NECI

Reliability Engineering Services

Prepared For:

NECI

Emerson Impact Partner

Mansfield, MA / Portsmouth, NH / Bangor, ME

Sample Report

Induced Draft Fan

Dynamic Fan Balancing

EMERSON

NECI - Reliability Engineering Services

Mansfield, Massachusetts
Phone: (508) 339-5522

Bangor, Maine
Phone: (207) 942-1400

John Doe – Reliability Engineer
Company XYZ
123 Maine Street
Boston, MA 02101
Cell: (617) 555-1234
John.Doe@CompanyXYZ.com

Dear John:

During the ongoing Vibration Monitoring Program, elevated vibration levels occurring at 1X fan turning speed was detected on the Unit #5 ID Fan as the result of an imbalance condition. A dynamic balancing procedure was performed, and weights were added to the fan wheel in order correct the imbalance condition. Upon completion of our testing, vibration levels were significantly lowered, and the equipment can be deemed to be running in proper operating condition.

Included in the report you will find the before & after spectra graphs showing the vibration amplitudes labeled with the 1X RPM peak.

NECI is committed to providing world class predictive maintenance technologies and ensuring customer satisfaction. I would like to thank you for allowing NECI Reliability Engineering Services to assist you in your Reliability Based Maintenance efforts.

If you have any questions, please do not hesitate to call.

Thank you,

Christian Comeau
Reliability Engineer
ISO Certified - Category II - Vibration Analyst
Cell: (508) 851-4393
CComeau@NECI.com

cc: Kristin Scharf, Director of Reliability Solutions, NECI
Kevin Pettinelli, Manager of Reliability Engineering Services, NECI

Machine Priority Summary Guide

Extreme	25%	Immediate action is required. Consider shutting down the equipment and taking repair action to avoid failure.
Serious	50%	Take maintenance action during the next planned downtime or maintenance period.
Moderate	75%	Issue is present that requires attention. No immediate repair action is required. Increase the frequency of measurements and monitor the condition of the machine.
Follow Closely	95%	Follow Closely. Continue to monitor and trend.
OK	100%	No repair action recommended. Continue to monitor and trend.

Machine Fault/Recommended Actions List

Equipment Description	Priority	Machine Summary
Induced Draft Fan	4	**Machine Fault:** Vibration data was collected on the motor and fan bearings. On-site spectral analysis revealed elevated amplitudes at 1X fan turning speed, indicating a fan imbalance condition. A dynamic balancing procedure was performed on the fan. Balancing weights were welded on to the fan wheel in order to lower the vibration levels at 1X turning speed. **Corrective Actions Taken:** At the time of our final testing and upon our departure, the imbalance condition was resolved and the fan can be deemed to be running in proper operating condition. Continue to monitor and trend vibration levels.

Overall Vibration Levels – Velocity – in/sec

Measurement Point Location	Overall Vibration Amplitude Velocity – in/sec BEFORE Balance	Overall Vibration Amplitude Velocity – in/sec AFTER Balance	Speed	% Decrease
Motor Outboard Horizontal	0.231 - in/sec	0.031 - in/sec	1191 RPM	87 %
Motor Outboard Vertical	0.051 - in/sec	0.019 - in/sec	1191 RPM	63 %
Motor Inboard Horizontal	0.257 - in/sec	0.043 - in/sec	1191 RPM	83 %
Motor Inboard Vertical	0.046 - in/sec	0.043 - in/sec	1191 RPM	6 %
Fan Inboard Horizontal	0.375 – in/sec	0.041 - in/sec	1191 RPM	89 %
Fan Inboard Vertical	0.128 - in/sec	0.011 - in/sec	1191 RPM	91 %
Fan Outboard Horizontal	0.439 - in/sec	0.032- in/sec	1191 RPM	93 %
Fan Outboard Vertical	0.067 - in/sec	0.013 - in/sec	1191 RPM	81 %

1X Fan Turning Speed Vibration – Displacement – (Pk-Pk)

Measurement Point Location	Vibration Amplitude @ 1X Turning Speed Displacement – (Pk-Pk) BEFORE Balance	Vibration Amplitude @ 1X Turning Speed Displacement – (Pk-Pk) AFTER Balance	Speed	% Decrease
Fan Inboard Horizontal	5.99 – mils	0.56 – mils	1191 RPM	91 %
Fan Inboard Vertical	2.03 – mils	0.06 – mils	1191 RPM	97 %
Fan Outboard Horizontal	6.93 – mils	0.28 – mils	1191 RPM	96 %
Fan Outboard Vertical	0.70 – mils	0.06 – mils	1191 RPM	91 %

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ID Fan - Motor

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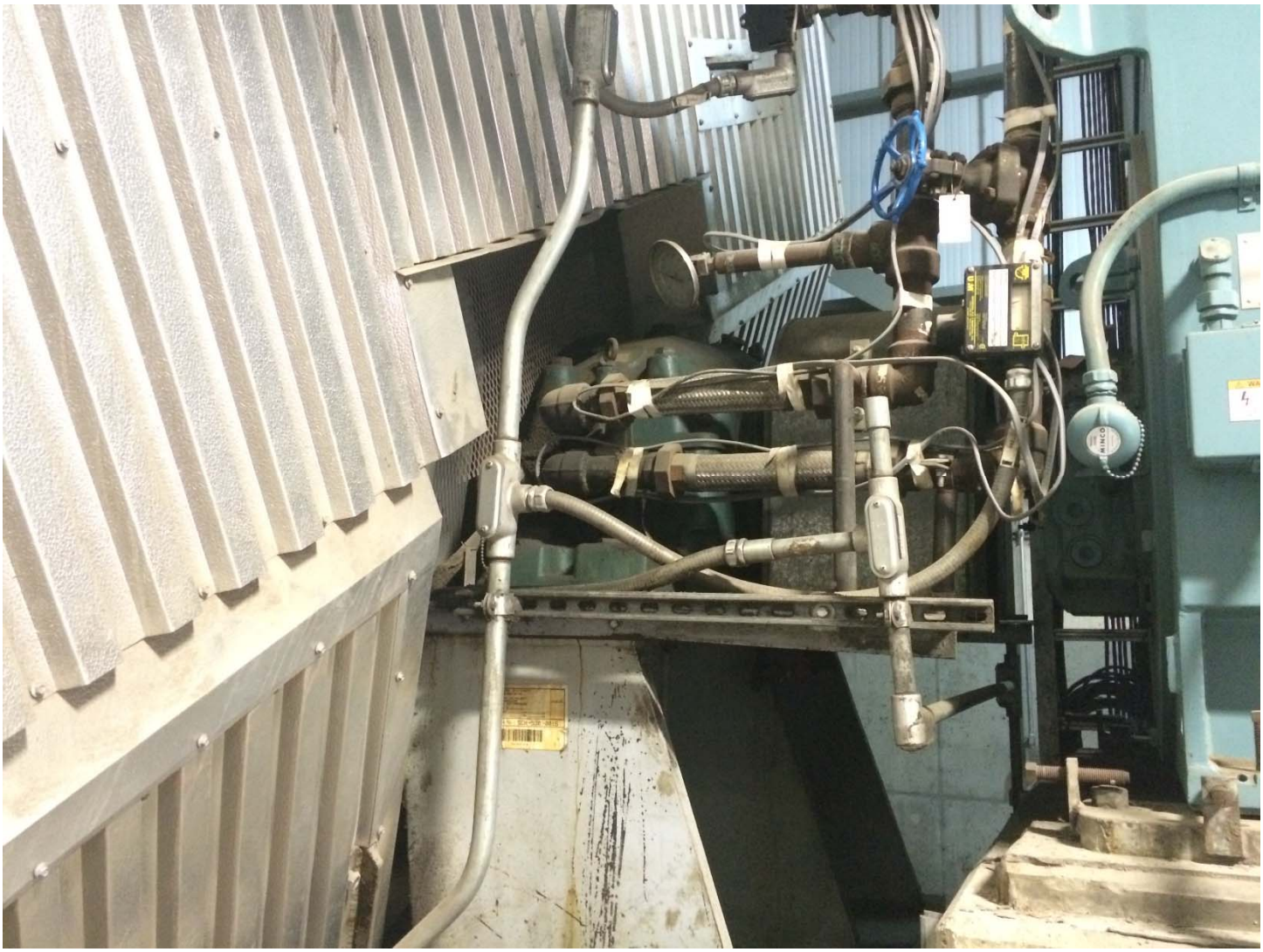
ID Fan – Drive Side - Fan Bearing



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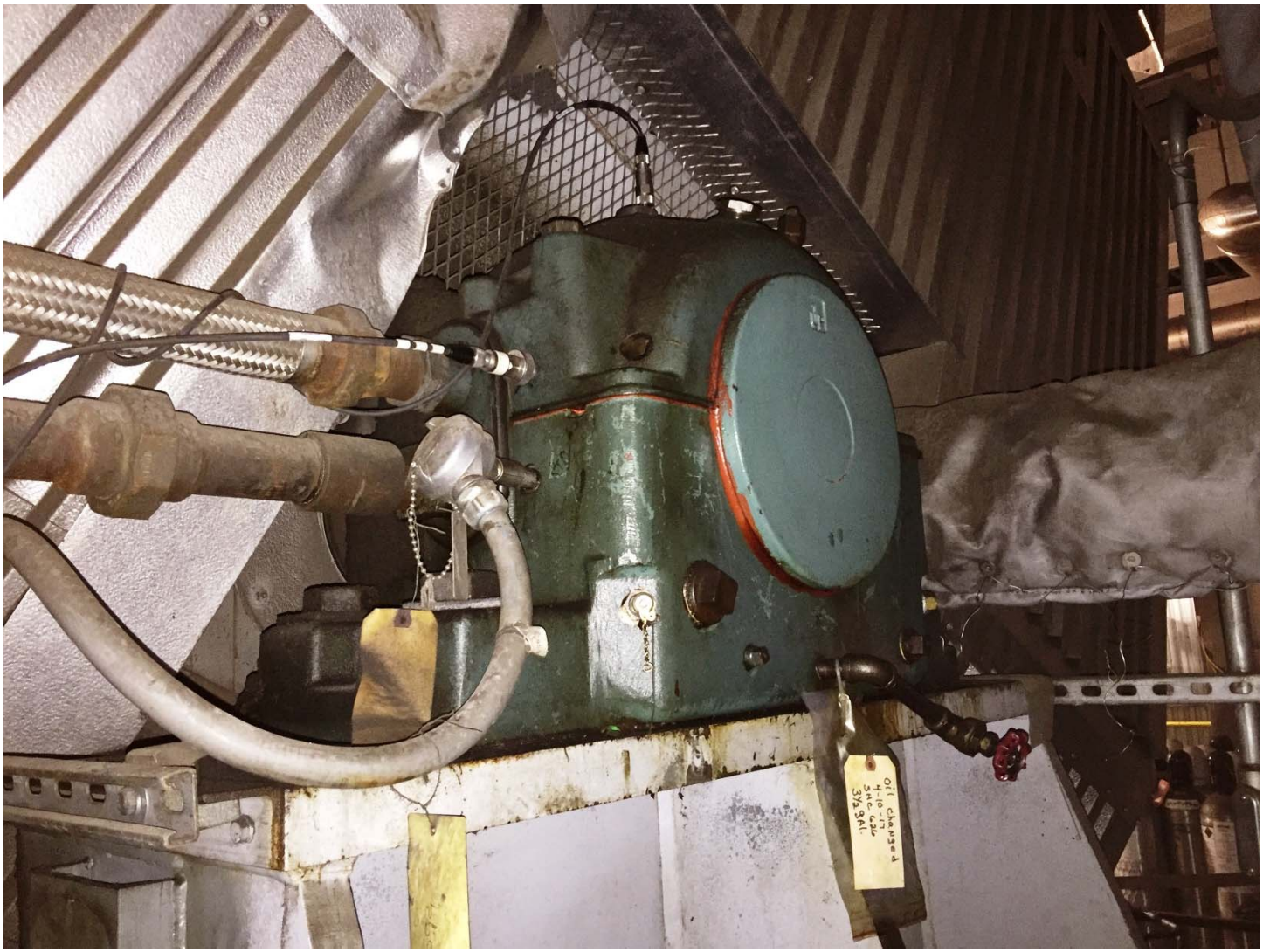
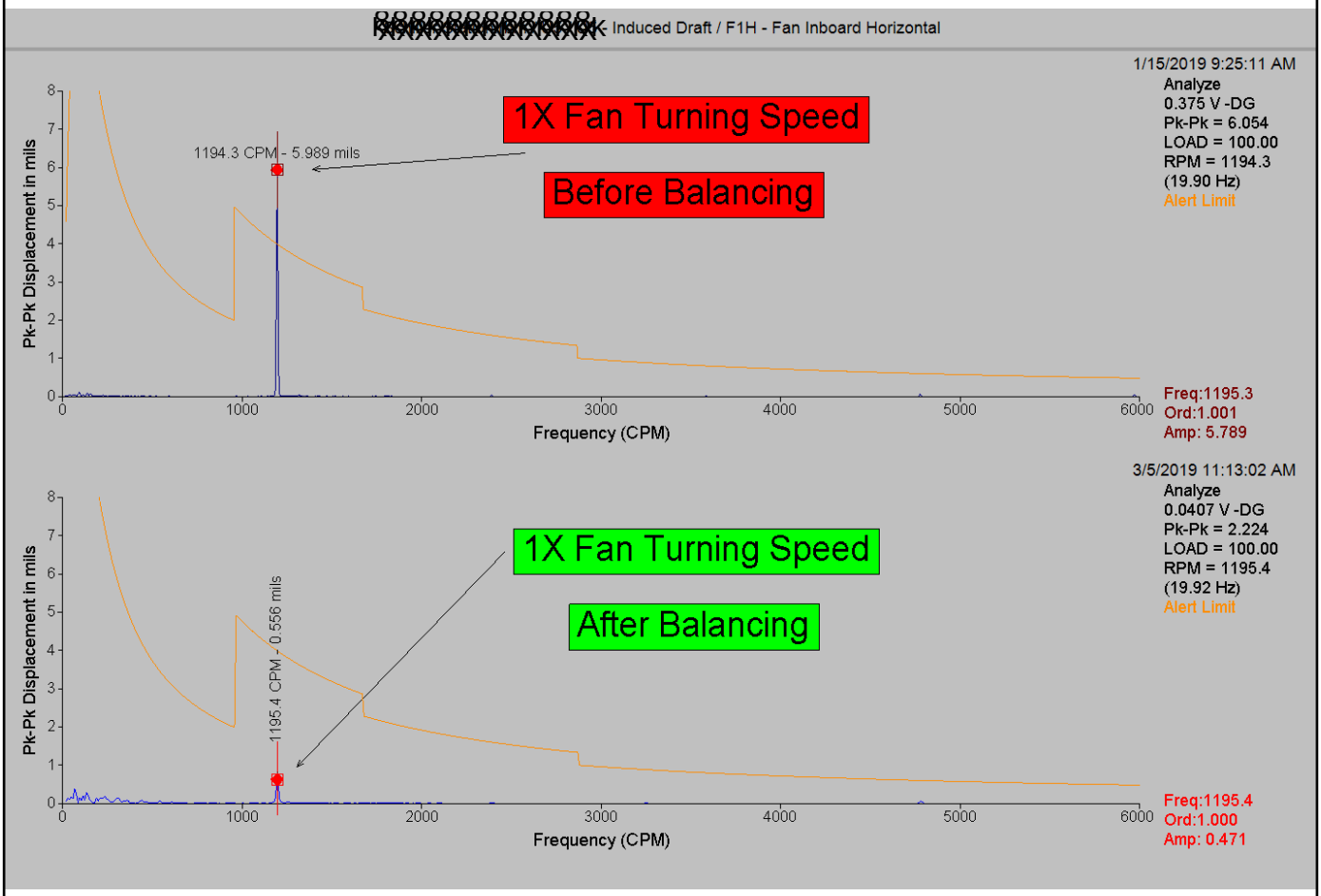
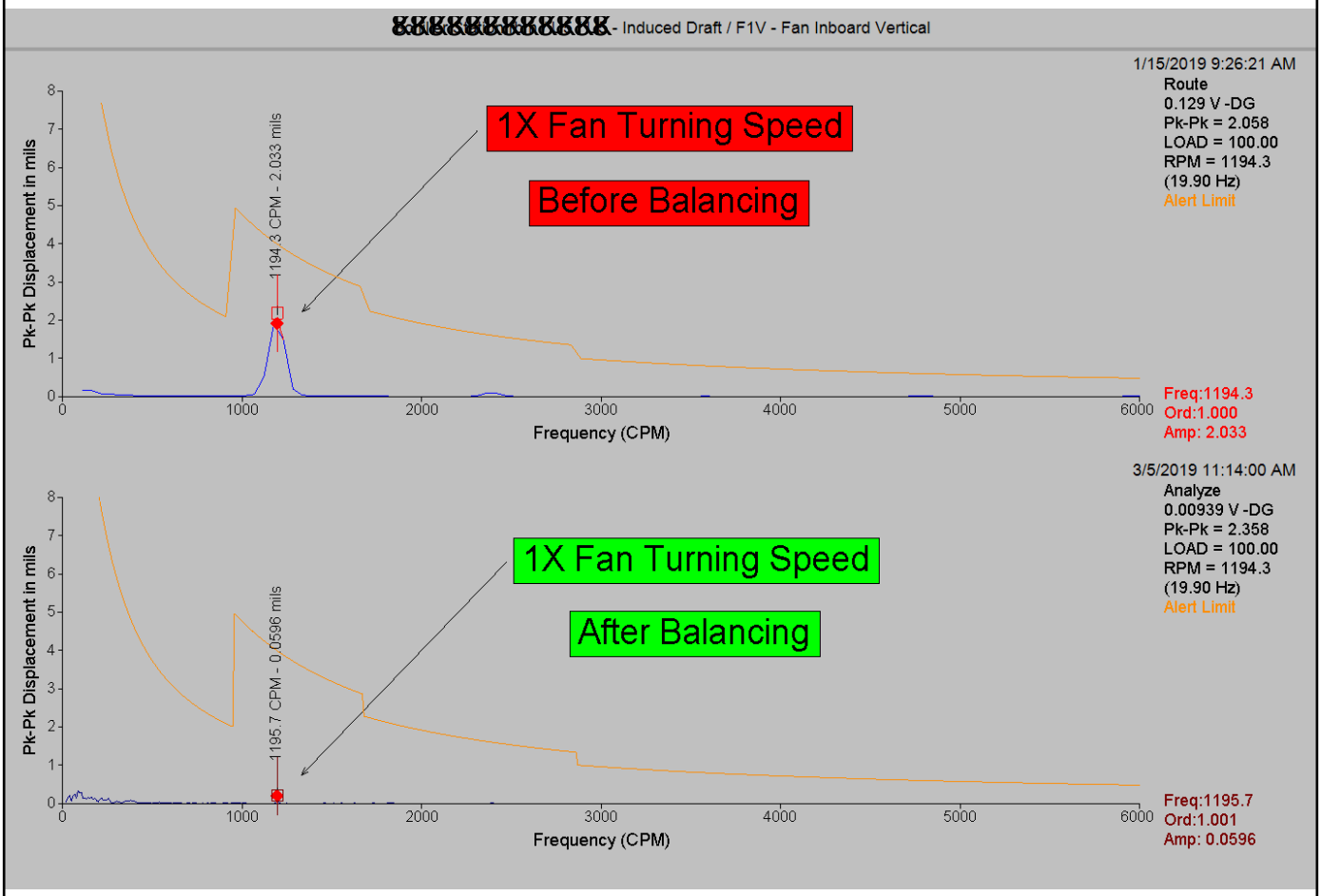
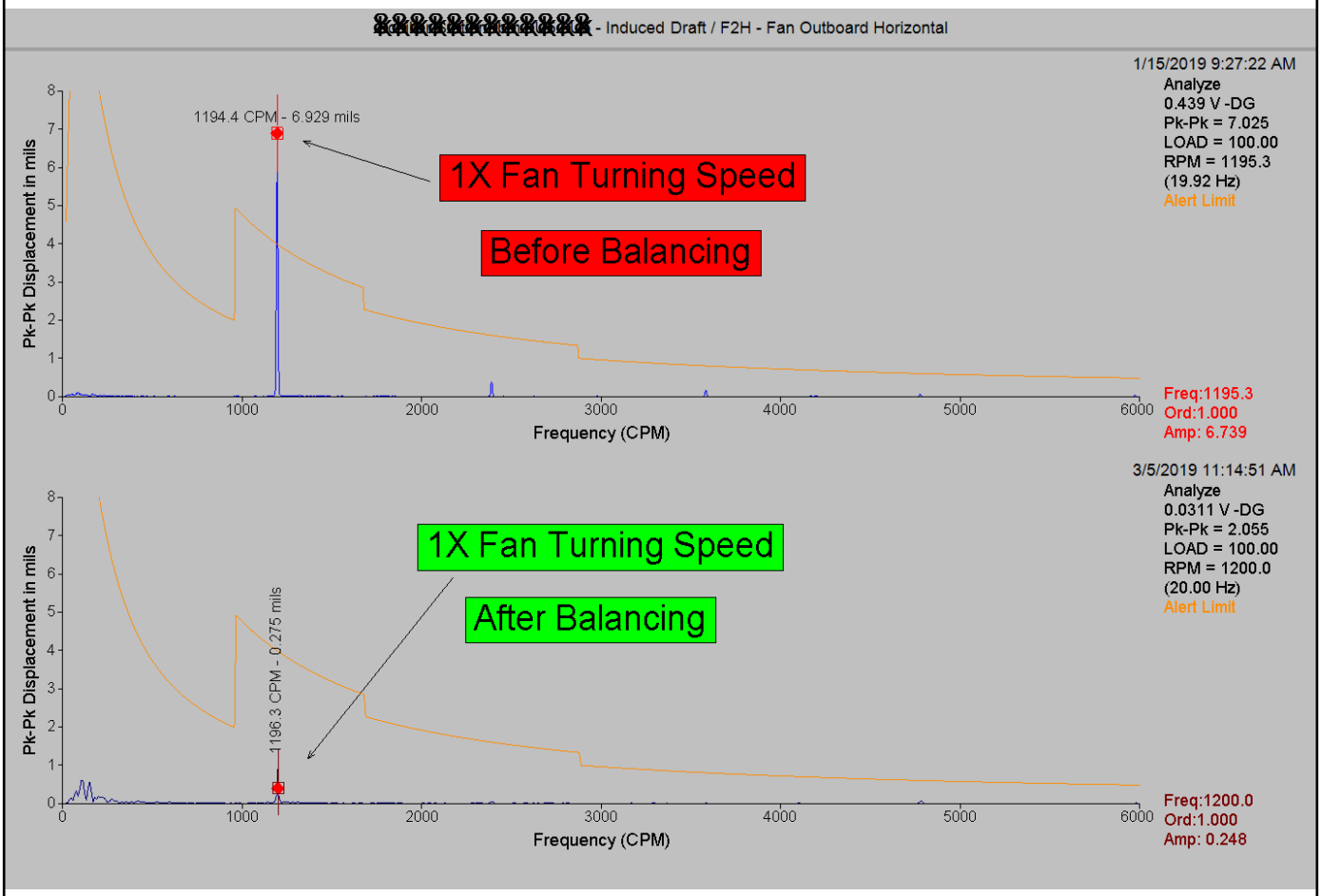
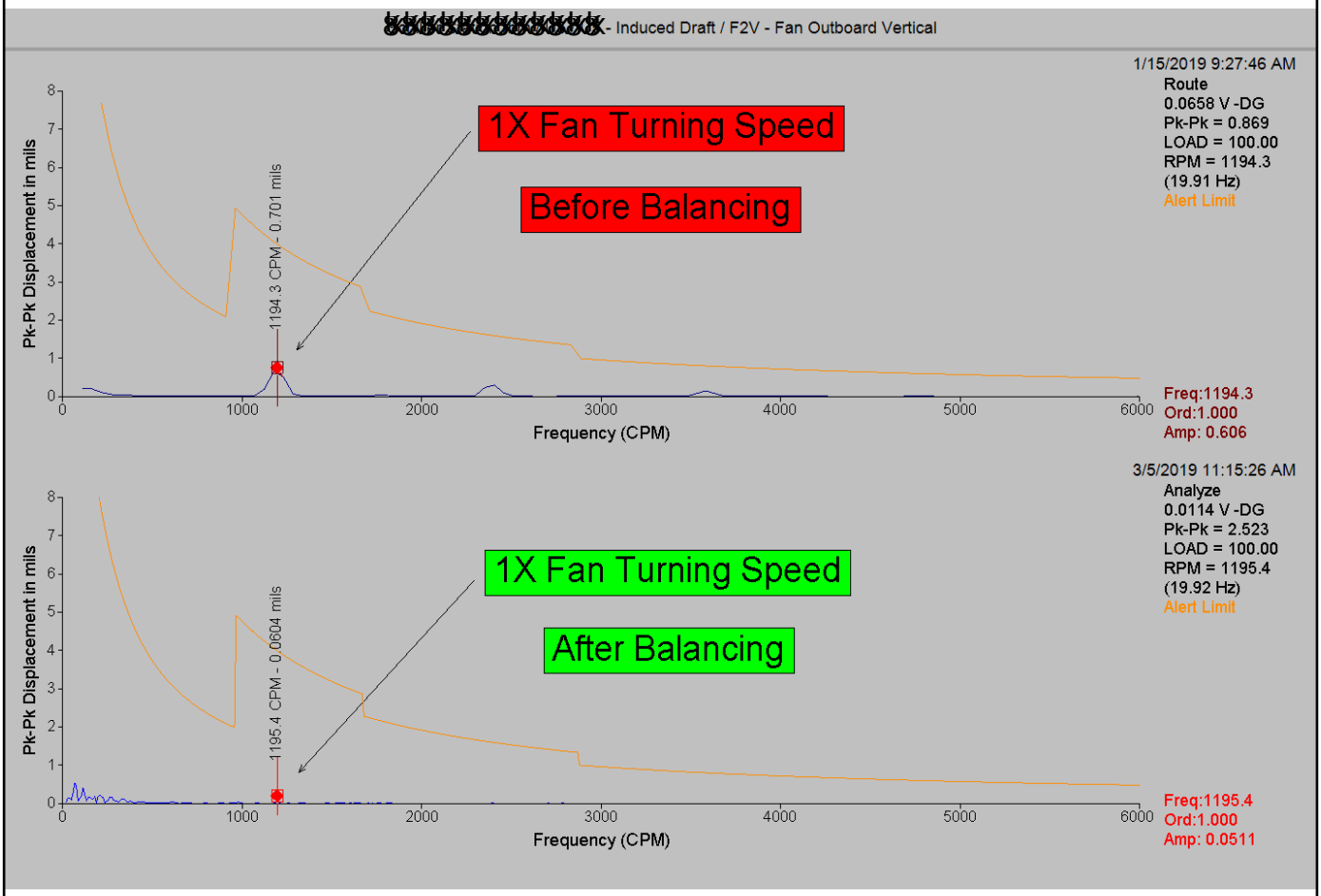
ID Fan – Non-Drive Side - Fan Bearing




XXXXXXXXXXXXXXXX Induced Draft / F1H - Fan Inboard Horizontal
1/15/2019 9:25:11 AM
Analyze
0.375 V -DG
Pk-Pk = 6.054
LOAD = 100.00
RPM = 1194.3
(19.90 Hz)
Alert Limit
1X Fan Turning Speed
Before Balancing
1194.3 CPM - 5.989 mils
Pk-Pk Displacement in mils
Frequency (CPM)
Freq:1195.3
Ord:1.001
Amp: 5.789
3/5/2019 11:13:02 AM
Analyze
0.0407 V -DG
Pk-Pk = 2.224
LOAD = 100.00
RPM = 1195.4
(19.92 Hz)
Alert Limit
1X Fan Turning Speed
After Balancing
1195.4 CPM - 0.556 mils
Pk-Pk Displacement in mils
Frequency (CPM)
Freq:1195.4
Ord:1.000
Amp: 0.471


[redacted] - Induced Draft / F1V - Fan Inboard Vertical
1/15/2019 9:26:21 AM
Route
0.129 V -DG
Pk-Pk = 2.058
LOAD = 100.00
RPM = 1194.3
(19.90 Hz)
Alert Limit
1X Fan Turning Speed
Before Balancing
1194.3 CPM - 2.033 mils
Pk-Pk Displacement in mils
Frequency (CPM)
Freq:1194.3
Ord:1.000
Amp: 2.033
3/5/2019 11:14:00 AM
Analyze
0.00939 V -DG
Pk-Pk = 2.358
LOAD = 100.00
RPM = 1194.3
(19.90 Hz)
Alert Limit
1X Fan Turning Speed
After Balancing
1195.7 CPM - 0.0596 mils
Pk-Pk Displacement in mils
Frequency (CPM)
Freq:1195.7
Ord:1.001
Amp: 0.0596


[redacted] - Induced Draft / F2H - Fan Outboard Horizontal
1/15/2019 9:27:22 AM
Analyze
0.439 V -DG
Pk-Pk = 7.025
LOAD = 100.00
RPM = 1195.3
(19.92 Hz)
Alert Limit
1194.4 CPM - 6.929 mils
1X Fan Turning Speed
Before Balancing
Pk-Pk Displacement in mils
Frequency (CPM)
Freq:1195.3
Ord:1.000
Amp: 6.739
3/5/2019 11:14:51 AM
Analyze
0.0311 V -DG
Pk-Pk = 2.055
LOAD = 100.00
RPM = 1200.0
(20.00 Hz)
Alert Limit
1X Fan Turning Speed
After Balancing
1196.3 CPM - 0.275 mils
Pk-Pk Displacement in mils
Frequency (CPM)
Freq:1200.0
Ord:1.000
Amp: 0.248


[redacted] - Induced Draft / F2V - Fan Outboard Vertical
1/15/2019 9:27:46 AM
Route
0.0658 V -DG
Pk-Pk = 0.869
LOAD = 100.00
RPM = 1194.3
(19.91 Hz)
Alert Limit
1X Fan Turning Speed
Before Balancing
1194.3 CPM - 0.701 mils
Pk-Pk Displacement in mils
Frequency (CPM)
Freq:1194.3
Ord:1.000
Amp: 0.606
3/5/2019 11:15:26 AM
Analyze
0.0114 V -DG
Pk-Pk = 2.523
LOAD = 100.00
RPM = 1195.4
(19.92 Hz)
Alert Limit
1X Fan Turning Speed
After Balancing
1195.4 CPM - 0.0604 mils
Pk-Pk Displacement in mils
Frequency (CPM)
Freq:1195.4
Ord:1.000
Amp: 0.0511

NECI
Emerson Impact Partner

Reliability Solutions

Enabling You to Operate with Confidence

NECI offers complete solutions for process optimization through reliability. Our methodology goes beyond predictive and preventative maintenance to create a structure for ongoing, continuous improvement that leads to process reliability.

VIBRATION ANALYSIS

PORTABLE VIBRATION ANALYSIS

AMS 2140 Portable Data Analyzer
Laser Alignment and Balancing Equipment

VIBRATION ANALYSIS HARDWARE

Accelerometers
Displacement Probes
Junction Boxes
Data Collector Accessories
Cables & Connectors

ONLINE VIBRATION MONITORING

AMS 6500 ATG Protection and Prediction Systems
AMS 9420 Wireless Vibration Transmitter

ASSET MANAGEMENT SOFTWARE

AMS Device Manager
AMS Machinery Health Manager
PlantWeb Optics Asset Management Platform
PlantWeb Health Advisor
PlantWeb Performance Advisor
PlantWeb Energy Advisor

VFD MOTOR BEARING PROTECTION

INDUCTIVE ABSORBERS FOR VFDs

CoolBLUE® and NaLA® Cores for Electrical Fluting Protection

LUBRICATION ANALYSIS & CONTAMINATION CONTROL

CONTAMINATION CONTROL

Desiccant Breathers
Lube Storage/Handling Systems
Filter Systems
Vacuum Dehydration
Lubrication Modification Plans

ELECTRICAL ASSET MONITORING

ELECTRICAL POWER CRITICAL ASSETS

IntelliSAW Continuous Monitoring for Poor Connections, Insulation Degradation, and Air Dielectric Breakdown
56WM Wireless Power Meter for Continuous Monitoring of Power Quality, Efficiency, & Consumption

AUTOMATIC LUBRICATORS

CONTINUOUS LUBRICATION SYSTEMS

Single-Point and Multi-Point Lubricators
Full Line of Fittings and Accessories
Unique Small Sizes to Prevent Over-Lubrication

ULTRASOUND TECHNOLOGY & THERMAL IMAGING

THERMAL IMAGING

Infrared Cameras
IR Inspection Windows

ULTRASOUND

Ultrasonic Probes
Ultrasonic Grease Caddies
Remote Access Sensors

NECI PARTNERS

EMERSON
DES-CASE
IntelliSAW An Emerson Company
CoolBLUE Motor Bearing Protection
FLIR
ue SYSTEMS INC
simalube smart lubrication

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Reliability Services
Enabling You to Operate with Confidence

Comprehensive Services for Continuous Improvement

PREDICTIVE SERVICES
Vibration Analysis
Oil Sampling/Analysis
Ultrasonic Inspections
Infrared Thermography
Onsite Services and Remote Analysis of User-Collected Data
Instrument and Control Valve Diagnostics Programs

CORRECTIVE SERVICES
Shaft Laser Alignment
Dynamic Balancing
Mechanical Repair
Belt/Sheave Laser Alignment
Bearing Replacement
Shaft Grounding Ring Installation
Cool BLUE® Motor Bearing Protection

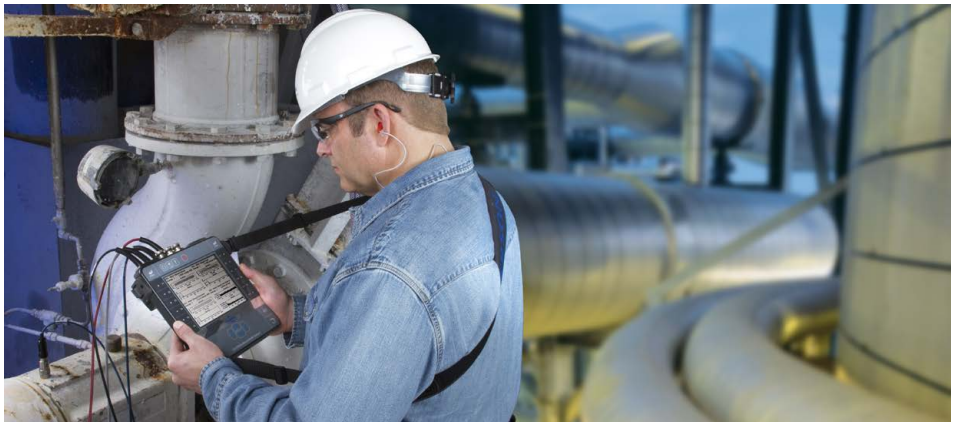
EDUCATION AND TRAINING
Reliability Seminars
Vibration Certification
Software Training
Lubrication Seminars
Onsite PdM Mentoring

PROFESSIONAL SERVICES
Precision Lubrication Benchmarking and Lubrication Room Design
ODS and Modal Analysis
Motion Amplification Analysis for Troubleshooting Structural Issues

RELIABILITY CONSULTING SERVICES
Asset Master Data
PM Optimization
CMMS Optimization
FMEA Library
IIoT Solutions for Prescriptive Maintenance Using Machine Learning and AI

INSTALLATION AND STARTUP SERVICES
Wireless Vibration System Startup and Commissioning
Continuous Turbine Protection System Startup and Commissioning
Installation of Permanent Accelerometers
IntelliSAW System Startup and Commissioning in Medium Voltage Electrical Cabinets and Bus Ducts

NECI PARTNERS
DES-CASE
EMERSON
CoolBLUE Motor Bearing Protection
ue SYSTEMS INC
IntelliSAW An Emerson Company
FLIR
RDI TECHNOLOGIES



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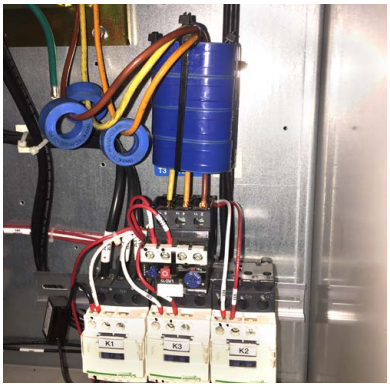
For the Highest Reliability & Longevity of Motors Controlled by VFDs

CoolBLUE® Inductive Absorbers

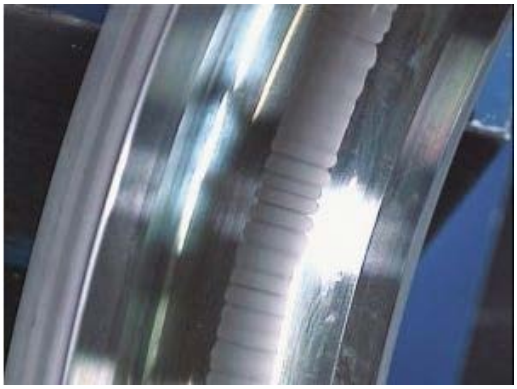
Common mode currents from VFDs can cause motor bearing damage, as well as electromagnetic interference that affects control signals, encoder feedback, communication links for PLCs, remote I/O, metal detectors, pump motors, and other types of sensors.

NECI provides CoolBLUE® inductive absorbers for any project where variable frequency drives (VFDs) are being installed, to protect motors from these stray currents. For existing installations, we use vibration analysis to diagnose bearing wear from electrical fluting, and we provide services to replace bearings and install CoolBLUE® cores to prevent future damage.

CoolBLUE® requires no motor modifications or shaft preparation, and installation is easy and can normally be completed in minutes. This cost-effective technology eliminates the need for expensive hybrid bearings or specially insulated bearings, and lasts the lifetime of the system.



Install CoolBLUE® in all VFD cabinets to prevent bearing damage.



Your new bearings could look like this in just a few months without CoolBLUE®.

CoolBLUE
Motor Bearing Protection

VFDs create high-frequency currents that can damage motor bearings. CoolBLUE® absorbs the damaging high frequency noise, so you can maximize equipment reliability, reduce maintenance costs, and avoid unscheduled downtime.

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Dynamic Balancing

Balancing your rotating equipment significantly improves the performance and extends the life of your critical equipment.

Unbalanced equipment is the leading cause of vibration in rotating machines. In most cases, it is not cost effective – or even possible – to disassemble equipment for off-site shop balancing.

NECI provides onsite field balancing at your plant or facility. With dynamic balancing, a trained NECI specialist conducts a comprehensive vibration inspection of your equipment. Based on our analysis, a balance procedure is performed to optimize the performance of your rotating equipment by correcting the imbalance condition.

Upon completion of the service, a detailed report is provided. This report will illustrate the as-found and as-left condition of your equipment, leaving you with a sense of security knowing that the precision dynamic balancing that was performed will extend the life of your equipment.

Dynamic balancing can be performed on many different types of equipment, including:

- **Pumps**
- **Fans**
- **Compressors**
- **Cooling towers**
- **Air handling units**
- **Blowers**
- **Centrifuges**

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Laser Alignment

Ensure proper alignment of your rotating equipment to improve the functionality and extend the life of your critical assets.

Misalignment is one of the leading factors in premature equipment failure. Misaligned components cause excessive vibration resulting in coupling wear and untimely failure of bearings and seals.

Precision laser alignment of coupled machinery is critical to maximizing the performance and availability of machine trains. Misaligned machines are more likely to experience seal and bearing failures, and can result in reduced product quality and ultimately production shutdowns.

NECI provides precision laser alignments in a timely manner at your plant or facility. Whether the purpose is to confirm the alignment of an existing machine, verify proper installation of new equipment, or correct an issue determined by vibration monitoring, it is important to achieve precise alignment.

We provide shaft alignment and belt/ sheave alignment for:

- **Pumps**
- **Fans**
- **Compressors**
- **Cooling towers**
- **Air handling units**
- **Blowers**

Upon completion of our service, a detailed report is provided that illustrates the before-and-after alignment readings of your equipment, leaving you with a sense of security knowing that an accurate laser alignment was performed that will extend the life of your equipment.

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Vibration Analysis

Vibration analysis offers a scientific approach to obtaining detailed information about the health of your rotating equipment.

Equipment failure as a result of excessive vibration may not only leave you with expensive repairs, but can also greatly increase the safety risks to personnel. Early detection and accurate diagnostics is the key to identifying the root cause of machinery problems.

NECI offers a wide variety of vibration analysis and monitoring solutions, which can be customized to accommodate many different types of facilities with unique requirements.

Whether it is periodic route-based testing, consulting, continuous online monitoring (wireless or wired), or turbine shutdown protection systems, NECI has the capabilities and resources to provide expert vibration analysis and associated maintenance recommendations.

Below is an excerpt from a typical summary report that tracks status of equipment for a route-based monthly vibration monitoring program. This provides the user with a quick view of asset health over time, including current issues and recommended actions. Access to a web browser-based asset health tracking software for program results can also be provided.

NECI **VIBRATION MONITORING PROGRAM SAMPLE EQUIPMENT SUMMARY REPORT**

Condition Legend:		
Extreme	1	Immediate action is required. Consider shutting down the equipment and taking repair action now.
Serious	2	Take maintenance action during the next planned downtime or maintenance period.
Moderate	3	Issue is present, but no immediate repair action is required. Continue to monitor.
OK	4	No repair action is recommended. Continue to monitor and trend.
Lubrication Fault	L	Lubricate bearing during next vibration test.
Not Tested This Survey	NT	Equipment was not running and/or unable to operate during the time of testing.

Equipment Description	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	*Comments*	*Recommended Action*
Cooling Tower Fan	4	4	4	4	4	4		
Trane Chiller Motor	4	4	4	4	4	L	Lack of lubrication on the motor bearings.	Grease motor.
Air Handling Unit - Supply Fan	4	4	NT	2	2	2	High PeakVue - motor bearing wear present.	Replace bearings next scheduled downtime.
Air Handling Unit - Return Fan	4	4	4	4	3	3	Unbalance condition.	Replace var pitch sheave on motor; balance fan.
Condenser Water Pump	4	NT	4	4	4	4		
Primary Chilled Water Pump	4	4	4	4	4	4		
Condenser Tower Water Pump - A	3	3	3	2	2	2	Increased vibration on motor & pump.	Check suction strainer; confirm proper alignment.
Condenser Tower Water Pump - B	2	2	NT	2	2	1	High PeakVue - significant pump bearing wear.	Only operate in an emergency until scheduled rebuild.
WFI Hot Loop Storage Pump	4	4	4	4	4	4		
RO Storage Pump	4	4	4	4	4	4		
WFI Compressor	4	4	4	4	3	3	Possible worn pulleys.	Inspect pulleys and confirm belt alignment/tension.

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Thermography

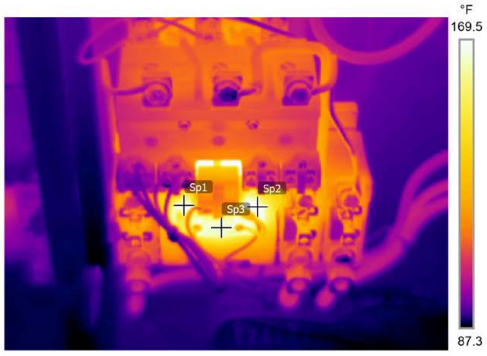
NECI uses infrared thermography to identify hot spots so that loose wires or other defects can be corrected before they cause unscheduled downtime.

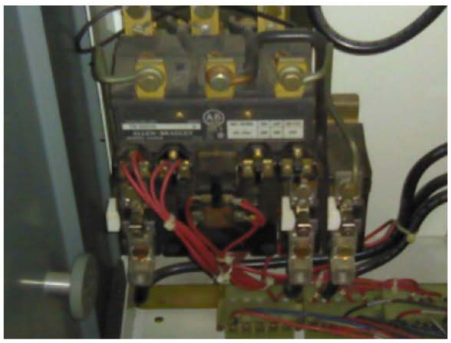
Heat can be an indicator of poor equipment performance, and infrared imaging is a key component of any predictive maintenance program. However, with tight resources, sometimes it is impossible to find time to check the temperature of critical equipment.

NECI offers a plant- or facility-wide thermography survey, where our trained field experts will use state-of-the-art thermal imaging equipment to check critical electrical or rotating equipment, such as:

- Electrical cabinets
- Breakers
- Motor control centers
- Pumps
- Motors
- Other equipment with potentially hot contact points

Thermography surveys identify hot spots that are indicators of defects. Surveys can be done as part of an ongoing service program, where NECI monitors operating conditions over time, capturing a data record that will enable us to identify any potential issues or unusual conditions that may emerge during the course of normal operation. After each survey, a report is provided documenting defects found and recommended actions.





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Ultrasonic Testing

NECI uses ultrasonic testing to quickly find leaks that are costing you money.

Leaks can be difficult to locate, and it is possible to waste hours trying to find a leak using the tried-and-tested soap bubble method of leak detection. Ultrasonic testing offers a faster, more reliable method for detecting leaks.

NECI offers a plant- or facility-wide ultrasonic survey for leak detection. Rather than detecting the presence of gas, ultrasonic equipment listens for leaks in the ultrasonic range — which is well beyond what the human ear can hear — and traces the sound to its source.

The report that NECI generates identifies leaks and provides a leak cost summary that offers a conservative estimate of capturable costs for each identified leak. The report also provides photos of the locations with leaks, and an assessment of the criticality of the leak.

Leaks can be found in many areas, including:

- **Gas lines**
- **Compressed air lines**
- **Steam traps**
- **Control valves**

Ultrasonic testing can also be used to:

- **Identify bearing lubrication issues**
- **Identify bearing damage**

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