

Environmental Measurement

Glossary of Terms

January 11, 2010

The intent of this glossary is to define terms, commonly used in association with detection, quantitation, and calibration in environmental laboratories, which may be unfamiliar to the lay person. The definitions are taken from various sources noted in an appendix at the end of this document. Offices with definitions fairly unique to their programs are noted; otherwise, the definition is considered to be generally accepted across all Agency programs. Definitions have been grouped into sections of common use. A list of acronyms for the citations is included at the end of the document in an appendix, as well.

CALIBRATION TERMS

Calibration – Set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by material measure or a reference material, and the corresponding values realized by standards. (ORD) (OW/EAD) (OPP) (OW/TSC) (OAR/OAQPS) (DECA) (ORCR)

Calibration Blank – See Quality Terms Section.

Calibration Curve – The graphical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response. (ORD) (OW/EAD) (OPP) (OW/TSC) (OAR/OAQPS) (DECA) (ORCR)

Calibration Method – A defined technical procedure for performing a calibration. (ORD) (OPP) (ORCR)

Calibration Standard (CAL) – (1) A substance or reference material used to calibrate an instrument. (OPP) (ORCR) (2) A solution prepared from the dilution of stock standard solutions. The calibration solutions are used to calibrate the instrument response with respect to analyte concentration. (ORD) (OW/EAD) (OPP) (OW/TSC) (OAR/OAQPS) (DECA) (ORCR) (3) A solution prepared from the primary dilution standard solution and/or stock standard solution, and the surrogate analytes. The CAL solutions are used to calibrate the instrument response with respect to analyte concentration. (OW/TSC)

Calibration Verification (CV) Solution – A solution of method analytes, used to evaluate the performance of the instrument system with respect to a defined set of method criteria. (ORD) (ORCR)

Calibration Verification Standard (VER) – (1) The mid-point calibration standard that is used to verify calibration. (OW/EAD) (OPP) (OAR/OAQPS) (ORCR) (2) A known,

standard solution, often from a source different from the calibration standards that is used to verify that a calibration is accurate. (OPP) (ORCR)

Continuing Calibration Check (CCC) (or Continuing Calibration Verification [CCV]) – (1) An analytical standard prepared from the same source as the calibration standards that is analyzed periodically prior to, during, and/or after analysis of samples to verify the continued accuracy of an instrument calibration. (ORD) (OW/EAD) (OPP) (OW/TSC) (OAR/OAQPS) (OECA) (ORCR) (2) A calibration standard containing the method analytes and surrogate(s), which is analyzed periodically to verify the accuracy of the existing calibration for those analytes. (OW/TSC) (ORCR)

Dynamic Range – The range over which instrument response is used to produce analytical results. (ORD) (OW/EAD) (OPP) (OW/TSC) (OAR/OAQPS) (ORCR)

External Standard – A known amount of analyte that is analyzed separately from samples as part of a set of calibration standards. The response of the analyte in the sample is compared to the response of the analyte in the external standard for quantitation. (ORD) (OW/EAD) (OPP) (OW/TSC) (OAR/OAQPS) (ORCR)

Independent Calibration Verification (ICV) – An analytical standard used to verify calibration prior to analysis of samples. The ICV is obtained from a separate source than the calibration standards, but may be from a different lot from the same vendor. (ORD) (OW/EAD) (OPP) (ORCR)

Internal Standard (IS) – (1) A pure analyte (s) added to a sample, extract, or standard solution in known amount(s) and used to measure the relative responses of other method analytes and surrogates that are components of the same solution. The internal standard must be an analyte that is not a desired target analyte. (ORD) (OPP) (OECA) (ORCR) (2) A labeled compound used as a reference for quantitation of other labeled compounds and for quantitation of a native compound other than the compound of which it is a labeled analog. See Internal standard quantitation. (OW/EAD) (OW/TSC) (OAR/OAQPS) (ORCR)

Internal Standard Quantitation – A means of determining the concentration of (1) a naturally occurring (native) compound by reference to a compound other than its labeled analog and (2) a labeled compound by reference to another labeled compound. (OW/EAD) (OPP) (OW/TSC) (ORCR) (3) A calibration method that uses a labeled version of a target analyte or compound that is chemically similar to the target analyte as a reference to measure the response of the target analyte over a range of concentrations. (ORD) (OAR/OAQPS) (ORCR)

Isotope Dilution – A technique for mass spectrometric quantitation of an analyte of interest in which a stable isotope-labeled compound is used as both a surrogate and an internal standard for a non-labeled compound. The stable isotope-labeled compound is added to the sample that then undergoes preparation and analysis. Losses of the analyte during preparation and interferences during analysis should be mirrored in the isotope-

labeled compound, and thus should not have an adverse effect on quantitation. (ORD) (OPP) (OAR/OAQPS) (OECA) (ORCR)

Isotope Dilution Quantitation – A means of determining a naturally occurring (native) compound by reference to the same compound in which one or more atoms has been isotopically enriched. In isotope dilution, labeled compounds are often spiked into each sample and allow identification and correction of the concentration of the native compounds in the analytical process. (OW/EAD) (OAR/OAQPS) (ORCR)

Labeled Injection Internal Standard – A labeled compound spiked into the concentrated extract immediately prior to injection of an aliquot of the extract into the LC/MS/MS. (OW/EAD) (OAR/OAQPS) (ORCR)

Quality Control Sample (QCS) or Quality Control Check Sample – (1) A sample prepared from method analytes that are obtained from a source external to the laboratory and different from the source of calibration standards. The QCS is used to check calibration standard integrity. (OW/TSC) (2) See Quality Term Section for an alternative definition. (ORD) (OECA) (ORCR) (3) A sample containing all or a subset of the analytes at known concentrations. The QCS is obtained from a source external to the laboratory or is prepared from a source of standards different from the source of calibration standards. It is used to check laboratory performance with test materials prepared external to the normal preparation process. (OW/EAD)

Second Source Calibration Standard – A standard obtained or prepared from a source independent of the source of standards for the initial calibration that is used to verify the correctness of a calibration. The second source standard is used to prepare the Independent Calibration Verification sample. (ORD)

DETECTION LIMIT TERMS

A-posteriori Detection – A binary detection decision based upon the observed (net) signal and a definite criterion of detection. It corresponds to the critical level, L_c . (OW/TSC)

A-priori Detection – An estimate, based on a knowledge of the probability distribution of a net signal, of the detection capabilities of a given measurement process. It corresponds to the detection limit, L_D . (OW/TSC)

Detection – To have obtained experimental evidence that the analyte concentration is greater than zero. (ORD) (OW/EAD) (OPP) (ORCR)

Detection Limit (DL) – (1) See definition for Limit of Detection. (ORD) (OPP) (2) See Method Detection Limit. (OW/EAD) (OPP) (3) The minimum concentration of an analyte that can be identified, measured and reported with 99% confidence that the analyte concentration is greater than zero. This is a statistical determination of precision and accurate quantitation is not expected at this level. (OW/TSC) (OECA)

Instrument Detection Limit (IDL) – The minimum quantity of analyte of the concentration equivalent that identifies an analyte signal equal to three times the standard deviation of the background signal at the selected wavelength, mass, retention time, or absorbance line, etc. (ORD) (ORCR)

L_Q – See definition for Minimum Reporting Level. (ORD)

L_Q Quantitation Definitions – Quantification Limit (LQ): The smallest detectable concentration of analyte greater than the detection limit where the required* accuracy (precision & bias) is achieved for the intended purpose. (OW/TSC) (ORCR)

Limit of Detection (LOD)/Limit of Quantification (LOQ) – The LOD and LOQ concentrations are calculated by applying the compound's calibration curve to the noise response of a sample to obtain a value which is then multiplied by a factor of 3 for LOD (3 times of noise) and 10 for LOQ (10 times of noise). The responses of the analytes are not considered in this approach. Only the noise level is included in the calculation. In some cases, the concentration of the lowest calibration standard is treated as the LOQ. The LOD is not defined in this case, although the LOD is often assumed to be 1/3 of the LOQ. The lowest possible LOD and LOQ values are not critical in these cases. The rationale of this approach is that the expected analyte concentrations in the samples are high and above the lowest calibration concentration and knowledge of the actual LOD/LOA is not necessary. (OPP)

Limit of Detection (LOD) = Detection Limit (DL) = Method Detection Limit (MDL) – The minimum concentration of an analyte that can be identified, measured, and reported with 99% confidence that the analyte concentration is greater than zero. (ORD) (OPP) (OAR/OAQPS) (OECA)

Method Detection Limit – (1) The method detection limit (MDL) is defined as 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 is determined using the procedure at 40 CFR 136, Appendix B. (OW/EAD) (OPP) (2) See definition for Limit of Detection/Detection Limit/Method Detection Limits. (ORD) (OPP)

QUANTITATION LIMIT TERMS

Limit of Quantitation (LOQ) – See definition for Minimum Reporting Level. (ORD) (ORCR)

Minimum Level (ML) – A minimum level at which the analytical system shall give recognizable mass spectra (background corrected) and acceptable calibration points. See 40 CFR Part 136. (OW/EAD) (ORCR)

Minimum Reporting Level (MRL) – The minimum concentration that can be reported as a quantitated value for a target analyte in a sample following analysis. This defined concentration can be no lower than the concentration of the lowest calibration standard for that analyte, and can only be used if acceptable quality control criteria for the analyte at this concentration are met. (ORD) (OW/EAD) (OPP) (OW/TSC) (ORCR)

Practical Quantitation Level (PQL) – The lowest concentration that can be reliably measured within specified limits of precision and accuracy for a specific laboratory analytical method during routine laboratory operating conditions. (OPP)

Quality Control Sample (QCS) – (1) A sample made from standards or matrix and used to verify acceptability of the results for an analytical batch. Examples of quality control samples are method blanks, laboratory duplicates, laboratory control samples, and matrix spikes. (ORD) (OECA) (ORCR) (2) See Quality Term Section for an alternative definition. (OW/EAD) (OW/TSC)

Quantitation versus Quantification – These are considered equivalent and can be used interchangeably. Both are commonly used in the literature. (ORD) (OPP) (ORCR)

Reporting Limit – (1) The minimum value below which data are documented as non-detects. (OW/TSC) (OECA) (ORCR) (2) The minimum value of the calibration range. Analyte detections between the detection limit and the reporting limit are reported as having estimated concentrations. (ORD) (ORCR)

MISCELLANEOUS TERMS

Environmental Laboratory Advisory Board (ELAB) – A Federal Advisory Committee, with members appointed by EPA and composed of a balance of non-state, non-federal representatives, from the environmental laboratory community, and chaired by an ELAB member. (ORD) (OW/EAD) (OPP) (OAR/OAQPS) (ORCR)

National Environmental Laboratory Accreditation Conference (NELAC)* – A voluntary organization of State and Federal environmental officials and interest groups purposed primarily to establish mutually acceptable standards for accrediting environmental laboratories. (ORD) (OW/EAD) (OAR/OAQPS)

** Note: This organization was officially dissolved in January 2007, although some of the terminology and definitions established are still used today.*

National Environmental Laboratory Accreditation Program (NELAP)* – The overall National Environmental Laboratory Accreditation Program of which NELAC is a part. (ORD) (OW/EAD) (OAR/OAQPS)

** Note: This program is now managed as part of The NELAC Institute (TNI), since NELAC was officially dissolved in January 2007, although some of the terminology and definitions established are still used today.*

QUALITY TERMS

Blank – A specimen that is intended to contain none of the analytes of interest and which is subjected to the usual analytical or measurement process to establish a zero baseline or background value. (OW/TSC) (OAR/OAQPS) (OECA) (ORCR) Different types of blanks include:

- **Calibration Blank:** (1) A sample of analyte-free media which is used to establish the low range of a calibration. (ORD) (OAR/OAQPS) (ORCR) (2) A volume of reagent water or other reference matrix containing none of the analytes above the method detection limits. The calibration blank is a zero standard and can be used along with prepared standards to calibrate the instrument. (OW/EAD) (ORCR)
- **Equipment Blank:** A sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures. (OW/EAD) (OPP) (OECA) (ORCR)
- **Field Blank:** (1) Blank prepared in the field by filling a clean container with pure de-ionized water and appropriate preservative, if any, for the specific sampling activity being undertaken. (ORD) (OPP) (OSWER) (OAR/OAQPS) (OECA) (ORCR) (2) An aliquot of reagent water or other reference matrix that is placed in a sample container in the field, and treated as a sample in all respects, including exposure to sampling site conditions, storage, preservation, and all analytical procedures. The purpose of the field blank is to determine if the field or sample transporting procedures and environments have contaminated the sample. (OW/EAD) (ORCR)
- **Instrument Blank:** (1) A clean sample (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination. (ORD) (OECA) (2) See Method Blank. (OW/EAD) (ORCR)
- **Laboratory Blank:** See Method Blank. (ORD) (OW/EAD)
- **Laboratory Reagent Blank:** See Method Blank. (ORD) (OW/EAD)
- **Method Blank:** (1) A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses. (ORD) (OPP) (OAR/OAQPS) (OECA) (ORCR) (2) An aliquot of reagent water that is treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, labeled compounds, internal standards, and surrogates that are used with samples. The method blank is used to determine if analytes or interferences are present in the laboratory environment, the reagents, or the apparatus. Also, referred to as a reagent blank. (OW/EAD) (OAR/OAQPS) (ORCR) (3) For aqueous analysis, an unspiked or non-fortified reagent water sample which proceeds through the entire testing method, including all preparatory and determinative steps. (ORCR)
- **Preparation Blank:** See Method Blank. (OW/EAD)
- **Reagent Blank (or Method Reagent Blank):** (1) A sample consisting of reagent(s), without the target analyte or sample matrix, introduced into the analytical procedure at the appropriate point and carried through all subsequent

steps to determine the contribution of the reagents and of the involved analytical steps. (2) A sample consisting of reagent(s), without the target analyte or sample matrix, introduced into the analytical procedure at the appropriate point and carried through all subsequent steps to determine the contribution of the reagents and of the involved analytical steps to error in the observed value. (OPP) (OAR/OAQPS) (3) See Method Blank. (OW/EAD)

Data Quality Indicators (DQIs) – The quantitative statistics and qualitative descriptors that are used to interpret the degree of acceptability or utility of data to the user. The principal indicators of data quality are precision, bias, accuracy, representativeness, comparability, completeness, and sensitivity. (OW/EAD)

Data Quality Objectives – Qualitative and quantitative statements derived from the DQO Planning Process that clarify the purpose of the study, define the most appropriate type of information to collect, determine the most appropriate conditions from which to collect that information, and specify tolerable levels of potential decision errors. (ORD) (OW/EAD) (OPP) (OAR/OAQPS) (ORCR)

Graded Approach – (1) The process of basing the level of application of managerial controls applied to an item or work according to the intended use of the results and the degree of confidence needed in the quality of the results. (OW/EAD) (2) Because of the diversity of work conducted through procurements and assistance agreements, EPA recognizes that a “one size fits all” approach to quality specifications will not work. Therefore, the implementation of the EPA Quality System is based on a graded approach to indicate that quality systems for different organizations and programs will vary according to the specific objectives and needs of the organization. (OPP) (OAR/OAQPS) (ORCR)

Initial Precision and Recovery (IPR) (or Initial Demonstration of Proficiency [IDP] or Initial Demonstration of Capability [IDC]) – Four aliquots of a reference matrix spiked with all the analytes of interest and labeled compounds and analyzed to establish the ability of the laboratory to generate acceptable precision and recovery. An IPR is performed prior to the first time a given method is used and any time the method or instrumentation is modified. (ORD) (OW/EAD) (ORCR)

Instrument Performance Check (IPC) – (1) A quality control sample, which may be a blank or fortified with analyte that is used to verify instrument performance and calibration. (ORD) (OECA) (2) See Ongoing Precision and Recovery Standard (OPR). (OW/EAD)

Laboratory Control Sample – (1) A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes from the same source as the calibration standards. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system. (ORD) (OPP) (ORCR) (2) See Ongoing Precision and Recovery Standard (OPR). (OW/EAD)

Laboratory Duplicate – The analysis or measurements of the variable of interest performed identically on two sub-samples of the same sample, usually taken from the same container. The results from duplicate analyses are used to evaluate analytical or measurement precision and include variability associated with sub-sampling and the matrix, but not the precision of field sampling, preservation, or storage internal to the laboratory. (ORD) (OW/EAD) (OPP) (OW/TSC) (ORCR)

Laboratory Fortified Blank – See Laboratory Control Sample. (ORD) (OW/EAD) (OW/TSC) (ORCR)

Laboratory Fortified Sample Matrix – See Matrix Spike. (ORD) (OW/EAD) (OW/TSC) (ORCR)

Measurement Quality Objectives – Qualitative and quantitative statements of the overall level of uncertainty that a decision maker is willing to accept in results or decisions derived from measurements. MQOs/DQOs provide the statistical framework for planning and managing measurement plans consistent with the data user's needs. (ORD) (OW/EAD) (OPP) (OW/TSC) (OAR/OAQPS) (ORCR)

Ongoing Precision and Recovery Standard (OPR) – A method blank spiked with known quantities of analytes. Its purpose is to assure that the results produced by the laboratory remain within the limits specified in this method for precision and recovery. Also, referred to as a Laboratory Fortified Blank (LFB), Spiked Blank, or Laboratory Control Sample (LCS). (OW/EAD)

Performance Based Measurement System (PBMS) – A set of processes wherein the data quality needs, mandates, or limitations of a program or project are specified, and serve as criteria for selecting appropriate methods to meet those needs in a cost-effective manner. (ORD) (OPP) (OAR/OAQPS) (ORCR)

Quality Assurance – An integrated system of management activities involving planning, implementation, documentation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the client. (OW/EAD) (OPP) (OW/TSC) (OAR/OAQPS) (OECA) (ORCR)

Quality Assurance Audits – (1) Each project will be audited by a panel chaired by the Quality Assurance Officer or Coordinator and consisting of a Team Leader, the chemist(s) who worked on the project, and one chemist not associated with the project. (OPP) (2) A systematic and independent examination to determine whether quality activities and related results comply with planned arrangements and whether these arrangements are implemented effectively and are suitable to achieve objectives. (OW/EAD)

Quality Assurance Project Plan (QAPP) – A formal document describing in comprehensive detail the necessary quality assurance, quality control, and other technical

activities that should be implemented to ensure that the results of the work performed will satisfy the stated performance criteria. (ORD) (OW/EAD) (OPP) (OW/TSC) (OAR/OAQPS) (DECA) (ORCR)

Quality Control – (1) The overall system of technical activities whose purpose is to measure and control the quality of a product or service so that it meets the needs of users. (ORD) (OPP) (OW/TSC) (OAR/OAQPS) (DECA) (ORCR) (2) The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality. (OW/EAD) COMMENT: Took this from the EPA quality manual.

Quality Control Check Sample (QCS) – A sample containing all or a subset of the analytes at known concentrations. The QCS is obtained from a source external to the laboratory or is prepared from a source of standards different from the source of calibration standards. It is used to check laboratory performance with test materials prepared external to the normal preparation process. (OW/EAD) (OW/TSC)

Quality Control Sample – (1) An uncontaminated sample matrix spiked with known amounts of analytes from a source independent from the calibration standards. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system. This does not include matrix spikes or laboratory duplicates, which are also QC samples. (OW/EAD) (2) A solution of method analytes of known concentrations that is used to fortify an aliquot of Laboratory Reagent Blank (LRB) or sample matrix. The QCS is obtained from a source external to the laboratory is different from the source of calibration standards. It is used to check laboratory performance with externally prepared test materials. This is a Performance Evaluation Sample in other arenas. (ORD)

Spiked Blank – See Laboratory Control Sample or OPR. (OW/EAD)

Standard Operating Procedures (SOPs) – (1) A written document outlining an analytical method which provides a level of detail intended to allow advanced analysts or analysts familiar with the method outlined in the SOP to perform that analytical method. (OW/EAD) (OPP) (OW/TSC) (OAR/OAQPS) (DECA) (ORCR) (2) A written document which details the method of an operation, analysis or action whose techniques and procedures are thoroughly prescribed and which is accepted as the method for performing certain routine or repetitive tasks. (ORCR)

Note: ORD uses the term Operating Procedures (OPs) to describe written procedures used by a laboratory and SOPs to describe documents of procedures that are performed in the same exact manner by multiple laboratories. (ORD)

Systematic Planning – (1) EPA uses systematic planning to plan projects and link goals, cost and schedule, and quality criteria with the final outputs. Systematic planning ensures that all participants understand the needs and expectations of the customer and

the product or results to be provided by the supplier. (ORD) (OPP) (OAR/OAQPS) (ORCR) (2) A planning process that is based on the scientific method and is based on a common sense, graded approach to ensure that the level of detail in planning is commensurate with the importance and intended use of the work and the available resources. A systematic planning process is performed to ensure that all organizations and/or parties who contribute to the quality of the environmental program or use the results are identified and that they participate in this process. The systematic planning process also provides for direct communication between the customer and the supplier to ensure that there is a clear understanding by all participants of the needs and expectations of the customer and the product or results to be provided by the supplier. (OW/EAD)

Technical Systems Audit – (1) A thorough, systematic, on-site, qualitative audit of facilities, equipment, personnel, training, procedures, record keeping, data validation, data management, and reporting aspects of a system. (ORD) (2) A technical audit or assessment is a systematic and objective examination of a program or project to determine whether environmental data collection activities and related results comply with the project's quality assurance project plan and other planning documents, are implemented effectively, and are suitable to achieve its data quality goals. (OPP) (OAR/OAQPS) (ORCR) (3) A thorough, systematic, on-site, qualitative audit of facilities, equipment, personnel, training, procedures, record keeping, data validation, data management, and reporting aspects of program or project to determine whether environmental data collection activities and related results comply with the project's quality assurance project plan and other planning documents, are implemented effectively, and are suitable to achieve its data quality goals. (OW/EAD)

STATISTICAL TERMS

Accuracy – The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components, which are due to sampling and analytical operations; a data quality indicator. (ORD) (OW/EAD) (OPP) (OW/TSC) (OAR/OAQPS) (OECA) (ORCR)

Alpha, (α) (or False Rejection) – The tolerated probability of a “false positive” (i.e., Type I error). See False Positive. (ORD) (OW/EAD) (OPP) (OW/TSC) (OAR/OAQPS)

Beta, (β) (or False Acceptance) – The tolerated probability of a “false negative” (i.e., Type II error). See False Negative. (ORD) (OW/EAD) (OPP) (OW/TSC) (OAR/OAQPS)

Bias – The constant or systematic distortion of a measurement process, different from random error, which manifests itself as a persistent positive or negative deviation from the known or true value. This can result from improper data collection, poorly calibrated analytical or sampling equipment, or limitations or errors in analytical methods and techniques. (ORD) (OW/EAD) (OPP) (OW/TSC) (OAR/OAQPS) (OECA) (ORCR)

Degrees of Freedom – The total number of items in a sample minus the number of independent relationships existing among them; the divisor used to calculate a variance term; in the simplest cases, it is one less than the number of observations. (ORD) (OW/EAD) (OPP) (OW/TSC) (OAR/OAQPS) (DECA) (ORCR) *General explanation: Degrees of freedom refers to how many variables in a single system are free to vary independently. Degrees of freedom may be none (0) or many. A single variable algebraic equation has no degrees of freedom. This is because there is only 1 right answer for the system described by the equation. For example, for the equation, $x + 3 = 4$, x is 1. x cannot be anything else. For a 2 variable equation, there is one degree of freedom. One variable is “free” to be anything, but once the value for one variable is selected, the value for the second one is fixed. For example, for the equation, $x + y + 3 = 8$, x is free to vary. The chosen value of x might be 1 or 7 or 1.25 or -2-. But, as soon as the value for x is chosen, the equation becomes a single variable equation, and the value for y is fixed. If 3 is the value chosen for x , then y must equal 2.*

False Negative – (general definition) An analysis determines the absence of an analyte when it is actually present at or above a given concentration or limit. (statistical definition) An error of the second kind (type II error), which means failing to reject the null hypothesis when it is actually false. (ORD) (OW/EAD) (OPP) (OW/TSC) (OAR/OAQPS) (ORCR)

False Positive – (general definition) An analysis determines the presence of an analyte when it is actually absent at a given concentration or limit. (statistical definition) An error of the first kind (type I error), which means rejecting the null hypothesis when it is actually true. (ORD) (OW/EAD) (OPP) (OW/TSC) (OAR/OAQPS) (ORCR)

Hypothesis Test – A statistical procedure for determining if a sample provides sufficient evidence to reject or accept one statement regarding the population of interest in favor of an alternative statement. (ORD) (OW/EAD) (OPP) (OW/TSC) (OAR/OAQPS) (ORCR)

L_c DETECTION – LAYPERSON'S DEFINITIONS -

1. **Critical Value (L_c)** - The minimum result which can be reliably discriminated from a blank (for example, with a 99% confidence level). (OAR/OAQPS)
2. **Critical Value (L_c)** – The lowest result that can be distinguished from the blank at a chosen level, α , of statistical confidence. (OW/EAD) (OW/TSC)

L_D DETECTION – LAYPERSON'S DEFINITIONS -

1. **Detection Limit (L_D)** - The lowest true concentration that will almost always be detected.
2. **Detection Limit (L_D)** - The minimum detectable value is smallest amount or concentration of a particular substance in a sample that can be reliably detected by a specific measurement process. (OAR/OAQPS)
3. **Detection Limit (L_D)** - The minimum true concentration that will return a result above the critical value given a specific measurement process and confidence level. (OW/EAD) (OW/TSC) (OAR/OAQPS)

L_c DETECTION - STATISTICAL DEFINITIONS -

1. **Critical Value (L_c)** - Smallest measured amount or concentration of analyte in a sample that gives rise to a Type I error tolerance of alpha under the null hypothesis that the true amount or concentration of analyte in the sample is equal to that of a blank. (The alternative hypothesis is that the true amount or concentration of analyte is greater than that of a blank.) (OW/TSC)
2. **Critical Value (L_c)** - The minimum observed result such that the lower 100 (1-α)% confidence limit on the result is greater than the mean of the method blanks.

L_D DETECTION - STATISTICAL DEFINITIONS -

1. **The Minimum Detectable Value (L_D)** - Once L_c is established, L_D is the smallest concentration or amount of analyte at which the tolerance for Type II error is equal to beta.
2. **The Minimum Detectable Value (L_D)** - The lowest true concentration such that the frequency that the result is greater than L_c will be 100% (1-β). (OW/TSC)

Median – The middle number or center value of a set of data in which all the data are arranged in sequence. (ORD) (OW/EAD) (OPP) (OW/TSC) (OAR/OAQPS) (DECA) (ORCR)

Outlier – An observation that is shown to have a low probability of belonging to a specified data population; any item rejected by the sampler, analyst, or data reviewer, usually accompanied by an attendant explanation. (ORD) (OW/EAD) (OPP) (OW/TSC) (OAR/OAQPS) (DECA) (ORCR)

Percent Relative Standard Deviation (%RSD) – The standard deviation expressed as a percentage of the mean (i.e., the coefficient of variation). Mathematically, it is the standard deviation divided by the mean times one hundred percent. (ORD) (OW/EAD) (OPP) (OW/TSC) (OAR/OAQPS) (DECA) (ORCR)

Precision – The consistency of measurement values quantified by measures of dispersion such as the sample standard deviation. Precision must be defined in context – e.g., for a certain analyte, matrix, method, perhaps concentration, lab or group of labs. (ORD) (OW/EAD) (OPP) (OW/TSC) (OAR/OAQPS) (DECA) (ORCR)

Range – The difference between the minimum and the maximum of a set of values. (ORD) (OW/EAD) (OPP) (OW/TSC) (OAR/OAQPS) (DECA) (ORCR)

Type I Error – See Alpha and False Positive. (ORD) (OW/EAD) (OPP) (OW/TSC) (OAR/OAQPS) (ORCR)

Type II Error – See Beta and False Negative. (ORD) (OW/EAD) (OPP) (OW/TSC) (OAR/OAQPS) (ORCR)

Uncertainty – (1) The range of values that contains the true value of what is being evaluated at some level of confidence. (OW/EAD) (OPP) (OAR/OAQPS) (2) A measure of the total variability associated with sampling and measuring that includes the two

major error components: systematic error (bias) and random error. (ORD) (OECA) (ORCR)

Uncertainty, Expanded – Quantity defining an interval about the result of a measurement that may be expected to encompass a large fraction of the distribution of values that could reasonably be attributed to the measurement. (OAR/ORIA/NAREL)

Uncertainty of Measurement – A parameter associated with the result of a measurement that characterizes the dispersion of the values that could reasonably be attributed to the measurement. (OW/EAD) (OECA) (ORCR)

GENERAL ANALYTICAL METHOD DEFINITIONS

Analyst – Any individual who performs analytical methods and associated procedures and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality. (ORD) (OW/EAD) (OPP) (OAR/OAQPS) (OECA) (ORCR)

Analytical Batch – (1) Environmental samples that are prepared and/or analyzed together with the same process and personnel and using the same lot(s) of reagents. (OW/EAD) (OPP) (2) A group of samples, including quality control samples, which are processed together using the same method, the same lots of reagents, and at the same time or in continuous, sequential time periods. Samples in each batch should be of similar composition and share common internal quality control standards. (ORD) (ORCR)

Analytical Response – A numerical observation whose magnitude is related to the amount or concentration of the analyte in a sample. One or more analytical responses (as specified by a method) are used, in conjunction with a calibration curve or factor), to produce an analytical result. (ORD) (OW/EAD) (OAR/OAQPS) (ORCR)

Analytical Result – (1) A formal numerical estimate of the concentration of an analyte in a sample, which is obtained by carrying out once following the procedure specified in an analytical method. Note that a method may specify analysis of more than one portion of a sample in order to produce one analytical result. (OW/EAD) (2) A formal numerical estimate of the concentration of an analyte in a sample obtained by following the procedure specified in an analytical method. Note that a method may specify analysis of more than one portion of a sample in order to produce one analytical result. (ORD) (ORCR)

Audit – A systematic evaluation to determine the conformance to quantitative and qualitative specifications of some operational function, activity, or quality assurance panel. (ORD) (OW/EAD) (OPP) (OAR/OAQPS) (ORCR)

Blind Sample – A sub-sample for analysis with a composition known to the submitter. The analyst/laboratory may know the identity of the sample but not its composition. It is

used to test the analyst's or laboratory's proficiency in the execution of the measurement process. (ORD) (OW/EAD) (OPP) (ORCR) Different types of blind samples include:

- **Single Blind:** (1) A sample submitted to evaluate performance with concentration and identity unknown to the analyst. (OW/EAD) (ORCR) (2) A blind sample in which the concentration is unknown to the analyst, but is known to the provider. (OPP)
- **Double Blind:** (1) A sample submitted to evaluate performance with concentration and identity unknown to the analyst and laboratory. (ORD) (OW/EAD) (ORCR) (2) A blind sample in which the concentration is unknown to the analyst and the provider; acceptance limits are generally calculated from results received from double blind samples. (OPP)

Holding Times (or Maximum Allowable Holding Times) – (1) The maximum times that samples may be held, after the sample is taken, prior to analysis and still be considered valid or not compromised. (OW/EAD) (OPP) (OW/TSC) (OAR/OAQPS) (ORCR) (2) The maximum times that samples may be held, after the sample is taken prior to preparation and/or analysis and still be considered valid or not compromised. (ORD) (ORCR)

Incurred Compound – A compound that is present in a sample without addition by the laboratory. The compound may be essentially alien, but has been introduced to the bulk material at some point prior to the material being sampled. Recovery of added (e.g., spiked or fortified) compound may be different from incurred compound. (OPP)

Inter-laboratory Procedure Study – (1) A study where a centralized study design coordinator sends identical samples to multiple different laboratories for analysis. The resulting raw data are analyzed by the study design coordinator by a given procedure to provide estimates inter-laboratory accuracy, precision, and/or detection limits. (OW/EAD) (OPP) (OAR/OAQPS) (ORCR) (2) An inter-laboratory method validation study is a practical testing of the written method on identical materials, usually derived from split samples, by a number of laboratories. The study is not intended to evaluate laboratories; it is intended to evaluate method reproducibility among laboratories. Deviations from the inter-laboratory study protocol should be strongly discouraged, and any deviations that occur should be documented. Participating in Inter-laboratory Comparison Studies/Programs can be either existing Proficiency Evaluation Programs or Round Robin Studies or a combination of programs and studies to assure evaluation of all laboratory operations.

Inter-laboratory Test Comparison – Organization, performance and evaluation of tests on the same or similar items or materials by two or more laboratories in accordance with predetermined conditions. (OPP) (ORCR)

Labeled Compound – (1) A molecule in which one or more of the atoms is isotopically enriched, thereby increasing the mass of the molecule. (OW/EAD) (OAR/OAQPS) (ORCR) (2) A molecule in which one or more of the atoms is isotopically enriched, thereby increasing the mass of the molecule. (ORD) (ORCR)

Linear Dynamic Range – The concentration range over which instrument response is linear. (ORD) (OW/EAD) (OPP) (OW/TSC) (OAR/OAQPS) (OECA) (ORCR)

Matrix – The material of which the sample is composed or the substrate containing the analyte of interest, such as waste water, storm water, and biosolids. Also called medium or media. (ORD) (OW/EAD) (OPP) (OW/TSC) (OAR/OAQPS) (OECA) (ORCR)

Matrix Effects – Manifestations of non-target analytes or physical/ chemical characteristics of a sample that prevents the quantification of the target analyte (i.e., the compound or element of interest being effectively quantified by the test method) as it is routinely performed, typically adversely impacting the reliability of the determination. For example, a matrix effect can give rise to a high or low bias. (ORD) (OW/EAD) (OW/TSC) (OAR/OAQPS) (OECA) (ORCR)

Matrix Spike (Spiked Sample or Fortified Sample) – A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency. (ORD) (OW/EAD) (OPP) (OAR/OAQPS) (ORCR)

Matrix Spike (MS) and Matrix Spike Duplicate (MSD) – Two aliquots of the same environmental sample to which known quantities of the target analytes are added in the laboratory. The MS and MSD are analyzed exactly like a sample, and their purpose is: to determine whether the sample matrix contributes bias to the analytical results, and to indicate precision associated with laboratory procedures. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the MS and MSD corrected for background concentrations. (ORD) (OW/EAD) (OPP) (OW/TSC) (OECA) (ORCR)

Maximum Contaminant Level (MCL) – This is a contaminant-specific standard for acceptable drinking water under SDWA. MCLs also may be used for purposes of RCRA (Resource Conservation and Recovery Act) ground water monitoring to reach contaminant-specific clean-up levels. (OW/EAD) (OW/TSC) (ORCR)

Method – (1) See Test Method. (2) Logical sequence of operations, described generically, used in the performance of measurements. (ORD) (OW/EAD) (OAR/OAQPS) (ORCR)

Censored Method – Analytical methods that frequently produce non-numerical results for blanks (i.e., ND for 'non-detect'). These nonnumeric values are not due to censoring of data. (OW/EAD)

Uncensored Method – Analytical methods that nearly always produce numerical values that meet qualitative identification criteria for method blanks. (OW/EAD)

Multi-laboratory Procedure Study – A study where multiple laboratories individually perform estimates of accuracy, precision, and/or detection limits and those individual

estimates are summarized in some fashion (e.g. averaging, upper or lower confidence intervals) to characterize some measure of how well the analytical method performs in qualified laboratories. (OW/EAD) (OAR/OAQPS) (ORCR)

Native Compound – (1) A molecule in which the atoms all have naturally occurring isotopic abundances. (OW/EAD) (OPP) (2) A compound that is present in a sample without addition by the laboratory. (ORD) (OAR/OAQPS) (ORCR)

Protocol – A detailed written procedure for field and/or laboratory operation (e.g., sampling, analysis), which must be strictly followed. (OAR/OAQPS)

Reagent Water – Water demonstrated to be free from the analytes of interest and potentially interfering substances at the method detection limit for the analyte. (OW/EAD) (OPP) (OW/TSC) (OAR/OAQPS) (DECA) (ORCR)

Recovery – The degree to which a methodology measures all of the analyte contained in a sample, often expressed in percent recovered. (ORD) (OW/EAD) (OW/TSC) (OAR/OAQPS) (DECA) (ORCR)

Recovery Efficiency – The fraction or percentage of a target analyte measured in a sample to which a known amount of the analyte has been added. (ORD) (OPP) (OAR/OAQPS) (ORCR)

Reference Material – A material or substance, one or more properties of which are sufficiently well established to be used for the calibration of an apparatus, the assessment of a measurement method, or assigning values to materials. (ORD) (OW/EAD) (DECA) (ORCR)

Replicate Analyses – The measurements of the variable of interest performed identically on two or more sub-samples of the same sample within a short time interval. (ORD) (OW/EAD) (OPP) (OAR/OAQPS) (DECA) (ORCR)

Sample – A part of a larger whole or a single item of a group; a finite subset of a statistical population. A representative sample serves to provide data or information concerning the properties of the whole group or population. (OW/EAD) (OPP) (OAR/OAQPS) (ORCR)

Sensitivity – (1) Sensitivity generally refers to the capability of a method or instrument to discriminate between small differences in analyte concentration. (OPP) (OAR/OAQPS) (ORCR) (2) A qualitative description of an instrument's or analytical method's detection limit. (ORD)

Signal-to-Noise Ratio (S/N) – The height of the signal as measured from the mean (average) of the noise to the peak maximum divided by the amplitude of the noise. (ORD) (OW/EAD) (OPP) (OW/TSC) (ORCR)

Spike – (1) A known quantity of an analyte added to a sample for the purpose of determining recovery or efficiency (analyst spikes), or for quality control (blind spikes). (OW/EAD) (OPP) (OAR/OAQPS) (ORCR) (2) A known quantity of an analyte added to a sample for the purpose of determining recovery or efficiency. (ORD) (OECA)

Standard Addition – The addition of a known amount of analyte to the sample in order to determine the relative response of the detector to an analyte within the sample matrix. The relative response is then used to assess either an operative matrix effect or the sample analyte concentration. (ORD) (OW/EAD) (OPP) (OAR/OAQPS) (ORCR)

Standard Deviation – A computed measure of variability indicating the spread of the data set around the mean. (ORD) (OPP) (OW/TSC) (OAR/OAQPS) (OECA) (ORCR)

Standard Uncertainty – Uncertainty of the result of a measurement expressed as a standard deviation. (ORD) (OW/EAD) (OPP) (ORCR)

Stock Solution – A solution containing an analyte that is prepared using a reference material traceable to EPA, the National Institute of Science and Technology (NIST), or a source that will attest to the purity and authenticity of the reference material. (ORD) (OW/EAD) (OPP) (OAR/OAQPS) (ORCR)

Surrogate Standard – A non-target analyte that has similar chemical properties to the analyte of interest. The surrogate standard is added to the sample in a known amount and used to evaluate the response of the analyte to preparation and analysis procedures. (ORD) (OW/EAD) (OPP) (OW/TSC) (OAR/OAQPS) (OECA) (ORCR)

Test Method – An adoption of a scientific technique for a specific measurement problem, as documented in a laboratory SOP or published by a recognized authority. (OW/EAD) (OPP) (OAR/OAQPS) (ORCR)

Variability During Routine Operations – Changes during the routine running of samples that might contribute to variability of results. This might include instrument drift through the course of the day due to changes in the ion source (such as contamination from running samples), differences in performance of instruments used for the same analysis, difference in technique for different analysts, etc. (OW/EAD) (ORCR)

APPENDIX – ACRONYMS

Acronyms	Acronym Expansion	Glossary Subject
ASQ	American Society for Quality	Offices, Programs, and References
ASTM	American Society for Testing Materials	Offices, Programs, and References
BEAD	Biological and Economic Analysis Division	Offices, Programs, and References
CAL	Calibration Standard	Calibration
CCC	Continuing Calibration Check	Calibration
CCV	Continuing Calibration Verification	Calibration
CFR	Code of Federal Regulations	Miscellaneous
CV	Calibration Verification	Calibration
CWA	Clean Water Act	Miscellaneous
DL	Detection Limit	Detection and Quantitation Limit
DQO	Data Quality Objective	Quality Control
EDL	Estimated Detection Limit	Detection and Quantitation Limit*
ELAB	Environmental Laboratory Advisory Board	Offices, Programs, and References
EPA	Environmental Protection Agency	Offices, Programs, and References
eRLN	Environmental Response Laboratory Network	Offices, Programs, and References
FACA	Federal Advisory Committee Act	Miscellaneous
FEM	Forum on Environmental Measurements	Offices, Programs, and References
FNQS	False Negative Quality Control Sample	Quality Control
ICV	Initial (or Independent) Calibration Verification	Calibration
IDL	Instrument Detection Limit	Detection and Quantitation Limit
IDP	Initial Demonstration of Proficiency	Quality Control
IPC	Instrument Performance Check	Quality Control
IPR	Initial Precision and Recovery	Quality Control
IR	Interregional Research Project	Miscellaneous
IS	Internal Standard	General Analytical Method
ISO	International Standards Organization	Miscellaneous
IUPAC	International Union of Pure and Applied Chemistry	Offices, Programs, and References
L _c	Critical Level	Statistical
LC	Laboratory Control Sample	Quality Control
LC	Liquid Chromatography	General Analytical Method
LCMRL	Lowest Concentration Minimum Reporting Level	Detection and Quantitation Limit
LCS	Laboratory Control Sample	Quality Control
L _D	Detection Limit	Detection and Quantitation Limit
L _d	Minimum Detectable Value	Statistical
L _D	Minimum Detectable Value	Statistical
LFB	Laboratory Fortified Blank	Quality Control
LFSM	Laboratory Fortified Sample Matrix (a.k.a. MS)	Quality Control
LFSMD	Laboratory Fortified Sample Matrix Duplicate (a.k.a. MSD)	Quality Control
LLOQ	Lower Level of Quantitation	Detection and Quantitation Limit
LOA	Limit of Analysis	Detection and Quantitation Limit
LOD	Limit of Detection	Detection and Quantitation Limit
LOQ	Limit of Quantitation	Detection and Quantitation Limit
L _Q	Quantification Limit	Detection and Quantitation Limit
LQ	Quantification Limit	Detection and Quantitation Limit
LRB	Laboratory Reagent Blank	Quality Control
MCL	Maximum Contaminant Level	General Analytical Method

MDL	Method Detection Limit	Detection and Quantitation Limit
ML	Minimum Level of Quantitation	Detection and Quantitation Limit
MQL	Method Quantitation Limit	Detection and Quantitation Limit
MQO	Method (or Measurement) Quality Objective	Quality Control
MRL	Minimum Reporting Limit	Detection and Quantitation Limit
MS	Mass Spectrometry	General Analytical Method
MS	Matrix Spike Sample	General Analytical Method
MSD	Matrix Spike Duplicate Sample	General Analytical Method
ND	Non-Detect	General Analytical Method
NEIC	National Enforcement Investigations Center	Offices, Programs, and References
NELAC	National Environmental Laboratory Accreditation Conference	Offices, Programs, and References*
NELAP	National Environmental Laboratory Accreditation Program	Offices, Programs, and References*
NERL	National Exposure Research Laboratory	Offices, Programs, and References
NHEERL	National Health and Environmental Effects Research Laboratory	Offices, Programs, and References
NIST	National Institute of Standards and Testing	Offices, Programs, and References
OAQPS	Office of Air Quality Planning and Standards	Offices, Programs, and References
OAR	Office of Indoor Air and Radiation	Offices, Programs, and References
OCDL	Organic Carbon Detection Limit	Miscellaneous
OECA	Office of Enforcement and Compliance Assurance	Offices, Programs, and References
OECD	Organization for Economic Cooperation and Development	Offices, Programs, and References
OEM	Office of Emergency Management	Offices, Programs, and References
OP	Operating Plan	Quality Control
OPP	Office of Pesticide Programs	Offices, Programs, and References
OPPTS	Office of Prevention, Pesticides, and Toxic Substances	Offices, Programs, and References
OPR	Ongoing Precision and Recovery	Quality Control
ORCR	Office of Resource Conservation and Recovery	Offices, Programs, and References
ORD	Office of Research and Development	Offices, Programs, and References
OSWER	Office of Solid Waste and Emergency Response	Offices, Programs, and References
OW/EAD	Office of Water/Engineering and Analysis Division	Offices, Programs, and References
OW/TSC	Office of Water/Technical Support Center	Offices, Programs, and References
PBMS	Performance Based Measurement System	Quality Control
PDL	Practical Detection Limit	Detection and Quantitation Limit
PDP	Pesticide Data Program	Offices, Programs, and References
PE	Performance Evaluation	Quality Control
PLD	Practical Limit of Detection	Detection and Quantitation Limit
PLQ	Practical Limit of Quantitation	Detection and Quantitation Limit
PQL	Practical Quantitation Limit	Detection and Quantitation Limit
QA	Quality Assurance	Quality Control
QAD	Quality Assurance Division	Offices, Programs, and References
QAMS	Quality Assurance Management Section	Offices, Programs, and References
QAPP	Quality Assurance Project Plan	Quality Control
QC	Quality Control	Quality Control
QCS	Quality Control Sample	Calibration
QCS	Quality Control Check Sample	Calibration
QL	Quantitation Limit	Detection and Quantitation Limit
RCRA	Resource Conservation and Recovery Act	Miscellaneous
RF	Response Factor	Calibration
RSD	Relative Standard Deviation	Statistical
SDWA	Safe Drinking Water Act	Miscellaneous
SICP	Selected Ion Current Profile	General Analytical Method

S/N	Signal-to-Noise Ratio	General Analytical Method
S _o	Standard Deviation	Statistical
SOP	Standard Operating Procedure	Quality Control
SW	Solid Waste	Miscellaneous
TNI	The NELAC Institute	Offices, Programs, and References
UCMR	Unregulated Contaminant Monitoring Rule	Offices, Programs, and References
USDA	United States Department of Agriculture	Offices, Programs, and References
USGS	United States Geological Survey	Offices, Programs, and References
VER	Calibration Verification Standard	Calibration
VIM	International Vocabulary of Basic and General Terms in Meteorology	Offices, Programs, and References
Webster's	Webster's Dictionary	Offices, Programs, and References
WQBEL	Water Quality Based Effluent Limit	Miscellaneous

*Acronym also listed in the Miscellaneous section of the glossary.

APPENDIX – REFERENCES

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