



MECH-302: Bearing Root Cause Failure Analysis

Abstract

The early detection and prevention of catastrophic bearing failures alone has justified the existence of predictive maintenance departments within companies. Preventing unexpected bearing failures and unplanned outages saves hundreds of thousands of dollars throughout industry on a daily basis.

But how far have we really come from the mechanic with a good ear and a broomstick or screwdriver? In truth, a vigilant operator or mechanic can catch a large percentage of bearing problems without ever touching instrumentation designed for vibration, oil analysis, enveloping, shock pulse measurement, etc. The real power of today's technology lies not in the detection of problems at an early stage, though that does have great value. More important is the ability to pinpoint the *root cause of bearing failure* and prevent it from happening again.

Much too often, finding and correcting the root cause of premature bearing failure is not even an issue; the failed bearing is simply replaced. Even with the best technology available, root causes of bearing failures still elude us. Bearing life calculations prove that bearings designed for critical equipment should last from 11.4 to 22.8 years. Yet, less than 10% of rolling element bearings reach their design life. Why?

First, to accurately troubleshoot bearing failures, you must understand the bearing itself. A working knowledge of rolling element bearing types, including their purpose, load and speed capabilities, is essential. You must also understand how to properly install a bearing...sounds simple, yet there remains much room for improvement, especially when it comes to such subjects as properly checking bearing fits, setting radial internal clearance, careful handling, etc. Next, you must understand the fundamentals of bearing lubrication and the effects of adverse operational and environmental conditions.

Finally, without knowledge of the physical symptoms of common bearing failure patterns along with their causes, many programs are scarcely better than the screwdriver. This is why it is so important to accurately identify and evaluate the physical symptoms of bearing failures that result from improper installation, inadequate lubrication, operational forces, and adverse environmental conditions.

This seminar provides practical, easy-to-implement techniques for not only detecting that a bearing is about to fail, but more importantly, finding and correcting the ROOT CAUSE OF FAILURE. The seminar focuses on finding the solution to the problem, not just treating the symptoms and simply replacing the bearing.



Preventive procedures, problem-solving techniques and activities include:

- Bearing Selection
- Bearing Installation
- Proper Handling, Installation, and Bearing Fits
- Detection of Impending Bearing Failure
- Root Cause Failure Analysis
- Identification and Evaluation of the Physical Symptoms of Bearing Failures
- Bearing Failure Troubleshooting and Diagnostics

Seminar Duration

The standard duration of this seminar is 24 hours. Seminar can be customized to meet specific client needs.

Who should attend?

This seminar is designed for maintenance, operations, engineering, technical support and management personnel whose job functions involve rotating machinery. The scope of content is appropriate for technicians who change bearings, those who detect, investigate and resolve premature machinery bearing failure problems, as well as those who direct activities relative to machine reliability.



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Associated Task(s)

1. When given sufficient machine history and a failed bearing, identify and evaluate specific symptoms of the failure, list probable causes of failure and generate potential solutions for preventing recurrence of the failure.
2. Identify and resolve premature bearing failures that result from the following four (4) general categories:
 - A. Improper installation and fit
 - B. Inadequate lubrication
 - C. Operating/mechanical conditions adverse to the bearing
 - D. Adverse environmental conditions

Seminar Objectives

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

1. Explain the benefits of precision maintenance.
2. Explain the purpose of bearings.
3. Discuss bearing life expectancy, including the effects of the following:
 - A. Bearing Load
 - B. Type of Machine Service
 - C. Shaft Rotating Speed
 - D. Static and Dynamic Loads
4. Define terms associated with bearing designation, bearing installation, bearing lubrication and bearing failure analysis as listed in the glossary.
5. When given the following types of bearings, explain the bearing construction, general applications, types of loads supported and general limitations:
 - A. Plain Bearings
 - B. Conrad (deep groove) Ball Bearing
 - C. Maximum Capacity Ball Bearing
 - D. Double Row Ball Bearing
 - E. Double Row Self-aligning Ball Bearing
 - F. Angular Contact Ball Bearing
 - G. Spherical Roller Bearing
 - H. Cylindrical Roller Bearing
 - I. Needle Roller Bearing
 - J. Tapered Roller Bearing
6. Explain how each of the following is used to describe a specific bearing and how these terms impact bearing performance:
 - A. Grade of Precision
 - B. Series Designation
 - C. Bore Size
 - D. Type of Fit
 - E. Radial Internal Clearance
 - F. Preload



- G. End Play
 - H. Contact Angle
 - I. Type of Cage
7. When given the following types of mounted bearings, identify the type of mounting and describe its general uses and limitations:
- A. Pillow Block Bearing
 - B. Flange Mountings
 - C. Take Up Units
8. Explain how the following methods are used to detect impending bearing failures, including, the advantages and disadvantages of each:
- A. Listen, Feel, Look
 - B. Vibration Monitoring, Analysis, and Diagnostics
 - C. Enveloping
 - D. Oil Analysis
9. Explain bearing root cause failure analysis and prevention procedures, including:
- A. Failure Investigation
 - B. Root Cause Analysis
 - C. Strategy and Corrective Action Determination
 - D. Success Evaluation
10. When given a failed bearing and sufficient machine history:
- A. Identify, describe, and document the major physical symptoms of failure.
 - B. Explain and document potential causes of failure.
 - C. Evaluate symptoms and potential causes to determine corrective actions.

Seminar Outline

1.0 Introduction

- 1.1 Making Precision Maintenance Happen
- 1.2 Seminar Overview, Objectives, and Schedule

2.0 Bearing Fundamentals

- 2.1 Purposes of Bearings
- 2.2 Bearing Life and Effects of Load, Speed, Etc.
- 2.3 Bearing Terminology
- 2.4 Functions and Characteristics of Different Bearing Types
- 2.5 Bearing Manufacturer Designations and their Meanings
- 2.6 Bearing Tolerances, Grades of Precision, Series, and Bore Size
- 2.7 Bearing Clearance and Preload
- 2.8 Bearing Fundamentals Activities!

3.0 Methods of Detecting Impending Bearing Failures

- 3.1 Listen, Feel, Look
- 3.2 Vibration Monitoring, Analysis, and Diagnostics
- 3.3 Enveloping
- 3.4 Oil Analysis
- 3.5 Bearing Detection Activities!

4.0 Rolling Element Bearing Failures, Causes, and Solutions

- 4.1 Root Cause Failure Analysis Processes
- 4.2 Normal vs. Abnormal Wear
- 4.3 Bearing Failure Terminology
- 4.4 Proper Bearing Removal/Disassembly
- 4.5 Installation and Fit Problems: Symptoms, Causes, and Solutions
- 4.6 Lubrication Failures: Symptoms, Causes, and Solutions
- 4.7 Operational Problems: Symptoms, Causes, and Solutions
- 4.8 Environmental Problems: Symptoms, Causes, and Solutions
- 4.9 Bearing Failures and Root Cause Analysis Activities!

5.0 Bearing Failure Troubleshooting and Diagnostics

- 5.1 Hands-on Bearing Root Cause Failure Analysis Activities!

6.0 Conclusions

NOTE: *This 2-tier condensed outline highlights the major subjects and general sequence of the seminar. More detailed and day-to-day outlines are available upon request.*

