



## MECH-401: Applied Precision Maintenance Skills

### Abstract

In recent years, more and more companies have realized the need to emphasize a precision mentality and re-focus on the fundamental skills required to achieve “precision.”

As a part of Universal Technologies’ seminar progression, we generally begin with the “Maximizing Machinery Reliability...the skilled craftsman” seminar to focus on these basic, yet critical concepts. While without exception, this seminar has proven extremely successful for our clients, we keep hearing the question “**How can we take it to the next level?**”



While the scope of the “skilled craftsman” seminar is comprehensive, time limitations have prohibited more detailed discussions on specific subjects, such as precautions associated with certain types of couplings, proper use of additional precision measurement instruments, and detailed installation procedures for certain components such as specific bearing types. In researching how to address these issues, we realized that the next step is to enable the technician to effectively transfer the basic precision maintenance knowledge and skills while repairing specific types of equipment.

In this seminar, attendees gain additional knowledge and skills by applying the fundamentals or precision maintenance to tasks involving **pump, fan/blower, gearbox, and compressor repair**. The intensively hands-on curriculum includes activities during which attendees will follow step-by-step procedures while inspecting, evaluating, and assembling each of these machines.



Craft personnel will leave this seminar with *an applied understanding* of precision maintenance concepts:

Pump, fan, gearbox, and compressor repair activities include:

- Detailed pre-disassembly and disassembly inspections
- Machine Specific Precision Measurement and Component Inspection Procedures
- Rolling Element and Plane Bearing Installation Procedures
- Mechanical Seal Installation Procedures
- Precision Assembly Techniques
- Equipment Specific Installation Procedures



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25797 Conifer Road #C210 Aspen Park, CO 80433 USA Tel: 303-838-3447 Fax: 303-838-3437 [www.unitechinc.com](http://www.unitechinc.com)

## **Seminar Duration**

The recommended duration of this seminar is 40 hours depending on client preference, worker availability, and the attendees' backgrounds.

## **Who should attend?**

This seminar is designed primarily for maintenance, engineering, technical support and management personnel whose job functions involve rotating machinery repair. The scope of content is appropriate for technicians who have attended Universal Technologies' "Maximizing Machinery Reliability...the skilled craftsman" seminar, have a sound understanding of fundamental skills of precision maintenance, and are responsible for diagnosing problems and repairing and installing plant machinery, including pumps, gearboxes, fans/blowers, compressors, etc. This seminar is also beneficial for supervisors and others who provide support for such tasks.



## Associated Task(s)

1. When given the task of repairing a pump, gearbox, fan/blower or compressor, perform the task in a manner that demonstrates proficient knowledge and skills with the fundamentals of precision maintenance, including:
  - A. Performing required pre-disassembly and disassembly inspections
  - B. Proper interpretation of dimensions, tolerances, and fits
  - C. Proper use of precision measurement tools
  - D. Proper use of fasteners, torquing, and tensioning
  - E. Precision assembly techniques
  - F. Proper installation of bearings and seals
  - G. Precision installation of impellers, gears, fans, and turbine wheels
  - H. Performing required post-assembly inspections
  - I. Proper equipment installation procedures

## Seminar Objectives

Upon successful completion of the seminar, the student will be able to:

1. Explain the benefits of precision maintenance and key components of a precision mentality.
2. For each of the following types of machines, explain the basic principles of operation and functions of all major component parts:
  - A. Centrifugal and Positive Displacement Pumps
  - B. Fans and Blowers
  - C. Gearboxes
  - D. Compressors
3. Explain and demonstrate how to properly perform pre-disassembly and disassembly inspections on each machine listed above.
4. Explain and demonstrate how to interpret and apply dimensions, tolerances and fit information provided by pump, fan, gearbox, and compressor manufacturers or approved procedures.
5. Properly use the following instruments to obtain required measurements on pumps, gearboxes, fans and compressors with an accuracy of +/- the instrument's smallest graduation:
  - A. Outside Micrometers
  - B. Inside Micrometers
  - C. Bore Micrometers
  - D. Depth Micrometers
  - E. Dial Indicators
  - F. Outside and Inside Calipers
  - G. Radius Gauges



6. Explain and demonstrate use of proper fastening, torquing and tensioning techniques during pump, gearbox, fan, and compressor repair procedures.
7. Explain and demonstrate how to assemble pumps, gearboxes, fans/blowers, and compressors in accordance with precision maintenance processes and according to approved procedures, including each of the following:
  - A. Proper inspection of component shafting, including runout, diameters, shoulder squareness, and fillet radii.
  - B. Proper installation of duplexed angular contact ball bearings, tapered roller bearings, and tapered-bore spherical roller bearings.
  - C. Proper installation of plane bearings, including contact checks, clearance checks, and pinch checks.
  - D. Proper installation of shaft seals, including:
    - 1) Compression packing
    - 2) Component-type Mechanical seals
    - 3) Cartridge-type Mechanical seals
    - 4) Labyrinth Seals
    - 5) Carbon Seals
  - E. Setting impeller position and clearances.
  - F. Checking, evaluating, and adjusting gear tooth contact and backlash.
  - G. Adjustment of nozzle clearances, thrust clearances
8. Explain and demonstrate how to properly perform post-assembly checks and inspections on pumps, gearboxes, fans/blowers, and compressors in accordance with precision maintenance processes and according to approved procedures.
9. Explain and demonstrate how to properly install the following types of couplings, including adherence to precautions associated with setting the proper coupling gap:
  - A. Shim Pack Couplings
  - B. Gear Couplings
  - C. Elastomeric Couplings
10. Explain precautions associated with proper installation of pumps, gearboxes, fans/blowers, and compressors, including identification and resolution of problems associated with:
  - A. Bases and foundations
  - B. Pipe strain
  - C. Coupling Gaps
  - D. Soft Foot
  - E. Thermal Growth/Dynamic Movement



## Seminar Outline

### Day 1

- 1.0 Introduction
  
- 2.0 Precision Maintenance Fundamentals Review
  - 2.2 Maximizing Machinery Reliability Concepts
  - 2.3 Dimensions, Fits and Tolerances
  - 2.4 Precision Measurement
  - 2.5 Fastening, Torquing and Tensioning
  - 2.6 Precision Assembly
  - 2.7 Alignment Fundamentals
  - 2.8 Prealignment Considerations
  - 2.9 Precision Alignment Overview
  - 2.10 Belt Drive Precision Maintenance
  - 2.11 Bearing Fundamentals
  - 2.12 Types of Bearings
  - 2.13 Bearing Specification Concepts
  
- 3.0 Principles of Operation of Common Machines
  - 3.1 Pumps
    - A. Types of Pumps
    - B. Principles of Operation
    - C. Component Parts and Functions
    - D. Pump Terminology
    - E. Pump Performance Curves
    - F. Typical Problems
  - 3.2 Fans and Blowers
    - A. Types of Fans and Blowers
    - B. Principles of Operation
    - C. Component Parts and Functions
    - D. Fan and Blower Terminology
    - E. Typical Problems
  - 3.3 Gearboxes
    - A. Types of Gearboxes
    - B. Principles of Operation
    - C. Component Parts and Functions
    - D. Gear Terminology
    - E. Typical Problems
  - 3.4 Compressors
    - A. Types of Compressors
    - B. Principles of Operation
    - C. Component Parts and Functions
    - D. Compressor Terminology



## E. Typical Problems

### Day 2

- 4.0 Pre-Disassembly Inspections
  - 4.1 General Inspection Criteria
  - 4.2 Pump Inspection Procedures
  - 4.3 Fan/Blower Inspection Procedures
  - 4.4 Gearbox Inspection Procedures
  - 4.5 Compressor Inspection Procedures
  - 4.6 Pre-disassembly Inspection Activities
  
- 5.0 Disassembly Inspections
  - 5.1 General Inspection Criteria
  - 5.2 Inspection Procedures
  - 5.3 Fan/Blower Inspection Procedures
  - 5.4 Gearbox Inspection Procedures
  - 5.5 Compressor Inspection Procedures
  - 5.6 Disassembly Inspection Activities
  
- 6.0 Dimensions, Fits, Tolerances and Precision Measurement
  - 6.1 Required Pump Fits, Tolerances and Measurements
  - 6.2 Required Fan/Blower Fits, Tolerances and Measurements
  - 6.3 Required Gearbox Fits, Tolerances and Measurements
  - 6.4 Required Compressor Fits, Tolerances and Measurements
  - 6.5 Precision Measurement Activities

### Days 3 & 4

- 7.0 Precision Assembly Procedures
  - 7.1 Pump Assembly
  - 7.2 Fan/Blower Assembly
  - 7.3 Gearbox Assembly
  - 7.4 Compressor Assembly
  - 7.5 Precision Assembly Activities
  
- 8.0 Post-Assembly Checks
  - 8.1 General Assembly Checks
  - 8.2 Pump Checks
  - 8.3 Fan/Blower Checks
  - 8.4 Gearbox Checks
  - 8.5 Compressor Checks

### Day 5

- 9.0 Precision Installation Procedures



- 9.1 Bases and Foundations
- 9.2 Pipe Strain
- 9.3 Coupling Gaps
- 9.4 Soft Foot
- 9.5 Thermal Growth/Dynamic Movement

**NOTES:**

1. This seminar consists of over 50% hands-on activities. Activities are performed in groups of 2 for 12 person classes and groups of three for 18 person classes. All activities are accompanied by detailed activity guides and complete rebuild procedures for each of the machines included. Each activity is structured such that each group will rotate as needed from machine to machine, i.e., pump to fan to gearbox to turbine as needed to perform each of the critical tasks such as those listed in Seminar Objective #7.
2. It is our intent to obtain a sufficient number of actual pumps, gearboxes, etc. to permit each individual client to match the types of machines used during the activities to the types most prevalent in their facilities.

