

Module 500 – Lesson Two: MEASUREMENTS

Lesson Description:

The lesson covers basic and precision measurements for metalforming employees. Students will learn about linear measurement, angular measurement and precision (hand-held) measuring instruments. Students develop basic skills using and reading dial/vernier calipers scales and outside/inside micrometer scales. In addition, students will be exposed to a height gage with an indicator/dial indicator. The basic concepts and importance of instrument care and calibration will be discussed. Reference to a Process/Control Plan or Inspection Sheet/Quality Plan (Gage Ticket) is incorporated into this lesson. *Prerequisite:* Module 500, Lesson One, *Engineering Drawings II*.

Learning Objectives:

At the completion of this lesson, the student will be able to:

- ◆ Take linear measurements to an accuracy of $1/64^{\text{th}}$ of an inch using a 6" steel rule.
- ◆ Sketch right, acute and obtuse angles
- ◆ Explain the use and limitations of a steel combination square.
- ◆ Name at least two measuring tools or pieces of equipment that measure angularity.
- ◆ Read inside, outside and depth/thickness measurements to an accuracy of 0.001" using a caliper.
- ◆ Read outside diameter measurements to an accuracy of 0.001" using a micrometer.
- ◆ Clean, care for and store steel rules/scales, calipers, micrometers and dial indicators.
- ◆ Explain the purpose of the calibration tag/sticker on precision measuring devices.
- ◆ Explain the importance of instrument calibration and its effect on inspection.
- ◆ Define an attribute and a variable and state the main difference between the two terms.
- ◆ Define what a checking fixture is and why/when it is used.
- ◆ Given a designated feature on a print and a control plan for reference, identify the correct measuring instrument used for measuring the feature.

Methods of Instruction:

Lecture, hands-on application exercises, simulated and real-world examples.

Methods of Evaluation:

Class presentations, hands-on demonstrations (*Skill Checks*) and written tests/exam (*PROficiency Practices and Assessment*) during and after training.

Lesson Materials Provided by PMA:

- ◆ *LS Starret Student Handouts – Reading Precision Measuring Tools (English and Metric)*
 - ◆ *Training Aid Kits – Slide Charts (Outside micrometer, vernier caliper, height gage and bevel protractor)*
 - ◆ *PMAEF Video – Dimensional Measuring & Gaging Piece*
 - ◆ Engineering drawings with associated part simulations
 - ◆ PMAEF Student Handouts and LS Starret Tool Wall Chart
 - ◆ PMAEF 6” Steel Rule and Protractor
 - ◆ *PMA Instructor Guide with SMART Lesson Plans, Prints/Drawings, Skill Checks and PROficiency Practices & Assessment*
 - ◆ Transparencies
 - ◆ PMAEF Item Bank (assessment questions) for construction of final examination.
 - ◆ List of recommend student reading & study materials (textbooks, supplier catalogs, etc.).
- ☞ Note: PMAEF student handouts, transparencies and item bank provided on CD or disk.

Lesson Topics & Content Outline:

- ◆ **Rules, Scales and Squares**
 - Discrimination
 - Types of Scales Used in Metalforming (rigid, flexible, narrow and hook)
 - Types of Squares Used in Metalforming and Their Limitations
 - Proper Use of Scales, Squares and Reference Points
 - Take Length (AOL) and Width Measurements Using a Steel Rule to 1/64th Accuracy
 - Sketch Angles (Right, Acute and Obtuse) and the Tools Used to Measure Angularity
 - Proper Care of Rules, Scales and Squares.
- ◆ **Limits, Allowance and Tolerance (Review)**
 - Basic (optimal) Size
 - Tolerance (upper/lower limits, max./min., +/- tolerance)
 - Converting Inches to Millimeters and Millimeters to Inches
 - Fits (inch, decimal inch and metric)
 - Overview of SPC.
- ◆ **Calipers**
 - What Calipers Measure
 - Types of Calipers Used in Metalforming (dial, vernier and digital)
 - Selection of Calipers
 - Components, Range and Graduations of a Dial Caliper
 - Take Outside and Inside Measurements Using a Dial Caliper to an Accuracy of 0.001”
 - Proper Care and Storage of Calipers (includes calibration checking sticker)
 - Purpose of Instrument Calibration and its Effect on Inspection, Quality Control and Record Keeping.

◆ **Micrometers**

What Micrometers Measure

Types of Micrometers Used in Metalforming (dial, vernier and digital/electronic)

Selection of Micrometers

Components (Basic Parts), Range, Accuracy and Graduations of an Outside Micrometer

Defining That One Complete Turn of the Thimble is Equal to 0.025” and That Each

Division on the Thimble is 0.001”

Application of the Ratchet Mechanism

Cleaning Faces and Setting an Outside Micrometer (includes adjusting zero line)

Take Outside (diameter and thickness) Measurements Using an Outside Micrometer to an

Accuracy of 0.001”

Proper Care and Storing of Micrometers (includes calibration checking sticker).

◆ **Introduction to Gaging**

Features, Attributes and Variables

Fixture and Go/No-Go Gage Types - Their Advantages and Applications

Installing Piece Part in a Fixture Gage

Zeroing and Measuring with a Height Gage and Dial Indicator

Care and Storage of Dial Indicators.

❖ **End of Lesson Exam** (*PROficiency Assessment*)

☞ Note: See SMART Lesson Plan contained in the Instructor’s Guide for detailed instruction content, flow of lesson, and in-training assessments (*PROficiency Practices* and *Skill Checks*). Instructor may provide additional/actual precision measuring instruments and/or gages.