



SAFETY COMPLIANCE FACILITY SAMPLING AND TESTING TECHNICAL GUIDANCE FOR MEDICAL MARIJUANA PRODUCTS

Revised October 30, 2019

Supersedes October 25, 2019

This information is intended for Licensed Safety Compliance Facilities (SCF) regulated by the Marijuana Regulatory Agency (MRA)

Version 5.0

This information does not constitute legal advice and is subject to change. Licensees are encouraged to seek legal counsel to ensure their operations comply with the Medical Marijuana Facilities Licensing Act and associated Administrative Rules.

INTRODUCTION

MRA is committed to evidence-based decision-making when implementing technical guidance for licensed SCFs. As research into marijuana use and safety advances, this guide will be revised and updated to reflect the state of science as it pertains to the medical marijuana industry.

The sampling and analysis described in this guidance shall be conducted by an SCF accredited to the International Organization for Standardization (ISO) 17025 standards by an ISO 17065 accrediting body (Rule 47(9)(b) R 333.247). This accreditation demonstrates implementation of a quality management system which includes management support, quality procedures, internal audits, and corrective actions. In addition to the quality management system, technical matters such as the equipment calibration, traceability of controls, relevance of the method, and the validation data will be reviewed by the auditor. Verification of the performance of the method in the laboratory will be also required.

Analytical testing of medical marijuana for safety and potency is increasingly recognized as a critical and necessary component of the industry for several reasons (Freeman et al. 2016):

- Laboratory testing minimizes the risk of pesticides, microbes, heavy metals, molds, and residual solvents from being consumed by an immunocompromised population.
- Quantification of cannabinoid profiles and potency becomes available for the consumer and aids in determining appropriate dosing for individual use.
- Laboratory testing provides a sense of public safety and product quality for the tested medical marijuana.

Medical marijuana safety and potency is to be analyzed using testing methodology validated by an independent third party and approved by the agency. The quality control and quality assurance program must conform to ISO/IEC 17025 standards.

QUALITY ASSURANCE

In accordance with the MMFLA all SCFs must retain one employee with a relevant advanced degree in a medical or laboratory science. The MRA suggests that this person fill the role of a laboratory manager who is responsible for duties including, but not limited to:

- Ensuring tests are conducted in accordance with ISO 17025;
- Ensuring test results are accurate and valid;
- Overseeing day-to-day operations;
- Validating reporting requirements in the statewide monitoring system;
- Verifying conformity with ISO 17025;
- Any other duties required and published by the agency.

All results entered into the statewide monitoring system (METRC) must be valid and defensible. Compliance testing data should be made legally defensible by keeping thorough and accurate records. The quality assurance (QA) plan and/or standard operating procedures (SOPs) need to describe the policies and procedures used by the facility for record integrity, retention, and storage. The marijuana SCF must have a procedure for monitoring the validity of results. The resulting data must be recorded in such a way that trends are detectable and, where practicable, statistical techniques shall be applied to review the results. This monitoring should be reviewed by the laboratory manager/quality assurance manager and shall include, but not be limited to:

- Use of reference materials or quality control (QC) materials;
- Functional check(s) of measuring and testing equipment;
- Use of check or working standards with control charts, where applicable;
- Intermediate checks on measuring equipment;
- Review of reported results;
- Intra-laboratory comparisons (proficiency testing).

SCFs analyzing marijuana samples must adhere to any required QC procedures specified in the methods. This is to ensure that routinely generated analytical data is scientifically valid and defensible and is of known and acceptable precision and accuracy. To accomplish these goals, each laboratory should prepare a written description of its QA activities, included in a QA plan. It is the responsibility of the laboratory manager/quality assurance manager to keep the QA plan up to date. All laboratory personnel need to be familiar with the contents of the QA plan. A laboratory QA plan should be responsive to the items below while remaining brief and easy to follow.

At a minimum, the following items should be addressed in each QA plan:

Laboratory organization and responsibility

- Include a chart or table showing the laboratory organization and lines of responsibility, including QA managers;
- List the key individuals who are responsible for ensuring the production of valid measurements and the routine assessment of measurement systems for precision and accuracy (e.g., who is responsible for internal audits and reviews of the implementation of the plan and its requirements);
- Reference the job descriptions of the personnel and describe training to keep personnel updated on regulations and methodology, and document that laboratory personnel have demonstrated proficiency for the methods they perform;

Standard Operating Procedures (SOPs) with dates of last revision

- Maintain SOPs that accurately reflect all phases of current laboratory activities;
- Keep a list of SOPs;
- Ensure that current copies of SOPs are in the laboratory and in the QA Managers files;
- Ensure that SOPs are reviewed annually and revised as changes are made;
- Ensure that SOPs have signature pages and revisions dated.

Note: All SOPs must be approved by the MRA. If changes are made, please submit the updated SOP for review.

Field sampling procedures

- Describe the process used to collect samples including cleaning procedures;
- Ensure that appropriate forms are legibly filled out in indelible ink or hard copies of electronic data are available;
- Ensure that sampling protocol is written and available to samplers;
- Store unprocessed and processed samples at the proper temperature, isolated from laboratory contaminants;
- Maintain integrity of all samples (e.g., by tracking samples from receipt by laboratory through analysis to disposal utilizing the identification number from the statewide monitoring system).
- Require Chain of Custody (COC) procedures for samples.

Instrument calibration procedures (may reference SOP)

- Specify type of calibration used for each method and frequency of use;
- Describe calibration standards' source, age, storage, and labeling;
- Perform data comparability checks;

Analytical procedures (may reference SOP)

- Cite complete method;
- Describe quality control procedures required by the methods that need to be followed.

Data reduction, validation, reporting, and verification (may reference SOP)

- Describe data reduction process: method of conversion of raw data to reported unit of measure;
- Describe data validation process;
- Describe reporting procedures, include procedures and format;
- Describe data verification process;
- Describe procedure for data corrections.

*Type of quality control (QC) checks and the frequency of their use (may reference SOP)
Parameters for chemistry should include or reference*

- Instrument performance check standards;
- Frequency and acceptability of method detection limit (MDL) calculations;
- Frequency and acceptability of demonstration of low-level capability, calibration, internal and surrogate standards, laboratory reagent blank, field reagent blank, field, and laboratory matrix replicates;
- QC and proficiency testing samples;
- Laboratory fortified blank and laboratory fortified sample matrix replicates;
- Initial demonstration of method capability;
- Use of control charts;
- Qualitative identification/confirmation of contaminants.

Parameters for microbiology should include or reference

- Positive and negative culture controls;
- Proficiency testing and quality control samples.

Preventive maintenance procedures and schedules

- Describe location of instrument manuals and schedules and documentation of routine equipment maintenance;
- Describe availability of instrument spare parts in the laboratory;
- List any maintenance contracts in place;

Corrective action contingencies

- Describe response to obtaining unacceptable results from analysis of proficiency testing samples and from internal QC checks;

- Name persons responsible for the various corrective actions;
- Describe how corrective actions taken are documented.

Record keeping procedures

- Describe procedures and documentation of those procedures;
- List length of storage, media type (electronic or hard copy);
- Describe security policy of electronic databases.

QUALITY CONTROL REQUIREMENTS

When methods do not include quality control parameters, the agency has adopted the following requirements:

Annual Requirements

Demonstration of Capability (DOC)

- Each analyst must have a DOC which includes documentation they can accurately run each test;
- Documentation that an analyst has read and understands all appropriate SOPs and methods;
- Backup analysts should do this once a year or any time there is a reason to question competence;
- Competency assessments should be completed not less than annually including having staff run a previously reported sample from sample prep through result reporting to assure all staff are following the written SOPs.

Method Detection Limit (MDL)

- Run at least 7 samples at low levels following procedure outlined below, i.e. Daily Requirements.

Daily Requirements

Analytical Batch

- Must be clearly defined (e.g., every 10 samples or every 20 samples).

Laboratory Reagent Blank

- Checks for background contamination, should be the first on the sample run; a blank should also be run before and after a calibration check (CC) and initial calibration verification (ICV) /continuing calibration verification (CCV) and at the end of the run.

ICV/CCV

- ICV -Analyze a known concentration as a sample after calibration and before samples to verify; should also be done after every 10 samples;
- CCV-Analyze a known concentration at the end of all samples daily.

Laboratory Fortified Blank (LFB)

- Analyze a known standard.

Laboratory Fortified Matrix (LFM)/Laboratory Fortified Matrix Duplicate (LFMD)

- Analyze a sample with a known amount of standard added (spike);
- Add a known amount of standard to a sample and expect that amount to be added to your sample concentration and repeat process for LFMD;
- Calculate Relative Percent Difference (RPD) between spiked sample and spiked duplicate, target value should be close to the first value and have a small RPD (less than 20%);
- Spike volume should be less than 1% of the volume. Example: spike with 1 mL of 1000 mg/L into 100 mL sample will equal a 10 mg/L increase in concentration.

Duplicate

- Analyze the same sample twice - should be a set procedure (e.g., every 7th sample will be repeated in duplicate).

Control Charts

- Create and maintain control charts if you have 20-30 data points within 90 days.

Corrective Action

- Corrective actions must be included in the SOPs for each method and should include what to do if QC tests fail or are out of range;
- For example, if standards fail, re-calibrate and run test again.

QC Acceptance

- Include in the SOP for each method the acceptance ranges for standards, duplicates, spikes, etc. and make sure they match the method requirements

QC Acceptance Criteria* unless specified in the method

- LRB < MDL
- LFB \pm 15%
- ICV/CCV \pm 10%
- LFM/LFMD \pm 20%
- RPD < 20%
- Reporting limit = MDL Calculations
- % Recovery for LFB = $\frac{\text{LFB Result} \times 100\%}{\text{Expected Concentration}}$
- RPD – relative percent differences for duplicates and LFM/LFMD

$$\text{RPD} = (|\text{Num1} - \text{Num2}| / ((\text{Num1} + \text{Num2}) / 2)) \times 100$$
 Where,
 Num1= Original Number
 Num2= Second Number
- % Recovery for LFM – when using less than or equal to 1% spike volume compared to sample volume

$$\% \text{ Recovery} = \frac{\text{LFM Result} - \text{Sample Result} \times 100\%}{\text{Actual Concentration of spike}}$$

An enormous variety of definitions relating to detection limits and quantitation limits are used in the literature and by government agencies. Universally accepted procedures for calculating these limits do not exist. This can be frustrating and confusing for both regulators and the regulated community. The definitions below are not an attempt to resolve the confusion, but rather, an attempt to clarify the meaning of these terms as used by the agency.

Limit of Detection (LOD) or detection limit: The lowest concentration level that can be determined to be statistically different from a blank (99% confidence). The LOD is typically determined to be in the region where the signal to noise ratio is greater than 5. Limits of detection are matrix, method, and analyte specific. The LOD is approximately equal to the MDL for those tests which the MDL can be calculated.

Method Detection Limit (MDL): To calculate MDLs, please follow this [procedure](#). The minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte. The MDL procedure is designed to be a straightforward technique for estimation of the detection limit for a broad variety of physical and chemical methods. The procedure requires a complete, specific, and well-defined analytical method. It is essential that all sample processing steps used by the laboratory be included in the determination of the MDL.

Limit of Quantitation (LOQ): The minimum concentration or mass of an analyte in a given matrix that can be reported as a quantitative result. The LOQ must be at least 1/2

of the published action limit. The analyst should determine LOQs, when any change is made which could affect the LOQs, or more frequently if required by the method. In addition, the analyst must demonstrate low-level capability on an ongoing basis through an LOQ determination or repeated low-level analyses.

Low Level Quantitation: The laboratory's minimum reporting limits (MRL) should be reported to the client along with the data. The reporting limit must be below the agency's published action limits. Laboratories should run an LFB at their MRL every analysis day and should not report contaminants at levels less than the level at which they routinely analyze their lowest standard. It is important for users of data to understand the statistical and qualitative significance of the data.

Initial Demonstration of Capability (IDOC): Before beginning the analysis of samples, an (IDOC) must be performed. The IDOC includes a demonstration of the ability to achieve a low background, the precision and accuracy required by the method, and determination of the limit of detection (LOD) (see below). An IDOC should be performed for each instrument. It is also recommended that an IDOC be performed by each analyst. In addition, it is recommended that the IDOC also address the variability introduced if more than one sample preparation analyst is used. Precision, accuracy, and LOD should be similar for each technician.

Demonstration of Capability (DOC): Each analyst should have a file kept from where they have calibrated and analyzed four standards to demonstrate they can accurately run each test. In the file should be documentation (signed form) that the analyst has read and understands all appropriate SOPs and methods. Backup analysts should do this once a year. The analyst should recalculate DOCs when a change in the method, analyst, or instrument is made which could affect the precision, accuracy, or sensitivity. Minor changes should prompt a check to ascertain that the precision, accuracy, and sensitivity have been maintained.

Laboratory Reagent Blank (LRB): Depending on the method, the LRB may be appropriate for this. An LRB should be carried through the full analytical procedure with every sample batch. In general, results from LRBs should not exceed the laboratory's Minimum Reporting Limit (MRL), the lowest concentration of standard used for quantitation.

Calibration requirements: Calibration must occur not less than monthly. At the beginning of each day, samples are to be analyzed. A calibration curve composed of four or more points including all target analytes should be generated according to the approved SOP. Where the determinative time is extensive and the instrument is very stable, the calibration curve should be initially developed; thereafter, each day that samples are to be analyzed, this curve should be verified by analysis of a Calibration Check (CC) following the requirements listed below. The check must be +/- 10% of the known value.

Calibration Check (CC): This verification should be done at both the beginning and end of the analyses, including at least one standard for each of the target analytes at the expected concentration range. It is recommended that a calibration standard of one component of a multicomponent analyte also be analyzed each day or work shift. All checks must be within 10% of the known value or the instrument is to be recalibrated as specified in the calibration requirements.

Linear Calibration Range (LCR): The region of a calibration curve within which a plot of the concentration of an analyte versus the response of that particular analyte remains linear, and the correlation coefficient of the line is approximately 1 (0.995 for most analytes). The plot may be normal-normal, log-normal, or log-log where allowed by the analytical method. At the upper and lower bounds of this region (upper and lower limits of quantitation), the response of the analyte's signal versus concentration deviates from the line.

Laboratory Fortified Sample Matrix: Laboratory fortified sample matrix requirements in the methods must be met. If there are no laboratory fortified sample matrix requirements in the method, the following guidelines are to be used. The laboratory should add a known quantity of analytes to a percentage (to be described in the approved SOP) of the routine samples to determine sample matrix interference. The fortified concentration should not be less than the concentration of the sample selected for fortification unless specified by the method. If the sample concentration is unknown or less than detectable, the analyst should choose an appropriate concentration (e.g., a percentage of the published action limit or mid-point in the calibration range). Over time, samples from all routine sample sources should be fortified. The procedure should be described in the SOP. If any of these checks are not within the criteria specified in the method or control limits specified in this document, and the laboratory performance is in control, the result for that sample should be flagged to inform the data user that the results are suspect due to matrix effects.

Quantitation of Multicomponent Organic Analytes (pesticides, fungicides, miticides): The quantitation of multicomponent organic analytes requires professional judgment on the part of the analyst. This is required due to the complex nature of the chromatography involved, sample weathering, degradation, and interferences that may be present in the samples. The pattern of peaks found in the sample should be examined carefully and compared to a standard. The peaks in the sample that match the peak ratios in the standard can be used in quantitation. Peaks that have obvious interferences or peaks exhibiting poor peak shape or that appear to have been degraded or weathered should not be used for quantitation. A representative number (5-9) of peaks is suggested. Peak area should be used for quantitation and the analyst should ensure that the samples and standards have been integrated in the same manner. Quantitation can be done by using the total peak area or height (comparing the area of the 5-9 peaks used for quantitation of the sample to the area of the standard) or by calculating each peak separately (using area) and taking the average concentration of the 5-9 peaks. Because of factors such as peak shape and baseline rise, the most accurate quantitation is

obtained when the concentration of the sample closely matches that of the standard (e.g., within 20% of the standard).

Standard Operating Procedure Requirements

All testing, QA, and QC procedures must be documented in an SOP and must provide the information necessary for someone who is not familiar with the test to perform it:

- Step by step instructions as well as how to report the values;
- QC Acceptance Criteria and definition of a “Batch” (e.g., every 10 or 20 samples) and the minimum frequency of QC checks.

Validation Requirements

For analytical chemistry methods:

A laboratory validation is required to show that the method is fit for purpose for the intended matrix and that any modifications to the original method do not negatively impact performance. All test methods must be based on compendia or published methods. [AOAC Appendix K](#) must be followed and, at a minimum, validations must verify accuracy, precision, analytical sensitivity, analytical selectivity, limit of detection, limit of quantitation, reportable range, and the identification of interfering substances. All validations must be submitted to the agency for approval with a proficiency testing study where all analytes have passed. Validation protocols must include marijuana matrices (e.g., flower, infused products and concentrates).

For microbiological methods:

A laboratory validation is required to show that the method is fit for purpose for the intended matrix and that any modifications to the original method do not negatively impact performance. All test methods must be based on compendia or published methods. [AOAC Appendix J](#) must be followed and, at a minimum, validations must verify accuracy, precision, analytical sensitivity, analytical selectivity, limit of detection, limit of quantitation, reportable range and the identification of interfering substances. All validations must be submitted to the agency for approval with a proficiency testing study where all analytes have passed. Validation protocols must make use of inoculation of marijuana matrices with live organisms - not spiked DNA - using stressed or unstressed cells depending on the type of matrix, as the method validation is not complete unless both extraction and detection for the assay are tested. To further test the accuracy of the assay, probability of detection (POD) analyses, inclusivity, exclusivity, lot-to-lot stability, and robustness studies must be included in the validation studies. Methods adopted from a matrix specific standard method do not require complete reassessment, provided that the referenced media, primers, probes, antibodies, critical chemistries, etc., were not modified.

Potency

There is not a standard method for the quantitative analysis of cannabinoids. The following information may be helpful:

De Backer B., Debrus H., Lebrun P., Theunis L., Dubois N., Drock L., Verstraete A., Hubert P., Charlier C. (2009) Innovative development and validation of an HPLC/DAD method for the qualitative and quantitative determination of major cannabinoids in cannabis plant material. J Chromatography B Anal Technol Biomed Life Sci 877:4115-24.

- <https://doi.org/10.1016/j.jchromb.2009.11.004>

All testing must meet the standard method performance requirements listed below. For matrices not listed, the method performance requirements should be as close to the published Standard Method Performance Requirements (SMPRs) as possible, using standard analytical methods.

- [Concentrates: AOAC SMPR 2017.001](#)
- [Dried Plant Materials: AOAC SMPR 2017.002](#)
- [Edible Chocolates: AOAC SMPR 2017.019](#)

Please note: Rule 47(16) prohibits a safety compliance facility from desiccating samples prior to performing potency analysis.

Note: All compliance potency must conform to ISO/IEC 17025 standards for quality control and quality assurance, including the validation of matrices not listed here.

Residual Solvent Testing

All testing must meet the SMPRs for the adopted reference method.

- [United States Pharmacopeia \(USP\), 2008. "<467> Residual Solvents."](#)

Note: All compliance testing must conform to ISO/IEC 17025 standards for quality control and quality assurance, including the validation of matrices not listed here.

Chemical Residue Testing

All testing must meet the SMPRs listed below.

- [AOAC Official Method 2007.01](#) Pesticide Residues in Foods by Acetonitrile Extraction and Partitioning with Magnesium Sulfate- Gas Chromatography/Mass Spectrometry and Liquid Chromatography/Tandem Mass Spectrometry.
- [Pesticides: AOAC SMPR 2018.011](#)

Note: All compliance testing must conform to ISO/IEC 17025 standards for quality control and quality assurance, including the validation of matrices not listed here.

Heavy Metals

All testing must meet the standard method performance requirements for the adopted reference method.

- [United States Pharmacopeia \(USP\), 233](#)
- [Using EPA 3052 \(microwave digestion\) for the sample prep.](#)

Note: All compliance testing must conform to ISO/IEC 17025 standards for quality control and quality assurance, including the validation of matrices not listed here.

Water Activity

- ASTM D8196-18

Note: All compliance testing must conform to ISO/IEC 17025 standards for quality control and quality assurance, including the validation of matrices not listed here.

Moisture Content

- Loss on drying: Determined on 1.000g of the marijuana by drying in an oven at 105⁰C for two hours.

Note: All compliance testing must conform to ISO/IEC 17025 standards for quality control and quality assurance, including the validation of matrices not listed here.

Microbial Qualitative Presence/Absence

Concerning the testing of marijuana product for microbiological contaminants, there is a large pool of standard methods on which to draw. All microbiological methods employed should include applicable controls. Qualitative pathogen methods must confirm presumptive results as either positive or negative by the inclusion of a confirmation step.

Methods applicable to *Salmonella* spp., *E. coli* testing and *Aspergillus* spp.:

- Association of Analytical Communities (AOAC) 2019. "[Salmonella in Foods, 967.25.](#)"
- [Food/Drug Administration \(FDA\), 2016. Bacteriological Analytical Manual \(BAM\).](#)
- International Standards Organization (ISO), 2002. "ISO/TS 6579:2002."
http://www.iso.org/iso/catalogue_detail.htm?csnumber=29315.
- International Standards Organization (ISO), 2012. "ISO/TS 13136:2012."
http://www.iso.org/iso/catalogue_detail.htm?csnumber=53328.

- [Salfinger, Yvonne and Tortorello, Mary Lou, 2015. Compendium of Methods for the Microbiological Examination of Foods, 5th Edition. American Public Health Association.](#)
- [United States Department of Agriculture: Food Safety and Inspection Service \(USDA FSIS\), 2016. Microbiology Laboratory Guidebook.](#)
- Association of Analytical Communities (AOAC) 2019. “Total Coliform and E. Coli, [991.14](#), [998.08](#)”, with an appropriate confirmation step
- Qualitative PCR assays.
- USP [61](#), [62](#), [1223](#)

Microbial Quantitation

Methods applicable to total aerobic, total coliforms, total yeast and mold, and bile-tolerant gram-negative bacteria:

- Association of Analytical Communities (AOAC) 2019. “[Yeast and Mold Counts in Foods, 997.02.](#)”
- Association of Analytical Communities (AOAC) 2019. “Total Coliform and E. Coli, [991.14](#), [998.08](#)”
- USP [61](#), [62](#), [1223](#)
- Quantitative PCR assays.

Note: All compliance testing must conform to ISO/IEC 17025 standards for quality control and quality assurance, including the validation of matrices not listed here.

Foreign Matter/Filth Analysis

AOAC Official Method 970.74 Foreign Matter in Drugs (Leafy, Crude).

For further information regarding the use of a microscope, please refer to the [ORA Laboratory Manual, FDA Office of Regulatory Affairs](#). In Section 4, Microanalytical & Filth Analysis, please see 4.2.2. Microscopic Examination and Microscope Accessories. Within that section, please refer to Section B (Discussion, Part 1 C re: stereomicroscopes) as well as Section B (Discussion, Part 2 Fundamental Microscopic Techniques and Procedures, part a).

SAMPLING QUALITY ASSURANCE

In an effective testing program, standardized sampling procedures are an integral component to quality laboratory testing. The data generated from all analytical methods should be consistently reliable and legally defensible. To achieve this, method precision and accuracy measurements should be performed during the sample testing process. The guidance below will provide some best practices for the sample collection by the SCF.

According to Rule 47(9)(c) of the Administrative Rules, an SCF shall maintain internal SOPs. It is the responsibility of the SCF to define an SOP that minimizes both imprecision and bias and lists chronological steps that ensure a consistent and repeatable method.

The objective of a sampling procedure is to ensure the proper collection, clear labeling, proper preservation, careful transportation, and storage of samples by trained personnel for laboratory analyses. Collection of the sample is critical as it must be truly representative of the material being analyzed or the results will not be meaningful. SCFs should develop a statistically valid sampling method to collect a representative sample from each batch of marijuana product.

For detailed information regarding sample collection, please refer to "[Good Samples: Guidance on Obtaining Defensible Samples](#)" (Thiex 2015) or "[Sampling Cannabis for Analytical Purposes](#)" (Sexton 2013).

Education and Training for Samplers

Sampler Qualifications

Model qualifications for samplers of marijuana are:

- Physically able to perform the duties of a sampler;
- No conflicts of interest (e.g., a managerial employee collecting samples);
- Employed by the SCF;
- Able to pass initial and ongoing demonstrations of capability.

Prior to testing samples, a satisfactory initial demonstration of capability (IDOC) or competency assessment must be documented and approved by the laboratory manager for all samplers. The IDOC should include principles, procedures, and policies for sampling. The IDOC should be repeated:

1. Every time there is a change in personnel or method.
2. When the method has not been performed by the SCF or sampler within a 12-month period.

This procedure should employ one of the following approaches to demonstrating capability:

1. Comparison of replicate samples within a defined Relative Standard Deviation (%RSD).
2. Comparison of a sample collected to that of one collected by personnel with an existing IDOC within a defined Relative Percent Difference (RPD).

Thereafter, ongoing continuing demonstration of capability (CDOC) as per the quality control requirements referenced in the SOP should be done at least annually. The SCF

should have a documented procedure for performing the CDOC. The SCF should retain documentation verifying CDOC for each sampler and make this documentation available upon request.

Field Duplicates

Field duplicates are recommended for any marijuana sampling event. Field duplicates should be sampled in such a way as to replicate the primary sampling event and all requirements should be clearly outlined in the SCF's field sampling SOP. If the SCF opts to take an amount greater than 0.5% for the purposes of collecting a field duplicate, Rule 48(2)(f) permits them to do so.

Field Audits

The SCF should adopt an ongoing system for performing audits of field activities which the laboratory manager will oversee. Field audits should be conducted periodically and in accordance with a predetermined schedule and procedure. The goal of the field audit is to verify that the sampling events continue to comply with the requirements of the regulations and are being performed according to the SCF's sampling SOP. When field audit findings cast doubt on the effectiveness of the events or on the correctness or validity of the field sampling events, the associated SCF should take timely corrective action and notify customers in writing if audits show that test results may have been affected.

Auditing Checks

1. Using audit checklists:
 - Review sampling and performance records from the preceding year for deficiencies in the application of sampling protocol;
 - Observe the sampler conducting sampling procedures;
 - Have the auditor and sampler collect samples from the same harvest lot for evaluation and comparison of results.
2. Record any deficiencies and initiate corrective action.

Field Quality Control

Field sampling equipment should be certified clean prior to use by the SCF. Cleaning techniques will vary depending upon the desired analysis. In general, sampling equipment should be sterile for microbiology samples and clean for chemistry samples. The SCF should perform cleanliness checks on each batch of sampling equipment prior to taking that equipment into the field. Results from cleaning procedure tests must be below the reporting limit of the target analyte(s) for the associated analyses. If

cleanliness checks fail, the sampling equipment must be re-cleaned, sterilized, and retested.

Representative sampling should meet a 95% confidence level and limit sampling error. Increasing the number of sample increments to compensate for normal batch heterogeneity is the simplest means to achieve a representative sample.

Sample size

Rule 1 of the Administrative Rules defines the following terms:

(b) "Batch" refers to all marijuana product of the same variety that has been processed together and exposed to substantially similar conditions throughout processing.

(i) "Harvest batch" refers to a designated quantity of harvested marijuana, all of which is identical in strain and has been grown and harvested together and exposed to substantially similar conditions throughout cultivation.

Rule 48(2)(b) states that the sample size must be **sufficient to complete all analyses required** but **shall in no case be less than 0.5%** of the weight of the batch. The maximum batch size is 15 pounds. There is no maximum batch size for products which do not meet the definition of a harvest batch.

Rule 38(7) requires SCFs to have an adequate chain of custody (COC). The following information is what the agency has deemed adequate and must be included at a minimum:

- Marijuana facility where the samples were collected (name, address, and license number);
- Date and time products were sampled;
- Indication whether the samples are for retesting due to an initial test failure;
- If samples are for retesting, ensure that the product is not prohibited from retesting;
- Product type (e.g., buds, concentrate, infused product);
- Whether products are in final package, i.e., individually wrapped as the patient would receive them with or without labeling;
- Total mass of the source package and unique statewide monitoring system package tag;
- Total container number, # of sample increments, # of containers sampled
- # of sample containers collected;
- Unique statewide monitoring system package tag for the sample package including the total mass sampled;
- SCF license number;
- Sampler's signature;

- Signature from the marijuana facility where samples were collected. The signatures are attesting to the accuracy of the sampling information;
- Creation of a transfer manifest in the statewide monitoring system;
- Sampling Procedure ID and revision date.

Please ensure that all information is legible. Do not scribble or write over errors. Any errors should have one line through them with the initials of the person correcting the information, the date, and the time.

Sampling a Batch of Marijuana

1. Physically locate the batch to be sampled as well as the source package and tag information from the statewide monitoring system. **Please note: It is the responsibility of the SCF to take 0.5% of the batch. Each batch mass should be compared to the statewide monitoring system to ensure that the SCF has access to the entire batch of product.**
2. Review the container label information for batch number, producer, and other pertinent information. Each harvest batch should be separated into batches of 15 lbs. or less and must be assigned a source package tag in the statewide monitoring system. **Do not sample if the product is not in the statewide monitoring system or if the batch weight or details do not match.**
3. Determine the number of containers in the batch and the batch size. Verify the batch size for each container. **Do not sample if the batch size is unavailable, the harvest batch exceeds 15 pounds, or the batch weight does not match the information entered into the statewide monitoring system.**
4. Determine the number of containers from which sample increments must be collected using a random number generator.
5. Select the appropriate sampling tool to ensure that it reaches all portions of the container. **Please note: All samples must be collected in compliance with Rule 33(4) A marijuana facility shall ensure that the handling of marijuana product is done in compliance with current good manufacturing practice in manufacturing, packing, or holding human food, 21 CFR part 110.**
6. Collection instruments should be clean prior to use to prevent cross-contamination of sample increments. Sampling tools which appear to be dirty or otherwise compromised should not be used.
7. To prevent contamination, sampling tools should be cleaned and sealed at the SCF prior to use or may be cleaned in the field between batches using an appropriate solvent and decontaminant to prevent cross-contamination of batches during sampling. Where aseptic technique is required, please refer to the FDA Aseptic Sample guidelines ([Investigations Operations Manual Subchapter 4.3.6](#)) for information.
8. Visually inspect each test sample increment to assess uniformity.
9. If non-uniformity is identified, record observation in the sampling report. It is expected with marijuana to have variable sizes of flowers. When drawing sample increments, approximately equal amounts of product are to be taken with each

- probing and from each container. Care must be taken by the sampler to not damage the portion of the product which is not being collected.
10. Combine all sample increments to form the composite sample.
 11. Ensure enough sample increments are taken to meet sample size requirements for all analytical methods being performed.
 12. Seal and label the composite sample with the following minimum requirements:
 - Sample package tag assigned in the statewide monitoring system;
 - Sampling date and name of sampler;
 - Producer's license.
 13. Complete the COC form while onsite at the facility.
 14. The sample, COC, and manifest from the statewide monitoring system must be transported to the SCF using packaging appropriate for secure and timely transport.

Sampling for Retesting

1. As prescribed in Rule 46, an SCF may test or retest a sample to validate the results of a failed safety test except as indicated under subrule (2) of this rule.
2. A failed test sample must pass 2 separate retests consecutively to be eligible to proceed to sale or transfer. If both retests pass, the batch is out of quarantine and eligible for sale or transfer. If 1 or both retests fail, the marijuana product must be destroyed as provided in these rules. A failed safety test must include documentation detailing the initial failure and the corrective action in the statewide monitoring system.
3. Rule 48(2)(f) A marijuana safety compliance facility may request additional sample material from the same licensee from which the sample was collected for the purposes of completing the required safety tests as long as the requirements of this rule are met.

Each retest will be a new sample (unique tag assigned in the statewide monitoring system) and the sample must be enough in mass to perform the testing for the required parameter and must be chosen at random from the harvest batch.

4. Rule 46 (3) A marijuana product is **PROHIBITED** from being retested in all the following circumstances:
 - a) The marijuana product is in a final package.
 - b) A final test for chemical residue failed pursuant to these rules, the marijuana product is ineligible for retesting and the product must be destroyed.
 - c) A final failed test for microbials on marijuana-infused product is ineligible for retesting and the product must be destroyed.

Research & Development (R&D) Testing

All testing must be entered into the statewide monitoring system. The licensee will select R&D testing at the time of the sampling. After the testing is completed, you will select the following, aside from mycotoxins:

R&D Testing	Select R&D Testing Batch Result #1 "R&D Chemical Residue" enter the value found during analysis and then select pass or fail as the status. Result #2 "R&D Foreign Matter" enter the value found during analysis and then select pass or fail as the status. Result #3 "R&D Metals" enter the value found during analysis and then select pass or fail as the status. Result #4 "R&D Microbials" enter the value found during analysis and then select pass or fail as the status. Result #5 "R&D Moisture Content" enter the value found during analysis and then select pass or fail as the status. Result #6 "R&D Mycotoxins" enter the value found during analysis and then select pass or fail as the status. Result #7 "R&D Potency" enter the value found during analysis and then select pass or fail as the status. Result #8 "R&D Residual Solvents" enter the value found during analysis and then select pass or fail as the status. Result #9 "R&D Water Activity" enter the value found during analysis and then select pass or fail as the status.
-------------	--

If the sample passes, please enter pass. If the sample fails, please enter the failure(s) into the notes section. You do not need to enter individual results for each test. The sample status will always be "testing in progress". Once compliance testing is completed, the status will change to pass or fail. If R&D testing is performed after compliance testing, the sample will stay in "testing in progress" until the MRA provides approval to update the status of the package.

REQUIRED SAFETY TESTS AND ACTION LIMITS

MRA has established action limits based on the literature available. The laboratory shall report the results of the testing by indicating "pass" or "fail" on the Certificate of Analysis (CofA) and entering these results into the statewide monitoring system. All results will be reported in parts per million (PPM) unless specified.

Potency

The required potency tests include Tetrahydrocannabinol level (THC), Tetrahydrocannabinol acid level (THC-A), Cannabidiol (CBD), and Cannabidiol acid levels (CBD-A). SCFs can perform additional cannabinoids CBN, CBG, CBC, THC-V, CBD-V, CBG-A with approval from the agency.

For Concentrates and Flower:

Total THC and CBD values should be calculated and reported as follows:

$$\text{Total THC\%} = (\text{THCa} * 0.877) + \text{d9-THC}$$

$$\text{Total CBD\%} = (\text{CBDa} * 0.877) + \text{CBD}$$

For marijuana-infused products, the Delta-9-THC should be reported in mg/serving. If the item contains more than one serving, the mg/container also need to be included.

Terpene Testing

In accordance with Rule 47(18) A marijuana safety compliance facility may perform terpene analysis on a marijuana product using a method approved by the agency. There are no established safety standards for this analysis. The laboratory shall analyze a sample of marijuana or marijuana-infused product to determine whether the terpenoid profile of the sample conforms to the labeled content of terpenoid. The laboratory shall report the result of the terpenoid testing on the CofA, both as a percentage and in mg/serving. If the item contains more than one serving, the mg/container also needs to be included.

Chemical Residue

Rule 47(8) states that for the purposes of the chemical residue test, the agency shall publish a list of action limits. A marijuana sample that is at or below the action limit is considered to be a passing sample. A marijuana sample with a value that exceeds the action limit is considered to be a failed sample. Chemical residue testing will be performed for the published list of banned chemical ingredients. The action limits are provided in the table below. If a sample exceeds the published action limit, the sample will be documented as a fail in the statewide monitoring system. Action limits will be updated based on the limits of quantitation (LOQ) achievable by the SCFs. The list will be continually evaluated and updated based on available scientific and industry information, or if the federal government adds marijuana to 40 CFR part 180, subpart C, or the federal insecticide, fungicide, and rodenticide act, 7 USC 136 to 136y.

Table 1. List of Banned ingredients

Analyte	Chemical Abstract Services (CAS) Registry number	Action Limit (ppm)
Abamectin	71751-41-2	0.5
Acephate	30560-19-1	0.4
Acequinocyl	57960-19-7	2
Acetamiprid	135410-20-7	0.2
Aldicarb	116-06-3	0.4
Azoxystrobin	131860-33-8	0.2
Bifenazate	149877-41-8	0.2
Bifenthrin	82657-04-3	0.2
Boscalid	188425-85-6	0.4

Carbaryl	63-25-2	0.2
Carbofuran	1563-66-2	0.2
Chlorantraniliprole	500008-45-7	0.2
Chlorfenapyr	122453-73-0	1
Chlorpyrifos	2921-88-2	0.2
Clofentezine	74115-24-5	0.2
Cyfluthrin	68359-37-5	1
Cypermethrin	52315-07-8	1
Daminozide	1596-84-5	1
DDVP (Dichlorvos)	62-73-7	1
Diazinon	333-41-5	0.2
Dimethoate	60-51-5	0.2
Ethoprophos	13194-48-4	0.2
Etofenprox	80844-07-1	0.4
Etoxazole	153233-91-1	0.2
Fenoxycarb	72490-01-8	0.2
Fenpyroximate	134098-61-6	0.4
Fipronil	120068-37-3	0.4
Flonicamid	158062-67-0	1
Fludioxonil	131341-86-1	0.4
Hexythiazox	78587-05-0	1
Imazalil	35554-44-0	0.2
Imidacloprid	138261-41-3	0.4
Kresoxim-methyl	143390-89-0	0.4
Malathion	121-75-5	0.2
Metalaxyl	57837-19-1	0.2
Methiocarb	2032-65-7	0.2
Methomyl	16752-77-5	0.4
Methyl parathion	298-00-0	0.2
MGK-264	113-48-4	0.2
Myclobutanil	88671-89-0	0.2
Naled	300-76-5	0.5
Oxamyl	23135-22-0	1
Paclobutrazol	76738-62-0	0.4
Permethrins*	52645-53-1	0.2
Prallethrin	23031-36-9	0.2
Phosmet	732-11-6	0.2
Propiconazole	60207-90-1	0.4
Propoxur	114-26-1	0.2
Pyridaben	96489-71-3	0.2
Pyrethrins+	8003-34-7	1
Spinosad	168316-95-8	0.2
Spiromesifen	283594-90-1	0.2
Spirotetramat	203313-25-1	0.2

Spiroxamine	118134-30-8	0.4
Tebuconazole	80443-41-0	0.4
Thiacloprid	111988-49-9	0.2
Thiamethoxam	153719-23-4	0.2
Trifloxystrobin	141517-21-7	0.2

* Permethrins should be measured as cumulative residue of cis- and trans-permethrin isomers (CAS numbers 54774-45-7 and 51877-74-8).

+ Pyrethrins should be measured as the cumulative residues of pyrethrin 1, cinerin 1 and jasmolin 1 (CAS numbers 121-21-1, 25402-06-6, and 4466-14-2 respectively)

Residual Solvents

Action limits are based on the “International Conference for Harmonisation (ICH) Guideline Q3C (R5) on Impurities: Guidelines for residual solvents” and information provided by states with current marijuana programs.

Table 2. Action Limits for Residual Solvents

Solvent	CAS Number	Action Limit for Inhalation (ppm)	Action Limit for all other products (ppm)
1,2-Dichloroethane	107-06-2	2	5
Acetone	67-64-1	750	5000
Acetonitrile	75-05-8	60	410
Benzene	71-43-2	1	2
Butanes all isomers	106-97-8	800	5000
Chloroform	67-66-3	2	60
Ethanol	64-17-5	1000	5000
Ethyl acetate	141-78-6	400	5000
Ethyl ether	60-29-7	500	5000
Ethylene oxide	75-21-8	5	50
Heptane	142-82-5	500	5000
Hexanes all isomers	110-54-3	50	290
Isopropyl alcohol	67-63-0	500	5000
Methanol	67-56-1	250	3000
Methylene chloride	75-09-2	125	600
Pentanes all isomers	109-66-0	750	5000
Propane	74-98-6	2100	5000
Trichloroethylene	79-01-6	25	80
Toluene	108-88-3	150	890
Total xylenes (ortho-, meta-, para-)	1330-20-7	150	2170

Heavy Metals

Table 4 lists the heavy metals required with their associated concentration limits based on a 10 gram/day consumption of marijuana. Most were derived from [USP 232-Elemental Impurities-Limits](#).

Table 4. Heavy Metals Concentration Limits

Heavy metal	Action Limit for all Inhaled Marijuana (ppm)	Action Limit for other Marijuana products (ppm)
Lead	0.5	0.5
Inorganic Arsenic	0.2	1.5
Mercury	0.1	3.0
Cadmium	0.2	0.5
Total Chromium	0.6	2.0
Nickel	0.5	N/A
Copper*	3.0	N/A

*Copper is only a requirement for vaping products

Foreign Matter Analysis

Pests and other foreign matter including insects, metal fragments, and both organic and non-organic debris are found in food as well as tobacco products, and will likely also be detected in marijuana, particularly as manufactured products enter the marketplace. The FDA considers debris of this kind in food to pose a negligible health hazard but recognizes that quality and user experience is compromised. Because of this, the FDA has methods for monitoring (FDA 2013b), which can be consulted to compare standards for different food commodities.

The action limit for crude marijuana is not more than 5.0% of stems and not more than 2.0% of other foreign matter. Failures should be documented photographically. It is recommended that the SCF clearly outline calculation guidelines and ranges for total surface area contamination. Foreign matter analysis should be performed prior to all other testing, aside from microbials. The material remaining after Foreign Matter Analysis is acceptable for all chemical testing but should not be used for any microbial testing. The amount of marijuana or marijuana product used for testing should be no less than 30% of the total gram weight or total sample lot obtained for compliance testing.

In the case of marijuana flower, the allotted 30% should come from separate, intact buds.

1. The buds should be separated into no less than 10 increments. The results from which can be averaged together as total foreign matter contamination.
2. Dissection of nodes should be done whenever physically possible.

3. If dissection of distinct nodes is deemed unnecessary, due to the small and compact nature of the buds (“popcorn” buds), the buds then should be examined in their entirety and additionally cut in half to observe the inside portion.
4. In the case of marijuana trim, kief, concentrate or infused product, the calculation to determine 30% of the sampling batch should be included in the SOP.
5. Filth analysis should be performed at a low-power magnification.
6. Quantitation of filth should be done as a total surface area calculation. The laboratory-derived calculation should be included in the SOP.
7. If a sample fails for foreign matter, the laboratory should include a note in the statewide monitoring system listing all contaminants identified.

Analysis for Organic Matter

The 2% action limit is defined by approximate surface area (SA) and a detailed example of how this value is estimated can be found below:

1 node of an average sized marijuana bud has a total surface area of approximately 1.0 inch. It is reasonable to assume that there are approximately 5 nodes / 1-gram bud and an average surface area of 5.25 inches / 1-gram bud resulting in a total SA of 52.5 inches for 10, 1-gram buds of flower material.

It is recommended that the SCF determine average surface area for common pests and create an easy-to-use scale for identifying passing and failing samples. Total surface area for contamination by mold could be done by estimating total surface coverage by mycelia or as otherwise determined by the SOP.

Analysis for Inorganic Matter

For these purposes, inorganic matter includes, but is not limited to, any material that would not normally be found on a living organism (plant) and includes materials such as glass, metal shavings, or synthetic fibers. In this case, the presence of any inorganic matter on any marijuana plant, concentrate, or infused product would result in an automatic failure for foreign matter. The observed matter should be documented photographically, and a note of the results should be included in the notes entered into the statewide monitoring system.

Moisture Content of Dry Material (Crude Marijuana After Packaging)

Not more than 15%.

Water Activity (Aw)

Water activity (Aw) is a measure of the available water that can be utilized for microbiological growth. Aw ranges from 0 to 1 with microbial growth unlikely below Aw

0.6. Most marijuana is dried and cured to a final water activity level of Aw 0.3-0.6. Most pathogens cannot grow below Aw 0.9 (Holmes et al. 2015).

- A marijuana sample shall be deemed to have passed water activity testing if the water activity does not exceed 0.65 Aw.
- An **edible** marijuana-infused product shall be deemed to have passed water activity testing if the water activity does not exceed 0.85 Aw.
- Non-edible marijuana-infused products are not subject to water activity testing.
- If the water activity is controlled to 0.85 or less in the finished product, it is not subject to the regulations of [21 CFR Parts 108, 113 and 114](#).

Microbial Limits

The criteria for acceptability are in Table 3 (below). Any detection that exceeds the published action limit is considered a fail.

Table 3. Microbial Screening Action Limits (CFU/g)

	Total Yeast and Mold Count	Total Coliform	Shiga toxin-producing <i>E. coli</i> (STEC)	<i>Pathogenic Salmonella spp.</i>	<i>Aspergillus flavus, fumigatus, niger & terreus</i>
Bud, Shake/Trim	10,000	1000	Not detected in 1 gram	Not detected in 1 gram	If <i>Aspergillus spp.</i> are detected, the sample fails
Infused Products	10,000	100			
CO2 and solvent-based extracts	1,000	100			

Homogeneity

Please refer to this [bulletin](#) for guidance.

Proficiency Testing

Rule 47(10) requires the agency to establish a proficiency testing program and designate SCF participation. An SCF shall analyze proficiency test (PT) samples using the same procedures with the same number of replicate analyses, standards, testing analysts and equipment as used for marijuana product testing. If the PT varies from normal sample preparation this must be documented in the SOP. The PT testing must

be rotated through all analysts who perform the testing. PT testing is to be completed by one analyst; results must not be shared until the graded PT is returned to the SCF.

The following proficiency testing must be performed by SCFs annually:

- SCFs will need to complete one set of acceptable PT samples at a minimum for all tests performed. The samples must be from an approved third-party vendor.
- Any ISO 17043 accredited PT vendor may be used.
- For parameters where there are currently no commercially available PT samples, SCFs should send samples (as blind samples) to another licensed SCF who performs testing by the same or similar methodology. The results should then be compared. A passing grade for the PT requires a score of at least 80%.
- The agency will require unscheduled random testing of matrix matched samples to evaluate the overall performance of the SCFs not less than annually.

Copies of all proficiency testing results, both passing and failing must be sent directly to the agency for review from the PT vendor via email to MRA-compliance@michigan.gov.

Table 5. Marijuana Testing Requirements

	Bud, shake/trim from Harvest Batch	Marijuana Extract non-solvent & non-CO₂*	Marijuana Concentrate Solvent-based**	Marijuana Concentrate (Supercritical CO₂) no additional solvent used***	Marijuana-Infused Product
Moisture Content	√				
Homogeneity					√
Potency Analysis	√	√	√	√	√
Foreign Matter Inspection	√	√			√
Microbial Screen	√	√			√ Failed tests cannot be repeated
Water Activity	√				√ ****
Heavy Metal Screen	√	√	√	√	√ (If Extract or concentrate not previously tested)
Residual Solvents			√		√ (If Extract or concentrate not previously tested)
Chemical Residue Analysis	√ Failed tests cannot be repeated	√ Failed tests cannot be repeated	√ Failed tests cannot be repeated	√ Failed tests cannot be repeated	√ (If Extract or concentrate not previously tested) Failed tests cannot be repeated

*Extraction using ice water, rosin press or dry ice.

**Solvents are used in the extraction process including Butane, Ethanol/Isopropyl alcohol, etc.

***Extraction process without winterization where a solvent is used. This abbreviated testing ONLY applies to products created without the use of a solvent. Products that are winterized MUST follow the solvent-based testing requirements.

****Not required for non-edible marijuana product

APPENDIX A-DEFINITIONS

Accuracy – A combination of the bias and precision of an analytical procedure, which reflects the closeness of a measured value to a true value. (Standard Methods, 18th edition). For the purposes of laboratory certification, accuracy means the closeness of a measured value to its generally accepted value or its value based upon an accepted reference standard.

Action Limit – A numerical value expressing the maximum concentration of a substance which is allowed by the agency in marijuana product. These standards are toxicologically derived to protect human health. Analytical values above the action limit require the product to fail testing.

Analytical Sensitivity – The assay's ability to detect very low concentrations of a given substance. Analytical sensitivity is often referred to as the limit of detection (LOD). LOD is the actual concentration of an analyte in a specimen that can be consistently detected $\geq 95\%$ of the time.

Analytical Selectivity – The degree to which the method can quantify the target analyte in the presence of other analytes, matrices, or other potentially interfering materials. This is usually achieved by isolation of the analyte through selective solvent extraction, chromatographic or other phase separations, or by application of analyte-specific techniques such as biochemical reactions (enzymes, antibodies) or instrumentation mass spectrometry (MS).

Batch – All marijuana product of the same variety that has been processed together and exposed to substantially similar conditions throughout processing.

Bias – Provides a measure of systematic, or determinative error in an analytical method. Bias is determined by assessing the percent recovery of spiked samples. Historically, the term accuracy has been used interchangeably with bias, although many sources make a distinction between the two. (Standard Methods, 18th edition).

Calibration – Modern instrumental methods depend upon the comparison of a signal from the unknown concentration of an analyte to that from a known concentration of the same or similar analyte. The simplest calibration procedure requires preparation of a series of standard solutions from the reference material, by dilution of a stock solution, covering a reasonable range of signal response from the instrument. Four or more points, approximately equally spaced over the concentration range of interest, performed in duplicate but measured at random (to avoid confusing nonlinearity with drift) is a suitable calibration pattern. Fit the calibration line and plot the residuals as a function of concentration. An acceptable fit produces a random pattern of residuals with a zero mean.

Chain of Custody – The chronological documentation showing the collection, custody, control, transfer, analysis, and disposition of a sample.

CFU/g – Colony forming units per gram.

Harvest batch – A designated quantity of harvested marijuana, all of which is identical in strain and has been grown and harvested together and exposed to substantially similar conditions throughout cultivation.

Instrument Detection Limit (IDL) – The concentration equivalent to a signal, due to the analyte of interest, which is the smallest signal that can be distinguished from background noise by a particular instrument. The IDL should always be below the method detection limit, and is not used for compliance data reporting, but may be used for statistical data analysis and comparing the attributes of different instruments.

Interfering Substances – One that at the given concentration causes a systematic error in the analytical result.

Linear Calibration Range (LCR), or Range of Linearity – The region of a calibration curve within which a plot of the concentration of an analyte versus the response of that particular analyte remains linear and the correlation coefficient of the line is approximately 1 (0.995 for most analytes). The plot may be normal-normal, log-normal, or log-log where allowed by the analytical method. At the upper and lower bounds of this region (upper and lower limits of quantitation), the response of the analyte's signal versus concentration deviates from the line.

Limit of Detection (LOD) or detection limit – The lowest concentration level that can be determined to be statistically different from a blank (99% confidence). The LOD is typically determined to be in the region where the signal to noise ratio is greater than 5. Limits of detection are matrix, method, and analyte specific. The LOD is approximately equal to the MDL for those tests which the MDL can be calculated.

Limit of Quantitation or lower limit of quantitation (LOQ) – The level above which quantitative results may be obtained with a specified degree of confidence. The LOQ is mathematically defined as equal to 10 times the standard deviation of the results for a series of replicates used to determine a justifiable limit of detection. Limits of quantitation are matrix, method, and analyte specific.

Marijuana-Infused Product – Any product containing marijuana that is intended for human consumption in a manner other than smoke inhalation.

Marijuana Product – Marijuana or a marijuana-infused product, or both, as those terms are defined in the act unless otherwise provided for in these rules.

Marijuana Concentrate – A product derived from medical marijuana that is kief, hashish, bubble hash, oil, wax, or other product, derived from marijuana or that includes cannabinoids extracted from the plant by any means.

Method Detection Limit (MDL) – The minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte. The MDL procedure is designed to be a straightforward technique for estimation of the detection limit for a broad variety of physical and chemical methods. The procedure requires a complete, specific, and well-defined

analytical method. It is essential that all sample processing steps used by the laboratory be included in the determination of the method detection limit. To calculate MDLs please follow this [procedure](#).

Milligrams (mg) – A unit of mass equal to one thousandth (10⁻³) of a gram.

Precision – A measure of the random error associated with a series of repeated measurements of the same parameter within a sample. Precision describes the closeness with which multiple analyses of a given sample agree with each other and is sometimes referred to as reproducibility. Precision is determined by the absolute standard deviation, relative standard deviation, variance, coefficient of variation, relative percent difference, or the absolute range of a series of measurements.

Reportable Range – The upper limit of the reportable range will be set at the concentration of the highest standard tested which exhibited acceptable results for linearity, accuracy and precision. The lower limit of the reportable range will be set at the lowest standard tested which exhibits acceptable results

Reporting Limit – Arbitrary number below which data is not reported. The reporting limit may or may not be statistically determined or may be an estimate that is based upon the experience and judgement of the analyst. Analytical results below the reporting limit are expressed as "less than" the reporting limit. Reporting limits are not acceptable substitutes for detection limits.

Representative Sample – A sample obtained according to a sampling procedure designed to ensure that the different parts of a batch or lot or the different properties of a batch or lot are proportionally represented.

Sample Matrix, or Matrix – Defines the general physical-chemical makeup of a particular sample. Although the actual matrix of a sample varies from product to product, general classes of matrices include flower, concentrate, marijuana-infused product, etc.

Sample Standard Deviation, or Standard Deviation (s) – A measure of the degree of agreement, or precision, among replicate analyses of a sample.

Sample – An amount of medical marijuana collected by laboratory personnel from a licensee and provided to a safety compliance facility for testing.

Solvent – A substance that can dissolve another substance, or in which another substance is dissolved, forming a solution. Examples of solvents include water, acetone, turpentine and ethanol.

Statewide Monitoring System – METRC.

Statistical Outlier, or Outlier – An observation or data point that appears to deviate markedly from other members of the population in which it occurs. The presence of outliers must be verified using an approved statistical method, at the 1% significance level.

Target Analyte – A chemical the lab must test for to see if it is present in medical marijuana.

Validation – The process of demonstrating or confirming the performance characteristics of a method of analysis. The validation of a method of analysis results in the specification of various aspects of reliability and applicability. Changes to the validation will require revalidation.

Water Activity – The partial vapor pressure of water in a substance divided by the standard state partial vapor pressure of water.

REFERENCES

- Aldous K, Applen J, Fan Z, Fox M, Kassner S, Latshaw M, Nascarella M, Starr G, Swantek S, Verbrugge D. Guidance for State Medical Cannabis Testing Programs. Association of Public Health Laboratories. 2016 May.
- Farrer DG. Technical Report: Oregon Health Authority's process to decide which types of contaminants to test for in cannabis. Oregon Health Authority. 2015 December.
- Freeman K, McHenry M, Cats-Baril W, Grace T. Cannabis Testing for Public Safety- Best Practices for Vermont Analytical Laboratories. PhytoScience Institute, 2016 January.
- Holmes M, Vyas J, Steinbach W, McPartland J. Microbiological Safety Testing of Cannabis. Cannabis Safety Institute, 2015 May.
- International Council for Harmonisation. Guideline Q3C (R5) on Impurities: Guidelines for residual solvents. 2015 September.
- International Council for Harmonisation. Guideline Q3D Elemental Impurities: Guidance for Industry. 2015 September.
- International Council for Harmonisation. Guidance for Industry: Q1A(R2) Stability Testing of New Drug Substances and Products. 2003 November.
- Kagen, S., Kurup V., Sohnle, P., Fink, J. Marijuana smoking and fungal sensitization. J Allergy Clin Immunol. 1983 Apr;71(4):389-93. DOI: 10.1016/0091-6749(83)90067-2
- Osterbauer N, Krepps S, Sackett J, Holladay C, Wendt E, Wells D, Price S, Kristof J. Protocol for Collecting Samples of Usable Marijuana. ORELAP-SOP-001 Rev.3.0. 2016 December.
- Raber J, Elzings S, Kaplan C. Understanding dabs: contamination concerns of cannabis concentrates and cannabinoid transfer during the act of dabbing. The Journal of Toxicological Sciences. Vol. 40, No. 6, 797-803, 2015 September.

Sampling and Sample Handling Working Group FDA, AAFCO, AFDO, APHL, and Industry. (2015). GOODSamples: Guidance on obtaining Defensible Samples. <http://aaafco.org/Publications/GOODSamples>

Sexton M, Ziskind J. Sampling Cannabis for Analytical Purposes. BOTEK Analysis Corp. 2013 November.

Thiex N, Ramsey C, Bhikha R, Cook J, Crawford A, Danielson D, Graves Q, Hirt W, Hoffman G, Andujar L, McLaughlin M, McManus K, McMullen S, Montalbano A, Novotny L, Salfinger Y, Schroder B, Scott T, Stephens R. Guidance on obtaining defensible samples. GOODSamples: Sampling and Sample Handling Working Group. 2015 October.

Tchounwou P, Yedjou C, Patlolla A, Sutton D. Heavy Metals Toxicity and the Environment. Molecular, Clinical and Environmental Toxicology. Volume 101 of EXS, 133-164. 2012 April.

Upton R, Craker L, ElSohly M, Romm A, Russo E, Sexton M. Cannabis Inflorescence: Standards of Identity, Analysis, and Quality Control. American Herbal Pharmacopoeia. Revision 2014.

Unger P, Braunger R, Hudalla C, Holmes M, Sherman B. Standards for Cannabis Testing Laboratories. Cannabis Safety Institute. 2014 December.

Voelker R, Holmes M. Pesticide use on cannabis. Cannabis Safety Institute, 2015 June.

U.S. Pharmacopeia Convention (USP). Chemical Tests / 561 Articles of Botanical Origin. 2014 July.

ACKNOWLEDGMENTS:

Lori Dodson, MS, MT(ASCP)
Deputy Director/Director of Laboratory Compliance
Natalie M. Laprade Maryland Medical Cannabis Commission
State of Maryland
Maryland Department of Health