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How LIMS enables compliance with ISO 17025

Getting ahead of the latest FDA mandate

ThermoFisher SCIENTIFIC

Introduction

Increasingly complex global food chains have led to an escalation in foodborne illnesses, chemical contamination and adulteration food safety concerns in recent years. The World Health Organization reported in 2019 that an estimated 600 million – almost 1 in 10 people in the world – fall ill after eating contaminated food and 420,000 die every year. In addition to the risk of bacterial contamination at all stages of food production, chemical contamination occurs due to the pesticides and veterinary drugs which are increasingly relied upon to combat the significant threat of insects and disease to crop and livestock supplies. Food producers are therefore required to ensure bacteria, drug residues and contaminant levels fall within published acceptable limits. Industry and governmental bodies have responded to increased food safety concerns by strengthening legislation and regulations to better manage food safety.

The US Food Safety Modernization Act (FSMA) Section 103, entitled "Hazard Analysis and Risk-Based Preventive Controls," outlines the structure of a "preventive controls plan" based on the HACCP methodology. The main challenge of implementing these controls is dealing with the incredible volume of data they produce. A comprehensive HACCP program produces thousands of data points each day, and this data is only as useful as the system that manages them. One of the best solutions for managing this flow of data is a Laboratory Information Management System, (LIMS).

The International Organization for Standardization (ISO)[1] is an independent, non-governmental body that brings together experts from around the world to develop and share International Standards. ISO/IEC 17025[2], *general requirements for the competence of testing and calibration laboratories*, was developed by laboratory experts for any organization that performs testing, sampling or calibration and wants to demonstrate their ability to deliver reliable results. In 2017, the standard was updated to provide a more risk-based approach and has an increased focus on information technology, mainly in the use of systems, the provision of electronic test results, and the provision of electronic records.

The US Food and Drug Administration (FDA) has agreed to issue a final rule by February 2022, that the testing of imported food and addressing of identified or suspected food safety problems be conducted by laboratories that voluntarily become accredited and must comply with most aspects of ISO 17025. These regulations require laboratories to put controls and checks in place to ensure reliable testing procedures. To achieve this, a LIMS is necessary to help manage and control laboratory processes, to drive quality testing, and to achieve and maintain compliance.

This eBook will outline how Thermo Scientific™ SampleManager™ LIMS software can be applied to achieve ISO 17025 accreditation for food safety testing.

1. International Organization for Standardization. Available online: https://www.iso.org/what-we-do.html [Accessed May 2020]
2. ISO/IEC 17025. Available online: https://www.iso.org/files/live/sites/isoorg/files/store/en/PUB100424.pdf [Accessed May 2020]

Understanding ISO 17025

ISO provides the most used global standards across manufacturing today. Standards provide information on recommended processes, facilitate consistent practice and give customers confidence in product quality. ISO 17025 is the international reference for testing and calibration laboratories. It is used by organizations to demonstrate that they operate a quality management system and are technically competent to carry out the work that they do.

ISO/IEC 17025:2017 supersedes the 2005 version to match newer standards such as ISO 9001 (quality management), ISO 15189 (quality of medical laboratories) and ISO/IEC 17021-1 (requirements for audit and certification bodies). As modern-day laboratories shift towards the use of information and communication technologies, the standard now recognizes and incorporates the use of these systems and electronic records to aid in the production of electronic results and reports. The updated standard also includes a chapter on risk-based thinking which describes the commonalities with the latest version of ISO 9001:2015, *Quality management systems – Requirements.* The concept of the Plan-Do-Check-Act cycle is also carried through ISO 17025, ensuring regular testing of tools and processes and monitoring to confirm suitable operation. If any issues are found, processes are required to correct them and continual monitoring would confirm the success of such adjustments. This forms the basis of continual improvement for the organization.

Figure 1. The Plan-Do-Check-Act cycle. This cycle can be applied to HACCP testing in food production.

Across many of the process-oriented standards, ISO follows a consistent structure; (1) definition and context, (2) organization and leadership, (3) support, (4) operations, and (5) performance monitoring and improvements and its guidance is focused on:

Resource qualification and control (personnel, instruments, third party laboratories)

- Validated sampling and testing methods
- Accuracy of results including measurement uncertainty
- Traceability of results
- Incidents, deviations - including customer complaints
- Performance evaluation
- Improvements

A systematic and software-driven approach can alleviate lab, process and data management challenges, enabling laboratories to optimize their workflow, increase compliance and improve productivity by integrating laboratory instruments and equipment in and out of the

laboratory. SampleManager LIMS software provides a single user interface that enables standardization and eases compliance across multiple laboratories.

Let's step through how a LIMS, such as SampleManager LIMS software, can be used to achieve and maintain compliance to ISO 17025.

Food safety and quality control requirements can be set up to comply with ISO 17025 using SampleManager LIMS software. The solution provides consistent practice and control through its preconfigured workflows. Data visualization and reporting provide real-time information and intelligence through Manufacturing Execution Systems (MES) to enable optimized production. The use of incidents is widely used to manage deviations and drive continuous improvement.

Where standards provide guidance around testing procedures, analytical methods can be configured in SampleManager LIMS software to comply with ISO, United States Department of Agriculture (USDA)[1] and Codex Alimentarius standards[2]. Information on the execution, consistent practice and control can be ensured through the Laboratory Execution System (LES) in SampleManager LIMS software.

ISO 17025 processes in the laboratory map directly to capabilities in SampleManager LIMS software. These processes are the building blocks of the SampleManager LIMS software food safety and quality solution.

Test Methods and Laboratory Execution

Once received into the laboratory, samples are prepared for testing. Methods for preparation and testing are configured using analyses in SampleManager LIMS software, and the full method can be executed using the Laboratory Execution System (LES) to further drive process integrity. The Laboratory Execution System (LES) guides analysts through each step of a method to ensure compliance to the SOP and captures the complete process history (Figure 2). Standard methods for typical tests in food chemistry and microbiology are provided and act as templates for any additional tests that are required (Figure 3).

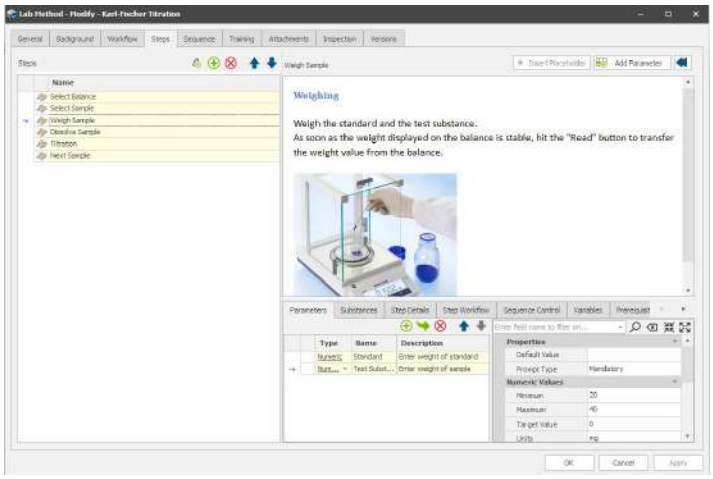


Figure 3. The LES steps users through SOPs using detailed images and instructions.

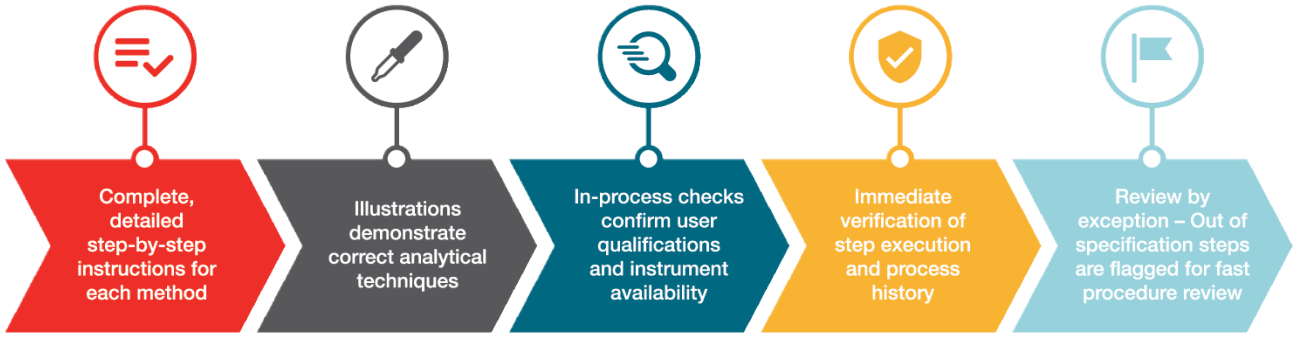


Figure 2. The benefits of the Laboratory Execution System (LES) in SampleManager LIMS software.

1. United States Department of Agriculture. Available online: https://fdc.nal.usda.gov/ [Accessed May 2020]
2. Codex Alimentarius standards. Available online: https://www.who.int/foodsafety/areas_work/food-standard/en/ [Accessed May 2020]

How SampleManager LIMS Software can be configured to achieve compliance to ISO 17025

Sections 1-3 cover the scope, references and terms of the standard. Section 4 details the general requirements of the laboratory while section 5 details structural elements. Section 6-8 in the standard can be supported by implementing a LIMS.

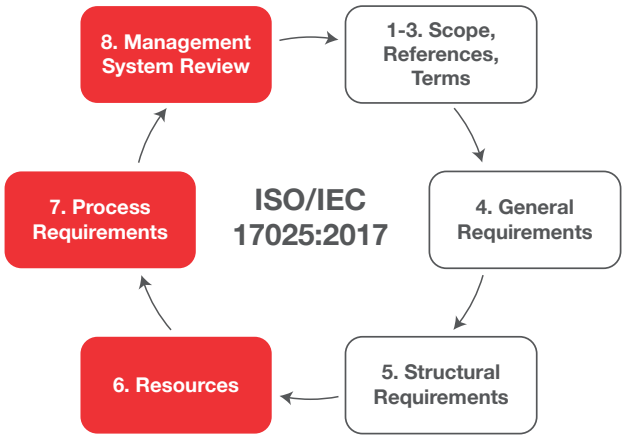


Figure 4. The eight sections of ISO 17025. Highlighted areas show that the LIMS is a critical component of sections 6-8.

Preconfigured Processes in SampleManager LIMS software

SampleManager LIMS software has functionality that is designed to support food and beverage laboratories. These features are developed under an ISO 9001:2017 compliant quality system (Table 1). Customers can leverage the testing done in the product release process as part of their risk-based assessment.

SampleManager LIMS software utilizes workflows to manage testing. This unique capability enables users to quickly

Table 1. A list of the software capabilities available in SampleManager LIMS software and the ISO 17025 section that each one relates to.

SampleManager LIMS software capabilities	ISO 17025 Reference
Resource compliance	6.2
Equipment use and availability	6.4
Instrument calibration	6.4
Reagents and stocks	6.4
Metrological traceability	6.5
Externally provided product and services	6.6
Test methods	7.2
Sampling	7.3
Handling of calibrated items	7.4
Technical records	7.5
Evaluation of measurement uncertainty	7.6
Ensuring validated results	7.7
Reporting results	7.8
Complaints	7.9
Non-conforming work	7.10
Control of data	7.11

build workflows which map to actual laboratory processes, automating decisions and actions and reducing the need for user intervention. Labs can easily adapt to new methods and process changes while simplifying initial system configuration, deployment and ongoing maintenance.

Figure 5. Users can quickly build workflows which map to actual laboratory processes

Complete laboratory processes are mapped during the implementation of SampleManager LIMS software. Each process can be broken down into reusable pieces that can be applied across testing and process workflows (Figure 5). SampleManager LIMS software is used widely in the food and beverage industry. By using the preconfigured capabilities in the LIMS designed for food testing, organizations can reduce project risk and expedite implementation and validation, leading to a faster time to value.

Section 6.2 - Personnel

Resource competence can be simplified through the LIMS by managing training records, roles and operator approval as shown below.

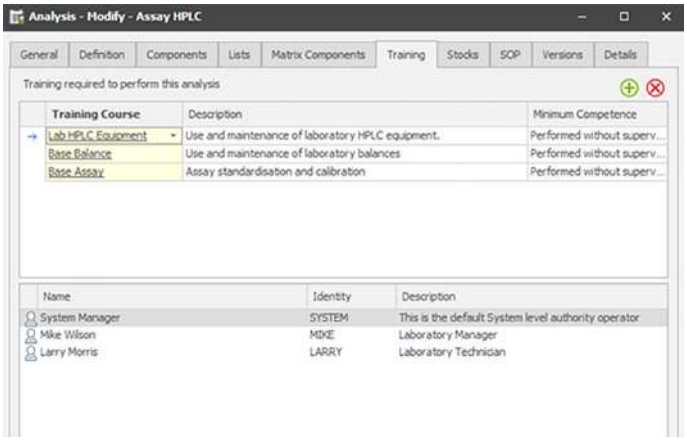


Figure 6. Training records outline the SOPs, instruments and equipment an analyst is authorized to use.

By managing the training records directly in the LIMS, the laboratory can ensure that testing is done by properly qualified analysts (Figure 6).

Section 6.4 - Equipment

The use of equipment is controlled through SampleManager LIMS software instrument records (Figure 7), so that only instruments that are verified as in service and calibrated can be used.

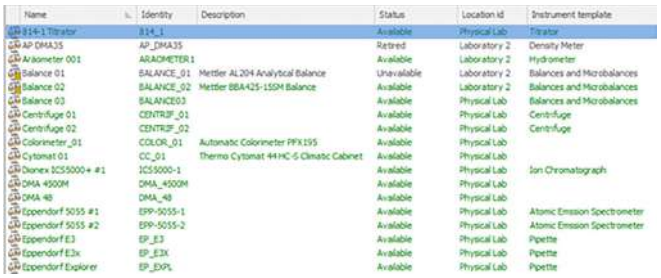


Figure 7. Instrument records allow the user to see if the instruments are authorized to be used.

Section 7.3 - Sampling

In food safety and quality, there are two distinct sample lifecycles: environmental monitoring and quality control (QC) samples.

To manage environmental monitoring, SampleManager LIMS software data and trends are used as part of a hazard analysis to identify critical control points (Figure 8). These CCPs are set up in SampleManager LIMS software as sample points within locations such as plants and rooms, and related samples are added to the LIMS test schedule. When samples are logged into the LIMS, each sample is associated with the CCP test limits for each analysis as defined in the specification.

Figure 8. LIMS visualization tools for hazard analysis, this figure shows air contamination results by sample point in SampleManager LIMS software.

QC samples are taken at various stages of the manufacturing process and all results are associated with the final product release. As ingredients are received, specific testing rules can be defined to reduce testing for trusted suppliers. QA/QC samples are largely event driven and may be manually logged into SampleManager LIMS software or automated and triggered through manufacturing systems. The rules that control sampling and sampling

What are sample plans?
Sample plans are set up with manufacturing and the sample lifecycle starts when it is taken in production and sent to the laboratory for analysis.

Login plans and testing in SampleManager LIMS software control the sample entry using templates. This enables the sample to be uniquely identified, labelled and assigned specific tests based on rules. The next step in the lifecycle is to receive the sample into the laboratory for testing.

procedures are set up in the login plan using the materials tables for the product being manufactured.

Section 7.4 – Handling of Test or Calibrated Items

Inspection plans can be set up in SampleManager LIMS software to manage calibration schedules for instruments and equipment (Figure 9). In the event of calibration failure, an incident can be raised to ensure the issue is resolved satisfactorily.

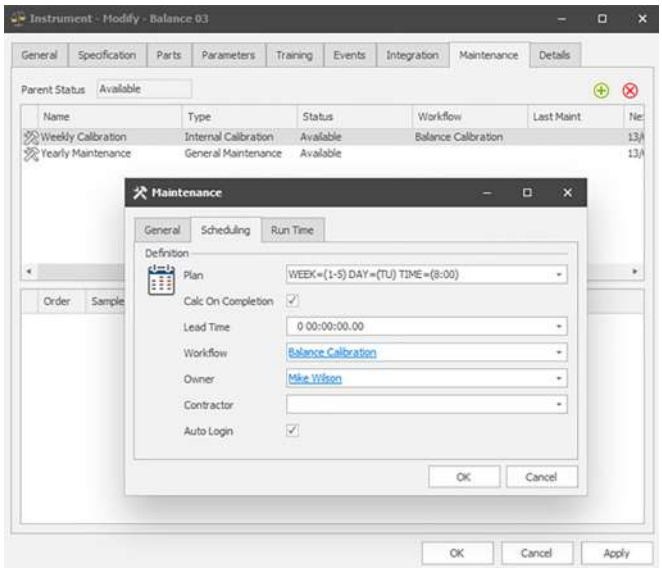


Figure 9. Instrument and equipment calibration schedules.

Section 7.5 - Technical Records

SampleManager LIMS software enables records to be made and kept according to ALCOA+ principles, preserving data integrity throughout lab processes. Often used in the pharmaceutical industry, ALCOA+ can be applied in food and beverage environments to ensure data traceability from raw ingredients to finished product. Data is reviewed and any changes made are fully recorded though version control and are traceable in the audit history.

Section 7.6 - Evaluation of Measurement Uncertainty

Measurement uncertainty factors can be assessed for each analysis and the resultant SOP updates made in the Laboratory Execution System to drive improved control of testing. SampleManager LIMS software's Statistical Quality Control (SQC) module provides the capability to

Figure 10. The Statistical Quality Control (SQC) module.

monitor day to day processes over time, and ensure they are within statistical control measures (Figure 10). Shewart rules, used to distinguish between variations due to sporadic or inherent causes in manufacturing processes, are applied to create charts with multiple options available to fit business needs.

The trend analysis tool allows the user to define trends based on certain criteria for use in all QC charts. Within SQC, the trend editor allows the user to build their own trend analyses based on a series of rules. Trend rules can then be tied into SampleManager LIMS software workflows to trigger actions based on statistical results, for example if a process appears to be going out of statistical control, an alert can automatically be sent to a process or operations manager.

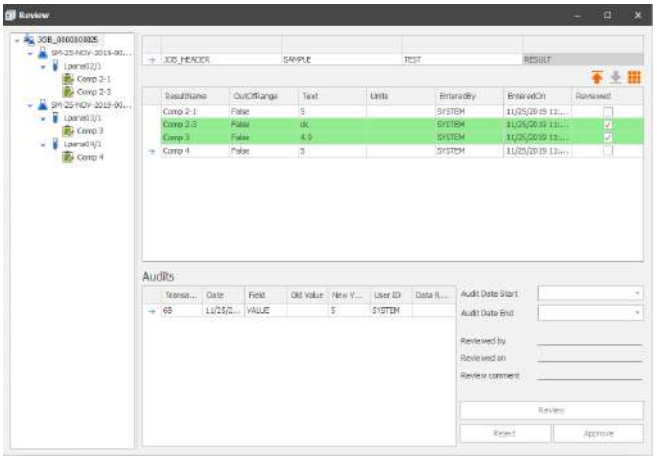


Figure 11. The Review and Approval module in SampleManager LIMS software.

Section 7.7 - Ensuring Validity of Results

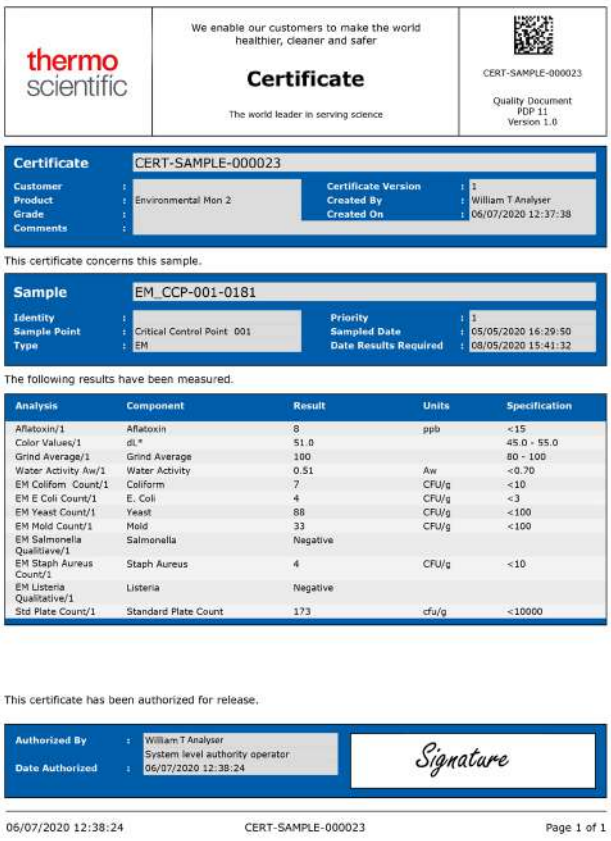
In the event that control charts indicate a process is moving out of control, incidents can be raised in SampleManager

LIMS software to investigate and address the issue. Incidents can outline and drive any corrective action which needs to occur. KPIs related to incidents can be tracked in the LIMS to demonstrate testing performance.

Section 7.8 – Reporting Results

The SampleManager LIMS software review and approval module is preconfigured and covers peer review at results level, supervisor test review and then QC sample review, as well as simultaneously facilitating the review of meta data (Figure 11).

Certificates of Analysis (CoAs) are a critical deliverable for manufacturing laboratories (Figure 12). LIMS makes it easy to generate CoAs. Any details stored in the LIMS can be included. Amendments are subject to version control and are fully tracked in the audit trail. Statements of conformity or opinion can be included specific to the results to which they apply. Calibration details including those around measurement uncertainty, conditions and any relevant repairs or adjustments can be added to certificates where required.



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We enable our customers to make the world healthier, cleaner and safer

Certificate

The world leader in serving science

CERT-SAMPLE-000023

Quality Document PDP 11 Version 1.0

Certificate	CERT-SAMPLE-000023		
Customer		Certificate Version	1
Product	Environmental Mon 2	Created By	William T Analyser
Grade		Created On	06/07/2020 12:37:38
Comments			

This certificate concerns this sample.

Sample	EM_CCP-001-0181		
Identity		Priority	1
Sample Point	Critical Control Point 001	Sampled Date	05/05/2020 16:29:50
Type	EM	Date Results Required	08/05/2020 15:41:32

The following results have been measured.

Analysis	Component	Result	Units	Specification
Aflatoxin/1	Aflatoxin	8	ppb	<15
Color Values/1	dL*	51.0		45.0 - 55.0
Grind Average/1	Grind Average	100		80 - 100
Water Activity Aw/1	Water Activity	0.51	Aw	<0.70
EM Colifom Count/1	Coliform	7	CFU/g	<10
EM E Coli Count/1	E. Coli	4	CFU/g	<3
EM Yeast Count/1	Yeast	88	CFU/g	<100
EM Mold Count/1	Mold	33	CFU/g	<100
EM Salmonella Qualitiave/1	Salmonella	Negative		
EM Staph Aureus Count/1	Staph Aureus	4	CFU/g	<10
EM Listeria Qualitative/1	Listeria	Negative		
Std Plate Count/1	Standard Plate Count	173	cfu/g	<10000

This certificate has been authorized for release.

Authorized By	William T Analyser System level authority operator	Signature
Date Authorized	06/07/2020 12:38:24	

06/07/2020 12:38:24 CERT-SAMPLE-000023 Page 1 of 1

Figure 12. The Certificate of Analysis created using SampleManager LIMS software.

Section 7.9 - Complaints

Customer complaints can be handled in SampleManager LIMS software using incidents to manage each case. Data surrounding the complaint can be analyzed and recorded in the incident record, which can be used to create and provide a full report.

Section 7.10 - Non-Conforming Work

Any incidents of non-conforming work are managed using incidents functionality in SampleManager LIMS software (Figure 13). Data surrounding the non-conformance is recorded along with any decisions around corrective action to resolve the issue.

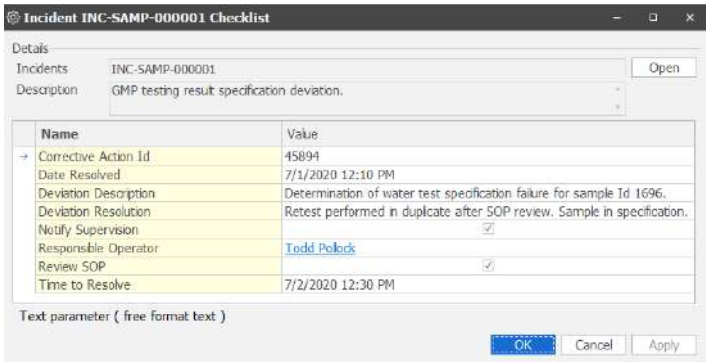

Figure 13. Incidents are used to manage non-conformances.

Section 7.11 - Control of Data and Information Management

SampleManager LIMS software provides analysts with all the data and information required to perform their tasks. Deployment includes validation to confirm that the system operates as specified and any calculations, data transfers and interfaces are all Operationally Qualified.

The system is protected against unauthorized access, tampering or loss. Data and information integrity is assured throughout. External support of SampleManager LIMS software conforms to the ISO 17025 standard, and instruction manuals and guides are provided in electronic format.

Section 8 - Management System Requirements

The records for many of the management system actions below are maintained and controlled in SampleManager LIMS, LES and SDMS software.

Data and statistical analysis can be performed to assess:

1. Resource performance
2. Training
3. Non-conformance by category
4. Complaints
5. Process usage

Any processes performed using the LES will provide statistical analysis such as frequency of use, average time to execute, etc. This information can be used with any related non-

conformances data to indicate process effectiveness and help identify opportunities for process improvement.

Summary

ISO 17025 outlines practices for the operation of laboratories to ensure reliable testing and quality results. SampleManager LIMS software can be configured to achieve and maintain compliance to ISO 17025, and many food and beverage organizations rely on preconfigured industry-standard workflows in the LIMS to drive efficiency, quality and productivity throughout their processes. Additionally, SampleManager LIMS software is fully configured to be 21 CFR Part 11 compliant out of the box, ensuring fully compliant electronic record, document and signature control.

Appendix

Achieving compliance to FDA 21 CFR Part 11

The FDA has a specific regulation for electronic records and electronic signatures called FDA 21 CFR Part 11, which is essential for accredited laboratories that wish to use electronic records and signatures as part of their workflow. SampleManager LIMS software is 21 CFR Part 11 compliant out of the box, with reference to the following:

1. Operator and user accounts controlled
2. User roles
3. Security groups
4. Password controls with expiry dates
5. Audit trail
6. Electronic signatures
7. Access log
8. System timeout

The Validation Process

SampleManager LIMS software must be validated to demonstrate compliance to ISO 17025 and 21 CFR Part 11, which requires three processes:

Installation Qualification (IQ) confirms that the software – as specified in the configuration specification – has been correctly installed.

Operational Qualification (OQ) confirms that the functionality of the software operates as intended, including any configurations and interfaces to confirm correct operation and data transfer.

Performance Qualification (PQ) requires testing of the user specification through operational processes to confirm that the system meets the specification requirements and that the users are competent in its operation.

The following documentation is required as evidence of the system's compliance to ISO 17025 and 21 CFR Part 11:

1. Customer User Requirements Specification (URS)
2. Requirements Trace Matrix (RTM) based on the URS
3. Functional Specification in response to the URS
4. Data Specification
5. Configuration Specification
6. Master Data Build Plan and Log
7. LIMS SOPs
8. IQ Report
9. OQ Report
10. PQ Report
11. Validation Log
12. Change Management Procedure

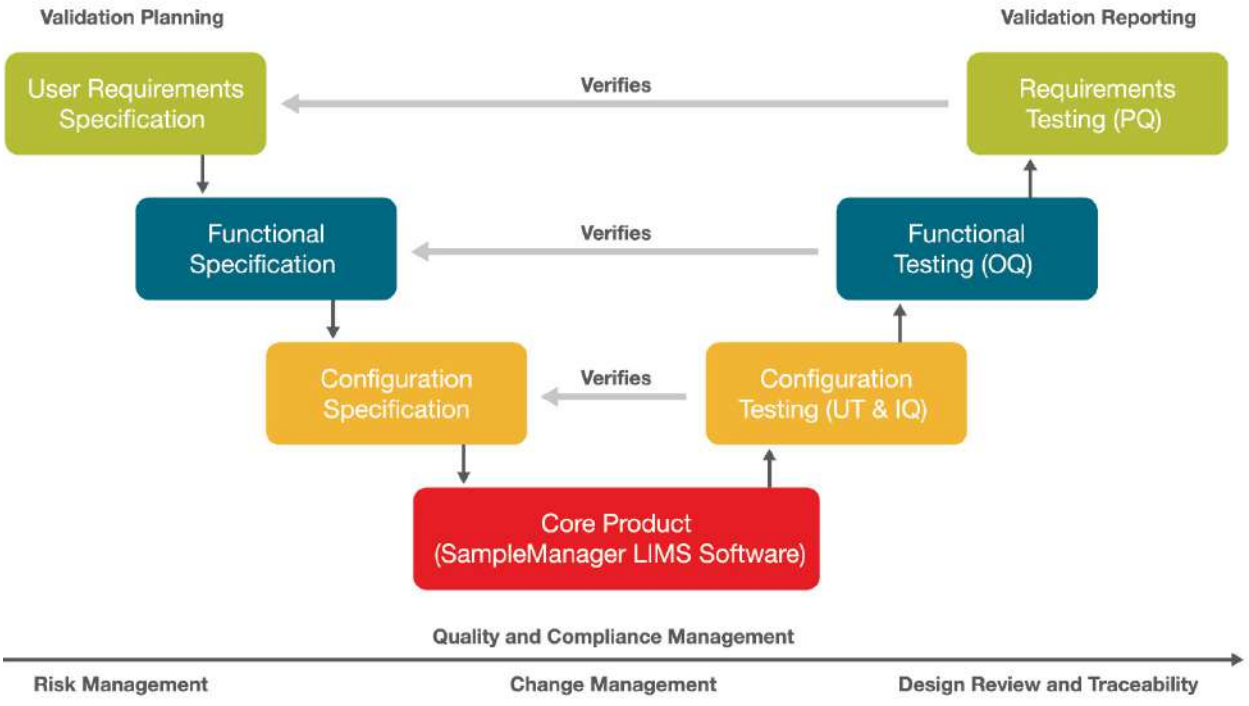

Figure 14: Validation planning and reporting for SampleManager LIMS software.

Data Integrity

Data integrity is a global regulatory issue that extends beyond Good Manufacturing Practice (GMP) to involve all aspects of science. In laboratories, 95% of data integrity issues occur due to poor data management and practice. It is vital that information used in day-to-day decision making is comprehensive, complete and reliable. The data on which these decisions are based should therefore be Attributable, Legible, Contemporaneous, Original and Accurate, as well as Complete, Consistent and Enduring. Together these basic principles are commonly referred as ALCOA+.

Static data must be loaded on to the system through a master data build plan. The source of the data, its risk assessment, mode of entry and verification should also be recorded.

Critical dynamic data points should be identified in the data specification to ensure that they are subject to ongoing review. It should be noted that data integrity also includes all the 21 CFR 11 features mentioned previously.

Supplier Compliance

The LIMS itself is an integral part of the laboratory's quality system. As a laboratory informatics supplier, Thermo Fisher Scientific develop, design and support their solutions within an ISO 9001 environment. This ensures a consistent practice to supply the best quality software solutions to their customers.

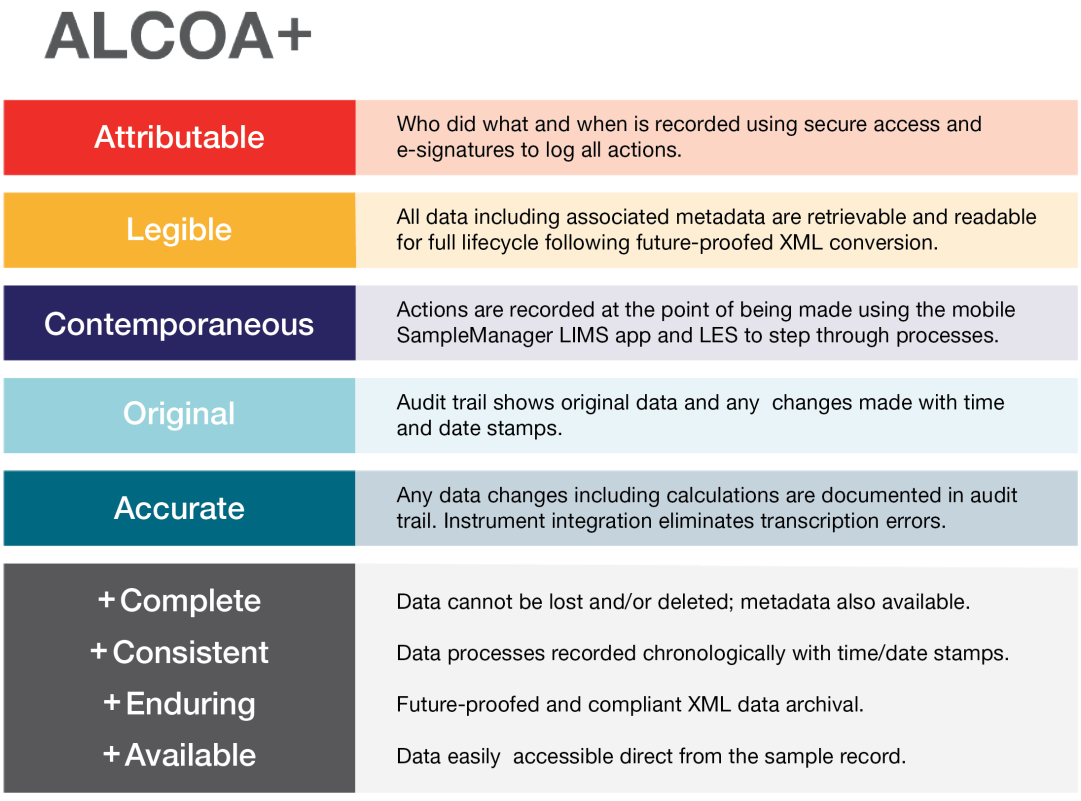

Figure 15. The ALCOA+ model. This model helps ensure data integrity in laboratories.

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