

Module 1: Setting the Stage

Striking the Balance between PM and PdM

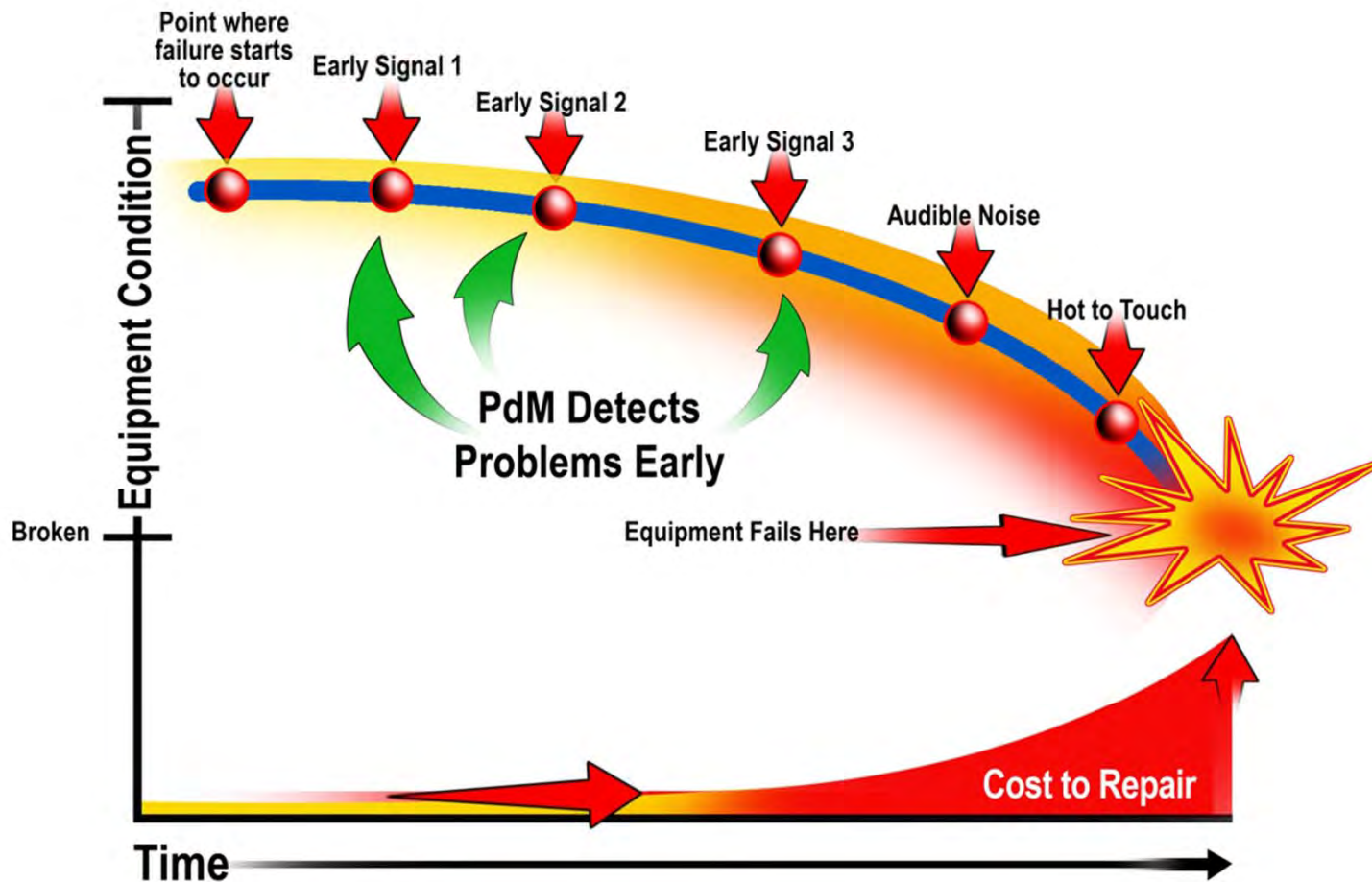
Andy Page
Allied Reliability, Inc.



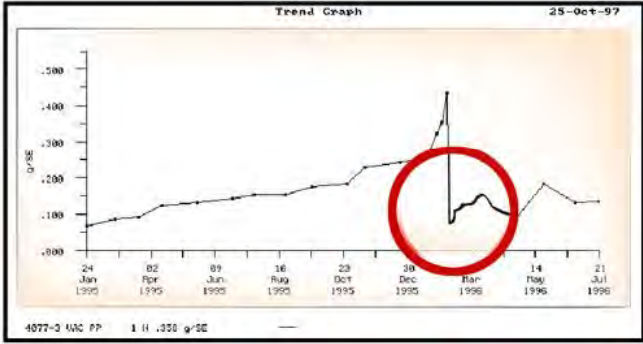
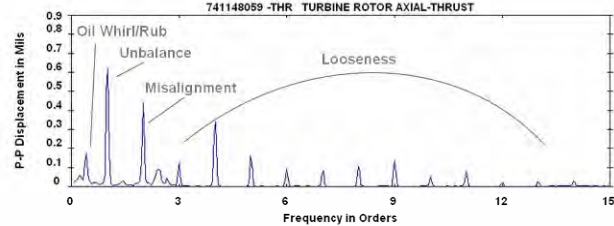
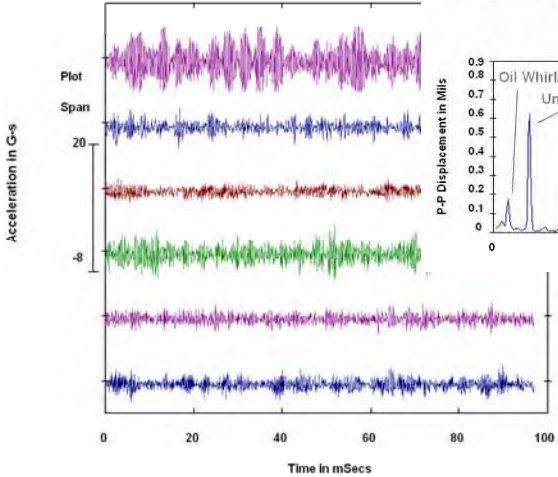
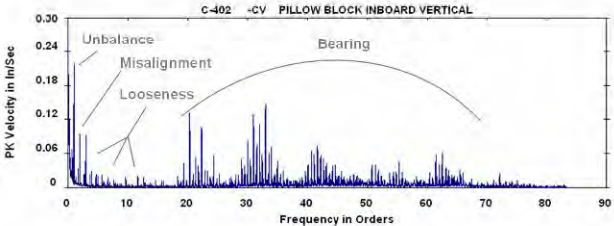
*What would you do with more
free time?*



How PdM Works – Early Identification of Defects



Vibration Analysis Failure Modes and Technologies



Vibration Analysis Failure Modes Detected

- Imbalance
- Misalignment
- Bent shaft
- Bearing looseness
- Structural looseness
- Gear wear
- Cracked or broken gear teeth
- Chain wear and looseness
- Cavitation
- Sleeve bearing wear and looseness
- Rolling element bearing defects
- Tilt pad bearing wear
- Loose bearing mountings
- Resonance
- Gear misalignment
- Belt wear and looseness
- Sheave run-out
- Fluid and airflow problems
- Oil whirl and whip
- Many electrical problems



Airborne/Structure-borne Ultrasound Failure Modes and Technologies



Airborne/Structure-borne Ultrasound Failure Modes Detected

- **Pressure / vacuum leaks (turbulence)**

- Compressed gases (air, oxygen, hydrogen etc.)
- Heat exchangers
- Boilers and condensers
- Tanks and pipes
- Valves and steam traps
- Autoclaves and forms

- **Electrical equipment**

- Switchgear
- Transformers
- Insulators
- Potheads
- Junction boxes
- Circuit breakers
- Arcing
- Tracking
- Corona

- **Mechanical components**

- Bearing faults
- Gear problems
- Mechanical looseness
- Lubrication problems
- Coupling defects



Oil Analysis Failure Modes Detected

- **Component Failure Modes**

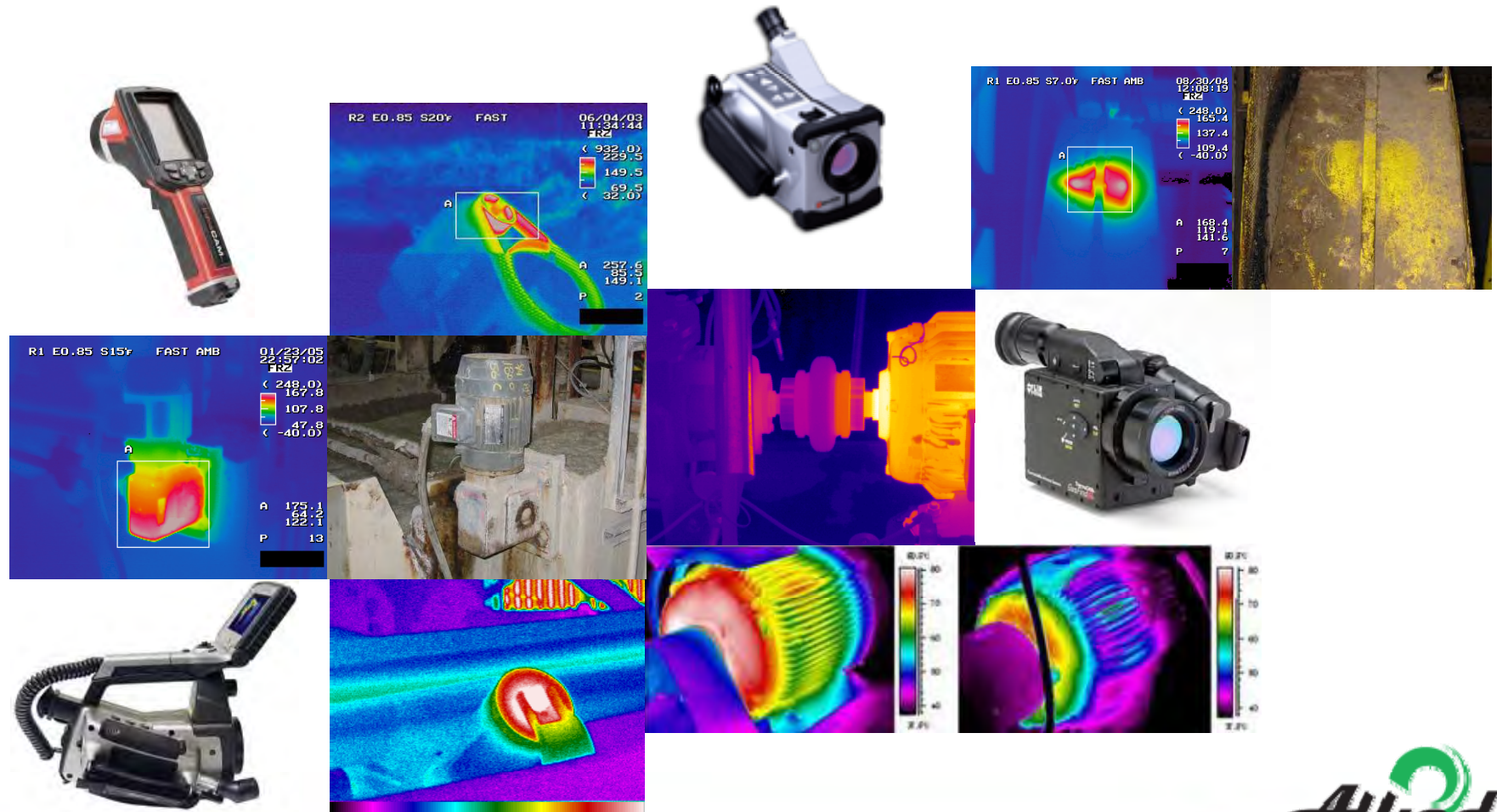
- Compromised Seal
- Bearing Fault
- Gear Problem
- Seal Damage
- Clutch Damage

- **Lubricant Failure Modes**

- Oxidation
- Nitration
- Additive Depletion
- Soot Loading
- Viscosity Change
- Poor Handling Practices
- Fuel Dilution
- Water



Infrared Thermography Failure Modes and Technologies



Infrared Thermography Failure Modes Detected

- Bearings and Couplings
 - Alignment
 - Heat Dissipation
 - Lubrication
 - Faults
- Energy Loss Due to Friction
 - Conveyor Belts
 - Gear Drives
 - Belt Drives

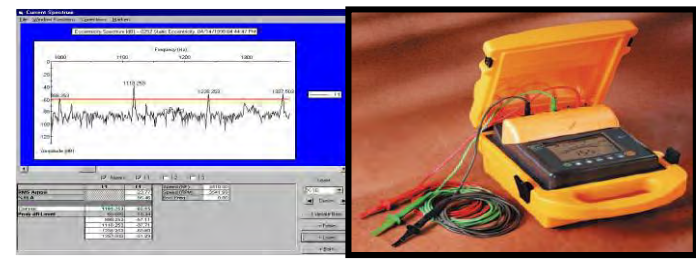
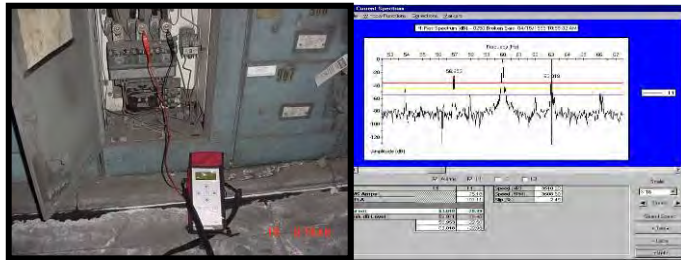


Infrared Thermography Failure Modes Detected, cont'd

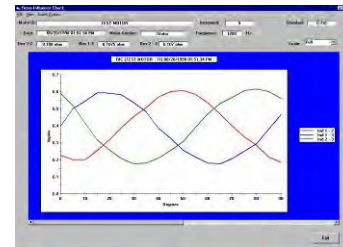
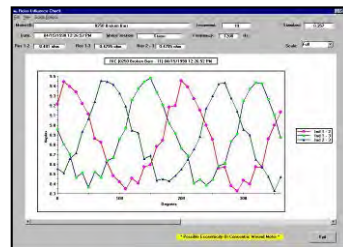
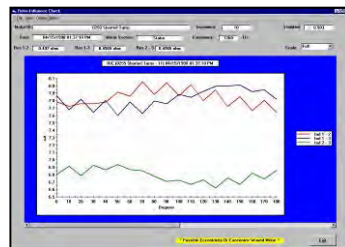
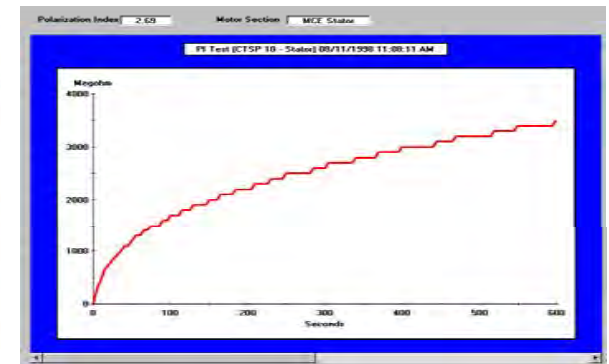
- Heat Causing Abnormal Stress
 - Metals
 - Plastics
 - Glass
 - Paper
- Non-Destructive Testing
 - Gears
 - Shafts
 - Castings
 - Extrusions
 - Turbine Blades
 - Welds



Motor Circuit Analysis Failure Modes and Technologies



History Chart for [0255 Shorted Turns]			
File	Summary	View Graph	Settings
Test Date	04/15/1998	04/16/1998	04/16/1998
Test Time	12:55:08 PM	10:00:37 AM	10:34:18 AM
Frequency	1200	1200	1200
Mohm Ph 1 to Gnd	BASELINE	BASELINE	
Charge Time	30	30	30
Voltage	500	500	500
Motor Temp	47	22	20
Measured Mohm	0.0	>2000	>2000
Corrected Mohm	0.0	>2000	>2000
pF Ph 1 to Gnd	11750	4250	4250
ohm Ph 1 to 2	0.50650	0.44100	0.44050
ohm Ph 1 to 3	0.50600	0.44200	0.44100
ohm Ph 2 to 3	0.50450	0.44200	0.44200
mH Ph 1 to 2	7.890	5.770	5.820
mH Ph 1 to 3	7.705	7.555	7.620
mH Ph 2 to 3	7.010	7.395	7.395
Avg. Inductance	7.532	6.910	6.945
% Res. Imbalance	0.23	0.15	0.19
% Ind. Imbalance	6.93	16.50	16.20
\$ Power Loss	1.31	0.65	0.98
Condition Code			Not Assigned
Test Location	N/A	N/A	N/A



Motor Circuit Analysis Failure Modes Detected

- Imbalance
- Shaft Misalignment
- Soft-foot / Twisted Frame
- Air Gap Eccentricity
- Bearing Fault
- Sheave and V-Belt Problems
- Gear Problems
- Mechanical Overload
- Pump Problems

