Partnership for Food Protection
Laboratory Science Workgroup

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Human and Animal Food Testing Laboratories Best Practices Manual

https://www.pfp-ifss.org/

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Introduction

Background on PFP and the Laboratory Workgroup

Led by the FDA, the Partnership for Food Protection (PFP) is a multi-agency organization dedicated to establishing a strong and effective Integrated Food Safety System (IFSS) in the United States. It is one of myriad activities aimed at protecting and ensuring the safety of the nation's food supply, having been created in 2008 upon the recommendations of four workgroups of the FDA-chaired Food and Drug Administration 50-State Meeting. Titled "Gateway to Food Protection," the recommendations galvanized efforts to establish an IFSS. Following this 50-state meeting, the PFP initiative focused on guiding the implementation of the necessary infrastructure and food safety strategies essential to building an integrated human and animal food safety system. The work of the PFP is allocated across several workgroups, comprised of strategic partners in federal, state, and local government charged with advancing the PFP in a coordinated and efficient manner.

Human and Animal Food Testing Laboratories

The Laboratory Science Workgroup was charged with documenting best practices for human and animal food laboratories to build confidence among stakeholders in the integrity and scientific validity of laboratory analytical data and to facilitate the acceptance of laboratory analytical data by regulatory agencies. The PFP Laboratory Science Workgroup is comprised of seven subcommittees: Accreditation, Regulatory Elements, Proficiency Testing (PT), Sampling, Methods, Analytical Worksheet Packages, and Reporting. These subcommittees are led by the FDA and state laboratory professionals and are comprised of members from multiple federal, state, and local agencies listed in Appendix 1.

Purpose of Manual

The Human and Animal Food Testing Laboratories Best Practices Manual is a consensus document, and the FDA Office of Regulatory Affairs (ORA) and FDA have adopted the earlier revision (2013) as a crucial operational resource. The manual's degree of acceptance and integration in ORA laboratory work supports its intended purpose to promote mutual acceptance and assurance of quality laboratory data shared among federal, state, local, territorial, and tribal human and animal food regulatory agencies. The significance of this is reflected in the fact that an essential component of an IFSS is the exchange of data among all agencies charged with oversight of human and animal food safety. Specifically, effective inter-agency data sharing promotes the use of all available resources, reduces redundancy, and allows agencies to respond quickly to emergencies.

First published as the *DRAFT PFP Laboratory Best Practices Manual* in 2013, this second edition contains significant additional detail and resources. It is a consensus document prepared by the PFP Laboratory Sciences Workgroup, whose members are human and animal food laboratory professionals from several sectors of federal and state agencies. Each of the seven chapters (Laboratory

Accreditation, Regulatory Elements, Proficiency Testing, Sampling, Methods, Analytical Worksheets, and Reporting*)* was developed by a separate subgroup, dedicated to identifying the most critical elements necessary to promote effective data/information sharing in a regulatory environment. This manual represents carefully crafted best practices based on many years of professionals' combined experiences in human and animal food testing in a regulatory environment.

While many laboratories have strong scientific programs and accreditation systems, it is critical that a regulatory laboratory produce data that meets high standards of validity and integrity for purposes of legal defensibility. Documenting the purpose for testing, sample origin and custody, sampling procedures, analytical methodologies, and staff competencies are especially important when data is used in legal actions.

Documenting the quality of both the sampling and the testing is essential to ensure defensibility of the data. For that reason, many agencies have been reluctant to accept and act on data other than their own. To facilitate a mutual reliance on the integrity of shared data, the PFP Laboratory Science Workgroup identified essential elements critical to the quality of regulatory data. The *Human and Animal Food Testing Laboratories Best Practices Manual* provides a set of tools, definitions, and references that laboratories can use to improve their operations. It is strongly recommended that laboratories wishing to exchange data with regulatory partners adopt these "Best Practices".

While these "Best Practices" are fundamental to all regulatory data sharing, each agency and/or food safety situation may entail different compliance and enforcement requirements based on statutes, regulations, legislative mandates, and internal policies. It is not possible to standardize and catalog all the detailed legal requirements and internal processes of the various federal, state, and other agencies. It is, however, hoped that these best practices are comprehensive and will help form the foundation for any additional specific agency requirements. It may not be possible to anticipate how an agency might require data to be presented, but it is hoped that this manual will provide agencies and their laboratories with a roadmap for collecting and providing the most critical information.

As governmental food safety partners increasingly embrace prevention-based approaches to food safety, including widespread surveillance efforts, the demand for laboratories that meet recognized best practices of analytical competency will rise dramatically. These best practices enable regulatory agencies to more expeditiously utilize laboratory data to identify, prevent, and remove unsafe food products from the marketplace. Considering the rapid globalization of the U.S. food market, and the growing pressure to ensure that imported food is safe for consumption, it has never been more important for these agencies to leverage the resources of the nation's food laboratories and join forces to take a prevention-based approach to food safety.

Chapter 1 – Pathway to Laboratory Accreditation

Background and Objectives

Accreditation can be defined as a rigorous assessment against a set of standards, conducted by an independent science-based organization, to ensure the overall capability and competency of a laboratory and its quality management system. A successful assessment results in formal recognition of the technical competence of a laboratory to perform specific analyses and the scientific integrity of such analyses. Given that accreditation can be an expensive and time-consuming endeavor, there is value added to a laboratory that successfully undergoes the accreditation process. The continued increase in the number of laboratories — federal, state, local, private, and foreign — undergoing this process is testament to that value.

By allowing the determination of the degree to which the nation's food testing laboratories generate high-quality, traceable, and defensible laboratory data submitted to regulatory food agencies, investment in laboratory accreditation provides added value relative to the mission of protecting public health.

One of the accreditation standards currently utilized by many human and animal food testing laboratories throughout the world is that of the International Organization for Standardization (ISO)/International Electrotechnical Commission (IEC). The ISO/IEC 17025:2017 standard, *General Requirements for the Competence of Testing and Calibration Laboratories* (http://webstore.ansi.org/default.aspx) is the latest version. There is an overall shift toward risk-based thinking that replaces many of the prescriptive requirements of the 2005 standard with performance-based requirements. The most substantive changes follow:

- The definition of a laboratory has been revised to include testing, calibration, and the sampling associated with subsequent calibration and testing.
- A new section has been added introducing the concept of risk-based thinking and describes the commonalities with the new version of ISO 9001:2015.
- The numbering of clauses of ISO/IEC 17025:2017 now conforms with other standards such as ISO 9001 (*Quality management systems – Requirements*), ISO 15189 (*Medical laboratories — Requirements for quality and competence*) and the rest of the ISO/IEC 17000 series. The ISO Committee on Conformity Assessment (CASCO) develops these international guidelines.
- A process-based approach emphasizes the risks and opportunities at each step of a workflow, from start to finish. The laboratory evaluates the process to determine if improvements are needed. Processes replace many of the procedures (i.e., detailed descriptions of tasks and steps) required in the 2005 version.

- There is greater emphasis on competence, impartiality, and consistency as a three-pronged approach to achieving and maintaining customer confidence in laboratory results.
- The 2017 version recognizes that many laboratories have adopted an electronic laboratory information management system (LIMS). Hard copies of manuals, records, and reports are slowly being phased out in favor of electronic versions. Consequently, laboratories are no longer required to maintain a master list of documents or a list of service providers.
- Laboratories are no longer required to have a Quality Manual, policy statement, or document control procedure, because these functions can be tracked electronically in many laboratories.
- The quality manager, top management, and deputy are no longer required in ISO 17025:2017. The laboratory determines how these duties are fulfilled.
- The terminology has been updated. Examples include changes to the International Vocabulary of Metrology (VIM) and alignment with ISO/IEC terminology, which has a set of common terms and definitions for all standards dedicated to conformity assessment.

The following sections describe the best practices for a laboratory to achieve ISO/IEC 17025 accreditation, compare existing quality standards or programs, and provide a guide to the types of changes or improvements a laboratory may need to implement on its path to accreditation. Each laboratory will need to evaluate which of the improvements are necessary and estimate what costs might be incurred.

Steps to Achieve ISO/IEC 17025 Accreditation

With the goal of helping laboratories achieve ISO/IEC 17025 accreditation, the Partnership for Food Protection gathered information from multiple state and federal laboratories regarding their experiences and distilled common actions that were vital to the process of achieving such accreditation. These actions are listed below in a suggested chronological order. The reader should bear in mind that each laboratory will be starting from a different baseline. Therefore, an individual laboratory may find it has already completed some of these actions, and the information provided will be of different value to each laboratory. (Note: Other specific requirements imposed or recommended by state or federal agencies, laws, regulations, professional associations, a laboratory's customers, or accrediting bodies are not addressed here. However, a laboratory should be able to use this information as part of its project management process to implement ISO/IEC 17025 and any other quality requirements.)

Steps toward accreditation:

- Educate management (including commissioners, directors, managers, supervisors, and human resources officials) as to the importance of accreditation and its benefits.
- Obtain management's commitment to the goal of achieving accreditation.
- Determine the laboratory sections or methods to be accredited. Determine whether the entire laboratory will operate under the quality management system (even if all areas are not accredited).
    - Determine and assign the team that will be leading the accreditation preparation effort and define roles/responsibilities. The laboratory may decide to hire a subject matter expert on ISO/IEC 17025 or quality management systems to assist with the process.
- Train all staff on the ISO/IEC 17025 standard and requirements. Some laboratories opt to train all staff to the same degree, while others tailor the depth of training to the employee's specific role in the organization. Training on how to perform internal audits should also be considered.
- Select an accreditation body. The accrediting body should be a full signatory to *The International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement* (ILAC MRA), which is a formal recognition of the technical competence of inspection bodies to perform specific types of inspection. Accreditation bodies often have additional policies or program-specific requirements to which a laboratory must comply.
    - Note: The selection of an accrediting body is an important process, because, ultimately, it is the accreditation body that determines whether the laboratory complies with the requirements of ISO/IEC 17025. We do not endorse and recommend any accreditation body. Accreditation bodies that are full members of ILAC can be found at the ILAC website http://ilac.org/signatory-search/.
- Conduct an initial gap analysis to the ISO/IEC 17025 standard. Identifying gaps will help in planning and focusing work to develop, implement, and maintain a quality management system.
- Take advantage of existing resources to obtain examples of documents, worksheets, and best practices to develop your own quality management system and develop associated documents, including standard operating procedures (SOPs).
- Conduct internal audits a few months after processes and SOPs have been implemented. Start this process even before all work is complete. Laboratories can choose to audit only those areas/processes that have been implemented.

- Conduct a management review after the internal audit to determine suitability and effectiveness of the quality management system.
- Apply for accreditation and schedule the initial assessment.

Applicable Quality Standards

Laboratories may already be certified or accredited to a quality standard other than ISO/IEC 17025 (see annotated list below). It is important to note that compliance with some of these quality standards is determined by peer assessment rather than by an accreditation body. A laboratory that already follows one or more of the standards below should perform a gap analysis to the requirements of ISO/IEC 17025. A detailed crosswalk between ISO/IEC 17025 and other quality standards can be found at APHL's website.

- American Association of Veterinary Laboratory Diagnosticians (AAVLD) Standard

  The current AAVLD's *Requirements for an Accredited Veterinary Medical Diagnostic Laboratory* includes 96% of the elements found in ISO/IEC 17025, and the AAVLD standard applies to accreditation of public veterinary diagnostic laboratories in the United States. However, there are some differences between the two standards, and also in the auditing process and accreditation process (see the white paper, titled *Management and Support to Facilitate Accreditation of Vet-LIRN Laboratories FDA-SOL-1130894*). One significant difference between the ISO/IEC 17025 and AAVLD is that AAVLD contains no requirements on estimating measurement uncertainty. The AAVLD standard includes sections addressing "Administrative Requirements," which specify the types of laboratories that are eligible for AAVLD accreditation, expertise of top management, and expectation of financial resources required for offering quality services. AAVLD has requirements for safety, biosafety, and biosecurity, which are not included in ISO/IEC 17025.

  AAVLD generally requires a laboratory to be audited every five years, whereas laboratories accredited to ISO/IEC 17025 are typically assessed every two years. In addition, the AAVLD Accreditation Committee is comprised of members who serve on a voluntary basis, and AAVLD auditors are active members of the veterinary diagnostic medicine profession who donate their time as assessors. On the other hand, private accreditation bodies are signatories to the ILAC MRA, and they contract with assessors to perform independent assessments of testing laboratories that seek compliance with the ISO/IEC 17025 standard.

  Currently, one of the ILAC MRA accreditation bodies can accredit to the AAVLD, but the cost may be a consideration for the laboratory. To comply with the ISO/IEC 17025 standard, a laboratory needs to elaborate on each general requirement of AAVLD and conform to any additional requirements of ISO/IEC 17025. More information on AAVLD accreditation can be found at www.aavld.org.

- The NELAC Institute (TNI) Laboratory Accreditation Standard

  The 2016 TNI standard is designed to assess competence of environmental laboratories and conforms to the requirements of ISO/IEC 17025. The TNI standards are integrated documents containing language from relevant ISO standards and language developed by TNI expert committees. Since the type of tests, materials, and proficiency testing programs that these laboratories utilize are not necessarily related to human and animal food testing, TNI-accredited laboratories would need to extend their scope of accreditation to perform testing on human and/or animal food samples. Module 2 is based on ISO/IEC 17025, which was updated in November 2017. A notice to update a TNI standard was issued in March 2018. This update requires that Module 2 of the Environmental Laboratory Standard be updated to reflect the changes in ISO/IEC 17025:2017. More information on the TNI standard is at www.nelac-institute.org.

- Association of American Feed Control Officials (AAFCO) Guidelines and AOAC International Analytical Laboratory Accreditation Criteria Committee (ALACC) Guidelines

  The *AAFCO Quality Assurance/Quality Control Guidelines for Feed Laboratories* (2014) and *AOAC International Guidelines for Laboratories Performing Microbiological and Chemical Analyses of Food, Dietary Supplements, and Pharmaceuticals – An Aid to the Interpretation of ISO/IEC 17025:2005* (2015 Edition) (ALACC Guidelines) provide recommended actions to implement the ISO/IEC 17025 requirements for testing of animal food (AAFCO) and human food and dietary supplements (ALACC). A 2018 update of the ALACC Guidelines is anticipated in response to the new ISO/IEC 17025:2017 document. More information on *AAFCO Quality Assurance/Quality Control Guidelines for Feed Laboratories* is located is at www.aafco.org.

- Clinical Laboratory Improvement Amendments (CLIA) Requirements and ISO 15189:2012 Medical laboratories – Requirements for quality and competence

  Food testing, both human and animal, is not under CLIA's scope, which is human specimen testing; however, isolates derived from this testing may be diverted into the CLIA public health laboratory for identification and/or typing. ISO/IEC 17025 is more comprehensive and applies to all testing laboratories, whereas CLIA contains clinical specimen-specific standards.

  It is important to note that CLIA and ISO/IEC 17025 differ in fundamental ways. For example, CLIA's managerial and technical requirements do not follow the ISO/IEC 17025 standard structure. CLIA is based on a management system approach that follows the specimen through the laboratory, and in some respects, is more prescriptive than ISO/IEC 17025. Several ISO/IEC 17025 elements not explicitly specified or required by CLIA include document control, management reviews, internal audits, and measurement uncertainty. More information on CLIA is here.

Following are some considerations regarding CLIA-certified laboratories involved in food testing: Relative to clinical human specimen testing, food testing involves very different procedures including those associated with sample handling, laboratory sampling, methods, instrumentation, data analysis, and reporting. Food testing laboratories certified only to CLIA should have policies and procedures for handling and testing of food materials to ensure traceability, integrity, and data accuracy and reliability. For example:

- Both validation/verification of methods and documentation should be publicly available.
- Analysts should be trained, deemed competent, and authorized for food testing.
- Pertinent proficiency tests for the methods used should be performed regularly and successfully.
- Quality control should be implemented for food testing.
- Internal audits should be scheduled and performed for food testing.
- Clinical laboratory testing should be separated from food testing to prevent cross-contamination between food samples and clinical specimens that could be from the same outbreak.

Options for food-testing laboratories seeking CLIA certification include:

- Seeking full ISO/IEC 17025 accreditation for the food testing section of the laboratory; this is the optimal option
- Applying for CLIA certification, even if the laboratory occasionally performing food testing could apply its current CLIA requirements to its food safety section and satisfy the gaps noted in a gap analysis against the ISO/IEC 17025 standard; refer to the checklist provided in Chapter 2 of the APHL white paper *Best Practices for Submission of Actionable Food and Feed Testing Data Generated in State and Local Laboratories* for suggestions on how to complete the gap analysis
- Referring food testing to another agency within the public health system or to another state or local laboratory accredited to ISO/IEC 17025
- Considering the recommendations in ISO 15189, *Medical laboratories – Particular requirements for quality and competence*, which provides an ISO/IEC 17025-based standard for CLIA-certified laboratories that is better aligned for food testing, and its quality system covers the entire laboratory

- Clinical and Laboratory Standards Institute Quality System Essentials (CLSI QSEs)

  CLSI document GP26-A4 *Quality Management System: A Model for Laboratory Services: Approved Guideline* introduces 12 building blocks of quality (referred to as a quality system essential or QSE) to create the management foundation needed to support the laboratory's path of workflow, from the initiation of a request for a laboratory service through the final provision of the laboratory report. The quality management system described in this guideline can be used around the world, including but not limited to medical laboratories, public health laboratories, research laboratories, veterinary laboratories, food laboratories, and environmental laboratories. The 12 QSEs are universal and are applicable to any size laboratory, whether simple or complex, in any laboratory discipline. More information is at http://clsi.org/.

- EPA Drinking Water Certification Manual

  The U.S. Environmental Protection Agency (EPA) developed several documents to assist laboratories and assessors for evaluating laboratory performance specifically for regulatory testing of public drinking water. The *Manual for the Certification of Laboratories Analyzing Drinking Water: Criteria and Procedures Quality Assurance* (5th edition)[1] provides guidance related to responsibilities and implementation of a state drinking water certification program including a quality assurance plan, chain-of-custody, certification maintenance, recordkeeping, and training. Separate chapters in the EPA manual guide the chemical, microbiological, and radiochemical analysis of public drinking water. These chapters provide recommendations for personnel qualifications; facilities; laboratory practices; test methods; primary sample collection, handling, and preservation; quality control; and data reporting.

  The drinking water manual has two supplemental guides with additional guidance. *Supplement 1 to the Fifth Edition of the Manual for the Certification of Laboratories Analyzing Drinking Water* (EPA 815-F-08-006, June 2008) outlines the following requirements for drinking water laboratory certification: officer-training certification; fraud and ethics training; fraud detection and deterrence; as well as training in primary sample collection, handling, and preservation practices for microbiology and chemistry. *Supplement 2 to the Fifth Edition of the Manual for the Certification of Laboratories Analyzing Drinking Water* (EPA 815-F-12-006, November 2012)

[1] Environmental Protection Agency (January 2005). *Manual for the Certification of Laboratories Analyzing Drinking Water: Criteria and Procedures Quality Assurance* (5th edition), EPA 815-R-05-004. https://www.epa.gov/dwlabcert/laboratory-certification-manual-drinking-water

provides guidance for *Cryptosporidium* testing, as well as how to develop a quality assurance (QA) plan and conduct a QA program.

Whereas ISO/IEC 17025 is generic and applicable to all laboratories, the EPA drinking water manual is unique to the drinking water program and places only minimal emphasis on a management system. For example, this manual does not require continual improvement of a quality management system or define mechanisms for achieving such. It does not require that customer feedback be actively solicited for improving the management system. The manual contains some of the key elements of a quality system. However, subcontracting, management reviews, internal audits, and client confidentiality are not explicitly specified or required. Comparisons across the EPA manual, TNI Laboratory Accreditation standard (2008) and ISO/IEC 17025:2005 are available from EPA and APHL.

A laboratory certified by EPA to perform regulatory testing for drinking water has many of the elements necessary to perform human and animal food testing. A gap analysis would identify missing requirements prior to testing human and animal foods but achieving ISO/IEC 17025 accreditation is preferable for effective data sharing among agencies' food testing laboratories.

Estimated Costs of Accreditation

The ISO/IEC 17025 standard focuses on laboratory operations and management with the goal of ensuring that laboratory staff are technically competent and generate technically valid results. Aside from the direct fees associated with commissioning an accrediting body, achieving accreditation often entails costs associated with staff time and expenses related to purchases (e.g., laboratory equipment). Given the organizational differences among laboratories, testing services offered, number of staff, volume of testing, equipment, location, and starting points in compliance with ISO/IEC 17025, it is impossible to provide accurate dollar estimates of costs. FDA has provided financial and technical support to laboratories pursuing ISO/IEC 17025 accreditation. APHL conducted a survey of many of these laboratories to gain a better understanding of the approximate costs associated with acquiring and maintaining ISO/IEC 17025 accreditation. This information can help inform future funding models and allow other laboratories to plan and prepare for accreditation. APHL's *Laboratory Costs of ISO/IEC 17025 Accreditation: A 2017 Survey Report* (February 2018) summarizes the median costs of accreditation. Each laboratory should evaluate which of the items apply to it, how it addresses those items, and estimate what costs might be incurred. The costs of accreditation can vary from laboratory to laboratory.

The most important factor when determining the cost of ISO/IEC 17025 accreditation is what policies, procedures, equipment, and software the laboratory had in place prior to deciding to pursue accreditation. The overall cost is influenced by multiple factors. A gap analysis would determine the degree of compliance with ISO/IEC 17025 and help identify new costs associated with fulfilling the remainder of the requirements. The laboratory should consider the complexity of methods, resources

needed to perform method verification or validation, volume of testing, workspace availability, and the age and condition of laboratory equipment when adding methods to the scope of accreditation.

New costs could include training staff or hiring new staff to perform testing, quality assurance, or support duties; contracting for service on laboratory equipment; obtaining LIMS or document control software; participating in a proficiency testing program; obtaining reference materials; and paying assessment and accreditation fees. Also, some laboratories hire a consultant to assist with initial accreditation, although this is not required. For more information on key components of a quality management system, refer to the checklist available in Appendix A of APHL's *Best Practices for Submission of Actionable Food and Feed Testing Data Generated in State and Local Laboratories*.

Other laboratory quality standards exist, and of those evaluated, PFP concluded that all these quality standards vary in the degree to which they meet or align with the requirements of ISO/IEC 17025. Although the criteria of other quality standards may contain requirements that extend beyond those of ISO/IEC 17025 in certain areas, laboratories meeting the requirements of any of these other quality standards should anticipate that additional work would be necessary to comply with ISO/IEC 17025. Overall, the recently issued TNI standard for environmental laboratories and AAVLD requirements align well with ISO/IEC 17025, as they incorporate most of the ISO/IEC 17025:2005 standard by direct reference. In contrast, CLIA requirements are heavily focused on patient specimens and do not require a quality management system; this alone represents a major departure from ISO/IEC 17025 requirements. The laboratory quality guidelines of AAVLD, AAFCO, and ALACC are designed to assist veterinary and animal and human food testing laboratories, specifically. Both AAVLD and AAFCO support and recommend that human and animal food testing laboratories pursue accreditation to the ISO/IEC 17025 standard using each organization's respective guidance for implementation of ISO/IEC 17025 requirements.

The path toward accreditation is complex and requires a degree of financial commitment. It involves a close examination of current systems, an accurate assessment of the improvements needed to meet the applicable quality standard(s), and a cost analysis to make those changes. All laboratory employees, including upper management and support staff, need to be involved in the accreditation process to successfully implement and maintain the quality management system.

Chapter 2 – Beyond the ISO/IEC 17025 Standard for Regulatory Testing Laboratories

Background and Objectives

ISO/IEC 17025 provides the foundation for laboratories testing human and animal food. Food testing laboratories accredited to ISO/IEC 17025 should also meet the *AOAC International Guidelines for Laboratories Performing Microbiological and Chemical Analyses of Food, Dietary Supplements and Pharmaceuticals* (ALACC Criteria) (https://www.aoac.org). Laboratories that test animal food are expected to meet the *AAFCO Quality Assurance/Quality Control Guidelines for Feed Laboratories*, as well.

However, for laboratories conducting regulatory human and animal food testing, regulatory elements and practices that supplement the above-referenced guidelines may be needed to ensure and foster acceptance and confidence in the integrity and scientific validity of data produced as specified by partnering agencies engaged in enforcement activities. Documents and references used by FDA for regulatory and enforcement actions and decisions include but are not limited to: *Investigations Operations Manual* (IOM), *Office of Regulatory Affairs Laboratory Manual*, and FDA compliance manuals and policy guides (all available at www.fda.gov). Additionally, the 2011 *Food Safety Modernization Act* (FSMA), and any upcoming regulations associated with the FSMA provide more details on FDA regulatory actions (www.gpo.gov).

The best practices stated below are presented to complement the applicable quality components of ISO/IEC 17025, ALACC Criteria, and AAFCO Guidelines for those who perform this work in support of regulatory programs. Laboratories performing regulatory analyses should strongly consider making these best practices part of their quality system to facilitate data acceptance by human and animal food safety regulatory officials.

Regulatory Organizations

If the laboratory is part of a larger organization that performs activities other than testing, the laboratory specifies the responsibilities, authorities, and inter-relationships of all personnel who make or affect regulatory actions; identifies potential conflicts of interest or bias for key personnel; and implements policies and procedures to prevent potential, actual, or apparent conflicts of interest, whether from an internal or external source.

The arrangements to ensure freedom from undue pressure are periodically examined for continued relevance and applicability to laboratory operations, management, and personnel.

Regulatory laboratories establish and maintain data integrity policies and procedures that are legally defensible. In addition, the laboratory has policies and procedures to assure that scientific misconduct including fabrication, falsification, and/or plagiarism do not occur or are reported and investigated (42 CFR 93). The laboratory provides planning, training, and method implementation in a manner that

ensures data integrity and has policies to assure confidentiality required by the regulatory organization (21 CFR 20.88).

The regulatory organization specifies the responsibility, authority, chain of communication, and inter-relationships of all personnel who make or affect regulatory actions. It also defines key personnel responsibilities for sample planning/collection, policies, procedures, regulatory interpretation, violation investigation, and regulatory enforcement.

Within the scope of their responsibilities, laboratory managers/directors provide adequate supervision by persons familiar with the interpretation of — and appropriate response to — relevant laws, rules, and regulations. The laboratory also provides access to legal or regulatory information and authorities — as needed to clarify regulations — to those key personnel who make decisions affecting regulatory actions.

Laboratory Management System

Regulatory laboratories establish, implement, and maintain a management system to ensure requirements for regulatory action are met regarding evidentiary integrity, which, in legal terms, is the identification and authentication of the evidence. Evidentiary integrity includes (1) trace-back, including chain of custody (i.e., possession/storage is documented from time of primary sample collection to disposal including any security requirements); (2) analyte integrity (i.e., the characteristic or concentration of the analyte of interest is maintained from collection of the primary sample through the test portion), which includes evidence the sample and test solutions were packaged, shipped, preserved, and stored in a manner and for a time period that does not compromise analyte integrity and no adulteration occurs; and (3) sampling errors are controlled throughout the process so that test portions and test results are representative of the decision unit. This systematic control ensures the scientific and evidentiary integrity of test results (see Chapter 4, Element 5: Evidentiary Integrity).

In addition, documentation in regulatory laboratories includes policies, systems, programs, procedures, and instructions for communicating regulatory requirements, making regulatory decisions, and taking regulatory action when it is within the scope of the laboratory's responsibilities. Regulatory laboratory staff participate in a planning process with program management and sampling staff to provide input on the sample quality criteria (SQC) within the scope of the laboratory's responsibilities (see Chapter 4). All laboratory personnel concerned with primary sample selection, laboratory sampling, preparation, and analysis are familiar with the quality documentation and with implementing agreed-upon policies and procedures. Regulatory laboratories provide regular training on regulatory requirements, changes, and updates for any staff involved in interpretation and/or reporting of regulatory limits.

Review of Requests, Tenders, and Contracts

Project planning for a regulatory laboratory — including review of requests, tenders (i.e. bids, quotes) and subsequent contracts for programs requiring regulatory analysis — takes into consideration and documents the sampling objectives and SQC needed to meet stated program goals. The regulatory organization ensures that management, sampling personnel, and laboratory personnel have a clear understanding of any regulatory requirements and potential actions resulting from laboratory testing and reporting (e.g., analyte integrity, test results, limits of detection, confirmation, quality control). Regulatory laboratory staff and regulatory program management communicate any known limitations of the data that could constrain regulatory actions. The laboratory ensures it has the capability and sufficient resources (e.g., primary sample selection, laboratory sampling, laboratory equipment) to obtain the data needed to meet program goals and objectives.

Subcontracting of Tests

Subcontracted regulatory work fully complies with the key elements and best practices listed in this chapter.

NOTE: Any subcontracted regulatory work requires that evidentiary and analyte integrity be maintained, which may include implementation of chain of custody. Subcontracting of work may impact regulatory use of the resulting data and is undertaken with consultation of the regulatory/enforcement organization.

Control of Non-conforming Testing

When a non-conformance is detected, laboratory data is held until the problem is resolved and verified by authorized personnel in accordance with the corrective action process.

NOTE: Re-sampling and re-testing may be required in accordance with policies of the regulatory organization to meet standards of legal defensibility.

Control of Records

Regulatory laboratories have policies and procedures to secure the retention and protection of records in a manner that ensures that actions are legally defensible. The needs of the regulatory organization drive the requirements for documentation of sample evidentiary and analyte integrity, including chain of custody, security, and traceability. Laboratory records for each sample contain sufficient information to identify the sampling objectives (i.e., SQC), decision unit, mass, number of increments, tools, handling, and any other factors to enable sampling to be repeated under conditions as close as possible to the original.

NOTE: Chain of custody includes policies and procedures for formal chronological documentation that records the sequence of collection, custody, control, transfer, analysis, and disposition of physical or electronic evidence, as well as a record of compliance for each sample.

Technical Records

The needs of the regulatory organization help define the requirements for documentation of testing as well as chain of custody, security, traceability, evidentiary and analyte integrity, and results reporting that are sufficient to establish an audit in the laboratory.

Personnel

Regulatory laboratories whose personnel are responsible for the opinions and interpretations included in test reports have general knowledge of applicable legislation or rules established at the local, tribal, state, or federal level. In addition, these personnel have appropriate qualifications, including training, experience, and satisfactory knowledge of the testing being conducted.

Facilities and Environmental Conditions

Environmental conditions are maintained and documented to ensure valid results and required quality of any measurement. The regulatory laboratory maintains policies and procedures for traceability, as well as maintaining evidentiary integrity and analyte integrity.

Test Methods and Method Validation and Verification

Methods that are fit for purpose or otherwise identified as suitable by the regulatory/enforcement body are used for regulatory testing. Standard methods are used whenever possible; however, if a standard method cannot be performed or cannot be found, the laboratory — with the concurrence of the regulatory organization — either uses a validated non-standard method or modifies and validates a method for use. The laboratory has procedures and records for method validation or verification, including statistical procedures and data presentation that, at a minimum, meet the requirements of the responsible regulatory organization.

NOTE: Regulatory requirements may mandate that all portions, subsamples, extracts, and all products of analysis (such as culture isolates) be fully traceable and documented.

- Standard methods: Standard methods are those that are: (1) published by international, regional, or national standards-writing bodies; (2) sanctioned by reputable technical organizations; (3) presented in legal references; or (4) agreed-upon by national human and animal food regulatory agencies such as FDA or U.S. Department of Agriculture (USDA). The laboratory's procedures should be traceable to a recognized, validated method.

- Non-standard method: A non-standard method is one not available from authoritative and validated sources. This includes methods obtained from scientific journals and unpublished laboratory-developed methods. It may be necessary to use these methods to perform testing for outbreaks and emergency investigations, where rapid development of a method is required.

The latest valid edition of a method is used, unless it is not appropriate or possible to do so. A policy and procedure are in place to ensure method capabilities are verified and that the laboratory can achieve the level of performance required in the methods. See Chapter 5 (Methods) for more specific information on acceptable methods and the validation or verification of methods.

Sampling

Policies and procedures for regulatory sampling reflect input and coordination among management, sample selection, laboratory and regulatory enforcement personnel. Sampling protocols, at a minimum, identify the SQC and procedures to ensure sample representivity, as well as analyte and evidentiary integrity.

Sampling protocols are consistent with established regulatory program sampling requirements. Sampling protocols are recorded along with any deviations from them in a manner that ensures the sampling can be reproduced (replicated). Records are traceable to the decision unit and include a description of the human and/or animal food. Sampling organizations not reporting directly to the laboratory should have policies, procedures, and records documenting their adherence to best practices.

There are procedures to ensure that established SQC are met and the testing results accurately represent the decision unit. Laboratory sampling protocols detail the receipt, handling, storage, comminution, and splitting or compositing steps in a manner that ensures their reproducibility. Contributions of laboratory sampling to measurement uncertainty are estimated. Also refer to Chapter 4 (Sampling).

Handling of Laboratory Samples and Calibration Items

The laboratory handles laboratory and analytical samples, analytical standards, reference materials, testing reagents, test solutions and other testing materials with appropriate care in accordance with the regulatory requirements of the organization to ensure traceability and analyte and evidentiary integrity. These requirements include sample chain of custody and security instructions for receipt, acceptance, storage, and laboratory sampling to generate test portions, and final disposition.

Test Reports

Regulatory test reports have legally defensible test results as well as identification of the sample origin and related information required by relevant regulations. If required by the regulatory organization, laboratory reports identify relevant regulations, interpretations or compliance decisions including non-compliance. These report elements are traceable to regulatory requirement and regulatory statute interpretation. Also refer to Chapter 7 (Reporting).

Best Practices for Non-accredited Testing in Support of Regulatory Inspections

Some governmental laboratories operate in an environment in which ISO accreditation may not be fiscally justifiable. Human and animal food testing may be performed only in rare instances, the volume of routine testing may be very low, or the requests received may be for esoteric testing that would fall outside of their scope of accreditation. In 2014, APHL convened a Data Acceptance Work Group to further define and clarify the gaps that would need to be filled by state and local public health laboratories choosing not to become accredited to the ISO/IEC 17025 Standard.

The Data Acceptance Work Group was comprised of members from APHL, the Association of Food and Drug Officials (AFDO), AAFCO, FDA, and USDA Food Safety and Inspection Service (FSIS). This work group published a white paper, titled *Best Practices for Submission of Actionable Food and Feed Testing Data Generated in State and Local Laboratories*, with the goal of advising on non-accredited testing for governmental laboratories. These laboratories may have a quality management system in place that demonstrates the ability to produce reliable data, but their system might not be based on ISO/IEC 17025. The aim of the white paper is to describe practices considered equivalent to ISO/IEC 17025 in order to instill confidence in laboratory data submitted to regulatory agencies. This paper is also intended to assist laboratories and end-users in data review and acceptance. This white paper is available on the APHL website and through the partnering organizations that helped create the document.

Chapter 3 – Proficiency Testing

Background and Objectives

A proficiency test is defined as the evaluation of laboratory testing performance by means of inter-laboratory comparisons. Proficiency test items are to be treated by the laboratory in the same manner as routine samples and should include all tested matrices, as appropriate. Proficiency testing is an accreditation requirement. However, any laboratory can benefit from selection and participation in appropriate proficiency testing programs and use the information derived from PT participation to maintain analyst competency

The information provided below represents the current state of human and animal food proficiency testing programs, accreditation standards and systems, and best practices for laboratory proficiency testing. Information is focused on currently available proficiency test series/programs (including federal, state, and private), leveraging existing proficiency testing series/programs and identifying potential enhancements.

In addition to meeting accrediting body requirements and accreditation standards, laboratories performing regulatory analyses should seriously consider incorporating the best practices listed below in their quality system. Doing so will promote confidence in laboratory competency and facilitate acceptance of data by human and animal food safety regulatory officials.

Proficiency Testing Best Practices

- Accredited laboratories participate in a check sample or proficiency testing program for all tests/methods/technologies/techniques covered under a laboratory's scope of accreditation as a means of demonstrating laboratory competency.
- If laboratories are not fully accredited but are working to meet the national standards outlined by the PFP, they participate in a check sample or proficiency testing program for all tests/methods/technologies/techniques used to test human and animal food samples for regulatory action as a means of demonstrating laboratory competency.
- Where possible, laboratories participate in a check sample or proficiency testing program furnished by a proficiency test provider adhering to, or accredited to, ISO/IEC 17043, *Conformity assessment – General requirements for proficiency testing*.
- Laboratories participate in check sample or proficiency testing programs relevant to their accreditation scope(s) or regulatory testing on a regular basis. Though, at a minimum, check sample or proficiency testing for the entire accreditation scope should be covered over a four-

year period; the suggested frequency is annual testing for each test/method/technology/technique covered under the laboratory's accreditation scope.

- Laboratories share results of their proficiency testing participation and testing results with their accreditation body (AB) and any relevant regulatory authority.
- When proficiency testing results do not meet study acceptance limits, laboratories take and document corrective actions to ensure that any problems are rectified, and the laboratory can demonstrate competency for the test/method/technology/technique.
- In the absence of a proficiency test program series that addresses a test/method/technology/technique required for compliance with these national standards, the laboratory relies on documented internal quality-control checks –
- And either participates in a round robin, performs an inter-laboratory comparison, or, at a minimum, performs a comparison with another method.

AAFCO and APHL post a catalog on their websites of existing proficiency testing programs/series that could be used to support laboratories in demonstrating competency for tests, methods, technologies, and techniques.

Specific language and or guidance applying to laboratory proficiency testing includes ILAC Requirements for Proficency Testing and Proficiency Testing Requirements and Best Practices for Specific Accreditation Standards.

ILAC Requirements for Proficiency Testing

ILAC issues *ILAC-P9:06/2014, ILAC Policy for Participation in Proficiency Testing Activities*, which is on the ILAC website (http://ilac.org/publications-and-resources/ilac-policy-series/); relevant portions are quoted below:

> *4.1 Accreditation bodies (ABs) seeking to sign or seeking to maintain their status as a signatory to the ILAC Multilateral Recognition Arrangement (MRA) shall demonstrate the technical competence of their accredited calibration and testing laboratories. One of the elements by which accredited laboratories can demonstrate technical competence is by satisfactory participation in PT activities where such activities are available and appropriate (see also 4.6) . . .*
>
> *Technical competence can also be demonstrated by successful participation in interlaboratory comparisons that have been organised for purposes other than PT in its strictest sense. For example:*
>
> *- to evaluate the performance characteristics of a method;*

- to characterise a reference material;

- to compare results of two or more laboratories on their own initiative;

- to support statements of the equivalence of measurement of [National Metrology Institutes] . . .

4.2 The minimum PT activity according to a laboratory's or inspection body's (where relevant) scope is:

- *evidence of satisfactory participation prior to gaining accreditation where PT is available and appropriate;*
- *further and ongoing activity that is appropriate to the scope of accreditation and consistent with the PT participation plan. (The main elements of a PT participation plan are provided in 4.3 below.)*

Note: Accreditation bodies should support the use of appropriate PT programmes which meet the essential requirements of ISO/IEC 17043 [1], where applicable.

4.3 ABs shall have a policy on the use of PT activities in the assessment and accreditation process. This policy shall include the following:

- *a reference to the importance of PT as a tool to demonstrate laboratory and inspection body competence (where relevant) and to assist in maintaining the quality of the laboratory or inspection body performance;*
- *any requirements regarding the minimum level and frequency of participation in PT by accredited laboratories, including the need for a PT participation plan which has been formulated by the laboratory or inspection body (where relevant) and is regularly reviewed in response to changes in staffing, methodology, instrumentation etc.;*
- *how PT participation and performance (in particular consistent poor performance), will be reviewed and utilised during the assessment and accreditation decision-making process. This may also include possibilities of varied surveillance intervals where performance is consistently good.*

The policy shall also make reference to the following considerations:

- *expectations regarding action by laboratories and inspection bodies (where relevant) in response to poor performance in PT, and any requirements for notification of this performance to the accreditation body;*
- *any PT requirements set by regulators, industry or professional sectors, Regional Cooperation bodies, or other interested parties . . .*

4.6 It is recognised that there are areas of testing and calibration for which suitable PT does not exist or is not practical in such cases, the accreditation body and the laboratory or where relevant the inspection body shall discuss and agree on suitable alternative means by which performance can be assessed and monitored. This would need to be considered as part of the planned PT and/or related activities.

Proficiency Testing Requirements and Best Practices for Specific Accreditation Standards

1. AAFCO requirements are stated within the *Quality Assurance/Quality Control Guidelines for Feed Laboratories* (2014) at http://www.aafco.org/Publications/QA-QC-Guidelines-for-Feed-Laboratories). Details are available at http://www.aafco.org/Laboratory/Proficiency-Testing-Program.
2. AAVLD requirements are stated in the AAVLD Standard (2010) at http://www.aavld.org/assets/documents/Requirements%20v5%200%2009-16-10.pdf.
3. ISO/IEC 17025 requirements are stated in Section 5.9 of ISO/IEC 17025:2005 and Section 7.7.2 of ISO/EC 17025:2017.
4. NELAC requirements are stated in the *NELAC Standard* at http://www.nelac-institute.org/docs/2003nelacstandard.pdf.
5. AOAC requirements are stated in the AOAC ALACC Guidelines, which clarify ISO requirements at http://www.aoac.org/aoac_prod_imis/AOAC/AOAC_Member/PUBSCF/ALACCCF/ALACC_M.aspx.

The above standards and guidelines are general approaches and do not specifically address complexities specific to human and animal food analysis. The requirements for analysis of food products for microbiological parameters are specific and unique, because microbial ecology in foods is unlike any other test medium, and recovery and detection of these organisms is subject to matrix effects, heterogeneity of the material, stability, and the properties of the analyte itself. Technical requirements to evaluate performance of laboratories that perform microbiological testing are

affected by factors such as methodologies that yield only qualitative results; methods with unknown "true values" are used to estimate measurement uncertainty and method limits of detection are not easily defined. All these factors affect variability among analysts and laboratories. Therefore, it is beneficial for regulatory laboratories testing human and animal food to participate in proficiency testing scheme(s) adhering to ISO/TS 22117 *Microbiology of food and animal feeding stuffs – Specific requirements and guidance for proficiency testing by interlaboratory comparison* (https://www.iso.org/standard/40720.html).

Chapter 4 – Sampling

Background and Objectives

The FSMA mandates the following:

> *The Secretary shall develop model standards that a laboratory shall meet to be accredited by a recognized accreditation body for a specified sampling or analytical testing methodology and included in the registry provided for under paragraph (1). In developing the model standards, the Secretary shall consult existing standards for guidance. The model standards shall include –*
>
> *(A) methods to ensure that –*
>
> *(i) appropriate sampling, analytical procedures (including rapid analytical procedures), and commercially available techniques are followed and reports of analyses are certified as true and accurate . . . .*
>
> *(iv) individuals who conduct the sampling and analyses are qualified by training and experience to do so . . . .*

Equivalency in the procedures used from primary sample collection to laboratory test portion selection is an essential first step to achieve comparable test results among multiple federal, state, and local human and animal food laboratories. This chapter introduces sampling best practices for achieving equivalency, accuracy, and defensibility.

Organizational responsibility for the different stages of the measurement process varies. One agency may oversee the entire pathway from decision unit to test portion. In other situations, the primary sampling activities are housed in an agency separate from the laboratory activities. There may be countless iterations of these scenarios (50 states = 50 scenarios!). Whatever the situation, it should be recognized that primary sampling to analysis is a single-measurement process, and accountability for the overall process is necessary. It should also be recognized that the laboratory itself is involved in a smaller-scale "sampling" process each time it selects a smaller mass from a larger mass (mass reduction). This may happen several times as the material moves through the laboratory workflow, with the final mass reduction stage being the selection of a test portion(s) for analysis.

Example of Stages in Sampling - Tomatoes

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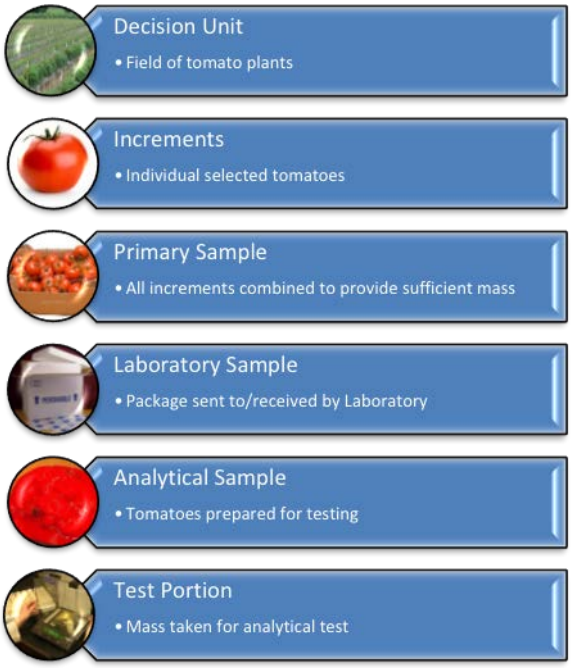

The *2013 Food/Feed Testing Laboratories Best Practices Manual (draft)* identified a need for a national sampling operations manual for use by organizations seeking to promote a fully integrated food safety system. Two scientific working groups were established under an FDA cooperative agreement and composed of members of the APHL, AFDO, AAFCO, and industry. The outcomes of these working groups were two best practices documents: *GOODSamples: Guidance on Obtaining Defensible Samples* and *Guidance on Obtaining Defensible Test Portions*. Based on the Theory of Sampling (TOS), *GOODSamples* and *GOODTest Portions* detail a scientific approach that can be implemented for any sampling situation to ensure that primary samples, analytical samples, and test portions are representative. Implementing *GOODSamples* concepts facilitates meeting FSMA requirements (for "appropriate sampling") and in achieving equivalency in analytical results generated by different organizations.

Sampling Best Practices Elements

GOODSamples introduces a theoretical basis for sampling and identifies key concepts that are necessary to implement good sampling practices. Readers are directed to the *GOODSamples* and *GOODTest Portions* documents for a fuller understanding of the principles of representative sampling.

The following specific critical elements are needed to ensure representative samples are used to make defensible decisions:

Best Practices Critical Element 1. Intra-agency Communication and Planning

A close collaboration between sampling, laboratory, and regulatory decision makers is essential to define appropriate SQC for each sampling exercise and to develop effective primary sampling and laboratory sample handling protocols. Sampling personnel and laboratory personnel need to understand the regulatory requirements necessary to make compliance decisions including what commodities need to be sampled, where, when, and why.

A "decision unit" is the material from which a sample is selected and to which an inference is made (e.g., a production lot of animal food, a shipping container of produce). The decision unit must be carefully defined, as it is the scale of observation and directly impacts the determination of the appropriate sampling protocol. It is necessary for the laboratory personnel, sampling personnel, and regulatory decision makers to discuss all concerns so that sampling protocols adequately represent the material being sampled for its intended purpose. These concerns include: information that must be collected to properly identify the sample, how regulators will evaluate the data, the types of inferences and decisions that might be made based on the data, the level of confidence in the data that is needed, and the level of error or uncertainty that is acceptable.

Regulators and sampling personnel need to understand the physical, chemical, biological, and radiological properties of the analytes of interest; how they might interact with the commodity and environment; how they need to be preserved during sampling, handling, and shipping; and any other factors that might affect the integrity of the sample. Often, the laboratory scientists can best identify these requirements. Regulators and laboratory staff need to understand the challenges sampling personnel face and develop training and sampling procedures that are flexible enough to ensure sampling personnel can make appropriate decisions in the field leading to test results that meet the desired SQC objectives. It is important that arrangements are made and authority is given to sampling personnel so that they have sufficient access to the decision unit to take representative samples. In addition, sampling personnel need to know the information that must also be collected and records that are necessary to support regulatory actions. Once the sample is in the laboratory, it is critical to maintain its representativeness and integrity during handling, laboratory sampling, and analysis. It is also important for sampling personnel and laboratory analysts to understand the circumstances that result in regulatory actions and how violations are communicated.

Best Practices Critical Element 2. Sampling Training

The sampling organization must establish and maintain evidentiary integrity procedures. The term "data" used in this best-practices critical element clause refers to field measurement data and all other

recordkeeping. The education, training, technical knowledge, and experience required for sampling personnel should be documented and may include:

- Familiarization and understanding of TOS and other relevant sampling theory;
- Knowledge of biological, chemical, and physical properties of the materials and analytes of interest and the significance of these properties in the proper conduct of their sampling;
- Hands-on, practical performance of sampling techniques and procedures;
- Hands-on calibration, use, and maintenance of sampling tools and equipment;
- Hands-on packaging, preservation, temperature control, and shipping of samples to ensure sample and analyte or microorganism integrity;
- Awareness of prevailing statutes, regulations, and ordinances as well as relevant Hazards Analysis and Critical Control Points (HACCP);
- Knowledge of food safety and public health principles;
- Competence in communication;
- Awareness of safety hazards and prevention of injury (i.e., sampling personnel must be provided with information and personal protective equipment specific to their collection assignments and sufficient to conduct sampling safely; personnel should be made aware of any possible hazards associated with the samples themselves and be instructed to comply with all safety procedures of the entities they visit);
- Competence in analyte and evidentiary integrity procedures;
- Understanding of scientific ethical behavior, as related to sample selection and data reporting; and
- Written acknowledgement of understanding applicable policies and procedures.

Training for sampling personnel should be reviewed and updated, and sampling performance should be observed and documented at periodic intervals (e.g., annually).

Best Practices Critical Element 3. Establishing Sample Quality Criteria

Samples are taken for many purposes (e.g., investigations, surveillance, emergency response, foodborne illness outbreaks, import regulations, monitoring). The purpose for which a sample is collected is one of the inputs into the SQC established for each sampling activity. SQC are specific statements that clarify both program fit-for-purpose technical requirements (e.g., commodity, decision

unit, analyte, target concentration) and quality requirements (e.g., acceptable variability, quality control) to support a defensible decision. It is critical that regulators have sufficient quality data to make defensible decisions based on the test results derived from samples.

For regulators to know how much a result varies from the true value, several matters must be considered. The total error in the final result is a combination of the random and systematic errors generated in primary sampling, laboratory sampling (e.g., subsampling, comminution, grinding), and the analytical error. Often, only the analytical error is known, and yet other sources of error can be very significant. It cannot be assumed that primary sampling and laboratory sampling errors are low. Replication of sampling, at various steps in the primary sampling to test portion selection pathway, should be incorporated into the routine quality-control programs to estimate all components of the global estimation error (see Critical Element 7 and *Guidance on Obtaining Defensible Test Portions [GOODTest Portions]* for more detail on incorporation of replicates to estimate error).

Best Practices Critical Element 4. Designing a Protocol for Representative Sampling

TOS provides a process to minimize and estimate repeatability (random error) and systematic/bias errors in sampling (sample correctness), especially for materials such as grains, small fruits, and vegetables, meats, and processed commodities, where individual elements of the decision unit cannot be selected individually. Sampling personnel must understand that the SQC, material properties, and TOS determine the mass, number and selection of increments, tools, and way a sample is selected. The resulting laboratory sampling protocol(s) specifies the way the sample is handled at the receiving laboratory, including protocols for comminution or other non-selection processes, protocols for selection processes, and protocols for analysis. The protocol(s) should specify the quality control (e.g., blanks, replicates) at both the primary sampling and sampling laboratory levels.

There are many guidance documents specifying how to select samples (e.g., a specific weight and number of increments (or subsamples) may be dictated for some commodities). Many of these guidances fail to provide SQC. If data is to be shared between agencies, it is essential to understand the requirements of the collaborating partners and exactly how the samples were selected, and, thus, what the final test result represents. Detailed records describing the sampling procedures and any deviations taken in the field are necessary.

Best Practices Critical Element 5. Evidentiary Integrity

Analyte integrity, representivity, and traceability comprise evidentiary integrity. Therefore, evidentiary integrity is demonstrated by documentation that (1) processes to ensure maintenance of analyte integrity were followed, (2) proper sampling procedures were adhered to, ensuring representivity (e.g., sample correctness), and (3) traceability of samples was maintained (e.g., chain of custody forms), as follows:

Ensure Analyte Integrity

This quality provides confidence that the chemical, biological, physical, or radiological element that was measured by the laboratory in the test portion has the same identity and concentration as that found in the decision unit. Precautions and procedures to address and monitor analyte integrity will be unique to each sampling problem and should be specified in sampling protocols. Refer to *GOODSamples* and *GOODTestPortions* for more information on analyte integrity.

Maintain Representivity

This quality ensures that a primary sample is representative of the decision unit (a necessary foundation for all subsequent activities) and ensures that errors are controlled during all sampling processes. Refer to *GOODSamples* and *GOODTestPortions* for more information on representivity.

Traceability

This quality is the combination of policies, procedures, and records for chronological documentation to trace the sequence of collection, custody, control, transfer, analysis, and disposition of the sample. Over time, many regulatory agencies have developed very specific types of documentation that must accompany regulatory actions. It is best to be familiar with these requirements so that they may be incorporated into sampling and laboratory practices.

At the discretion of legal counsel, documentation will be unique for every organization and its sampling objectives. Such documentation may include:

Identify Sample by Providing/Specifying

- A unique sample identification number for each sample
- Date and time of collection
- Description of decision unit (e.g., size, location)
- Identification of all persons involved in the collection
- Mass selected
- Number of increments selected
- Tools used
- Technique for ensuring randomness of increments selection
- Label showing initials and date of custody on the seal or bag, if applicable
- Photographs of the product and any identifying packaging including the unique ID and accurate date stamp
- Description of the physical characteristics (e.g., temperature), if appropriate
- Description of packaging, if appropriate (e.g., canned, bagged, bulk)

- Description and documentation of a commodity or species in sufficient detail that additional product could be collected in the future and that regulatory limits could be clearly applied (e.g., distinguish sweet vs field corn, specify stage of maturity [e.g., fresh vs frozen])
- Lot number, if applicable
- Bill of lading
- For imports: port of entry, importer, import entry number or paper trail of distribution chain
- Records documenting interstate shipment, when establishing federal jurisdiction
- Records documenting adulteration or misbranding after initial shipment, including when and how it occurred and responsible person(s)

Record Details of the Responsible Person(s)

Record enough information to clearly establish responsibilities of the:

- Person(s) who owns/holds/sells the product
- Exporter, importer, grower, packer, manufacturer, distributor, etc.
- Date of sample collection and the initials (of the person from whom the samples were collected)
- Wrappings, promotional literature, etc.

Collect Data on Shipping Details

- Carrier
- Tracking number, if appropriate
- Container

Note/Record Observations

- Sanitary conditions at the facility
- Unusual appearance
- Any information given by the person involved in the collection

Specify Regulatory Activities

- Purpose for collection (e.g., routine surveillance, suspected contamination, follow-up to previous violation)
- Compliance status of the decision unit (e.g., stop sale, stop harvest, voluntary destruction)
- Regulatory actions taken (e.g., Notice of Violation, Closure of Facility)

- Related samples and sampling activities (e.g., related shipment expected, another harvest of same field in future)
- Description of owner response to regulatory actions

Provide Security for Records

This is a vital step and may include:

- Secure storage, backups
- Restricted access
- Audit trails
- Retention according to policy

Best Practices Critical Element 6. Laboratory Sampling and Quality Control (QC)

GOODSamples states that the laboratory has three primary responsibilities regarding sampling:

1. To respect the decision unit
2. To ensure that analyte integrity is maintained during laboratory sampling and storage
3. To obtain representative test portion(s) of the laboratory sample received

Respect the Decision Unit

Laboratory staff need a clear understanding of the SQC and the scale of observation of the sampling activity. Accurate representation of the decision unit can be compromised by inappropriate compositing or exclusion/inclusion of portions of the laboratory sample (e.g., extraneous material) without an understanding of the implications.

Ensure Analyte Integrity Is Maintained

See Critical Element 5.

Obtain Representative Test Portions

Mass reduction is the term describing each laboratory selection process, where a smaller amount of material is selected from a larger quantity. This might happen in several stages or steps, with the final selection process being that of selecting the test portion for a specific test. Every subsequent selection process may introduce the same types and sources of error as are introduced in the primary sampling stage. In addition, each non-selection process (e.g., blending, grinding, transferring) may introduce bias, which needs to be controlled to maintain sample correctness.

The principles of TOS, which should be applied in all laboratory selection processes, are well documented in *GOODTestPortions.* A common error introduced in laboratory practice is the inappropriate splitting of the laboratory sample *before* comminution (i.e., reducing particle size by grinding, blending, or other means). The common practice of mass reduction without first reducing particle size can quickly lead to an unacceptably large total sampling error (TSE).

Implement Additional Best Practices

These are emphasized in *GOODSamples* and *GOODTestPortions*, should be implemented in all laboratories, and include:

- Validate laboratory sampling protocols before they are put into practice.
- Implement performance tests for grind/blend quality and recovery, carryover and mixing efficiency.
- Implement quality control in laboratory sampling to monitor and estimate error.

Best Practices Critical Element 7. Determine Global Estimation Error

Global estimation error (GEE) is the total of all errors in the entire measurement process from primary sampling through generation of test results. GEE includes primary sampling error, error from laboratory selection and non-selection processes, and analytical error. It is improper to measure and control only analytical error, which is usually the smallest error component. Systematic error must be controlled in a way that reduces it to a negligible level because it cannot be easily measured. Random error components of GEE include fundamental sampling error (FSE) and grouping and segregation error (GSE) associated with each selection process (a,b,c, . . .); they are independent and do not add up directly but propagate by the square root of the sum of squares:

$$Global\ Estimation\ Error = \sqrt{(a^2 + b^2 + c^2 + \cdots \ldots + n^2)}$$

where *a, b, c, . . . , n* are individual random errors for each selection (mass reduction) process and analytical/test method. Since error terms are squared, it follows that errors that are largest compared to others will have the greatest contribution to GEE, and mitigating them will have the most dramatic effect on lowering GEE. When differentiating the sampling error from analytical error, the sum of error from all sampling processes is termed “total sampling error.” Due to the relative magnitude of the errors, estimating total sampling error for a measurement process is as critical, and generally more critical, than estimating analytical uncertainty.

Critical Element 8. Data Quality Assessment

To reach a defensible decision based on laboratory data from a primary sample selected from a decision unit, it is necessary to implement a data assessment process.

Obtain the following information during assessment

- Is the documentation complete?
- Does the documentation support the premise that the correct procedure was followed?
- Were any exceptions to the procedure noted?
- Were sufficient increments selected at random for each mass reduction stage?
- Was there any reason to suspect contamination from outside sources?
- Were correct tools and equipment used?
- Was there any evidence of breakage or spillage?
- Does quality control document testing that meets GEE?
- Do blanks (at all critical stages) support the absence of contamination below a critical level?
- Are replicates (from all critical stages) within an acceptable range?
- Is the GEE acceptable to meet SQC and below 35%?
- What is the proximity of the actual concentration and GEE to the specification limit?
- Were outliers or other data inappropriately accepted or rejected?
- Do the data support a defensible decision?

Adherence to the principles presented in *GOODSamples* and *GOODTestPortions* will ensure that a sample is fit for supporting a decision. While not comprehensive, the list of critical elements provided highlights procedures that both meet the principles of sound sampling theory and sound quality management system.

Chapter 5 – Methods

Background and Objectives

The development and selection of methods for human and animal food regulatory laboratory analysis is a complex process that involves several practical as well as technical issues. Public health regulatory laboratories conduct routine surveillance testing based on established regulatory standards as well as outbreak and emergency testing on known, evolving, or unknown hazards. Methods used for routine testing are typically well validated, verified, and consistent with the ISO/IEC 17025 standard. However, testing used for outbreaks and emergency investigations may benefit from situational method development. Many factors should be considered including, but not limited to, method source, accuracy, validation, throughput, robustness, positive predicted value, precision, and practicality.

Key factors that impact method selection often are dependent on a combination of cost, assay sensitivity/specificity, and availability, as well as various program requirements. Many regulatory methods can be found at the Compendium of Analytical Laboratory Methods for Food and Feed Safety website.

Best Practices for Selection of Methodology

Determine If Method Is Fit for Purpose

It is important to define the purpose, scope, and application of the chosen or desired analytical method. Communication with the program partner (or other customer) and regulatory authority is necessary to determine the specific analytical testing requirements. Although methods must be suitable for their intended purpose, it is important to remember that validation need only be as extensive as necessary to support that purpose. Matrix extension also requires validation, though possibly on a more limited basis. The references cited below can provide guidance on specific validation activities. Basic application of knowledge, training, and experience in the selection/development process is critical and may involve the following actions:

1. Define the analytical requirement by determining what information is needed and the specifications (e.g., analyte[s], matrices, limit of detection [LOD], limit of quantitation [LOQ]).
2. Determine if a method already exists that can fulfill the requirements by conducting a thorough search of available methods compendia and/or literature.
3. If a method is available, determine whether it has been validated. A validated method (particularly one that has undergone a multi-laboratory validation) helps ensure a degree of reliability, repeatability, and robustness for the analytical process including integrity of the observed data. A laboratory also looks at the validation organization and ensures that its

specifications produce a method that meets the analytical requirements (see #1 above). Regardless, the method is verified in the laboratory where it will be used to ensure it can be performed properly.

4. If a validated method is available, determine whether it is appropriate and practical for the analysis. Consider whether the method has the necessary capacity and/or throughput capabilities that will be needed. Older validated methods, while reliable, might be difficult to use or require equipment no longer in use.

5. If a practical, validated method is not available, a non-validated, appropriate method may be found in peer-reviewed literature. A method from a peer-reviewed journal has had some level of validation but needs to be verified to work in the laboratory. Laboratories should also consider communicating with peer state or federal laboratories that may have a validated method for the analysis in question. The Food Emergency Response Network (FERN), PulseNet, Laboratory Response Network (LRN), etc., can serve as excellent networks for reaching out to peer laboratories.

6. If no method is available, then one may need to be developed and validated within a laboratory. Method development and validation is a critical skill for all regulatory laboratories as it is a principal source for new regulatory methods.

7. The laboratory must be sure it has the necessary resources (e.g., personnel, equipment, budget, literature access, and training) to develop or adapt a method, if one is not available from a reliable source. For situations in which methods are not available, the laboratory itself can accurately assess its capabilities to develop or adapt a method and produce a method that would meet the analytical requirements.

8. Confirm that the laboratory has proper quality assurance/quality control procedures in place. Proper quality assurance/quality control helps ensure that methods used in a laboratory perform as needed. These can include an independent assessment of laboratory technical performance such as proficiency testing.

9. Verify that the laboratory has proper safety equipment and guidelines in place. Proper safety guidelines help ensure that method evaluation or development is conducted without undue risks to testing staff. In some cases, very strict guidelines are required to work with some compounds/organisms such as those on the U.S. Centers for Disease Control and Prevention (CDC) Select Agent List or those covered by the *Controlled Substances Act*.

Disclaimer: The list above is by no means exhaustive. Every laboratory responding to its analytical needs/situations will have unique characteristics. However, a basic approach format such as this one will help ensure that the results generated meet the defined analytical requirements.

Determine If Validation Level Is Sufficient

Method validation is the process of defining an analytical requirement and confirming that the method under consideration has performance capabilities consistent with what the application requires. A method's performance capabilities and suitability are evaluated in the process, as are the method's performance parameters. The method must be fit for the intended purpose. This means that not all method validation events will have the same requirements in terms of number of matrices, validation samples, replicates, etc. The following FDA documents provide the necessary validation guidelines for the food regulatory laboratory community.

- *Guidelines for the Validation of Analytical Methods for the Detection of Microbial Pathogens in Foods and Feeds*
- *Guidelines for the Validation of Chemical Methods for the FDA FVM Program*
- *OFVM Method Development, Validation and Implementation Program*
- *FDA Office of Foods and Veterinary Medicine Acceptance Criteria for Confirmation of Identity of Chemical Residues using Exact Mass Data*

See http://www.fda.gov/ScienceResearch/FieldScience/ucm273423.htm for more information.

The EPA, in collaboration with other federal agencies, has developed guidelines for radiological testing.

- *Multi-Agency Radiological Laboratory Analytical Protocols (MARLAP) Manual*

  See https://www.epa.gov/radiation/multi-agency-radiological-laboratory-analytical-protocols-manual-marlap for more information. These guidelines draw from pre-existing validation protocols such as those from AOAC International (https://www.aoac.org/), the International Union of Pure and Applied Chemistry (https://iupac.org/), and FERN (www.fernlab.org).

Determine If a Method Is Available

There are several methods compendia (see list below categorized by discipline). Some require subscriptions or have restricted access. This is an initial set of best practices (i.e., for method selection, suggested validation protocols). Also listed are method source compendia for the regulatory human and animal food laboratory community. Adherence to these best practices

should reinforce confidence in laboratory competency and facilitate the acceptance of laboratory analytical data by regulatory authorities.

- Multidisciplinary Compendia
  - *AOAC International Official Methods of Analysis* (electronic format, 2005 to present) http://www.eoma.aoac.org/
  - *American Association of Cereal Chemists (AACC) Approved Methods of Analysis* http://methods.aaccnet.org/
  - *Standard Methods for the Examination of Water and Wastewater* (APHA) http://www.apha.org/
  - *Standard Methods for the Examination of Dairy Products* (APHA) http://www.apha.org/
  - *USDA-FSIS Analytical Chemistry Laboratory Guidebook* http://www.fsis.usda.gov/wps/portal/fsis/topics/science/laboratories-and-procedures/guidebooks-and-methods
  - *FERN Methods Coordination Committee (MCC) Approved Methods* www.elexnet.com
  - CDC method manuals (several available such as the *NIOSH Manual of Analytical Methods*) http://www.cdc.gov/niosh/docs/2003-154/method-a.html
  - *EPA Selected Analytical Methods for Environmental Remediation and Recovery* https://www.epa.gov/homeland-security-research/sam
  - *Recommended Procedures for the Examination of Seawater and Shellfish* (APHA) http://www.apha.org/
  - *National Shellfish Sanitation Program (NSSP) Guide for the Control of Molluscan Shellfish: 2015 Revision* http://www.fda.gov/food/guidanceregulation/federalstatefoodprograms/ucm2006754.htm
  - *FDA Compliance Program Guidance Manual* (CPGM) http://www.fda.gov/ICECI/ComplianceManuals/CompliancePrograMManual/default.htm
  - *Methods and Guidance for the Analysis of Water* (official EPA versions) http://nepis.epa.gov
  - *AAFCO Guidelines for Preparing Laboratory Samples* http://www.aafco.org/Publications/Guidelines-for-Preparing-Laboratory-Samples

- Microbiological Methods Compendia
  - *USDA-FSIS Microbiology Laboratory Guidebook* (MLG) http://www.fsis.usda.gov/wps/portal/fsis/topics/science/laboratories-and-procedures/guidebooks-and-methods

- *Compendium of Methods for the Microbiological Examination of Foods, Fifth Edition* (APHA) http://ajph.aphapublications.org/doi/book/10.2105/MBEF.0222
- *FDA Microbiological Methods & Bacteriological Analytical Manual* (BAM) http://www.fda.gov/Food/FoodScienceResearch/LaboratoryMethods/ucm114664.htm
- *Health Canada Official Methods for the Microbiological Analysis of Foods* http://hc-sc.gc.ca/fn-an/res-rech/analy-meth/microbio/index-eng.php
- International Commission on Microbial Specifications for Foods (ICMSF) http://www.icmsf.org/
- *Manual for the Surveillance of Vaccine-Preventable Diseases* (CDC) http://www.cdc.gov/vaccines/pubs/surv-manual/index.html

- Chemical Methods Compendia

  - *Official Methods and Recommended Practices of the American Oil Chemists' Society* (AOCS) http://www.aocs.org/Methods/?navItemNumber=584
  - *USDA Chemistry Laboratory Guidebook* http://www.fsis.usda.gov/Science/Chemistry_Lab_Guidebook/index.asp
  - *FDA Pesticide Analytical Manual* (PAM) http://www.fda.gov/Food/FoodScienceResearch/LaboratoryMethods/ucm2006955.htm
  - *FDA Elemental Analysis Manual* (EAM) http://www.fda.gov/Food/FoodScienceResearch/LaboratoryMethods/ucm2006954.htm
  - *Food Chemicals Codex*
  - https://www.foodchemicalscodex.org/
  - *International Commission for Uniform Methods of Sugar Analysis (ICUMSA) Methods Book* http://www.icumsa.org/index.php?id=860
  - *Health Canada Chemical Methods - Compendium of Methods for Chemical Analysis of Foods* http://www.hc-sc.gc.ca/fn-an/res-rech/analy-meth/chem/index-eng.php
  - *National Forage Testing Association Reference Methods* http://foragetesting.org/index.php?page=reference
  - *United States Pharmacopeia/National Formulary* (USP/NF) http://www.usp.org/usp-nf
  - *Homeopathic Pharmacopoeia* http://www.hpus.com/
  - *Japanese Pharmacopoeia*
  - http://jpdb.nihs.go.jp/kyokuhou/archives-e.htm
  - *Chinese Pharmacopoeia*
  - http://www.usp.org/products/chinese-pharmacopoeia
  - *British Pharmacopoeia*

http://www.pharmacopoeia.co.uk/

- Radiological Methods Compendia
  - *Department of Energy (DOE) Environmental Measurements Laboratory (EML) Procedure Manual* (HASL-300) http://www.orau.org/ptp/PTP%20Library/library/DOE/eml/hasl300/HASL300TOC.htm
  - *DOE Methods Compendium* https://www.eichrom.com/eichrom/methods/compendial-methods/
  - *Oak Ridge Institute for Science and Education (ORISE) Laboratory Procedures Manual* http://orise.orau.gov
  - *Compendium of EPA-Approved Analytical Methods for Measuring Radionuclides in Drinking Water* (DOE) http://www.orau.org/ptp/PTP%20Library/library/DOE/Misc/radmeth3.pdf

- Macro Methods Compendia
  - *Macroanalytical Procedures Manual* (MPM) (FDA) https://www.fda.gov/Food/FoodScienceResearch/LaboratoryMethods/ucm2006953.htm

Disclaimer: This is not a comprehensive list but should provide a reasonable number of options for laboratories searching for appropriate analytical methods.

Chapter 6 – Analytical Worksheet Packages

Background and Objectives

Human and animal food testing laboratories across the nation have developed unique ways of recording raw data. For the purposes of data review and mutual reliance for regulatory action, it is imperative that food testing laboratories consistently and uniformly record analytical trace-back and quality-control information. While there are considerable resources available focusing on data collection, there is a lack of guidance about the recording of information for use in regulatory action. National best practices for recording raw analytical food testing data will provide laboratorians with a listing of critical elements required in data packets to properly document the processes, potentially allowing regulatory action by other agencies.

Uniform static worksheets were developed for use in various food testing laboratories with the goal of demonstrating practical applications of national best practices. This was done by ensuring that the standardized worksheets contain all quality control elements and are easy to navigate. Standardized worksheets designed to align with laboratory procedure(s) make it simple for data reviewers to follow the analytical pathway and interpret the data. This simplification increases efficiency for both laboratory analysts and partner agencies reviewing and making decisions based on the data.

These standardized worksheets/data elements also provide assurance to the laboratory that they are meeting national standards. Some laboratories have, or are working toward, paperless systems; therefore, efforts should be made to translate these standards into an electronic format (e.g., LIMS).

Best Practices for Analytical Worksheet Packages

The list of elements that should be contained in raw data worksheets to meet the national best practices are detailed below. The raw data worksheets may be paper forms filled out by an analyst or may be electronic forms that are filled out using a computer or in LIMS software.

<u>Detailed Sample Description</u>

- Detailed visual description of the sample (e.g., commodity, color, shape, texture, and other general appearance)
- Any identification numbers on the sample – unique sample identifier (e.g., federal and/or state sample identification, barcode)
- Detailed description of the containers used to transport the specimen
- The number of subsamples submitted
- The gross weight or volume of the sample/subsamples (if applicable)

- The controls, standards, or any other items contained in the shipment
- The physical condition of the laboratory sample upon receipt (e.g., temperature and any apparent abnormalities)
- Detailed description of container in contact with the laboratory sample (e.g., material and dimensions)
- Product codes and lots (if applicable)
- Description of the label on sample containers

Laboratory Chain of Custody

- Receipt date
- Received from/by
- Condition of custody seals (i.e., seals intact, sample integrity maintained)
- Secured storage information (i.e., from receipt through testing and disposal)
- Storage conditions
- Reserve sample storage information (if applicable)
- Disposition, including date and method and by whom (i.e., shipment to another laboratory, long-term storage, or destruction)

Analytical Information

- Name and location of the laboratory
- Unique sample identification on all pages of the worksheet
- Product name on all pages of the worksheet
- Method reference
- Summary of results
- Reporting limits (if applicable)
- Analyst signature/initials and date
- Reviewer signature/initials and date

Quality Control

- Equipment identification information
- Identity and lot numbers/expiration dates for sterile supplies used
- Identity and lot numbers/expiration dates for media used
- Identity and lot numbers/expiration dates for reagents used
- Quality control standard information
- Quality control organism identification information (i.e., ATCC#, genus and species)
- Results of controls (e.g., outcome of media control, blank, spikes)
- Condition of blanks
- Measures of accuracy and repeatability (e.g., spike recoveries)
- Identity and concentration of analytical reference standards
- Measures of linearity
- Measures of limits of detection and/or quantitation

Raw Data

- Detailed laboratory sampling information
- All calculations, including formulas used
- All standard preparations and concentrations
- Any dilution schemes
- Calibrations
- Test conditions
- Deviations (i.e., additions or exclusions)
- Any raw data associated with analysis including observations

Attachments

- Instrument printouts, computer-generated charts and data sheets, photographs, photocopies, etc., should be included

- Unique attachment identifier (e.g., Attachment A)
- Each page should have:
  - The unique attachment identifier at the top
  - The product name at the top
  - The unique sample identification number at the top
  - The initials or signature of the primary analyst and date
  - Consecutive page numbering (e.g., 1 of 4, 2 of 4)
- Awkward attachments can be mounted to a sheet of paper

Labels

- Commercial labeling — original labels, photographs of labels, or photocopies of labels — may be mounted on paper, if necessary
- Labels, photographs, or photocopies should have sample identification, the date the sample analysis began, and the analyst's initials

General Good Recordkeeping Practices

- Document/version control matching requirements by ISO/IEC 17025
- Clear annotation of entries
- Logical sequence of recordings
- Consecutive page numbering (e.g., 1 of 12, 2 of 12…12 of 12)
- All unused areas are lined out, dated, and initialed (a diagonal line can be used to cross out multiple areas at once)
- All entry errors are corrected by putting a single line through the error, clearly rewriting the entry, dating, and initialing the error and an explanation of the correction, if not obvious
- No correction fluid or correction tape on worksheets
- No blacking out entry errors (ensure that original entry is legible)

In addition to the list of elements identified above, worksheets have been developed to demonstrate practical application of these elements in a laboratory. These worksheets do not encompass all analytes and testing methods. However, some have been created for specific routine pathogens and chemical contaminants of concern. These worksheets are available for use in laboratories nationwide and are posted along with this document. There is also an area for feedback or for submission of proposed new worksheets to be considered for inclusion.

Disclaimer: While this chapter is filling an immediate need, these worksheets are a short-term solution to the larger issue of national data sharing. Automated data capture processes can mimic the worksheets developed by this group.

Chapter 7 – Reporting

Background and Objectives

While many laboratories have a working LIMS, there is no universal, mandatory national Information Technology (IT) system for human and animal food testing laboratories, and few laboratories are truly "paperless." With the advent of initiatives such as the FSMA for electronic transmission and acceptance of state data, secure and comprehensive IT systems incorporating national reporting best practices would facilitate handling the large volume of data in an efficient and effective manner to suit the needs of both state and federal partners. This issue continues to be addressed by various workgroups, committees, and subcommittees.

The elements that should be contained in a test report have been provided as a best practice. Test reporting requirements contained within ISO/IEC 17025, ALACC Criteria and *AAFCO Quality Assurance/Quality Control Guidelines* provide a robust foundation that meets the needs of the PFP in terms of increasing confidence in laboratory competency and facilitating acceptance of laboratory data by partner agencies. Additional test reporting parameters may be required based on the customer's needs (e.g., local, state, or federal agency). Test reports should include all information agreed to with the customer and necessary for interpretation of test results, and all information required by the method used.

If agreed to by the customer, results can be presented in a simplified manner; however, all required information should be maintained by the laboratory in a manner that allows information to be readily available. All issued reports should be retained in accordance with recordkeeping procedures. Procedures should be in place to prevent unauthorized production of reports or other documents including restricting access to word processing packages and company letterhead to authorized people. Electronic records and electronic signatures should be equivalent to paper records and handwritten signatures.

Test reporting requirements may vary significantly, depending on specific regulatory policy and/or the program, and establishment of exact criteria for data reporting (electronic or otherwise) requires input from the entities making regulatory (compliance and enforcement) decisions for data acceptance and any subsequent action that may be taken by the partner agency with regulatory authority.

Best Practices for Laboratory Reports

<u>Description of Items Included on Test Report</u>

- Title
- Laboratory name and address
- Location where the laboratory activities were performed

- Unique test report identification, identifying all components as part of a complete report, including page number, total number of pages, and a clear indication of the report's end
- Customer name and contact information
- Receipt date
- Test item description, condition, and identification
- Test date(s)
- Test results and units of measurement
- Identification of the method used
- Additions, deviations, or exclusions from the method
- Report date
- Sampling plan or procedure reference, if relevant
- Primary sample collection date (and time, if necessary)
- Primary sample collection location and condition
- Identification of person(s) completing and authorizing the test report and clear indication when the results are from external providers (test report format should accommodate each type of test performed and minimize the possibility of misunderstanding or misuse)

Additional Components of the Report

- The report should contain a statement to the effect that the results relate only to the items tested, as well as a statement specifying that reproduction of the test report must be in full and requires written approval from the reporting laboratory.
- Additional information, where necessary for interpretation of results, on the test report may include: test conditions, compliance/non-compliance statements, measurement uncertainty, and opinions and interpretations.
- Statements of conformity and the decision rule should be clearly defined. The affected results must be identified, including which parts of the specification or standard were met/not met, and which decision rule was applied. Also, the customer should be informed of and agree to the decision rule unless it is inherent to a specification or standard.
- The laboratory should document the basis for interpretations and opinions, when provided. Interpretations and opinions should be clearly marked and clearly indicate which results are affected.
- Where the laboratory is responsible for the primary sampling activity, test reports should contain the same items listed above. It should also include: sampling date, collection time, producer/product name/lot number/manufactured date of test item (sample), sampling protocol, conditions that could affect test results, and any additional information required by the method and/or customer. Note that some of this information (e.g., collection details) is not generated by the laboratory but is provided by the sampling entity via a collection report, test request form, chain of custody, or other similar documentation. Data provided

by a customer should be clearly identified as such in the report, accompanied by a statement that the results apply to the laboratory sample as it was received.

- Subcontracted test results should be clearly identified including laboratory name, analyst, reviewer, date/time of analysis, etc.
- ISO/IEC 17025:2017 now refers to subcontracts as "resources" or "externally provided products and services." The laboratory no longer must maintain a list of external service providers.
- The laboratory establishes criteria to select and evaluate external service providers to ensure that external testing activities meet the requirements of the customer and the laboratory itself. Furthermore, the laboratory must obtain the customer's approval prior to subcontracting.
- When an issued report must be amended, changed, or re-issued, any changed information should be clearly identified and, if necessary, explained. Amendments to reports are made only in the form of another document or data transfer, which includes the statement that clearly indicates that the report is an "Amendment or Correction to Test Report ID #XXX", or equivalent. Any amendment should meet all the requirements of the original test report. If it is necessary to issue a completely new test report, the new report is uniquely identified and contains a reference to the original that it replaces.
- Accrediting bodies and customers, such as other regulatory agencies, may require human and animal food testing laboratories to meet additional requirements.

Use of the Accreditation Symbol or Other Reference to the Laboratory Accreditation

- The accreditation symbol may only be used in a test report when the identified test method is under the scope of accreditation. If the test report contains results from both non-accredited and accredited tests, the report should acknowledge that work falling outside of the laboratory's accreditation scope is included, and those tests must be clearly identified.

- Test reports containing opinions and interpretations outside the laboratory's accreditation scope should not contain or display the accreditation symbol or other reference to the laboratory's accreditation status.

Proposed Best Practices with Respect to Electronic Data Capture and Future National IT Development

The following best practices have been shared with relevant PFP and FSMA national IT subcommittees and workgroups.

- The structure of any data report should have a set of "minimum data elements" that meets the test reporting best practices outlined in this document.

- The system should be protected from unauthorized access and be safeguarded against tampering and loss.
- The system should be operated in an environment that complies with provider or laboratory specifications and safeguard the accuracy of manual recording and transcription.
- The system should be maintained to ensure the integrity of the data and information.
- The system should include recording system failures and appropriate immediate and corrective actions.
- Calculations and data transfers should be verified in an appropriate and systematic manner.
- The system should maintain flexibility to allow for the accommodation of additional reporting requirements, as determined by the specific regulatory policy and/or program.
- The system should allow for communication between data submitter and the entity receiving the data and who potentially would be taking regulatory action.
- The system should allow for security parameters to meet national data storage security needs, based on user roles/permissions.
- Resources permitting, it would be extremely advantageous to develop capabilities for housing regulatory raw analytical data in an accessible repository (essentially a national data management system). If pursued, the system should not only encompass all the test reporting requirements outlined in this document but also encompass the requirements for analytical worksheet packages identified in Chapter 6.

Appendix 1: PFP Laboratory Science Workgroup Members

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Appendix 2: Abbreviations and Acronyms

AACC - American Association of Cereal Chemists

AAFCO - Association of American Feed Control Officials

AAVLD - American Association of Veterinary Laboratory Diagnosticians

AB - Accreditation Body

AFDO - Association of Food and Drug Officials

ALACC - Analytical Laboratory Accreditation Criteria Committee

AOAC - Association of Analytical Communities International

AOCS - American Oil Chemists' Society

APHA - American Public Health Association

APHL - Association of Public Health Laboratories

BAM - Bacteriological Analytical Manual (FDA)

CAC - Codex Alimentarius Commission

CDC - U.S. Centers for Disease Control and Prevention

CFIA - Canadian Food Inspection Agency

CFR - Code of Federal Regulations

CLIA - Clinical Laboratory Improvement Amendments

CLSI - Clinical and Laboratory Standards Institute

CODEX - Codex Alimentarius International Food Standards

CPGM - Compliance Program Guidance Manual (FDA)

DOE - U.S. Department of Energy

EAM - Elemental Analysis Manual (FDA)

EML - Environmental Measurements Laboratory (DOE)

EPA - U.S. Environmental Protection Agency

EPA DW Manual - Manual for the Certification of Laboratories Analyzing Drinking Water

FDA - U.S. Food and Drug Administration

FERN - Food Emergency Response Network

FSE - Fundamental Sampling Error

FSIS - Food Safety and Inspection Service (USDA)

FSMA - Food Safety Modernization Act

GEE - Global Estimation Error

GSE - Grouping and Segregation Error

HACCP - Hazard Analysis Critical Control Point

ICMSF - International Commission on Microbiological Specifications for Foods

ICUMSA - International Commission for Uniform Methods of Sugar Analysis

IFSS - Integrated Food Safety System

ILAC - International Laboratory Accreditation Cooperation

IOM - Investigations Operations Manual (FDA)

ISO/IEC - International Organization for Standardization/International Electrotechnical Commission

IT - Information Technology

IUPAC - International Union of Pure and Applied Chemistry

LCS - Laboratory Control Sample

LIMS - Laboratory Information Management System

LOD - Limit of Detection

LOQ - Limit of Quantitation

LRN - Laboratory Response Network

MARLAP - Multi-Agency Radiological Laboratory Analytical Protocols Manual

MCC - Methods Coordination Committee (FERN)

MLG - Microbiology Laboratory Guidebook (USDA)

MPM - Macroanalytical Procedures Manual (FDA)

MRA - Mutual Recognition Agreement

NELAC - National Environmental Laboratory Accreditation Conference

NSSP - National Shellfish Sanitation Program

OFVM - Office of Foods and Veterinary Medicine (FDA)

ORA - Office of Regulatory Affairs (FDA)

ORISE - Oak Ridge Institute for Science and Education (DOE)

PAM - Pesticide Analytical Manual (FDA)

PFP - Partnership for Food Protection

PT - Proficiency Test/s/ing

QA - Quality Assurance

QC - Quality Control

QSE - Quality System Essentials

QMS - Quality Management System

SOP - Standard Operating Procedure

SQC - Sample Quality Criteria

TNI - The NELAC Institute

TOS - Theory of Sampling

USDA - U.S. Department of Agriculture

USP/NF - United States Pharmacopeia and the National Formulary

Appendix 3: Definitions of Terms

Accreditation: Third-party attestation of a laboratory's demonstration of competence to perform specific testing activities in compliance with a nationally or internationally recognized standard.

Accreditation Body (AB): An independent entity that operates under ISO/IEC 17011 (*Conformity assessment – Requirements for accreditation bodies accrediting conformity assessment bodies*) and has the authority to accredit testing laboratories for conformance to ISO/IEC 17025. The AB should be a signatory to the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Agreement (ILAC MRA) to ensure it demonstrates competence to ISO/IEC 17011.

Analyte Integrity: The characteristic or concentration of the analyte of interest is maintained from selection of the primary sample through selection of the test portion.

Audit: Systematic and documented process for obtaining evidence and evaluating it objectively against a set of criteria (e.g., ISO/IEC 17025) to determine compliance with testing and quality procedures

Bias (Systematic Error): The tendency for a measurement to over- or under-estimate the actual (true) value. The mean of a bias (systematic error) is not zero.

Chain of Custody: Policies and procedures for formal chronological documentation that records the sequence of collection, custody, control, transfer, analysis, and disposition of physical (e.g. laboratory sample) or electronic evidence.

Comminution: Reduction of particle size by crushing, chopping, blending, grinding, etc.

Competence: Possession of required skill, knowledge, and qualifications to perform a task.

Correction: Action to eliminate a detected nonconformity; the immediate action taken to correct a problem; examples include making an adjustment, fixing a mistake, taking immediate remedial action, repeating analyses, recalibrating equipment.

Corrective Action: The long-term action taken to eliminate the cause(s) of an existing nonconformity (see nonconformity definition) as determined through root-cause investigation.

Custody Seals: An official closure, adhesive seal, or locking device that is affixed to the sample container after collection. The seal is affixed such that the sample material cannot be reached without breaking the seal or rupturing the container. Each time the seal is broken, a custody record should be kept. A new official seal may be affixed if the regulatory agency requires. If possible, broken seals should become part of the official documentation.

Data Integrity: The assurance that results reported by the laboratory are accurate, complete, and true representations of the laboratory sample and analysis.

Decision Unit: A material from which a sample is collected and to which an inference is made.

Deviation: A temporary change to a test method; requires a document to be prepared and approved; technical justification to demonstrate the ability to get the correct result and approval from the customer.

Document Control: A system to track, manage, and store documents, data, and software that support the laboratory's management system.

Evidentiary Integrity: The identification and authentication of the evidence.

Fit for Purpose: The ideal level of quality for data produced by a measurement process to enable a user to make technically and administratively correct decisions for a stated purpose.

Global Estimation Error (GEE): Estimate of the total errors in the entire measurement process, from primary sampling through final measurement.

Imprecision (Random Error): The tendency for a measurement to vary randomly, typically expressed as a variance or standard deviation. The mean of imprecision (random error) is zero.

Increment: A group of elements collected by a single operation of a sampling device and combined with other increments to make a sample. For some finite materials, an increment may consist of a single element.

Inference: The process of estimating a concentration or characteristic about a larger amount of material from data derived from testing a smaller amount of material.

Lot: A specific identified portion of a batch, having uniform character and quality within specified limits; or, in the case of a product produced by continuous process, it is a specific identified amount produced in a unit of time or quantity in a manner that assures its having uniform character and quality within specified limits (as defined by 21 CFR 210.3).

Mass Reduction Process: Selection of a smaller mass or volume of material from a larger mass or volume.

Measurement Uncertainty: Estimated value characterizing the dispersion of the values within which the measured quantity is likely to lie.

Method, Non-standard: This refers to a method that is not taken from standard sources. This includes methods from scientific journals and unpublished laboratory-developed methods.

Method, Standard: Standard methods are those published by international, regional, or national standards-writing bodies; by reputable technical organizations; in legal references; and in FDA published methods. The laboratory's procedures should be traceable to a recognized, validated method, if one is available.

Nonconforming Work: When one or more characteristics of a process fail to meet specified requirements including testing data, calibration data, and quality control/proficiency test failures.

Nonconformity: Departure, deficiency, nonconformance; the failure to properly follow written policies, procedures, instructions, etc.; or the nonfulfillment of a specified requirement.

Nonselection Process: Manipulation of a sample (e.g., comminution, removal of extraneous material, removal of water), usually performed before a selection process (e.g., mass reduction).

Proficiency Testing (PT): An independent and unbiased assessment of the performance of all aspects of a laboratory, both human and equipment/instruments; an analysis of samples of known value(s) obtained from approved providers to evaluate/monitor continuing acceptable performance. Also known as a check sample.

Quality Control (QC): Those activities that are performed during the analysis to fulfill the requirements for quality. Normally, quality control is applied to the full method, as opposed to just the final determinative step (e.g., using a "Laboratory Control Sample" (LCS) or reference materials).

Quality Management System (QMS): A structured documented system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for conducting work and producing items and services.

Records: Evidence that documents in the laboratory's quality management system have been followed; examples of records include completed worksheets, temperature logs, and completed chain of custody forms.

Reference Material: A material that is sufficiently homogenous and stable with respect to one or more specified properties and that has been established to be fit for its intended use in a measurement process and provides traceability.

Regulatory Action: When a governmental agency acts to enforce compliance with a law, administrative rule, or regulation adopted by a governmental agency, pursuant to authority conferred by law.

Regulatory Human and Animal Food Laboratory: A regulatory food laboratory that conducts measurements and tests that result in qualitative and/or quantitative analysis findings that may be used to interpret and enforce — and/or be used as evidence to determine whether there has been a violation of — a law, administrative rule, or regulation adopted by a governmental agency, pursuant to authority conferred by law.

Sample: A mass or volume of a material selected from larger mass or volume of material using the principles of Theory of Sampling (TOS). For clarity, the following modifiers are suggested for use with the word "sample":

Primary sample: The material selected from a decision unit.

Laboratory sample: The material received by the laboratory.

Analytical sample: The material from which the test portion is selected.

Test portion: The mass or volume of material selected from an analytical sample for a single test.

Replicate sample(s): Multiple samples collected under comparable conditions.

Split sample(s): Equal portions obtained by dividing a primary, laboratory, or analytical sample in its entirety.

Composite sample: Multiple laboratory samples, multiple analytical samples, or multiple test portions combined solely for analytical efficiency.

Sample Correctness: Exists when increment delimitation error (IDE) and increment extraction error (IEE) are controlled to a negligible level to provide for an equally probable chance of selection for all elements of a material.

Sample Quality Criteria (SQC): A series of statements that clarify program technical and quality requirements to support defensible decisions. These statements include the question to be answered, definition of the decision unit, and the desired confidence in the inference.

Sample Security: Physical security of samples prevents intentional adulteration or substitution of the laboratory sample. This ensures that the material collected remains representative of the product, and that it is usable as evidence in court.

Sampling Plan: Defines the purpose and frequency of sampling, the types of food/feed commodities, and the firms/locations that may be sampled.

Sampling Protocol: A detailed procedure for obtaining a representative sample from a specific decision unit that meets the sample quality criteria. The protocol includes appropriate mass, number of increments, sample correctness, quality control, and procedures for maintaining evidentiary integrity.

Scope of Accreditation: The fundamental document attesting to an organization's competence to perform test and/or calibration services; a detailed statement from the accrediting body of the activities for which a laboratory is accredited.

Selection Process: The act of selecting a smaller mass or volume of material from a larger mass or volume. There are two types of selection processes: mass reduction and splitting.

Standard Operating Procedure (SOP): A written document that details the method for an operation, analysis, or action with thoroughly prescribed techniques and steps, and that is approved as the method for performing certain routine or repetitive tasks.

Tamper-evident Packaging: A tamper-evident container, closure, adhesive seal, or locking device that is affixed to evidence.

Theory of Sampling (TOS): A set of principles that describe all errors contributing to the total sampling error (TSE) as well as techniques for estimation and mitigation of error to an acceptable level to meet sample quality criteria.

Total Sampling Error (TSE): Error from all nonselection and selection processes that causes the measured concentration or characteristic of interest of the test portion to deviate from the true concentration or characteristic of interest in the decision unit.

Traceability: Physical accountability ensures that the laboratory samples, test samples, test potions, test solutions, etc., are traceable. To support regulatory action, the life of the laboratory sample should be documented until final disposal, including all test samples and test portions.

Validation: The process of establishing the performance characteristics and limitations of a method and the identification of the influences that may change these characteristics and to what extent the method under consideration has performance capabilities consistent with what the application requires.

Verification: The process of demonstrating that a laboratory can execute a validated method with an acceptable level of performance.

Violation: A legal designation established through competent and substantial evidence that an action — including the manufacture or distribution of a product — or a lack of action constitutes a failure to adhere to the requirements of a law, administrative rule, or regulation adopted by a governmental agency, pursuant to authority conferred by law.