Availability 201
Improving Plant Availability by Proper Equipment Installation

In this course:

Overview

Every incremental hour of availability can make an impact on your bottom line. You know that the benefits are great—what can you do to maximize availability?

You have to start at the very beginning. Over time, even the best equipment can fail because of wear or damage—causes that can be hard to detect before it's too late. What's surprising is that many failures also occur early in the equipment life cycle, often because of improper installation. In fact, improper installation can reduce equipment life 80% or even more, leading to early failures and loss of availability, as well as higher maintenance, depreciation, and ongoing capital cost. Whether you're building a new process, or replacing a piece of equipment in an existing one, proper installation can have a big financial impact.

Stress factors such as excess vibration, contamination, and temperature and pressure extremes are frequently "installed in" with equipment. Correcting these practices can eliminate early and wear out zone failures, resulting in increased availability and reduced costs for maintenance and repairs—all of which have a direct impact on plant profitability. Fortunately many of the same monitoring technologies that reduce

maintenance cost can be used to identify installation errors, thus eliminating early failures.

In this course you will learn about many of the installation errors that reduce equipment availability and useful life, and how to avoid them. The course covers techniques for rotating equipment, field instruments, and valves.

Hint

As you go through the topics in this course, watch for answers to these questions:

- What are the most common installation errors that affect availability for rotating equipment? What monitoring techniques can detect them?
- What are the most common installation errors that affect process instruments? What diagnostics can detect them?
- What are the most common installation problems with valves?

Rotating Equipment

Rotating equipment can have a huge impact on plant financial performance because failure of pumps, motors, compressors, and other rotating equipment often causes an immediate loss of production.

In addition, catastrophic failure of rotating equipment frequently leads to expensive collateral damage, and can result in fugitive emissions.

These financial impacts can be minimized by carefully avoiding common installation problems—and quickly detecting those that do occur.

Common installation errors in rotating equipment include:

- **Improper Cleaning**
- **Misalignment**
- **Imbalance**
- **Looseness**

These factors, either individually or in combination, can reduce equipment life by a factor of 10.

Rotating Equipment >> Improper Cleaning

Improper cleaning and improper maintenance and installation procedures introduce chemical, moisture, and abrasive particle contamination, leading to corrosion or abrasive pitting. This type of damage can reduce bearing life by 80% or more.

A lubricant change shortly after installation can eliminate contamination, potentially before any damage has occurred. But don’t wait too long. Once damage has started, preventive maintenance such as lubrication changes cannot undo the damage. Progressive damage can be slowed down, but cannot be stopped.

Rotating Equipment >> Misalignment

Misalignment causes wear and early failure by placing undue stress on equipment.

Misalignment has two components. Shaft centers can be parallel but offset and shafts can meet at an angle. Misalignment strains bearings, bearing races, gears, and other contacting parts. Because parts do not “break in,” small alignment problems won’t disappear. It is important that parts are in alignment after tightening.

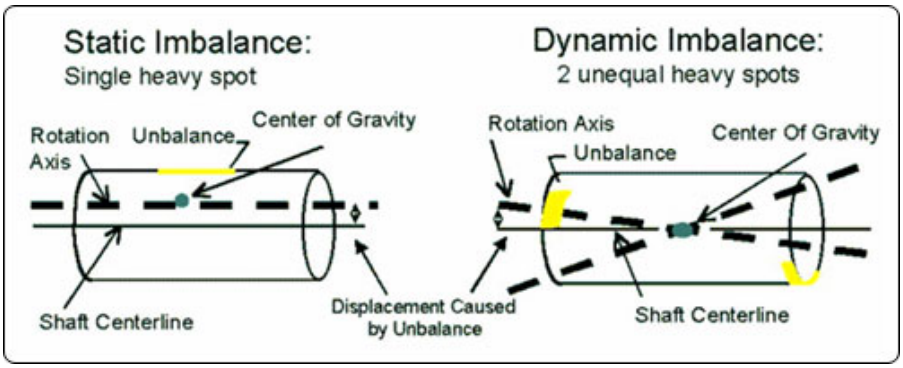
Techniques such as laser alignment can eliminate misalignment.

Proper Installation Using Laser Alignment Tools

Rotating Equipment >> Imbalance and Looseness

Smooth running equipment seldom fails, and rough running equipment tends to give problems.

Imbalance causes excess wear to bearings, races and other contacting parts. If possible, the equipment should be balanced over the entire operating range, and under load. The image shows proper balancing under dynamic load.



Proper balancing includes both static and dynamic balancing under load.

Mechanical assemblies have natural harmonic frequencies. If equipment is operated at a harmonic frequency, it can result in extreme vibration and catastrophic failure.

Looseness can cause imbalance and misalignment through movement of equipment during operation. This can cause severe wear.

Equipment should be aligned when correcting looseness, as shifting position can cause misalignment during tightening.

Note

Sometimes harmonics are present at speeds encountered at startup or shutdown. Automated startup procedures that pass through harmonic speeds quickly are recommended. Harmonic frequencies and severity may be different for even “identical” pieces of equipment. Therefore, startup should be adjusted accordingly.

Rotating Equipment >> Detecting Errors

Misalignment, imbalance, and looseness in rotating equipment can all be detected by **vibration monitoring**. Contamination is detected using **lube oil analysis**.

Equipment monitoring and predictive maintenance should start immediately after installation to detect installation errors, and prior to the onset of wear and damage. This will result in longer life and more trouble-free operation.

The PlantWeb Advantage

Emerson provides balance and alignment tools, and comprehensive services to increase availability. Services include Asset Optimization consulting, Equipment Startup, Monitoring and Analysis Services, Application of Technology, Asset Reliability Services, and Education and Certification. Machinery assets served include rotating equipment, motor control centers, switchgear, connectors and cables, transmission and distribution, boilers, and other assets.

Field Devices

Field devices such as measurement transmitters are generally very reliable. The greatest cause of instrument failure is often installation problems.

These installation problems are numerous and device-specific. Some of the most common problems include:

- **Excess Equipment Temperature**
- **Excess Shock and Vibration**
- **Improper Process Connections and Device Orientation**
- **Improper Materials of Construction**

Field Devices >> Excess Equipment Temperature

Temperature plays a key role in determining the life of electronics.

A 10° C increase in device electronics temperature can reduce electronics life by 50%, leading to failure and downtime. Insulation, heat shielding, or mounting of transmitters away from hot processes can increase life.

For inline devices such as magnetic flow, vortex, and Coriolis meters that require the sensor to be in the pipe, remote mounting of electronics can be used to control temperature.

Freezing can also cause equipment to fail. Heat tracing or heated enclosures are used where freezing is a problem. Keep heat tracing away from electronics to reduce overheating.

Many intelligent devices have internal temperature sensors that can be used to monitor for temperature related problems. It’s important to monitor internal device temperature year-around, as heat tracing can fail in winter or be left on by accident in summer.

Field Devices >> Excess Shock and Vibration

Another cause of failure is excess vibration and shock. Thermocouples and RTD's, for example, are subject to failure through mechanical fatigue. The constant stresses of vibration eventually cause the sensor to mechanically break.

Redundant sensors provide some degree of enhanced reliability. In many cases the redundant sensor is subject to exactly the same vibration and will commonly fail shortly after the primary sensor.

Field Devices >> Improper Connections and Orientation

Impulse lines are often used to locate transmitters at a convenient place for routine checks and frequent calibration. However, impulse lines can plug, leading to loss of the process signal and potential downtime.

Plugged impulse line diagnostics are available to detect line problems. Routine checks can be done remotely via a digital protocol. In many cases, impulse lines should be eliminated and devices should be connected close to the process using commercially available hookups. If impulse lines are used, they should be installed with the proper slope and size to minimize plugging.

Mount devices with the correct orientation to prevent plugging and eliminate trapping of liquid in gas lines, or gas in liquid lines.

Proper device orientation, mounted on the top of the pipe with the sensor facing down for a gas application, will eliminate the possibility of accumulating liquid that could plug or cause zero shift.

An integrated assembly also reduces engineering time, procurement expense, and installation time and errors. The net result is lower cost, higher accuracy, and higher reliability.

Traditional Impulse Lines

Direct Hookup

Impulse lines are prone to plugging and freezing. Mounting the sensor through direct coupling eliminates impulse lines and the failures associated with them.

The PlantWeb Advantage

Emerson provides hookups that eliminate impulse line plugging and other device problems. These hookups reduce total installed cost, eliminate many operating problems, reduce emissions through leaks, speed project execution, and reduce downstream maintenance cost.

In addition, diagnostics in Emerson devices can detect installation and operational errors in many types of equipment including flow, temperature, level, analytical, and other devices. These could affect availability such as impulse line plugging, improper grounding, drift, sensor fouling, or other failure modes.

Field Devices >> Improper Materials of Construction

Improper materials of construction are another major cause of failure. Chemical or mechanical attack by the process fluid can destroy an inappropriate material of construction in months, days, or even hours, where appropriate materials of construction can have life orders of magnitude higher.

Exotic materials of construction can significantly increase initial purchase price, but generally the maintenance and lost production consequences of an inappropriate material of construction is much higher.

Valves

Air supply problems are one of the most common causes of valve failure. Other common causes are contamination of the valve on installation and problems related to incorrect calibration and setup.

- **Air Supply Problems**

  The measures that should be taken to prevent failure due to air supply problems include:

  - Use only dry, clean air
  - Ensure adequate air pressure
  - Use tubing that's the right size
  - Check for air leaks, droop, and excess consumption
  - Mount I/P close to the valve to improve response time.
  - Assemble air lines WITHOUT pipe dope or tape as these can plug the air supply and cause failure.

  Air supply diagnostics including leakage and plugging detection are available.

- **Contamination of Valves**

  Valves are frequently painted after installation in an attempt to reduce corrosion. Painting or contaminating valves on installation should be avoided as:

  - Paint on a valve stem can destroy the packing in a very short time.
  - Applying paint on the linkages can restrict movement, increase deadband, and cause the valve to cycle. The excess valve travel accelerates wear leading to premature failure.

- **Incorrect Calibration and Setup**

  Calibrate the valve correctly. Incorrect calibration can cause excess seat wear and early failure. Maintain correct seat load to ensure full valve closure and eliminate excess wear through erosion. Both these cause premature failure.

  Excess tightening of the packing, or tightening only some of the packing bolts, causes friction problems and can cause packing failure or severe performance problems.

The PlantWeb Advantage

Valvelink Performance Diagnostics detect air supply problems, excess friction, deadband, excess valve travel, and other valve conditions that could lead to quality, throughput, or availability problems.

Many diagnostics run continuously, even when your process is running, so that problems that occur between scheduled tests are detected before plant operations are impacted.

Detecting Installation Problems

Many installation errors can be detected using diagnostic and prediction tools that are used for predictive maintenance.

- Vibration monitoring and lube oil analysis can detect installation contamination, balance, alignment, and looseness problems in rotating equipment.
- Instrument diagnostics such as plugged impulse line detection and device temperature monitoring can detect heat or line plugging problems.
- Valve diagnostics for friction, valve seating force, and air supply problems can detect many valve installation problems such as incorrect calibration, incorrect valve packing, or air supply problems.

The net result is that monitoring can help verify a clean installation and provide early warning of wear and equipment degradation. And this results in higher availability, lower operations and maintenance cost, and longer equipment life.

[End of course]