



## **OPS-101: Basic Operator Care for Machinery Reliability**

---

---

### **Abstract**

In order to successfully implementing machinery reliability programs, it takes a total team approach. One key organizational entity is Operations. Operation/Process personnel can provide a wealth of input into the condition monitoring program, as well as take key roles in its' implementation. In order to do so, not only do processes need to be in place, but also a sound knowledge foundation must be established identifying Operation/Process' role in the overall plant initiatives.

This seminar provides Operation/Process personnel with an overview of the maintenance philosophies, equipment failure modes, and predictive technologies that are available. A sound understanding of the principles of operation of the various rotating machinery is essential, including an awareness of common problems that are encountered for each. An activity based approach to address the capabilities of, and the safe and effective use of various inspection tools integrated with the application of the visual, audible, and tactile techniques of inspection are covered.

### **Seminar Duration**

The duration of this seminar is 24 to 30 hours, but can be modularized into segments for implementing within a desired time period.

### **Who should attend?**

This seminar is designed for operation/process personnel and management personnel whose job functions involve the operation and monitoring of machinery.



Copyright © 2001-2005 by Universal Technologies, Inc.

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

## **Terminal Objective:**

### **Demonstrate and explain how each of the following relates to improved machinery reliability in your facility:**

- Performing rounds in accordance with “best round” expectations.
- Ensuring the best lubrication practices are applied on rotating equipment
- Understanding the principles of operation of common machinery and component types
- Perform maintenance tasks in accordance with autonomous maintenance concepts.
- Assisting other departments in the early detection of machinery failures
- Communicating operating problems on specific equipment to the Mechanical Department

## **Seminar Objectives**

1. Explain the advantages and disadvantages of the following four fundamental maintenance philosophies, including where they are applied and with particular emphasis on the benefits of condition-based and precision maintenance strategies:
  - A. Breakdown
  - B. Preventive
  - C. Condition-based
  - D. Precision
2. Explain the critical role operators/process personnel play in machinery reliability, condition-based maintenance and precision maintenance.
3. Explain the six primary patterns of component failures and how those failure patterns impact maintenance strategies.
4. Given selected condition monitoring technologies, briefly explain the capabilities and limitations of each:
  - A. Physical Inspection and Monitoring (walk around inspection)
  - B. Vibration Detection and Analysis
  - C. Oil Analysis
  - D. Infrared Thermography
  - E. Ultrasonics
  - F. Performance Monitoring
5. Briefly explain how vibration detection and analysis are used to enhance machinery reliability, including use of amplitude and frequency data.
6. Explain and demonstrate how to perform routine inspections of a piece of rotating equipment utilizing visual, audible, and tactile techniques and procedures.
7. Effectively communicate, both orally and in writing, machine performance data/information into the condition monitoring program/system, and to Maintenance for repair activities.
8. Explain the basic principles of operation, major components of, and develop the ability to detect common problems/root cause failures associated with the following equipment:
  - A. Motors
  - B. Pumps
  - C. Turbines



Copyright © 2001-2005 by Universal Technologies, Inc.

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

- D. Gearboxes
  - E. Heat Exchangers/Coolers
  - F. Valves
  - G. Compressors (Centrifugal and Reciprocating)
  - H. Fans
  - I. Belt Drive Systems
9. Discuss the basic start-up and shutdown processes for various component configurations and types, and describe the significance of each step of the process.
10. Describe the effect of the following operational activities on pump performance:
- A. Warm-up
  - B. Valve Alignment and Manipulation
  - C. Establishing flow rates of support systems
  - D. Shutdowns
  - E. Switch-overs
  - F. Double Pumping
11. When given a basic system-operating curve, determine how the operating envelope is determined and what indications are available to the operator when operating outside the envelope, including the impact on machinery reliability.
12. Explain what actions an operator routinely takes that could have an impact on where a machine is operating with respect to the operating envelope, including techniques for eliminating cavitation.
13. Describe the effect of the following operating conditions on compressor performance:
- A. Plant/System load
  - B. Cooling water temperatures
  - C. Cooling water flow
14. Describe and demonstrate various methods for resolving compressor surge problems.
15. Explain how a Mechanical Seal functions to seal a rotating shaft.
16. Explain the possible paths of leakage in a mechanical seal, including how each can be detected.
17. Explain the basic configuration and operational activities related to Seal Flush Systems used in your facility.
18. Explain the major causes of premature mechanical seal failure and operational activities that can be used to detect and mitigate these failures.
19. Explain the principles of operation for plane and rolling element bearings.
20. Explain the major causes of premature bearing failure and operational activities that can be used to detect and mitigate these failures.
21. Explain fundamental principles of lubrication, including:
- A. Purposes of lubricants
  - B. Types of lubricants
  - C. Grades and types used within facility

22. Explain the principles of operation, precautions and procedures for properly operating the following lubrication systems:
  - A. Trico Oiler Bulbs
  - B. Force Fed
  - C. Circulating
  - D. Oil Mist
23. Describe the proper steps involved with changing out lubrication filters, including placing filters on-line.
24. Discuss the significance of priming the lubrication system for a gearbox after oil changes prior to start-up.
25. Discuss the lubrication precautions associated with slow-rolling turbines.
26. Explain how to properly apply grease to equipment found in your facility.
27. Explain the meaning and purpose of torque, tension, and preload relative to fasteners.
28. Explain common methods, tools, and processes used to achieve proper fastener preload.
29. Explain how the following affect torque and tension applications:
  - A. Extensions on torque wrenches
  - B. Bolt, stud, and nut conditions
  - C. Thread lubricants
30. Explain and demonstrate proper preload sequencing and torquing techniques for common rectangular and circular bolt patterns.
31. Identify the potential leak paths (internal and external) in basic valves in your facility.
32. Explain and demonstrate how to properly adjust valve packing.
33. Identify the types of valve packing used in your facility, and how each functions.
34. Discuss precautions associated with adjustment of pump packing.
35. Explain the process for properly troubleshooting Hx/coolers, including:
  - A. Evaluating temperature and pressure differentials
  - B. Performing general visual inspections
  - C. Determining corrective actions for identified problems
  - D. Venting and back flushing processes



## Seminar Outline

- 1. Introduction/Pretest**
- 2. Machinery Reliability Concepts**
  - A. Maintenance Philosophies
  - B. How machines fail
  - C. Sources of Premature Machinery Failure
- 3. Overview of Condition Monitoring Technologies**
  - A. Physical Inspection...visual, audible, tactile
    - Machinery Inspection Procedures
    - Using a strobe light
  - B. Vibration Detection and Analysis
    - Amplitude and frequency
    - Vibration Instruments (Bentley Nevada TK 81, CSI data collectors)
  - C. Oil Analysis
    - Basic principles
    - Sampling precautions
  - D. Thermography
    - Spot Radiometers
    - Thermal Imaging
  - E. Ultrasonics
    - Principles of operation
- 4. Field Activities/Demonstrations**
  - A. Visual/Audible/Tactile Inspections
  - B. Strobe Use
  - C. Vibration
  - D. Ultrasonic
- 5. Activity Debrief/Lessons Learned**
- 6. Principles of Operation of Common Machines**
  - A. Induction Motors
  - B. Turbines
  - C. Centrifugal Pumps
  - D. Centrifugal Compressors
  - E. Fans
  - F. Screw Compressors
  - G. Gearboxes
  - H. Heat exchangers
- 7. Operating Practices**
  - A. Overview of System and Pump Operating Curves
  - B. Symptoms of problems and troubleshooting
  - C. Start-up/Shutdown Processes
  - D. Heat exchanger troubleshooting



- E. Compressor surge causes, consequences, and solutions
- F. Belt Drive System Inspection/Troubleshooting

## **8. Machine Component Overview**

- A. Mechanical Seal Overview
- B. Common Mechanical Seal Problems and Sources of Failure
- C. Overview of Bearings
- D. Common Bearing Failure Sources

## **9. Field Activities/Demonstrations**

- A. Heat Exchanger Troubleshooting
- B. Pump Manipulation
- C. Vibration/Ultrasonics
- D. Compressor Manipulation

## **10. Activity Debrief/Lessons Learned**

## **11. Maintenance Practices**

- A. Overview of precision maintenance process
- B. Heat exchanger routine maintenance
- C. Torquing and tensioning
- D. Valve Packing Adjustment
- E. Pump Packing Adjustment

## **12. Lubrication**

- A. Overview of Lubrication Principles
  - Purpose of lubricant
  - Boundary Lubrication
  - Hydrodynamic lubrication
  - Lubrication levels
  - Visual appearance of lubricants
  - Sight glass applications
  - Foaming
- B. Types of Lubricants
- C. Facility Lubrication Systems...operation and troubleshooting
  - Trico Oiler
  - Force Fed
  - Circulating
  - Oil Mist
- D. Lubrication Filters...types and maintenance
- E. Specific Facility Lubrication Procedures

## **13. Field Activities/Demonstrations**

- A. Torquing and Tensioning Activity
- B. Lubrication Inspection/Sampling Activity

## **14. Conclusion/ Post Test/Course Critique**



Copyright © 2001-2005 by Universal Technologies, Inc.

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