsibilities.

5.1.2. The format for initial competency assessment(s) will be specified in the training program (see Section 4.3.2). The program may use different formats such as oral, written, and video as a means of ensuring and documenting competency

5.1.3. All areas of technical expertise will include a practical component for their competency assessment (e.g., issuing a report, providing interpretation).

5.1.4. The trainee shall demonstrate integration of theoretical and practical knowledge, skills and abilities to perform their functions through the completion of competency tests.

5.1.5. Verification document(s) demonstrating that personnel have achieved the required competence must be maintained by the laboratory.

5.2. Ongoing Competency

5.2.1. The laboratory shall monitor competency of personnel on a continuous basis, documented annually.

5.2.2. Competency shall be assessed at the appropriate level commensurate with job duties.

5.2.3. Evaluation of competency may be determined through the following:

5.2.3.1. Audits of casework

5.2.3.2. Compliance with standard operating procedures

5.2.3.3. Direct observation of employee duties

5.2.3.4. Evaluation of testimony

5.2.3.5. Proficiency testing

5.2.3.6. Technical review

5.2.3.7. Written and/or oral examination

5.2.4. The laboratory shall establish a predetermined, acceptable level of performance.

5.2.5. The laboratory shall establish remediation and corrective action plans when expected outcome(s) are not achieved.

6. Experience

6.1. General

6.1.1. Experience is a component of building competency prior to performing the job function. Experience includes both practical and theoretical aspects of the discipline.

6.2. Technician

6.2.1. No experience beyond initial training is required.

6.3. Analyst

6.3.1. No experience beyond initial training is required.

6.4. Toxicologist (Alcohol)

6.4.1. Prior to assuming independent responsibilities and providing comprehensive and interpretive testimony, one year of relevant laboratory experience including the analysis of biological specimens is required.

6.4.2. Relevant job experience from previous laboratory work experience can be included in the one year minimum experience requirement.

6.4.3. An initial training phase culminating in a competency assessment shall occur as part of this laboratory experience.

6.5. Toxicologist (General)

6.5.1. *Bachelor's degree* – Prior to assuming independent responsibilities and providing comprehensive and interpretive testimony, six years relevant laboratory experience including the analysis of biological specimens is required.

6.5.2. *Master's degree* – Prior to assuming independent responsibilities and providing comprehensive and interpretive testimony, three years relevant laboratory experience including the analysis of biological specimens is required.

6.5.3. *Doctoral degree* – Prior to assuming independent responsibilities and providing comprehensive and interpretive testimony, one year relevant laboratory experience including the analysis of biological specimens is required.

6.5.4. Relevant job experience from previous laboratory work experience can be included in the minimum experience requirement.

6.5.5. An initial training phase culminating in a competency assessment shall occur as part of this laboratory experience (see Section 5).

6.6. Technical Director

6.6.1. Prior to assuming independent responsibilities as Technical Director of an alcohol laboratory, a minimum of two years of experience as a Toxicologist (Alcohol or General) performing independently is required.

6.6.2. Prior to assuming independent responsibilities as Technical Director of a general forensic toxicology laboratory, a minimum of two years of experience as a Toxicologist (General) performing independently is required.

7. Continuing Education and Professional Development

7.1. All laboratory personnel have an ongoing obligation to remain current within the discipline through continuing education and professional development activities appropriate for the scope of job functions.

7.2. While casework is the primary focus, individuals should also strive to advance the profession. This may be accomplished through professional involvement such as research, mentoring, teaching, participating in professional organizations, scientific publications and other professional activities.

7.3. Recognition of any continuing education or professional development requires proper documentation. The laboratory is responsible for maintaining permanent, official training records. Assignment of CE credit for various activities is the purview of the respective Certification Bodies.

7.3.1. The laboratory shall maintain documentation of attendance through a mechanism such as certificates of completion, duration of training, program agenda/syllabi, travel documentation (if applicable).

7.3.2. The activities must be independently verifiable and may include attending seminars, conferences, coursework, professional meetings or documented training sessions/classes in relevant subject areas.

7.3.3. Continuing education activities also include an individual's contribution to the field of forensic toxicology. Examples include presentations, publications in peer-reviewed literature, or authorship of books or chapters.

7.3.4. Continuing education and professional development will be a combination of internal and external activities. The sources of external continuing education and professional development are diverse *(*e.g.*,* government agencies, academic institutions, training academies or institutions, private sector organizations, professional societies, vendors).

7.3.5. Continuing education and professional development can be delivered in-person or online.

7.3.6. Continuing education and professional development from organizations that provide recognized continuing education credits are preferred.

7.4. Minimum continuing education and/or professional development requirements for forensic toxicology personnel are as follows:

7.4.1. A minimum of 25% of the required continuing education and/or professional development must be obtained from external sources.

7.4.2. Technician: four (4) hours annually, which must be relevant to forensic toxicology.

7.4.3. Analyst: eight (8) hours annually, which must be relevant to forensic toxicology.

7.4.4. Toxicologist (Alcohol and General): sixteen (16) hours annually, which must be relevant to forensic toxicology.

7.4.5. Technical Director (General): twenty (20) hours annually, which must be relevant to forensic toxicology and/or laboratory management.

7.5. It is the responsibility of the laboratory to ensure that the following resources shall be available and accessible to laboratory personnel:

7.5.1. Reference texts in key subject areas (e.g., analytical chemistry, toxicology, pharmacology).

7.5.2. Reference literature containing physical, chemical, pharmaceutical and/or analytical data (e.g., Merck Index, Clarke's Analysis of Drugs and Poisons).

7.5.3. Relevant periodicals and peer-reviewed journals.

7.6. Laboratory management has an ongoing responsibility to provide support and opportunities for continuing education and professional development.

8. Certification

8.1. General

8.1.1. Certification provides the public and the judicial system a means of identifying those practitioners who have successfully demonstrated competency. It provides an additional means of verifying ethical standards and is an external review of ongoing competency.

8.2. Individuals Requiring Certification

8.2.1. All individuals (however named) performing functions commensurate with those of an Analyst, Toxicologist, or Technical Director shall be certified in forensic toxicology within 3 years of reaching eligibility requirements as established by the certification bodies.

8.3. Standards for Forensic Toxicology Certification Bodies include:

8.3.1. A formal application process.

8.3.2. Verification of minimum educational qualifications

8.3.2.1. Review of official transcript(s) from an accredited college or university sent directly to the certification body.

8.3.2.2. Transcripts from foreign institutions must be evaluated for equivalence by a transcript evaluation service that is recognized or accepted by an accredited college or university within the United States.

8.3.3. Review of professional references.

8.3.3.1. A minimum of two references from practitioners with knowledge of the applicant's experience in forensic toxicology submitted directly to the certification body.

8.3.4. Evaluation of credentials.

8.3.4.1. Documentation of successful completion of relevant training (internal and/or external).

8.3.4.2. Competency (practical) evaluation including but not limited to proficiency testing or review of same.

8.3.4.3. Verification of required training and experience.

8.3.5. Statement of adherence to a professional code of conduct.

8.3.6. A written, proctored examination appropriate to the level of certification

8.3.6.1. Examination questions shall be periodically evaluated for relevancy and bias.

8.3.6.2. Examinations shall include specific questions to determine the applicant's ability to evaluate and interpret test results where appropriate.

8.3.6.3. Certification bodies shall have predefined criteria for successful completion.

8.3.7. A requalification process that occurs at least every 5 years and includes:

8.3.7.1. Mandatory minimum annual continuing education requirements appropriate for the level of certification.

8.3.7.2. Evaluation of competency through one or more of the following: proficiency testing, case audits, evaluation of court testimony, and/or other appropriate mechanisms based on the discipline and level of certification.

8.3.8. A process to reapply for certification in the event an individual does not qualify.

8.3.9. Certification bodies shall be accredited based on a relevant ISO standard (e.g., ISO/IEC 17024 Conformity assessment: General requirements for bodies operating certification of persons).

9. References

National Institute of Justice, Education and Training in Forensic Science: A Guide for Forensic Science Laboratories, Educational Institutions, and Students, Washington DC: National Institute of Justice (2004).

National Research Council, Strengthening Forensic Science in the United States: A Path Forward. Washington, DC: The National Academies Press (2009).

Appendix A: Summary of Minimum Standards for Laboratory Personnel

	Technician	Analyst	Toxicologist (Alcohol)	Toxicologist (General)	Technical director
Scope	Performs basic analytical functions but does not evaluate data[1], reach conclusions[2] or sign a report for court or investigative purposes.	Conducts, directs or reviews the analysis of forensic toxicology samples, evaluates data[1] and reaches conclusions[2]; may sign a report for court/investigative purposes based on examinations. Does not provide interpretive opinions.	Provides interpretive opinions related to the results of toxicological tests for court or investigative purposes, specific to alcohol testing.	Provides interpretive opinions related to the results of toxicological tests for court or investigative purposes.	Responsible for the technical oversight of the toxicology laboratory
Education	Associate's degree[3]	Bachelor's degree[3]	Bachelor's degree[3]	Bachelor's degree[3]	Master's degree[3]
Required courses	NA	• General & organic chemistry (16 semester hr) • Statistics • 2 analytical and/or interpretive courses (Appendix B)	• General & organic chemistry (16 semester hr) • Statistics • 1 analytical and 1 interpretive course (Appendix B)	• General & organic chemistry (16 semester hr) • Statistics • 1 analytical and 2 interpretive courses (Appendix B)	• General & organic chemistry (16 semester hr) • Statistics • 1 analytical and 2 interpretive courses (Appendix B)
Training and work experience	• Completion of formal, structured training appropriate to job function.	• Formal, structured training program appropriate to job function.	• Formal, structured training program appropriate to job function. • 1 yr relevant forensic alcohol experience is required prior to assuming independent *Toxicologist (Alcohol)* duties.	• Formal, structured training program appropriate to job function. • 1 yr relevant forensic toxicology experience is required prior to assuming independent *Toxicologist (General)* duties upon completion of *doctoral degree*. • 3 yr relevant forensic toxicology experience is required upon completion of a *master's degree*. • 6 yr relevant forensic toxicology experience is required upon completion of a *bachelor's degree*.	• Formal, structured training program appropriate to job function. • 2 yr experience as a Toxicologist performing independently before assuming role of a *Technical Director*.
Independent certification	• Not required	• Required	• Required	• Required	• Required
Annual continuing education (CE) & Professional development	• 4 hr of CE relevant to forensic toxicology • 1hr from external source	• 8 hr of CE relevant to forensic toxicology • 2 hr from external source	• 16 hr of CE relevant to forensic toxicology • 4 hr from external source	• 16 hr of CE relevant to forensic toxicology • 4 hr from external source	• 20 hr of CE relevant to forensic toxicology and/or lab management • 5 hr from external source

[1] Evaluate data refers to the evaluation of scientific data to meet reporting criteria. [2] Reach conclusions refers to the decision to report the substance as detected/not detected and submit those findings for review. [3] Represents a degree in a natural science or applied science from an accredited institution.

Appendix B: College-Level Course Overview

The courses below serve as *examples* of acceptable courses in accredited colleges or universities. **This list is not meant to exclude similar courses with similar content bearing different titles**. These courses do not replace the required 16 semester hours of chemistry.

Table 1
Examples of Acceptable College-level Courses.

Column A Chemistry courses (analytical)	Column B Specialized science courses (interpretive)
Analytical chemistry	Biochemistry
Chemical informatics	Drug metabolism
Instrumental analysis	Forensic toxicology
Mass spectrometry	Medicinal chemistry
Quantitative analysis	Pharmacology
Separation science	Physiology
Spectroscopic analysis	Toxicology

Chemistry Course Descriptions – Examples (Column A)

Analytical Chemistry – A study of the separation, identification, and quantification of chemical components.

Chemical Informatics – Computer methods for experimental design and data analysis of spectroscopic, electrochemical and chromatographic data. Topics include sampling theory, detection limits, curve resolution, Fourier transform-based instruments and factor analysis.

Instrumental Analysis – Theory and practice of spectrophotometric, electroanalytical and chromatographic methods.
Mass Spectrometry – Topics include mass spectrometry ionization methods, mass analyzers, theory and applications for ion structure determination.
Quantitative Analysis – Theory and practice of gravimetric, volumetric and instrumental analysis techniques and treatment of multiple equilibria in aqueous solutions.
Separation Science – Principles of separation science as applied to chemical problems with emphasis on current techniques, instrumentation and applications.
Spectroscopic Analysis – Theory and application of spectroscopic techniques to determine molecular structure.

Specialized Science Courses – Examples (from Column B)

Biochemistry – A presentation of structural biochemistry, enzymology, biophysical techniques, bioenergetics and an introduction to intermediary metabolism.
Drug Metabolism – Biotransformation and emphasis on the molecular aspects of Phase I and Phase II drug metabolism.
Forensic Toxicology – Basic principles of analytical and/or interpretive toxicology as they apply to legal issues.
Medicinal Chemistry – A combination of fundamentals and applications of drug design including molecular aspects of drug action.
Pharmacology – The mechanisms of action of major drug classes and basic principles of pharmacology, including pharmacokinetics and pharmacodynamics.
Physiology – A human physiology course based on an analysis of organ systems.
Toxicology – Dynamic interactions of xenobiotics with living systems. Correlations of toxicological responses with biochemical, functional and morphological changes.