



Quality Assurance Standards for Forensic DNA Testing Laboratories

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This document consists of definitions and standards. The standards are quality assurance measures that place specific requirements on the laboratory. Equivalent measures not outlined in this document may also meet the standard if determined sufficient through an accreditation process.

Effective Date

These standards shall take effect July 1, 2009.

References

DNA Advisory Board. Quality assurance standards for forensic DNA testing laboratories July 1998, *Forensic Science Communications* [Online]. (July 2000). Available: <http://www.fbi.gov/hq/lab/fsc/backissu/july2000/codis2a.htm>.

DNA Advisory Board. Quality assurance standards for convicted offender DNA databasing laboratories April 1999, *Forensic Science Communications* [Online]. (July 2000). Available: <http://www.fbi.gov/hq/lab/fsc/backissu/july2000/codis1a.htm>.

1. Scope

The standards describe the quality assurance requirements that laboratories performing forensic DNA testing or utilizing the Combined DNA Index System (CODIS) shall follow to ensure the quality and integrity of the data generated by the laboratory. These standards also apply to vendor laboratories that perform forensic DNA testing in accordance with Standard 17. These standards do not preclude the participation of a laboratory, by itself or in collaboration with others, in research and development on procedures that have not yet been validated.

2. Definitions

As used in these standards, the following terms shall have the meanings specified:

Accredited laboratory is a DNA laboratory that has received formal recognition that it meets or exceeds a list of standards, including the FBI Director's Quality Assurance Standards, to perform specific tests, by a nonprofit professional association of persons actively involved in forensic science that is nationally recognized within the forensic community in accordance with the provisions of the Federal DNA Identification Act (42 U.S.C. § 14132) or subsequent laws.

Accuracy is the degree of conformity of a measured quantity to its actual (true) value.

Administrative review is an evaluation of the report and supporting documentation for consistency with laboratory policies and for editorial correctness.

Analyst (or equivalent role, position, or title as designated by the Laboratory Director) is an employee that has successfully completed the laboratory's training requirements for casework sample analysis, passed a competency test, and has entered into a proficiency testing program according to these Standards. This individual conducts and/or directs the analysis of forensic samples, interprets data, and reaches conclusions.

Analytical documentation is the documentation of procedures, standards, controls, and instruments used; observations made; results of tests performed; and charts, graphs, photos, and other documentation generated which are used to support the analyst's conclusions.

Analytical procedure is an orderly, step-by-step process designed to ensure operational uniformity and to minimize analytical drift.

Annual is once per calendar year.

Audit is an inspection used to evaluate, confirm, or verify activity related to quality.

Biochemistry is the study of the nature of biologically important molecules in living systems, DNA replication and protein synthesis, and the quantitative and qualitative aspects of cellular metabolism.

Calibration is the set of operations which establish, under specified conditions, the relationship between values indicated by a measuring instrument or measuring system, or values represented by a material, and the corresponding known values of a measurement.

Casework CODIS administrator (or equivalent role, position, or title as designated by the Laboratory Director) is an employee of the laboratory responsible for administration and security of the laboratory's CODIS at a laboratory performing DNA analysis on forensic and casework reference samples.

Casework reference sample is biological material obtained from a known individual and collected for purposes of comparison to forensic samples.

CODIS is the Combined DNA Index System administered by the FBI. CODIS links DNA evidence obtained from crime scenes, thereby identifying serial criminals. CODIS also compares crime scene evidence to DNA profiles from offenders, thereby providing investigators with the identity of the putative perpetrator. In addition, CODIS contains profiles from missing persons, unidentified human remains, and relatives of missing persons. There are three levels of CODIS: the Local DNA Index System (LDIS), used by individual laboratories; the State DNA Index System (SDIS), used at the state level to serve as a state's DNA database containing DNA profiles from LDIS laboratories; and the National DNA Index System (NDIS), managed by the FBI as the nation's DNA database containing all DNA profiles uploaded by participating states.

Competency test(s) is a written, oral, and/or practical test or series of tests designed to establish that an individual has demonstrated achievement of technical skills and met minimum standards of knowledge necessary to perform forensic DNA analysis.

Competency is the demonstration of technical skills and knowledge necessary to perform forensic DNA analysis successfully.

Contamination is the unintentional introduction of exogenous DNA into a DNA sample or PCR reaction.

Continuing education is an educational activity (such as a class, lecture series, conference, seminar, or short course) that is offered by a recognized organization or individual that brings participants up-to-date in their relevant area of knowledge.

Coursework is an academic class officially recognized and taught through a college or university program in which the participating student successfully completed and received one or more credit hours for the class.

Critical equipment or instruments are those requiring calibration or a performance check prior to use and periodically thereafter.

Critical reagents are determined by empirical studies or routine practice to require testing on established samples before use on evidentiary or casework reference samples.

Developmental validation is the acquisition of test data and determination of conditions and limitations of a new or novel DNA methodology for use on forensic and/or casework reference samples.

Differential amplification is the selection of one target region or locus over another during the polymerase chain reaction. Differential amplification can also arise between two alleles within a single locus if one of the alleles has a mutation within a PCR primer-binding site, causing this allele to be copied less efficiently because of the primer-template mismatch.

DNA record is a database record that includes the DNA profile as well as data required to manage and operate NDIS, i.e., the Originating Agency Identifier, which serves to identify the submitting agency; the Specimen Identification Number; and DNA personnel associated with the DNA profile analyses.

DNA type (also known as a DNA profile) is the genetic constitution of an individual at defined locations (also known as loci) in the DNA. A DNA type derived from nuclear DNA typically consists of one or two alleles at several loci (e.g., short tandem repeat loci). The DNA type derived from mitochondrial DNA is described in relation to the revised Cambridge Reference Sequence (Nature Genetics [1999] 23:147).

Employee is a person (1) in the service of the applicable federal, state, or local government, subject to the terms, conditions, and rules of federal, state, or local employment and eligible for the federal, state, or local benefits of service; or (2) formerly in the service of a federal, state, or local government who returns to service in the agency on a part-time or temporary basis. For purposes of a vendor laboratory, an employee is a person in the service of a vendor laboratory and subject to the applicable terms, conditions, and rules of employment of the vendor laboratory.

FBI is the Federal Bureau of Investigation, the federal agency authorized by the DNA Identification Act of 1994 to issue quality assurance standards governing forensic DNA testing laboratories and to establish and administer the National DNA Index System (NDIS).

Forensic DNA analysis is the process of identification and evaluation of biological evidence in criminal matters using DNA technologies.

Forensic sample is a biological sample originating from and associated with a crime scene. For example, a sample associated with a crime scene may include a sample that has been carried away from the crime scene.

Genetics is the study of inherited traits, genotype/phenotype relationships, and population/species differences in allele and genotype frequencies.

Guidelines are a set of general principles used to provide direction and parameters for decision making.

Integral component is that portion of an academic course that is so significant and necessary to the understanding of the subject matter as a whole that the course would be considered incomplete without it.

Internal validation is the accumulation of test data within the laboratory to demonstrate that established methods and procedures perform as expected in the laboratory.

Known samples are biological material whose identity or type is established.

Laboratory is a facility (1) employing at least two full-time employees who are qualified DNA analysts and (2) having and maintaining the capability to perform the DNA analysis of forensic samples and/or casework reference samples at that facility.

Laboratory support personnel (or equivalent role, position, or title as designated by the Laboratory Director) are employees who perform laboratory duties exclusive of analytical techniques on forensic or database samples.

Methodology is used to describe the analytical processes and procedures used to support a DNA-typing technology: for example, extraction methods (manual vs. automated), quantitation methods (slot blot, fluorometry, real-time); typing test kit; and platform (capillary electrophoresis, real-time gel and end-point gel systems).

Molecular biology is the study of the theories, methods, and techniques used in the study and analysis of gene structure, organization, and function.

Multilaboratory system is used to describe an organization that has more than one laboratory performing forensic DNA analysis.

Multiplex system is a test providing for simultaneous amplification of multiple loci that is either prepared commercially or by a laboratory.

Negative amplification control is used to detect DNA contamination of the amplification reagents. This control consists of only amplification reagents without the addition of template DNA.

NIST is the National Institute of Standards and Technology.

On-site visit is a scheduled or unscheduled visit by one or more representatives of the outsourcing laboratory to the vendor laboratory work site to assess and document the vendor laboratory's ability to perform analysis on outsourced casework.

Outsourcing is the utilization of a vendor laboratory to provide DNA services in which the NDIS participating laboratory takes or retains ownership of the DNA data for entry into CODIS, when applicable. Outsourcing does not require the existence of a contractual agreement or the exchange of funds.

Ownership occurs when any of the following criteria are applicable:

1. The originating laboratory will use any samples, extracts, or materials from the vendor laboratory for the purposes of forensic testing (i.e., a vendor laboratory prepares an extract that will be analyzed by the originating laboratory);
2. The originating laboratory will interpret the data generated by the vendor laboratory;
3. The originating laboratory will issue a report on the results of the analysis; or
4. The originating laboratory will enter or search a DNA profile in CODIS from data generated by the vendor laboratory.

Performance check is a quality assurance measure to assess the functionality of laboratory

instruments and equipment that affect the accuracy and/or validity of forensic sample analysis.

Platform is the type of analytical system utilized to generate DNA profiles, such as capillary electrophoresis, real-time gel, and end-point gel instruments or systems.

Polymerase Chain Reaction (PCR) is an enzymatic process by which a specific region of DNA is replicated during repetitive cycles, which consist of the following:

1. Denaturation of the template;
2. Annealing of primers to complementary sequences at an empirically determined temperature; and
3. Extension of the bound primers by a DNA polymerase.

Positive amplification control is an analytical control sample that is used to determine if the PCR performed properly. This control consists of the amplification reagents and a known DNA sample.

Precision characterizes the degree of mutual agreement among a series of individual measurements, values, and/or results.

Preferential amplification is the unequal sampling of the two alleles present in a heterozygous locus primarily due to stochastic (random) fluctuation arising when only a few DNA molecules are used to initiate the polymerase chain reaction.

Procedure (protocol, standard operating procedure, or other equivalent) is an established practice to be followed in performing a specified task or under specific circumstances.

Proficiency testing is a quality assurance measure used to monitor performance and identify areas in which improvement may be needed. Proficiency tests may be classified as:

1. An internal proficiency test, which is produced by the agency undergoing the test.
2. An external proficiency test, which may be open or blind, is a test obtained from an approved proficiency test provider.

Qualified auditor is a current or previously qualified DNA analyst who has successfully completed the FBI's DNA auditor training course.

Quality system is the organizational structure, responsibilities, procedures, processes, and resources for implementing quality management.

Quantitative PCR is a method of determining the concentration of DNA in a sample by use of the polymerase chain reaction.

Reagent blank control is an analytical control sample that contains no template DNA and is used to monitor contamination from extraction to final fragment or sequence analysis. This control is treated the same as, and parallel to, the forensic and/or casework reference samples being analyzed.

Reference material (certified or standard) is a material for which values are certified by a technically valid procedure and accompanied by, or traceable to, a certificate or other documentation which is issued by a certifying body.

Reproducibility is the ability to obtain the same result when the test or experiment is repeated.

Review is an evaluation of documentation to check for consistency, accuracy, and completeness.

Second agency is an entity or organization external to and independent of the laboratory.

Semiannual is used to describe an event that takes place two times during one calendar year, with the first event taking place in the first six months of that year and the second event taking place in the second six months of that year, and where the interval between the two events is at least four months and not more than eight months.

Service is the performance of those adjustments or procedures specified which are to be performed by the user, manufacturer, or other service personnel in order to ensure the intended performance of instruments and equipment.

Technical leader (or equivalent role, position, or title as designated by the Laboratory Director) is an employee who is accountable for the technical operations of the laboratory and who is authorized to stop or suspend laboratory operations.

Technical review is an evaluation of reports, notes, data, and other documents to ensure there is an appropriate and sufficient basis for the scientific conclusions.

Technical reviewer is an employee who is a current or previously qualified analyst in the methodology being reviewed that performs a technical review of, and is not an author of, the applicable report or its contents.

Technician (or equivalent role, position, or title as designated by the Laboratory Director) is an employee who performs analytical techniques on forensic samples under the supervision of a qualified analyst. Technicians do not interpret data, reach conclusions on typing results, or prepare final reports.

Technology is used to describe the type of forensic DNA analysis performed in the laboratory, such as RFLP, STR, YSTR, or mitochondrial DNA.

Test kit is a preassembled set of reagents that allows the user to conduct a specific DNA extraction, quantitation, or amplification.

Traceability is the property of a result of a measurement whereby it can be related to appropriate standards, generally international or national standards, through an unbroken chain of comparisons.

Underlying scientific principle is a rule concerning a natural phenomenon or function that is a part of the basis used to proceed to more detailed scientific functions.

Validation is a process by which a procedure is evaluated to determine its efficacy and reliability for forensic casework analysis and includes the following:

1. Developmental validation is the acquisition of test data and determination of conditions and limitations of a new or novel DNA methodology for use on forensic samples.
2. Internal validation is an accumulation of test data within the laboratory to demonstrate that established methods and procedures perform as expected in the laboratory.

Vendor laboratory is a governmental or private laboratory that provides DNA-analysis services to another laboratory or agency and does not take ownership of the DNA data for purposes of entry into CODIS.

Work product is the material that is generated as a function of analysis, which may include extracts, amplified product, and amplification tubes or plates as defined by the laboratory.

3. Quality Assurance Program

Standard 3.1. The laboratory shall establish, follow, and maintain a documented quality system that is appropriate to the testing activities and is equivalent to or more stringent than what is required by these Standards.

3.1.1. The quality system shall be documented in a manual that includes or references the following elements:

3.1.1.1. Goals and objectives

3.1.1.2. Organization and management

3.1.1.3. Personnel

3.1.1.4. Facilities

3.1.1.5. Evidence control

3.1.1.6. Validation

3.1.1.7. Analytical procedures

3.1.1.8. Equipment calibration and maintenance

3.1.1.9. Reports

3.1.1.10. Review

3.1.1.11. Proficiency testing

3.1.1.12. Corrective action

3.1.1.13. Audits

3.1.1.14. Safety

3.1.1.15. Outsourcing

Standard 3.2. The laboratory shall maintain and follow a procedure regarding document retention that specifically addresses proficiency tests, corrective action, audits, training records, continuing education, case files, and court testimony monitoring.

Standard 3.3. The quality system as applicable to DNA shall be reviewed annually, independent of the audit required by Standard 15. The review of the quality system shall be completed under the direction of the technical leader, and the approval by the technical leader shall be documented.

4. Organization and Management

Standard 4.1. The laboratory shall:

- 4.1.1.** Have a managerial staff with the authority and resources needed to discharge their duties and meet the requirements of the Standards in this document.
- 4.1.2.** Have a technical leader who is accountable for the technical operations. Multilaboratory systems shall have at least one technical leader.
- 4.1.3.** Have a casework CODIS administrator who is accountable for CODIS on-site at each individual laboratory facility utilizing CODIS.
- 4.1.4.** Have at least two full-time employees who are qualified DNA analysts.
- 4.1.5.** Specify and document the responsibility, authority, and interrelation of all personnel who manage, perform, or verify work affecting the validity of the DNA analysis.
- 4.1.6.** Have a documented contingency plan that is approved by laboratory management if the technical leader position is vacated.

5. Personnel

Standard 5.1. Laboratory personnel shall have the education, training, and experience commensurate with the examination and testimony provided. The laboratory shall:

- 5.1.1.** Have a written job description for personnel that may be augmented by additional documentation that defines responsibilities, duties, and skills.
- 5.1.2.** Have a documented training program for qualifying all analyst/technician(s).
 - 5.1.2.1.** The laboratory's training program shall include a training manual covering all DNA analytical procedures that the analyst/technician will perform. Practical exercises shall include the examination of a range of samples routinely encountered in casework.
 - 5.1.2.2.** The training program shall teach and assess the technical skills and knowledge required to perform DNA analysis.
 - 5.1.2.2.1.** The training program shall require an individual's demonstration of competency. The laboratory shall maintain documentation of the successful completion of such competency test(s).
 - 5.1.2.2.2.** When hiring experienced analyst/technician(s), the technical leader shall be responsible for assessing their previous training and ensuring it is adequate and documented. Modification to the training program may be appropriate and shall be documented by the technical leader.
 - 5.1.2.2.3.** All analyst/technician(s), regardless of previous experience, shall successfully complete a competency test(s) covering the routine DNA methodologies to be used prior to participating in independent casework analysis.
- 5.1.3.** Have a documented program to ensure technical qualifications are maintained through participation in continuing education.
 - 5.1.3.1.** Continuing education: The technical leader, casework CODIS administrator, and analyst(s) shall stay abreast of developments within the field of DNA typing by attending seminars, courses, professional meetings, or documented training sessions/classes in relevant subject areas at least once each calendar year. A minimum of eight cumulative hours of continuing education are required annually and shall be documented.
 - 5.1.3.1.1.** If continuing education is conducted internally, the title of the program, a record of the presentation, date of the training, attendance list, and the curriculum vitae of the presenter(s) shall be

documented and retained by the laboratory.

5.1.3.1.2. If the continuing education is conducted externally, the laboratory shall maintain documentation of attendance through mechanisms such as certificates, program agenda/syllabus, or travel documentation. Attendance at a regional, national, or international conference shall be deemed to provide a minimum of eight hours of continuing education.

5.1.3.1.3. Programs based on multimedia or Internet delivery shall be subject to the approval of the technical leader. Participation in such programs shall be formally recorded, and its completion shall be submitted to the technical leader for review and approval. The documentation shall include the time required to complete the program.

5.1.3.2. The laboratory shall have a program approved by the technical leader for the annual review of scientific literature that documents the analysts' ongoing reading of scientific literature. The laboratory shall maintain or have physical or electronic access to a collection of current books, reviewed journals, or other literature applicable to DNA analysis.

5.1.4. Maintain records on the relevant qualifications, training, skills, and experience of the technical personnel.

Standard 5.2. The technical leader shall meet the following qualifications:

5.2.1. Minimum educational requirements: The technical leader of a laboratory shall have, at a minimum, a master's degree in a biology-, chemistry-, or forensic science-related area and successfully completed 12 semester or equivalent credit hours from a combination of undergraduate and graduate coursework covering the following subject areas: biochemistry, genetics, molecular biology, and statistics or population genetics.

5.2.1.1. The 12 semester or equivalent credit hours shall include at least one graduate-level course registering 3 or more semester or equivalent credit hours.

5.2.1.2. The specific subject areas listed in 5.2.1 shall constitute an integral component of any coursework used to demonstrate compliance with this Standard.

5.2.1.3. Individuals who have completed coursework with titles other than those listed in 5.2.1 shall demonstrate compliance with this Standard through a combination of pertinent materials such as a transcript, syllabus, letter from the instructor, or other document that supports the course content.

5.2.1.4. If the degree requirements of section 5.2.1 were waived by the American Society of Crime Laboratory Directors (ASCLD) in accordance with criteria approved by the Director of the Federal Bureau of Investigation (FBI), such a documented waiver shall be permanent and portable.

5.2.2. Minimum experience requirements: A technical leader of a laboratory shall have three years of forensic DNA laboratory experience obtained at a laboratory where forensic DNA testing was conducted for the identification and evaluation of biological evidence in criminal matters. As of the effective date of this revision, any newly appointed technical leader shall have a minimum of three years of human DNA experience (current or previous) as a qualified analyst on forensic samples. The technical leader shall have previously completed or successfully complete the FBI-sponsored auditor training within one year of appointment.

5.2.3. The technical leader shall be responsible for the following:

5.2.3.1. General duties and authority:

5.2.3.1.1. Oversee the technical operations of the laboratory.

5.2.3.1.2. Authority to initiate, suspend, and resume DNA analytical operations for the laboratory or an

individual.

5.2.3.2. The minimum specific responsibilities to be performed by the technical leader include the following:

5.2.3.2.1. To evaluate and document approval of all validations and methods used by the laboratory and propose new or modified analytical procedures to be used by analysts.

5.2.3.2.2. To review the academic transcripts and training records for newly qualified analysts and approve their qualifications prior to independent casework analysis and document such review.

5.2.3.2.3. To approve the technical specifications for outsourcing agreements.

5.2.3.2.4. To review internal and external DNA audit documents and, if applicable, approve corrective action(s) and document such review.

5.2.3.2.5. To review, on an annual basis, the procedures of the laboratory and document such review.

5.2.3.2.6. To review and approve the training, quality assurance, and proficiency testing programs in the laboratory.

5.2.4. Accessibility: The technical leader shall be accessible to the laboratory to provide on-site, telephone, or electronic consultation as needed. A multilaboratory system may have one technical leader over a system of separate laboratory facilities. For multilaboratory systems the technical leader shall conduct a site visit to each laboratory at least semiannually.

5.2.4.1. The technical leader shall be a full-time employee of the laboratory or multilaboratory system.

5.2.4.1.1. In the event that the technical leader position of a laboratory is vacated and there is no individual in the laboratory or multilaboratory system who meets the requirements of this Standard and will serve as a technical leader, the laboratory shall immediately contact the FBI and submit a contingency plan within 14 days to the FBI for its approval. Work in progress by the laboratory may be completed during this 14-day period, but new casework shall not be started until the plan is approved by the FBI.

5.2.5. Newly appointed technical leaders shall be responsible for the documented review of the following:

5.2.5.1. Validation studies and methodologies currently used by the laboratory; and

5.2.5.2. Educational qualifications and training records of currently qualified analysts.

Standard 5.3. The casework CODIS administrator shall be an employee of the laboratory and meet the following qualifications:

5.3.1. Minimum educational requirements: The casework CODIS administrator shall meet the educational requirements for an analyst as defined in Standard 5.4. A casework CODIS administrator appointed prior to the effective date of this revision shall be deemed to have satisfied the minimum educational requirements; satisfaction of these minimum educational requirements shall be applicable to the specific laboratory the casework CODIS administrator is employed by prior to the effective date of this revision and shall not be portable.

5.3.2. Minimum experience requirements: A casework CODIS administrator shall be or have been a current or previously qualified DNA analyst as defined in Standard 5.4, with documented mixture-interpretation training. A casework CODIS administrator appointed prior to the effective date of this revision who is not or has never been a qualified analyst (with documented training in mixture interpretation) shall be deemed to have satisfied the minimum experience requirements upon

completion of FBI-sponsored CODIS training; satisfaction of these minimum requirements shall be applicable to the specific laboratory the casework CODIS administrator is employed by prior to the effective date of this revision and shall not be portable.

5.3.3. Minimum CODIS training requirements: The casework CODIS administrator shall participate in FBI-sponsored training in CODIS software within six months of assuming CODIS casework administrator duties if the administrator had not previously attended such training. The casework CODIS administrator shall successfully complete the FBI-sponsored auditor training within one year of assuming their administrator duties if the administrator had not previously attended such training.

5.3.4. The casework CODIS administrator shall be responsible for the following:

5.3.4.1. Administering the laboratory's local CODIS network.

5.3.4.2. Scheduling and documenting the CODIS computer training of casework analysts.

5.3.4.3. Ensuring that the security of data stored in CODIS is in accordance with state and/or federal law and NDIS operational procedures.

5.3.4.4. Ensuring that the quality of data stored in CODIS is in accordance with state and/or federal law and NDIS operational procedures.

5.3.4.5. Ensuring that matches are dispositioned in accordance with NDIS operational procedures.

5.3.5. The casework CODIS administrator shall be authorized to terminate an analyst's or laboratory's participation in CODIS until the reliability and security of the computer data can be ensured in the event an issue with the data is identified.

5.3.6. A laboratory shall not upload DNA profiles to NDIS in the event that the casework CODIS administrator position is unoccupied.

Standard 5.4. The analyst shall be an employee of the laboratory and meet the following qualifications:

5.4.1. Minimum educational requirements: The analyst shall have a bachelor's (or its equivalent) or an advanced degree in a biology-, chemistry-, or forensic science-related area and shall have successfully completed coursework (graduate- or undergraduate-level) covering the following subject areas: biochemistry, genetics, molecular biology, and coursework and/or training in statistics and/or population genetics as it applies to forensic DNA analysis.

5.4.1.1. The specific subject areas listed in Standard 5.4.1 shall be an integral component of any coursework for compliance with this Standard.

5.4.1.2. Analysts appointed or hired after the effective date of these revisions shall have a minimum of nine cumulative semester hours or equivalent that covers the required subject areas.

5.4.1.3. Analysts who have completed coursework with titles other than those listed in 5.4.1 above shall demonstrate compliance with this Standard through a combination of pertinent materials, such as a transcript, syllabus, letter from the instructor, or other document that supports the course content. The technical leader shall document approval of compliance with this Standard.

5.4.2. Minimum experience requirements: The analyst shall have six (6) months of forensic human DNA laboratory experience. If prior forensic human DNA laboratory experience is accepted by a laboratory, the prior experience shall be documented and augmented by additional training, as needed, in the analytical methodologies, platforms, and interpretations of human DNA results used by the laboratory.

5.4.2.1. The analyst shall complete the analysis of a range of samples routinely encountered in forensic casework prior to independent work using DNA technology.

5.4.2.2. The analyst shall successfully complete a competency test before beginning independent DNA analysis.

Standard 5.5. The technician shall meet the following qualifications:

5.5.1. Documented training specific to their job function(s).

5.5.2. Successful completion of a competency test before participating in DNA analysis on evidence.

Standard 5.6. Laboratory technical-support personnel shall have documented training specific to their job function(s).

6. Facilities

Standard 6.1. The laboratory shall have a facility that is designed to ensure the integrity of the analyses and the evidence.

6.1.1. Access to the laboratory shall be controlled and limited in a manner to prevent access by unauthorized personnel. All exterior entrance/exit points require security control. The distribution of all keys, combinations, etc., shall be documented and limited to the personnel designated by laboratory management.

6.1.2. Except as provided in 6.1.4, techniques performed prior to PCR amplification, such as evidence examinations, DNA extractions, and PCR setup, shall be conducted at separate times or in separate spaces from each other. Standard 6.1.4 is applicable if robotic workstations are used by the laboratory.

6.1.3. Except as provided in 6.1.4, amplified DNA product, including real-time PCR, shall be generated, processed, and maintained in a room(s) separate from the evidence-examination, DNA-extraction, and PCR-setup areas. The doors between rooms containing amplified DNA and other areas shall remain closed.

6.1.4. A robotic workstation may be used to carry out DNA extraction, quantitation, PCR setup, and/or amplification in a single room, provided that the analytical process has been validated in accordance with Standard 8. If the robot performs analysis through amplification, the robot shall be housed in a separate room from that used for initial evidence examinations.

6.1.5. The laboratory shall have and follow written procedures for cleaning and decontaminating facilities and equipment.

7. Evidence Control

Standard 7.1. The laboratory shall have and follow a documented evidence-control system to ensure the integrity of physical evidence.

7.1.1. Evidence shall be marked with a unique identifier on the evidence package. The laboratory shall clearly define what constitutes evidence and what constitutes work product. The laboratory shall have and follow a method to distinguish each sample throughout processing (such as plate or rack mapping) that may not require the assignment of unique identifiers or individual evidence seals for each specimen.

7.1.2. Chain of custody for all evidence shall be documented and maintained in hard or electronic format. The chain of custody shall include the signature, initials, or electronic equivalent of each

individual receiving or transferring the evidence, the corresponding date for each transfer, and the evidentiary item(s) transferred.

7.1.3. The laboratory shall have and follow documented procedures designed to minimize loss, contamination, and/or deleterious change of evidence and work product in progress.

7.1.4. The laboratory shall have secure, controlled access areas for evidence storage and work product in progress.

Standard 7.2. Where possible, the laboratory shall retain or return a portion of the evidence sample or extract.

Standard 7.3. The laboratory shall have and follow a documented policy for the disposition of evidence that includes a policy on sample consumption.

8. Validation

Standard 8.1. The laboratory shall use validated methodologies for DNA analyses. There are two types of validations: developmental and internal.

Standard 8.2. Developmental validation shall precede the use of a novel methodology for forensic DNA analysis.

8.2.1. Developmental validation studies shall include, where applicable, characterization of the genetic marker, species specificity, sensitivity studies, stability studies, reproducibility, case-type samples, population studies, mixture studies, precision and accuracy studies, and PCR-based studies. PCR-based studies include reaction conditions, assessment of differential and preferential amplification, effects of multiplexing, assessment of appropriate controls, and product-detection studies. All validation studies shall be documented.

8.2.2. Peer-reviewed publication of the underlying scientific principle(s) of a technology shall be required.

Standard 8.3. Except as provided in Standard 8.3.1.1, internal validation of all manual and robotic methods shall be conducted by each laboratory and reviewed and approved by the laboratory's technical leader prior to using a procedure for forensic applications.

8.3.1. Internal validation studies conducted after the date of this revision shall include as applicable: known and nonprobative evidence samples or mock evidence samples, reproducibility and precision, sensitivity and stochastic studies, mixture studies, and contamination assessment. Internal validation studies shall be documented and summarized. The technical leader shall approve the internal validation studies.

8.3.1.1. Internal validation data may be shared by all locations in a multilaboratory system. Each laboratory in a multilaboratory system shall complete, document, and maintain applicable precision, sensitivity, and contamination assessment studies. The summary of the validation data shall be available at each site.

8.3.2. Internal validation shall define quality assurance parameters and interpretation guidelines, including, as applicable, guidelines for mixture interpretation.

8.3.3. A complete change of detection platform or test kit (or laboratory-assembled equivalent) shall require internal validation studies.

Standard 8.4. Before the introduction of a methodology into the laboratory, the analyst or examination team shall successfully complete a competency test to the extent of his/her/their participation in casework analyses.

Standard 8.5. The performance of a modified procedure shall be evaluated by comparison with the original procedure using similar DNA samples.

Standard 8.6. Each additional critical instrument shall require a performance check. Modifications to an instrument, such as a detection platform, that do not affect the analytical portion of the instrument shall require a performance check.

Standard 8.7. Modifications to software, such as an upgrade, shall require a performance check prior to implementation. New software or significant software changes that may impact interpretation or the analytical process shall require a validation prior to implementation.

9. Analytical Procedures

Standard 9.1. The laboratory shall have and follow written analytical procedures approved by the technical leader. The standard operating procedures are to be reviewed annually by the technical leader, independent of the audit required by Standard 15, and this review shall be documented.

9.1.1. The laboratory shall have and follow a standard operating procedure for each analytical method used by the laboratory. The procedures shall specify reagents, sample preparation, extraction methods (to include differential extraction of nuclear DNA samples with adequate amount of sperm), equipment, and controls which are standard for DNA analysis and data interpretation.

Standard 9.2. The laboratory shall use reagents that are suitable for the methods employed.

9.2.1. The laboratory shall have written procedures for documenting commercial reagents and for the formulation of in-house reagents.

9.2.2. Commercial reagents shall be labeled with the identity of the reagent and the expiration date as provided by the manufacturer or as determined by the laboratory.

9.2.3. In-house reagents shall be labeled with the identity of the reagent, the date of preparation and/or expiration, and the identity of the individual preparing the reagent.

Standard 9.3. The laboratory shall identify critical reagents and evaluate them prior to use in casework. These critical reagents shall include, but are not limited to, the following:

9.3.1. Test kits or systems for performing quantitative PCR and genetic typing.

9.3.2. Thermostable DNA polymerase, primer sets, and allelic ladders used for genetic analysis that are not tested as test-kit components under Standard 9.3.1.

Standard 9.4. The laboratory shall quantify the amount of human DNA in forensic samples prior to nuclear DNA amplification. Quantitation of human DNA is not required for casework reference samples if the laboratory has a validated system that has been demonstrated to reproducibly and reliably yield successful DNA amplification and typing without prior quantitation.

Standard 9.5. The laboratory shall monitor the analytical procedures using the following controls and standards:

9.5.1. Where quantitation is used, quantitation standards shall be used.

9.5.2. Positive and negative amplification controls associated with samples being typed shall be amplified concurrently with the samples at all loci and with the same primers as the forensic samples. All samples typed shall also have the corresponding amplification controls typed.

9.5.3. Reagent blank controls associated with each extraction set being analyzed shall be:

9.5.3.1. Extracted concurrently;

9.5.3.2. Amplified utilizing the same primers, instrument model, and concentration conditions as required by the sample(s) containing the least amount of DNA; and

9.5.3.3. Typed utilizing the same instrument model, injection conditions, and most sensitive volume conditions of the extraction set.

9.5.4. Allelic ladders and internal size markers for variable number tandem repeat sequence PCR-based systems.

9.5.5. The laboratory shall check its DNA procedures annually or whenever substantial changes are made to a procedure against an appropriate and available NIST standard reference material or standard traceable to a NIST standard.

Standard 9.6. The laboratory shall have and follow written guidelines for the interpretation of data.

9.6.1. The laboratory shall verify that all control results meet the laboratory's interpretation guidelines for all reported results.

9.6.2. For a given population(s), the statistical interpretation of autosomal loci shall be made following the recommendations 4.1, 4.2, or 4.3 as deemed applicable of the National Research Council report titled *The Evaluation of Forensic DNA Evidence* (1996) and/or a court-directed method. These calculations shall be derived from a documented population database appropriate for the calculation.

9.6.3. A laboratory performing genetic analyses not addressed by Standard 9.6.2, such as Y-chromosome or mtDNA typing, shall have and follow documented statistical interpretation guidelines specific for such testing.

9.6.4. Laboratories analyzing forensic samples shall have and follow a documented procedure for mixture interpretation that addresses major and minor contributors, inclusions and exclusions, and policies for the reporting of results and statistics.

Standard 9.7. The laboratory shall have and follow a documented policy for the detection and control of contamination.

10. Equipment Calibration and Maintenance

Standard 10.1. The laboratory shall use equipment suitable for the methods employed.

Standard 10.2. The laboratory shall have and follow a documented program for conducting performance checks and calibrating instruments and equipment.

10.2.1. At a minimum, the following critical instruments or equipment shall require annual performance checks:

10.2.1.1. Thermometer traceable to national or international standard(s) that is used for conducting performance checks

10.2.1.2. Balance/scale.

10.2.1.3. Thermal cycler temperature verification system.

10.2.1.4. Thermal cycler including quantitative-PCR.

10.2.1.5. Electrophoresis detection systems.

10.2.1.6. Robotic systems.

10.2.1.7. Genetic analyzers.

10.2.1.8. Mechanical pipettes.

Standard 10.3. The laboratory shall have a schedule and follow a documented program to ensure that instruments and equipment are properly maintained. The laboratory shall retain documentation of maintenance, service, or calibration.

Standard 10.4. New critical instruments and equipment, or critical instruments and equipment that have undergone repair, service, or calibration, shall undergo a performance check before use in casework analysis.

10.4.1. At a minimum, the following critical equipment shall undergo a performance check following repair, service, or calibration:

10.4.1.1. Electrophoresis detection systems.

10.4.1.2. Robotic systems.

10.4.1.3. Genetic analyzers.

10.4.1.4. Thermal cycler including quantitative-PCR.

11. Reports

Standard 11.1. The laboratory shall have and follow written procedures for taking and maintaining casework notes to support the conclusions drawn in laboratory reports. The laboratory shall maintain all analytical documentation generated by analysts related to case analyses. The laboratory shall retain, in hard or electronic format, sufficient documentation for each technical analysis to support the report conclusions such that another qualified individual could evaluate and interpret the data.

Standard 11.2. Casework reports shall include the following elements:

11.2.1. Case identifier;

11.2.2. Description of evidence examined;

11.2.3. A description of the technology;

11.2.4. Locus or amplification system;

11.2.5. Results and/or conclusions;

11.2.6. A quantitative or qualitative interpretative statement;

11.2.7. Date issued;

11.2.8. Disposition of evidence; and

11.2.9. A signature and title, or equivalent identification, of the person accepting responsibility for the content of the report.

Standard 11.3. Except as otherwise provided by state or federal law, reports, case files, DNA records, and databases shall be confidential.

11.3.1. The laboratory shall have and follow written procedures to ensure the privacy of the reports, case files, DNA records, and databases.

11.3.2. The laboratory shall have and follow written procedures for the release of reports, case files, DNA records, and databases in accordance with applicable state or federal law.

11.3.3. Personally identifiable information shall only be released in accordance with applicable state and federal law.

12. Review

Standard 12.1. The laboratory shall conduct and document administrative and technical reviews of all case files and reports to ensure conclusions and supporting data are reasonable and within the constraints of scientific knowledge. The review of data generated external to the laboratory is governed by Standard 17.

12.1.1. An individual conducting technical reviews shall be or have been an analyst qualified in the methodology being reviewed.

Standard 12.2. Completion of the technical review shall be documented, and the technical review of forensic casework shall include the following elements:

12.2.1. A review of all case notes, all worksheets, and the electronic data (or printed electropherograms or images) supporting the conclusions.

12.2.2. A review of all DNA types to verify that they are supported by the raw or analyzed data (electropherograms or images).

12.2.3. A review of all profiles to verify correct inclusions and exclusions (if applicable) as well as a review of any inconclusive result for compliance with laboratory guidelines.

12.2.4. A review of all controls, internal lane standards, and allelic ladders to verify that the expected results were obtained.

12.2.5. A review of statistical analysis, if applicable.

12.2.6. A review of the final report's content to verify that the results/conclusions are supported by the data. The report shall address each tested item or its probative fraction.

12.2.7. Verification that all profiles entered into CODIS are eligible and have the correct DNA types and correct specimen category.

12.2.7.1. Prior to upload to or search of SDIS, verification of the following criteria for DNA profiles: eligibility for CODIS, correct DNA types, and appropriate specimen category.

12.2.7.2. For entry into a searchable category at SDIS, verification of the following criteria for DNA profiles by two concordant assessments by a qualified analyst or technical reviewer: eligibility for CODIS, correct DNA types, and appropriate specimen category.

Standard 12.3. The administrative review shall include the following elements, any or all of which may be included within the technical review:

12.3.1. A review of the case file and final report for clerical errors and that information specified in Standard 11.2 is present and accurate.

12.3.2. A review of chain of custody and disposition of evidence.

12.3.3. A procedure to document the completion of the administrative review.

Standard 12.4. The laboratory shall document the elements of a technical and administrative review. Case files shall be reviewed and documented according to the laboratory's procedure.

Standard 12.5. The laboratory shall have and follow a documented procedure to address unresolved discrepant conclusions between analysts and reviewer(s).

Standard 12.6. The laboratory shall have and follow a documented procedure for the verification and resolution of database matches.

Standard 12.7. The laboratory shall have and follow a program that documents the annual monitoring of the testimony of each analyst.

13. Proficiency Testing

Standard 13.1. Analysts, technical reviewers, technicians, and other personnel designated by the technical leader shall undergo semiannual external proficiency testing in each technology performed to the full extent in which they participate in casework. Semiannual is used to describe an event that takes place two times during one calendar year, with the first event taking place in the first six months of that year and the second event taking place in the second six months of that year, and where the interval between the two events is at least four months and not more than eight months. Such external proficiency testing shall be an open proficiency testing program and shall be submitted to the proficiency testing provider in order to be included in the provider's published external summary report.

13.1.1. Individuals routinely utilizing both manual and automated methods shall be proficiency tested in each at least once per year to the full extent in which they participate in casework.

13.1.2. Newly qualified individuals shall enter the external proficiency testing program within six months of the date of their qualification.

13.1.3. For purposes of tracking compliance with the semiannual proficiency testing requirement, the laboratory shall define, document, and consistently use the date that the proficiency test is performed as the received date, assigned date, submitted date, or the due date.

13.1.4. Except as provided in Standard 13.1.4.1, each analyst shall be assigned and complete his or her own external proficiency test.

13.1.4.1. Laboratories that use a team approach to casework examination may do so on external proficiency tests. However, all analysts, technicians, and technical reviewers shall be proficiency tested at least once per year in each of the DNA technologies, including test kits for DNA typing and each platform in which they perform forensic DNA analysis.

13.1.5. Typing of all CODIS core loci or CODIS core sequence ranges shall be attempted for each technology performed.

13.1.6. The laboratory shall maintain the following records for proficiency tests:

13.1.6.1. The test-set identifier;

13.1.6.2. Identity of the analyst and other participants;

13.1.6.3. Date of analysis and completion;

13.1.6.4. Copies of all data and notes supporting the conclusions;

13.1.6.5. The proficiency test results;

13.1.6.6. Any discrepancies noted; and

13.1.6.7. Corrective actions taken.

13.1.7. The laboratory shall include, at a minimum, the following criteria for evaluating proficiency test results:

13.1.7.1. Inclusions and exclusions as well as all reported genotypes and/or phenotypes are correct or incorrect according to consensus results or are within the laboratory's interpretation guidelines.

13.1.7.2. All results reported as inconclusive or not interpretable are consistent with written laboratory guidelines.

13.1.7.2.1. The technical leader shall review any inconclusive result for compliance with laboratory guidelines.

13.1.7.3. All discrepancies/errors and subsequent corrective actions shall be documented.

13.1.7.4. All final reports are graded as satisfactory or unsatisfactory.

13.1.7.4.1. A satisfactory grade is attained when there are no analytical errors for the DNA profile-typing data.

13.1.7.4.1.1. Administrative errors and corrective actions, as applicable, shall be documented.

13.1.8. All proficiency test participants shall be informed of his or her final test results, and this notification shall be documented.

13.1.9. The technical leader shall be informed of the results of all participants, and this notification shall be documented. The technical leader shall inform the casework CODIS administrator of all nonadministrative discrepancies that affect the typing results and/or conclusions at the time of discovery.

Standard 13.2. The laboratory shall use an external proficiency test provider that is in compliance with the current proficiency testing manufacturing guidelines established by the American Society of Crime Laboratory Directors/Laboratory Accreditation Board or be in compliance with the current International Organization for Standardization.

14. Corrective Action

Standard 14.1. The laboratory shall establish and follow a corrective action plan to address when discrepancies are detected in proficiency tests and casework analysis. A laboratory corrective action plan shall define what level/type of discrepancies are applicable to this practice and identify (when possible) the cause, effect of the discrepancy, corrective actions taken, and preventative measures taken (where applicable) to minimize its recurrence. Documentation of all corrective actions shall be maintained in accordance with Standard 3.2.

Standard 14.2. Corrective actions shall not be implemented without the documented approval of the technical leader.

15. Audits

Standard 15.1. The laboratory shall be audited annually in accordance with these standards. The annual audits shall occur every calendar year and shall be at least 6 months and no more than 18 months apart.

Standard 15.2. At least once every two years, an external audit shall be conducted by an audit team comprised of qualified auditors from a second agency(ies) having at least one team member who is or has been previously qualified in the laboratory's current DNA technologies and platform.

15.2.1. Each analyst, casework CODIS administrator, and technical leader shall have his or her education, experience, and training qualifications evaluated and approved during two successive, separate external audits conducted after July 1, 2004. Approval of an individual's education, experience, and training qualifications shall be documented in the audit document.

15.2.2. Each validation study shall be evaluated and approved during one external audit. Approved validation studies shall be documented in the audit document.

Standard 15.3. For internal audits, the auditor or audit team shall have the following expertise: currently qualified auditor and currently or previously qualified as an analyst in the laboratory's current DNA technologies and platform.

Standard 15.4. Internal and external audits shall be conducted utilizing the FBI DNA Quality Assurance Standards Audit Document.

Standard 15.5. Internal and external DNA audit documents and, if applicable, corrective action(s) shall be submitted to the technical leader for review to ensure that findings, if any, were appropriately addressed.

15.5.1. For NDIS participating laboratories, all external audit documentation and laboratory responses shall be provided to the FBI within 30 days of laboratory receipt of the audit documents or report.

Standard 15.6. Internal and external audit documentation shall be retained and available for inspection during subsequent audits.

16. Safety

Standard 16.1. The laboratory shall have and follow a documented environmental health and safety program. This program shall include the following:

16.1.1. A bloodborne pathogen and chemical hygiene plan.

16.1.2. Documented training on the bloodborne pathogen and chemical hygiene plan.

Standard 16.2. The laboratory's environmental health and safety program shall be reviewed once each calendar year, and such review shall be documented.

17. Outsourcing

Standard 17.1. A vendor laboratory performing forensic DNA analysis shall comply with these Standards and the accreditation requirements of federal law.

17.1.1. An NDIS participating laboratory that outsources DNA sample(s) to a vendor laboratory to generate DNA data that will be entered into CODIS shall require the vendor laboratory to provide documentation of compliance with these Standards and the accreditation requirements of federal law. The NDIS participating laboratory shall maintain such documentation.

Standard 17.2. Except as provided in Standard 17.2.1, an NDIS participating laboratory's technical leader shall document approval of the technical specifications of the outsourcing agreement with a vendor laboratory before it is awarded. Such documentation shall be maintained by the NDIS participating laboratory.

17.2.1. A vendor laboratory that is performing forensic DNA analysis for a law enforcement agency or other entity and generating DNA data that may be entered into or searched in CODIS shall not initiate analysis for a specific case or set of cases until documented approval has been obtained from the appropriate NDIS participating laboratory's technical leader of acceptance of ownership of the DNA data.

Standard 17.3. An NDIS participating laboratory shall not upload or accept DNA data for upload to or search in CODIS from any vendor laboratory or agency without the documented prior approval of the technical specifications of the outsourcing agreement and/or documented approval of acceptance of ownership of the DNA data by the NDIS participating laboratory's technical leader.

Standard 17.4. An NDIS participating laboratory shall have and follow a procedure to verify the integrity of the DNA data received through the performance of the technical review of DNA data from a vendor laboratory.

Standard 17.5. Prior to the upload or search of DNA data to SDIS, the technical review of a vendor laboratory's DNA data shall be performed by an analyst or technical reviewer employed by the NDIS participating laboratory who is qualified or previously qualified in the technology, platform, and typing amplification test kit used to generate the data and participates in the laboratory's proficiency testing program.

17.5.1. The technical review shall include the following elements:

17.5.1.1. A review of all DNA types to verify that they are supported by the raw and/or analyzed data (electropherograms or images).

17.5.1.2. A review of all associated controls, internal lane standards, and allelic ladders to verify that the expected results were obtained.

17.5.1.3. A review of the final report (if provided) to verify that the results/conclusions are supported by the data. The report shall address each tested item (or its probative fractions) submitted to the vendor laboratory.

17.5.1.4. Verification of the DNA types, eligibility, and the correct specimen category for entry into CODIS.

Standard 17.6. An NDIS participating laboratory or multilaboratory system outsourcing DNA sample (s) to a vendor laboratory or accepting ownership of DNA data from a vendor laboratory shall have and follow a procedure to perform an on-site visit(s) of the vendor laboratory. This procedure shall include, at a minimum, the following elements:

17.6.1. A documented initial on-site visit prior to the vendor laboratory's beginning of casework analysis for the laboratory.

17.6.1.1. The on-site visit shall be performed by the technical leader or a designated employee of the NDIS participating laboratory who is a qualified or previously qualified DNA analyst in the technology, platform, and typing amplification test kit used to generate the DNA data.

17.6.2. If the outsourcing agreement extends beyond one year, an annual on-site visit shall be required. Each annual on-site visit shall occur every calendar year and shall be at least 6 months and no more than 18 months apart.

17.6.2.1. An NDIS participating laboratory may accept an on-site visit conducted by another NDIS participating laboratory using the same technology, platform, and typing amplification test kit for the generation of the DNA data and shall document the review and approval of such on-site visit.