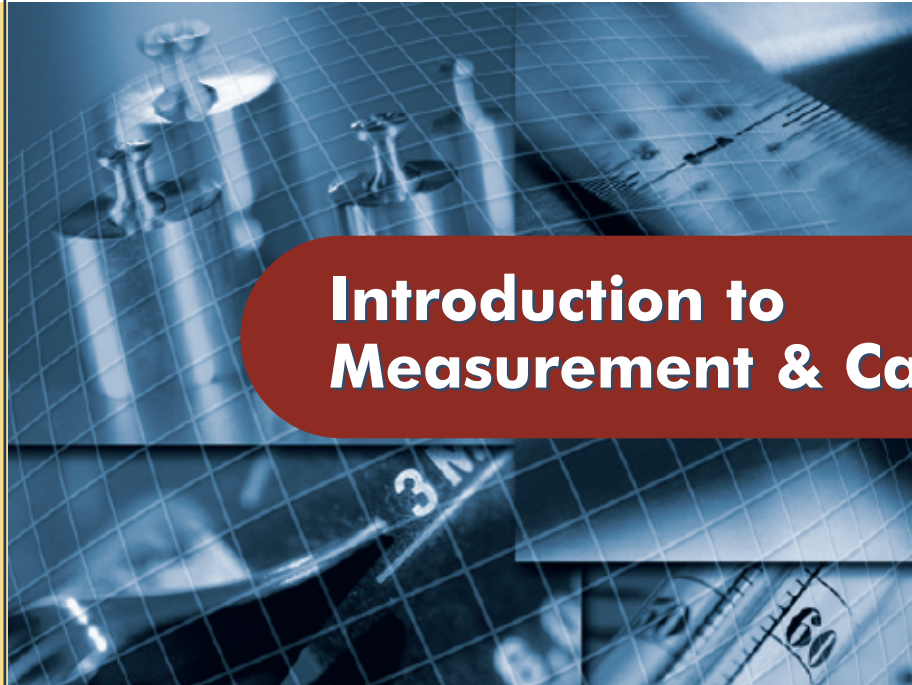


GUIDED COURSE NOTES



Introduction to Measurement & Calibration

Use the following course notes as a guide and retention tool to enhance and emphasize important topics that relate to your job.

NOTICE

These Course Notes are designed to accompany WorkPlace Training's computer based training modules. Complete as you see fit to increase retention of material. They can be customized to suit your need. Permission is granted to reproduce for internal use only, alter for your own space requirements, add your own labs specific procedure requirements or instrument specs, etc. They can be incorporated into technicians' training records.

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Disclaimer

The material contained in this course is for training purposes only. The content is not intended to limit the subject matter or be all-inclusive of all topics.

Every effort has been made to achieve technical accuracy. Do not use this course as a technical reference. Consult the latest accepted industry standards for specifications relating to your specific application.

PRECISION MEASUREMENT SERIES	LEVEL II TITLES	ISO/IEC 17025 COMPLIANCE
Introduction to Measurement and Calibration ←	Dimensional: Surface Texture, Roundness, Hardness	Uncertainty Management
Precision Electrical Measurement	Acoustics and Vibration	Introduction to 17025 for Technicians
Precision Dimensional Measurement	Time and Frequency	Audit/Assessment to 17025
Precision Pressure Measurement	AC/DC Metrology	Interval Analysis
Precision Flow Measurement	Microwave Principles	Proficiency Testing
Precision Mass Measurement	Fiber Optics Part I	
Precision Force/Torque Measurement	Test Equipment Operation and Calibration	
Precision Humidity Measurement	Certified Calibration Technician Exam Prep	
Precision Temperature Measurement	Uncertainty Management	
Measurement Uncertainty	Metrology Applications for Engineers and Scientists	

INTRODUCTION

Definition of metrology

Measurements in manufacturing

Measurement in the global marketplace

Importance of measurement

Development and Concerns of Metrology

Need for better measurements;

Determine and describe the differences between
Resolution

Accuracy

Precision

Calibration

Type A Uncertainty

Type B Uncertainty

Review questions

STANDARDS AND STANDARDIZATION

Working standards

Check standards

International standards

Levels of standard accuracies

Accuracy ratio between levels of calibration pyramid:

Requirements of traceability

Metrology standardization documents

Review questions

MANAGING THE METROLOGY SYSTEM

When a metrology system is needed

Components of a metrology system

Periodic calibration

Determining period

Fixed time intervals or other means

Measurement assurance

Record keeping

Categories on a good record keeping form

Computer record keeping programs

Record stickers

Documented procedures

Components of a procedure

Standardization documents

ISO and QS9000, ANSI Z-540, ISO 17025, Malcolm Baldrige

TRAINING

Components of a training program

Records

Review questions

MAKING GOOD MEASUREMENTS: ELEMENTS OF A MEASUREMENT SYSTEM

Measuring instrument (calibration)

Calibration pyramid

Relating the instrument to the national standard

Unit under test

Preparation of the UUT

Fixture or jig setup

Measuring procedure

Operator

Analysis of measured data

Display of final analyzed result

Measurement assurance

Isolating errors

Capability study

Gage R & R

Review questions

UNITS AND MEASUREMENT INSTRUMENTS

Length: rulers, height gages, optical comparators, micrometer/calipers, metrology laser

Others: roundness, squareness, flatness, surface finish, area, volume

Mass: balances (single-pan, dual pan, electronic)

Time: electronic counters, atomic clocks,

Temperature: thermometers (liquid-in-glass, metallic stem, thermostats, electrical thermometric, thermistors)

Flow: flowmeters (rotation, pressure drop, positive displacement)

Electrical quantities: DC voltages (meters), resistance (multimeters), DC current, AC measures

Review questions

GLOSSARY

Accuracy: Closeness of the agreement between the result of a measurement and a true value of the measurand. VIM 3.5

Accuracy Ratio: Ratio reflecting the difference in the accuracy of standards from one level of a calibration pyramid to another. The desired increase in accuracy from one level to the next higher level is 10 to 1.

Atomic Clock: Clock that measures a second as 9,192,631,770 periods of the radiation resulting from a change in the ground state of the Cesium 133 atom.

Bias: Systematic error of the indication of a measuring instrument. VIM 5.25 Estimated by calculating the difference between the true value of a measurand and its estimated value based on the average of a set of random samples.

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 a material measure or a reference material, and the corresponding values realized by standards VIM 6.11

Calibration Pyramid: Hierarchy of comparisons of standards used to calibrate measurement instrument, ranging from the least accurate standards (many working standards) at the bottom of the pyramid to the most accurate standard at the top.

Capability Study: Procedure to determine how much of the total measurement error to assign to various components of a measurement system: measurand, measurement instrument, and operator.

Drift: Slow change of a metrological characteristic of a measuring instrument. VIM 5.16

Error: Result of a measurement minus a true value of the measurand. VIM 3.10

Gage R & R: Gage Repeatability and Reproduceability Study, which is a procedure for a simplified capability study prepared by the Automotive Industry Action Group (AIAG).

Mean: The average of a set of values

Measurand: Particular quantity subject to measurement VIM 2.6

Measurement Assurance: Metrology management method designed to quickly report the presence of measurement error by monitoring both instrument and operator factors that can influence the accuracy and precision of a measurement

Measurement Error: Amount by which a measurement characteristic varies from the true value of the characteristic. Sources of measurement error can be related to the measurand or measurement instrument.

Measurement Quality: The quality of a measurement, which is based on three factors: (1) Resolution: Does the measurement meet the requirements of the application? (2) Accuracy: Does the measurement reflect the true characteristics (length, mass, electrical characteristics, etc.) of the measurand? and (3) Precision: Do you get the same reading each time you measure the same size of quantity?

Measurement System: Complete set of elements required to obtain a measurement, including the measurand, the measurement instrument, the procedures and the operator.

Metrology: Science of measurement VIM 2.2

Mode: The most frequently occurring value in a set of values.

Noise: Signal from a measurement system that contains no useful information and interferes with the true reading.

Non-prescriptive Standard: Document designed to ensure the quality of a measurement by specifying what is to be accomplished. No specifications for how to achieve the desired quality are provided.

Offset: Difference between the true zero reading and the current zero reading on a measurement system. All readings will be incorrect by the difference.

Precision: Ability of a measurement system to always give the same reading when measuring the same size or quantity.

Prescriptive Standard: Document designed to ensure the quality of measurements by specifying both what is to be accomplished and how it is to be accomplished.

Primary Standard: Standard that is designated or widely acknowledged as having the highest metrological qualities and whose value is accepted without reference to other standards of the same quantity. VIM 6.4

Reference Standard: Standard, generally having the highest metrological quality available at a given location or in a given organization, from which measurements made there are derived. VIM 6.6

Random Error: Result of a measurement minus the mean that would result from an infinite number of measurements of the same measurand carried out under repeatability conditions. VIM 3.13

Resolution: Smallest difference between indications of a displaying device that can be meaningfully distinguished. VIM 5.12

Secondary Standard: Standard whose value is assigned by comparison with a primary standard of the same quantity. VIM 6.5

Standard: Material measure, measuring instrument, reference material or measuring system intended to define, realize, conserve or reproduce a unit or one or more values of a quantity to serve as a reference. VIM 6.1

Systematic Error: Mean that would result from an infinite number of measurements of the same measurand carried out under repeatability conditions minus a true value of the measurand. VIM 3.14

Traceability: Property of a result of a measurement or the value of a standard whereby it can be related to stated references, usually national or international standards, through an unbroken chain of comparisons all having stated uncertainties. VIM 6.10

Uncertainty: Parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could be reasonably attributed to the measurand. VIM 3.9

Type A uncertainty: Those which are evaluated by statistical methods.

Type B uncertainty Those which are evaluated by other means