



# Powerful Motor Management

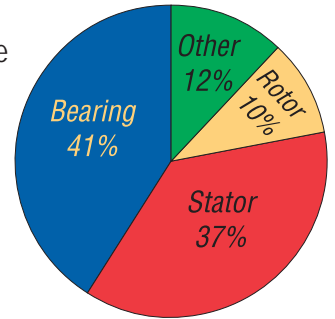


revolutionizing electrical reliability

[www.pdma.com](http://www.pdma.com)

# How Do Motors Fail?

Often electrical defects are the root cause, even when mechanical failure is the apparent cause. A study by the Electrical Power Research Institute (EPRI)\* identified that a major source of motor failures were electrical.



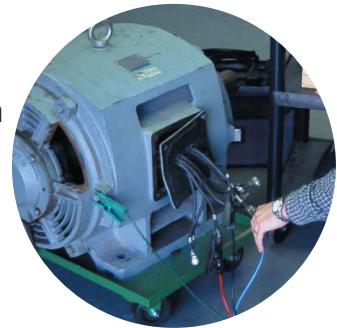
## Your Solution:



Complete your electrical motor maintenance program with the addition of the **MCEMAX™** — the single most powerful component in your “toolbox.” MCEMAX provides more information in **three minutes** than any other predictive technology. Use it for:

### Quality Assurance

Pre-qualify motors upon receipt and/or evaluate quality after costly repairs.



Test Date	06/03/2002	06/03/2002	06/03/2002
Test Time	10:01:58 AM	03:47:57 PM	04:16:53 PM
Frequency	1200	1200	1200
Mohm Ph 1 to Gnd	Baseline		
Charge Time	60	60	60
Voltage	1000	1000	1000
Motor Temp	30	30	30
Measured Mohm	3900.0	163.9	157.5
Corrected Mohm	2000.0	82.0	78.8
pF Ph 1 to Gnd	31500	45250	44750
ohm Ph 1 to 2	0.02800	0.05700	0.05650
ohm Ph 1 to 3	0.02800	0.05400	0.05350
ohm Ph 2 to 3	0.02800	0.05550	0.05550
mH Ph 1 to 2	2.395	2.425	2.170
mH Ph 1 to 3	2.340	2.390	2.325
mH Ph 2 to 3	2.390	2.415	2.350
Avg. Inductance	2.375	2.410	2.262
% Res. Imbalance	0.00	2.70	3.02
% Ind. Imbalance	1.47	0.83	4.89
\$ Power Loss	0.00	84.14	84.14
Test Location	Motor Leads	Motor Leads	Motor Leads
MCE #	030489HV	030489HV	030489HV
User			
Notes	No	No	No

### Trending

Easy to use software stores your motor data and immediately alerts you if there is an alarming condition.

### Diagnostics/Troubleshooting

Analyze data, define problems and isolate the root cause of each potential motor failure.

VOLTAGE					POWER				
Phase	Volts	Phase	Watts	PF	THD	Phase	Watts	Watts	Watts
Voltage 1-2	480.91	441.30	1.45	1.47		Phase 1	4.91	4.07	8.38
Voltage 2-3	490.25	450.87	1.46	1.56		Phase 2	5.22	2.94	5.99
Voltage 1-3	482.70	463.12	1.45	1.54		Phase 3	6.46	4.13	7.57
Average	481.29	451.69				Total	16.59	11.15	20.93
% Imbalance	2.51	2.51	HVF	0.01		Power Sequence	18.59	11.15	19.98
NEMA Derating	82.31	%NEMA	Derating	100.00					
Voltage 1	265.31	265.54	1.40	1.41					
Voltage 2	249.82	250.05	1.47	1.56		Efficiency	83.12		
Voltage 3	258.41	258.73	1.41	1.70		HP Output	13.69		
Average	261.53	260.77				kW Output	13.79		
% Imbalance	4.11	4.11							
CURRENT					SEQUENCE DATA				
Phase	Current	Phase	Positive	Negative	Zero	Vol Phase-Phase	Vol Phase-Neutral	Current	Current
Current 1	24.04	24.07	1.60	2.01		481.20	12.65	0.00	
Current 2	23.97	24.01	1.55	2.82		260.50	7.30	4.75	
Current 3	28.78	29.81	1.48	2.23		25.50	3.16	1.15	
Average	25.60	25.63							
Variance	12.24	12.24							
% FLA	100.38	100.51							
IMPEDANCE					PHASE CONFIGURATION				
Phase	Real	Magnitude	Angle	Angle	Phase Configuration	Line to Neutral 120 Degree	Phase Rotation	Phase Rotation	Phase Rotation
Phase 1	8.93	11.04	39.66		Line to Neutral 120 Degree		Line to Neutral 120 Degree	Line to Neutral 120 Degree	Line to Neutral 120 Degree
Phase 2	8.08	10.42	29.43		Phase Rotation		Phase Rotation	Phase Rotation	Phase Rotation
Phase 3	7.89	9.26	32.62		Phase Rotation		Phase Rotation	Phase Rotation	Phase Rotation
% Imbalance	1.77				Phase Rotation		Phase Rotation	Phase Rotation	Phase Rotation

\* 1985 EPRI/ GE Study



# Immediate COLOR CODED Evaluation

The screenshot displays the PdMA software interface. At the top is a menu bar with 'Setup', 'View', 'Utility', and 'About'. Below it is a toolbar with icons for 'Add', 'Delete', 'Copy', 'Test', 'Data', 'Reports', 'Find Motor', 'Create File', 'Battery Check', and 'Nameplate'. The main window is divided into three sections: 'Motor List', 'Last Test Dates', and 'Motor Information'. The 'Motor List' shows a tree view with 'MCE' containing 'Motor 1', 'Motor 2', and 'Motor 3'. The 'Last Test Dates' section shows test results for 'MCE' under 'Stator' and 'Emax' categories. The 'Motor Information' section provides details for 'Motor 1', including 'Asset ID', 'Circuit', 'Motor Type' (AC Induction), 'Manufacturer' (LOUIS ALLIS), 'Horsepower' (150), 'Volts' (480), 'Full Load Amps' (162.5), and 'Speed/RPM' (1788). A 'Notes' table shows a note from 8/1/02 at 9:51:33 AM regarding a 'Condition Code Change'. A 'Fault Zone' dialog box is overlaid on the bottom right, showing color-coded status for various fault zones: Power Circuit (ALARM), Power Quality (ALARM), Insulation (ALARM), Stator (ALARM), Rotor (GOOD), and Air Gap (CAUTION). A legend at the bottom left of the software interface shows color-coded status indicators: Not Assigned (grey), Good (green), Observe (blue), Caution (yellow), and Severe (red). It also includes checkboxes for 'Select Motors on Click' and 'Allow multiple condition code select'.

Category	Item	Date	Time
MCE Stator	AC Standard	06/03/02	04:16 PM
	PI	06/03/02	10:16 AM
	RIC	06/05/02	01:25 PM
MCE Emax	Hi Res	06/03/02	02:41 PM
	Low Res	06/03/02	02:41 PM
	Eccentricity	06/03/02	02:42 PM
	In-Rush/Startup	06/03/02	02:42 PM
	Power	06/03/02	02:37 PM

Date	Subject
8/1/02 9:51:33 AM	Condition Code Change

Fault Zone	Condition
Power Circuit	ALARM
Power Quality	ALARM
Insulation	ALARM
Stator	ALARM
Rotor	GOOD
Air Gap	CAUTION

For every motor you test, our expert software immediately evaluates the data and color codes the condition of each motor fault zone.



Revolutionizing Electrical Reliability

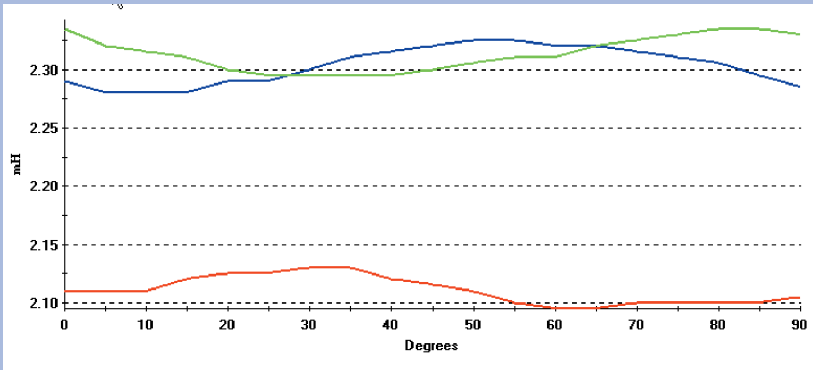
PHONE: (714) 523-3778

FAX: (714) 523-3494

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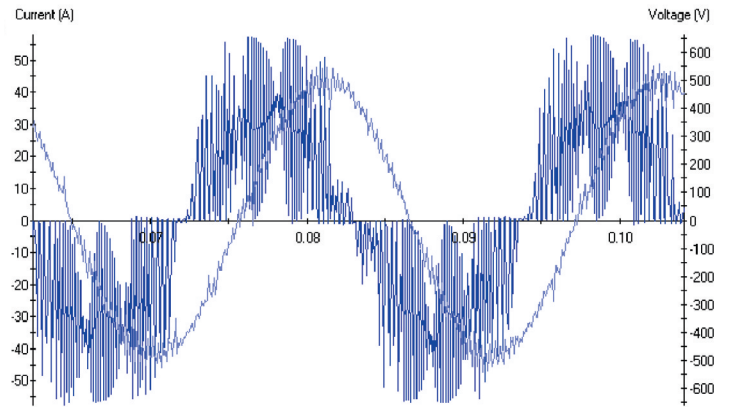
# Easily Evaluate All Six Fault Zones with MCEMAX...

## Stator



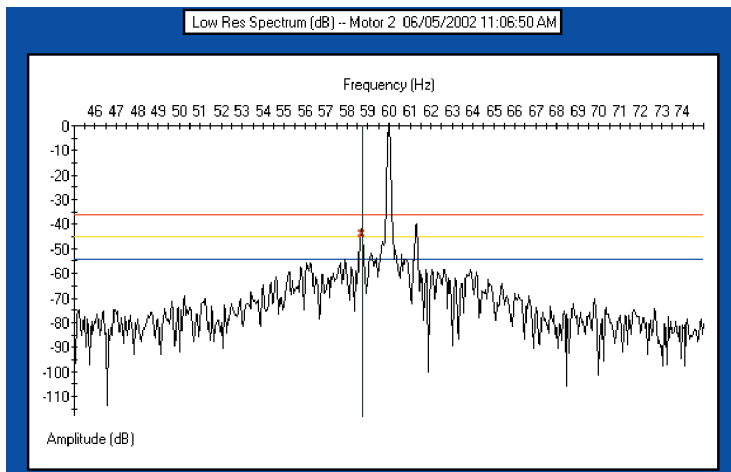
Phase-to-phase resistance, inductance, impedance and current imbalances are used to determine turn or phase shorts as well as faulty internal connections.

## Power Quality



The power being fed to your motor is in reality the food it needs to operate efficiently. MCEMAX monitors three phases of voltage and current and will alert you when an unhealthy condition exists.

## Rotor



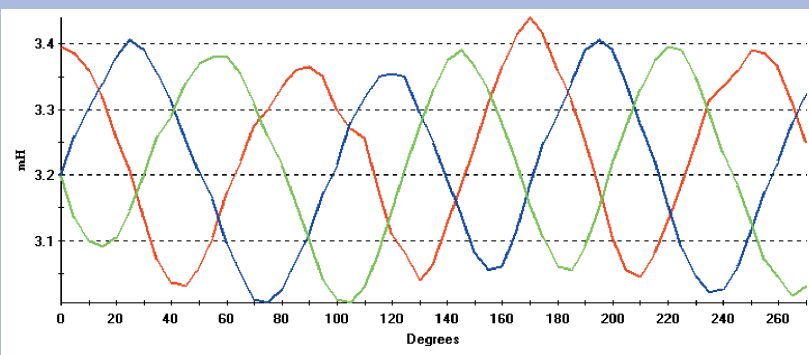
Identify cracked/broken rotor bars, porosity and high resistance connections in the end rings thru motor current signature analysis (MCSA) and the rotor influence check (RIC).

## Power Circuit

Test Date	06/03/2002	06/03/2002	06/03/2002
Test Time	10:01:58 AM	03:47:57 PM	04:16:53 PM
Baseline			
Frequency	1200	1200	1200
Mohm Ph 1 to Gnd			
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ohm Ph 1 to 2	0.02800	0.05700	0.05650
ohm Ph 1 to 3	0.02800	0.05400	0.05350
ohm Ph 2 to 3	0.02800	0.05550	0.05500
mH Ph 1 to 2	2.395	2.425	2.170
mH Ph 1 to 3	2.340	2.390	2.325
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Avg. Inductance	2.375	2.410	2.282
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Test Location	Motor Leads	Motor Leads	Motor Leads
MCE #	030489HV	030489HV	030489HV
User			
Notes	No	No	No

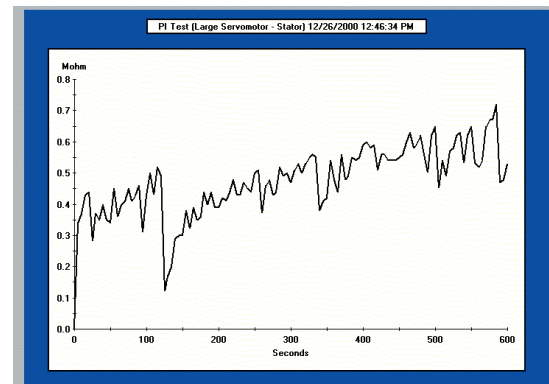
All connections, components and cables between the MCC and the motor must be resistively balanced. Potential problems occur when you introduce loose or corroded connections into the circuit. The MCEMAX compares each phase of resistance, current and voltage to ensure a perfect balance.

## Air Gap



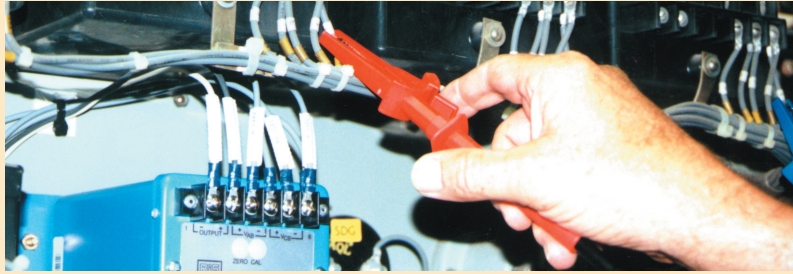
Bowed shafts, cocked end rings or degraded journal bearings create magnetic imbalances. These magnetic imbalances show up as 1st and 3rd sidebands around eccentricity frequency or as a "bow tie" shape on the RIC.

## Insulation



Resistance-to-ground values for motor windings decrease as moisture and contamination increases. The MCEMAX not only provides testing capabilities up to 5000VDC\*\* but also offers continuous graphing polarization index (PI) and computer automated step voltage tests.

\*\*obtained with the 5kv Module



## Your Benefits:

### ***Comprehensive***

MCEMAX tests all potential fault zones: stator, rotor, air gap, power quality, power circuit and insulation.

### ***Correlative***

MCEMAX correlates both online and offline data to confirm troubleshooting efforts.

### ***Versatile***

MCEMAX tests AC induction, synchronous, wound rotor, DC, specialty motors, generators and transformers.

### ***Unparalleled Support***

Free expert technical support for the life of the unit.

## Frequently Asked Questions

### ***How long does it take for the MCEMAX to pay for itself?***

Based on a recent customer survey the average length of time for the MCEMAX to fully pay for itself is 5 months. There have been no reports of ROI taking longer than one year.

### ***Are you compliant to IEEE 43-2000 standards?***

Yes. When testing motor windings rated between 2501-5000 volts you should use 1000-2500 volts. With our 5kv Module, the MCEMAX is capable of providing up to 5000 volts DC for Resistance-to-Ground, Dielectric Absorption, Step Voltage or Polarization Index testing.

### ***Do you test VFD motors?***

Yes. MCEMAX is not only the most comprehensive tool on the market to test VFD motors, it also can test transformers, generators, synchronous motors, DC motors, wound rotor motors and more.

### **Rely on MCEMAX for the single best motor tester.**

<b>Task</b>	<b>MCEMAX</b>	<b>MCSA</b>	<b>Hi-Pot</b>	<b>Surge</b>	<b>Infrared</b>	<b>Megger</b>
Tests stator windings	✓			○		
Tests squirrel cage rotor	✓	○				
Tests power circuit	✓				○	
Tests power quality	✓	○				
Tests armature and synchronous rotor	✓			○		
Tests insulation system	✓		○	○		○
Identifies air gap eccentricity	✓	○				
Provides statistical analysis	✓					
Provides quality assurance	✓		○	○		○
Allows for troubleshooting	✓	○	○	○	○	○
Ability for trending	✓	○				○
Powered by battery	✓	○			○	○

**Clearly, the MCEMAX is the most comprehensive motor tester available.**

A New

**GOLD STANDARD**

in Motor/Asset Management

**MCEGOld™**



[www.PdMA.com](http://www.PdMA.com)

A Leader in Electric Motor Testing



# The **FUTURE** of Motor/Asset Management Has Arrived

Introducing

**MCE<sup>®</sup>  
MAX**

powered by

**MCEGold<sup>™</sup>**



Combining the latest technology, analysis, and information systems, MCEMAX<sup>®</sup> powered by MCEGold<sup>™</sup> is a complete motor/asset management tool for today's motor management needs. Designed to integrate testing, diagnostics, inventory control, scheduling, and cost containment in an enterprise arena, the system is an important step toward improving communication between plant maintenance and corporate management.

This marriage of maintenance and management is the first of its kind to provide technology, analysis, and information system in one package ... and it's only available from PdMA Corporation, a leader in electrical predictive maintenance since 1983.

With MCEMAX powered by MCEGold monitoring your motors, in any plant around the globe, you can:

#### **MAXIMIZE MAINTENANCE EFFICIENCY**

- Regular maintenance is scheduled and performed when it is most cost effective for you.

#### **MINIMIZE PRODUCTION LOSSES**

- Potential motor problems are identified before they occur, minimizing losses due to catastrophic motor failure.

#### **DECREASE OPERATING COSTS**

- Downtime and repairs are scheduled during outages.

#### **INCREASE PROFITABILITY**

- Reducing operating costs and production losses has a significant impact on profits.
- Improved report functions allow data mining, analyzing cost, inventory control, and scheduled repairs and maintenance.

#### **CHOOSE MULTIPLE OPTIONS**

- Choose to test offline or online with one system. Plus, choose to use it as a desktop, field, wireless, or network tester. You can also have access to both regular or wireless communication applications.
- Choose from three scalable database designs — Stand Alone, Small Business (*single site*) or Enterprise Edition (*multi-site/multi-seat*).

#### **UTILIZE TODAY'S MEDIA**

- Integrate with third-party applications, such as Microsoft<sup>®</sup> Excel<sup>®</sup>, for easy reporting and analysis.
- Communicate easily through database synchronization.
- MCEGold can communicate and provide multiple database support with MSDE and SQL server.
- Adaptable and flexible to serve your needs today ... and in the future.

MCEMAX powered by MCEGold provides solutions to operate a plant at maximum efficiency and lowest cost. Technicians and managers alike will benefit from this powerful system's advanced testing, analysis, reporting, and information management features.

**PdMA is Setting the Gold Standard for Motor Management.**

# Enterprise Management: A Bird's Eye View



Without a doubt, one of the leading issues today in any company is processing information. While technicians are performing tests and maintenance, it's hard to find the time to communicate the necessary information to management. How much do they need to know? What reports should you pull? How much extra time needs to be spent explaining the reports?

MCEGold has enterprise capabilities to provide management with their own information system. Technicians are now free to do their work and concentrate less on informing managers, and managers are able to see reports at any time that relate to their bottom line.

The screenshot displays the MCEGold software interface. The main window shows a site condition dashboard for 'TriBay'. The dashboard includes the following data:

Category	Count	Percentage
Number of Motors	139	
Number of Generators	0	
Not Tested	8	
Tested/No Condition Assigned	35	
Severe	18	13%
Caution	21	15%
Observe	21	15%
Good	34	24%

The interface also shows a list of assets with columns for Order, Criticality, Name, Type, Last Enam Test Date, and Last MCE Test Date. A message center at the bottom shows a message about a condition code change for a blower.

## DASHBOARD

Managers need a quick overview of the motor/asset status. Site Condition provides a "Dashboard" that places key information at their fingertips. All motors/assets, and the severity level of each as determined by the technician, are listed. Managers can easily open notes (Message Center) and view updates on the motor/asset in question. They can also create their own "WatchList" to keep an eye on critical motors/assets.

## SITE VIEW

What's a manager to do when he's responsible for motors/assets in multiple plant sites? Now, he doesn't have to leave his desk or spend hours pouring through multiple technicians' reports. With MCEGold, he can view motors/assets from any plant instantly. He can

compare plants for tested motors/assets, key performance indicators for motor/asset condition, monitoring work, and benchmarking.

## TECHNOLOGY

Nothing slows a company down faster than using obsolete technology. MCEGold uses a SQL database design to optimize bandwidth utilization, reduce network traffic, and use less "pipe." Using a Wide Area Network (WAN), MCEGold has multi-site capabilities with a centralized database. Most importantly, the software provides for faster data synchronization from field tester to server. Plus, because this system can convert data to XML, a platform-independent technology, you can now export and integrate third-party applications, create PDF documents to make your job easier.

PdMA Corporation is the first in the industry to address the requirements of both the manager and the technician, while integrating advanced technology and information system management tools to make a powerful system for your motor/asset management needs. You can rely on MCEMAX powered by MCEGold to grow and adapt with your company.





# Day-To-Day Data Management

MCEGold makes it easier for you to test, analyze, and make decisions. Plus, with its advanced reporting functions, you don't have to worry about simplifying complex reports; MCEGold does that for you. You can spend your time doing what you do best — keeping the motors running at top efficiency.

## TESTING

With MCEGold you can easily evaluate all six fault zones. Plus, you can set up automatic testing for MCE, EMAX or both. EMAX now allows you to test DC online.

### POWER CIRCUIT

All connections, components, and cables between the MCC and the motor must be resistively balanced. Potential problems occur when loose or corroded connections are introduced in a circuit. MCEGold compares each phase of resistance, current, and voltage to ensure a perfect balance.

### ROTOR

Identify cracked/broken rotor bars, porosity, and high resistance connections on the end rings through motor current signature analysis (MCSA) and the rotor influence check (RIC).

### POWER QUALITY

The power being fed to a motor is the fuel it uses to operate. MCEGold monitors three phases of voltage and current, and alerts users when an unhealthy condition exists.

### AIR GAP

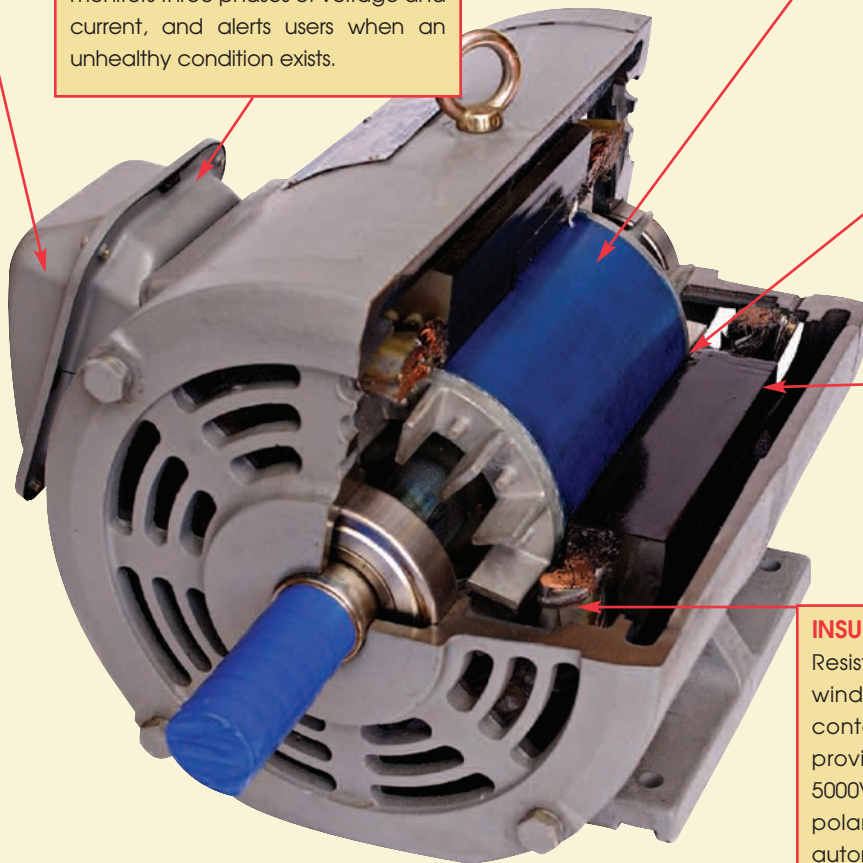
Bowed shafts, cracked end rings, and degraded journal bearings create magnetic imbalances. These imbalances show up as 1st and 3rd sidebands around the eccentricity frequency or as a "bow tie" shape on the RIC.

### STATOR

Phase-to-phase resistance, inductance, impedance, and current imbalances are used to determine turn or phase shorts as well as faulty internal connections.

### INSULATION

Resistance-to-ground values for motor windings decrease as moisture and contamination increases. MCEGold provides testing capabilities up to 5000VDC and offers continuous graphing polarization index (PI) and computer automated step voltage tests.





## AT A GLANCE ...

### SITE CONDITION

MCEGold makes it easy to see which motor/asset is critical or in need of attention. Instantly, you can view the number of motors/assets in the site, how many have been tested, and the condition code status. See more detailed information with a click of the mouse. Use this feature to create your own "WatchList" of motors/assets to "keep an eye on."

**Site Name: TriBay**

<b>Number of Motors</b>	139
<b>Number of Generators</b>	0
<b>Not Tested</b>	8
<b>Tested / No Condition Assigned</b>	35

<b>Severe</b>	18	13 %
<b>Caution</b>	21	15 %
<b>Observe</b>	21	15 %
<b>Good</b>	34	24 %

### WATCHLIST

Create a list of specific motors/assets to "watch." You may choose to make a list of critical motors/assets, motors/assets with a specific condition code, or specific routes for your technicians. Make as many WatchLists as you need and even drill down into a motor/asset summary to make daily management decisions even easier.

Order	Criticality	Name	Type	Last Emag Test Date	Last MCE Test Date	Last Condition Change
1	2	PF-7.1B	AC Induction Motor	8/26/2002 10:34:19 AM	8/26/2002 10:33:57 AM	
2	2	PF-7.1A	AC Induction Motor	8/26/2002 10:25:20 AM	8/26/2002 10:24:51 AM	
3	2	PF-7.1C	AC Induction Motor	8/26/2002 10:42:20 AM	8/26/2002 10:42:00 AM	
4	2	PF-7.1D	AC Induction Motor	8/26/2002 10:52:20 AM	8/26/2002 10:50:24 AM	
5	2	PF-7.1E	AC Induction Motor	8/26/2002 11:00:33 AM	8/26/2002 11:00:16 AM	
6	4	PF-7.1F	AC Induction Motor	8/26/2002 11:00:33 AM	8/26/2002 11:13:01 AM	
7	3	PF-8.6A	AC Induction Motor	8/26/2002 12:00:38 PM	8/26/2002 11:54:39 AM	
8	3	PF-8.6B	AC Induction Motor	8/26/2002 11:46:40 AM	8/26/2002 11:39:25 AM	
9	5	Blower #4	Blower	8/26/2002 12:14:46 PM	8/26/2002 12:14:04 PM	
10	1	Blower #5	Blower	8/26/2002 12:36:25 PM	8/26/2002 12:28:16 PM	

### MESSAGE CENTER

Keep management and other technicians updated on the progress of any motor/asset by entering notes in the Message Center. Notes are automatically updated when a condition is assigned, changed, or when the warning levels are changed. Pictures and other documents can be added to fully communicate the information.

**All Condition Code changes are immediately placed in the Message Center**



# Products

## MCE®

Both portable and comprehensive, the MCE is the most inclusive static motor testing tool on the market. Through a series of powerful, nondestructive tests, the MCE thoroughly analyzes motors and their associated circuits, providing early detection of high resistance connections, insulation degradation, stator faults, rotor defects, and air gap eccentricity. The static nature of the unit makes the MCE ideal for both condition monitoring during plant shutdowns and quality assurance applications.

## EMAX

As a dynamic tester, the EMAX accurately evaluates motors and their associated circuits by collecting data while the motor is operating, thus eliminating the need to shut off power or otherwise interrupt production. The EMAX evaluates three phases of current and voltage simultaneously, providing power quality and efficiency data in addition to early indication of faults in the rotor, stator, air gap, power circuit, and power quality. With the ability to detect in-rush/start-up current and conduct process analysis, the EMAX is the most complete and accurate dynamic tester in its class.

## MCEMAX®

By combining the capabilities of the MCE and EMAX into one portable package, PdMA has created the MCEMAX - the single most powerful motor testing tool available. Regardless of the size, type, or condition of your motors, the MCEMAX offers the flexibility required to meet your needs. From power quality, power circuit, and insulation to the rotor, stator, and air gap, nearly every facet of the motor can be evaluated with the revolutionary MCEMAX. Never before has such flexibility and comprehensiveness been available in one tester.

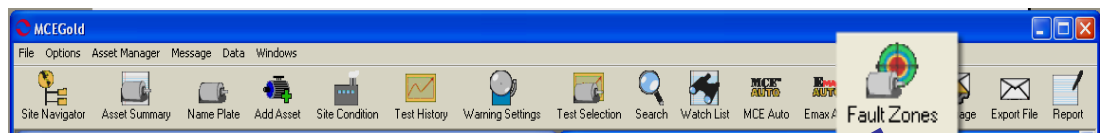
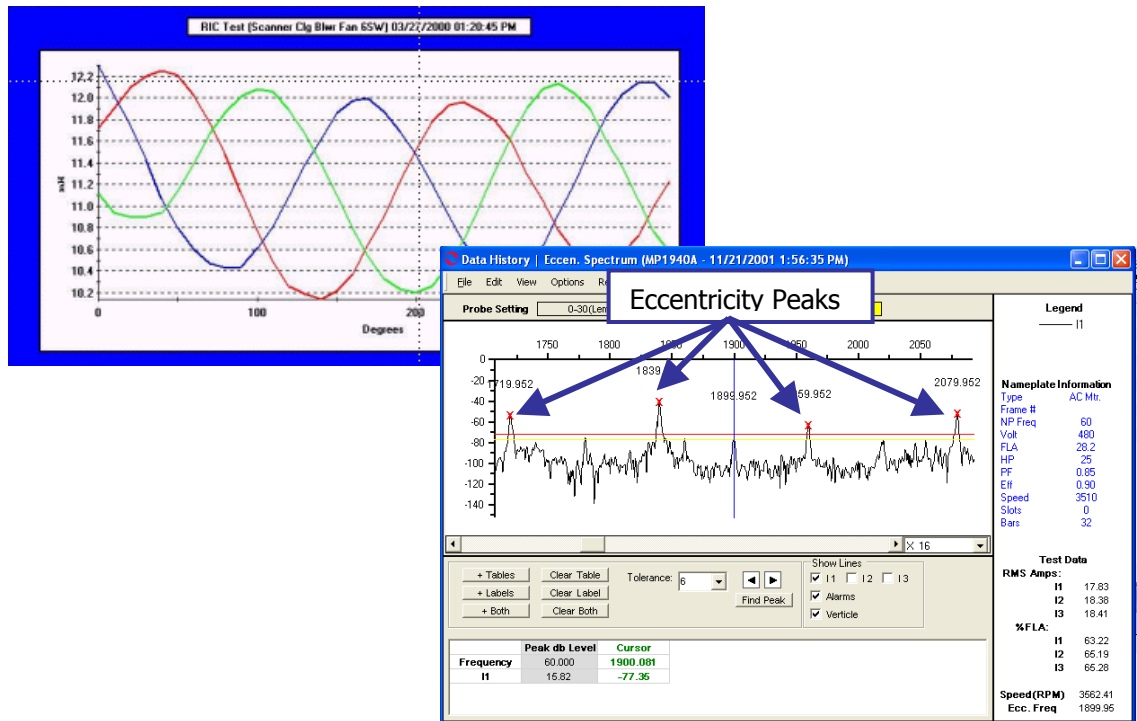




# Fault Zone – Air Gap

The Air Gap fault zone describes the measurable distance between the rotor and stator within the motor. If this distance is not equal throughout the entire circumference air gap eccentricity occurs. The varying magnetic flux within the air gap creates imbalances in the current flow, which can be identified in the current spectrum.

Eccentricity analysis using the MCE Rotor Influence Check (RIC) test is most successfully applied in troubleshooting if pre-existing data is available so that trends can be observed. Eccentricity analysis using EMAX technology is performed through a high frequency spectrum of the current signal. If the number of rotor bars and the speed are known, the MCEGold™ software automatically places an (X) at the four peak locations which identify eccentricity.



Fault Zone	Test Type	Date	Condition Code	
Power Circuit	Voltage Imbalance (%)	0.05	7/21/2003 8:07:59 AM	Good
	Resistive Imbalance (%)	0.28	7/21/2003 12:07:35 PM	Good
	Voltage THD Ph-Ph (%)	0.41	7/21/2003 8:07:59 AM	Good
Power Quality	Current THD (%)	1.30	7/21/2003 8:07:59 AM	Good
	MWF (%)	0.00	7/21/2003 8:07:59 AM	Good
Stator	Winding Resistance (Ohms)	588.00	7/21/2003 12:07:35 PM	Severe
	PI	1.68	7/21/2003 12:30:22 PM	Severe
	CTG (uF)	31500.00	7/21/2003 12:07:35 PM	Severe
Rotor	Imp. Imbalance (%)	1.80	7/21/2003 8:07:59 AM	Good
	Inductive Imbalance (%)	0.37	7/21/2003 12:07:35 PM	Good
Air Gap	Ec Amplitude (Delta dB)	95.15	7/21/2003 8:16:32 AM	Severe
	Eccentricity	20.40	7/21/2003 8:19:28 AM	Caution
	Peak One (Delta dB)	1.49	7/21/2003 8:19:28 AM	Caution
	Peak Two (Delta dB)	19.14	7/21/2003 8:19:28 AM	Caution
	Peak Three (Delta dB)	36.28	7/21/2003 8:19:28 AM	Caution
	Peak Four (Delta dB)	36.28	7/21/2003 8:19:28 AM	Caution
	RIC (Eccentricity)	False	7/21/2003 12:11:31 PM	Good

The MCEMAX powered by MCEGold™ provides a Fault Zone Report, which is a one-page summary of the test results relevant to the six fault zones. The Fault Zone Report may be reached directly through the Fault Zones icon on the toolbar.



# Fault Zone – Insulation

The Insulation fault zone refers to the condition of the insulation between the windings and ground. For electrical equipment to operate properly and safely, it is important that the flow of electricity take place along well-defined paths or circuits and that it not be leaking from one path to another. Deterioration of the insulation systems can result in an unsafe situation for personnel exposed to the leakage current

The MCE™ technology allows you to identify potential problems with the insulation by recognizing adverse trends in resistance to ground. After conducting a baseline test, all subsequent tests are compared to the initial data with significant changes in value highlighted in yellow for caution or red for alarm.

AC Standard	Polarization Index	RIC	Step Voltage
	A	B	C
Test Date	9/28/1996	3/23/1998	3/29/1999
Test Time	9:47:45 AM	9:11:11 AM	12:32:07 PM
Test Location	Motor Leads	Motor Leads	Motor Leads
User	Administrator	Administrator	Administrator
<b>Baseline</b>			
Frequency	1200	1200	1200
Charge Time	30	30	30
Voltage	1000	1000	1000
Motor Temp	40	34	42
Measured Mohm	770.00	850.00	430.00
Corrected Mohm	770.00	505.00	490.00
mH Ph 1 to 2	1.975	1.990	1.980
mH Ph 1 to 3	1.985	1.995	1.985
mH Ph 2 to 3	1.970	1.970	1.965
Average Inductance	1.977	1.968	1.977
Imbalance	0.19	0.63	0.18
Imbalance	0.42		

Trend degradation of insulation over time.

The screenshot shows the MCEGold software interface with several data panels. The 'VOLTAGE' panel shows RMS values for three phases. The 'POWER' panel shows kW, kVAR, and kVA. The 'EFFICIENCY' panel shows input and output power. The 'SEQUENCE' panel shows phase sequence. The 'IMPERFORMANCE' panel shows imbalance percentages. The 'VOLTAGE' panel data is as follows:

Voltage	Fund RMS	3rd RMS	C.F.	THD
Voltage 1-2	452.98	453.46	1.40	1.28
Voltage 2-3	0.09	0.10	5.12	34.48
Voltage 3-1	452.72	453.20	1.40	1.30
Average	301.93	302.25		
% Imbalance	99.97	99.97		

In an ungrounded voltage distribution system, the EMAX technology immediately assesses and displays any component on the distribution system that may be grounded.

The screenshot shows the MCEGold software toolbar with various icons. The 'Fault Zones' icon is highlighted with a blue arrow pointing to the 'Fault Zone Report' window.

The screenshot shows the 'Fault Zone Report' window with a table of test results. The table has columns for Fault Zone, Test Type, Value, Date, and Condition Code. The data is as follows:

Fault Zone	Test Type	Value	Date	Condition Code
Power Circuit	Voltage Imbalance (%)	1.11	3/28/2002 11:27:57 AM	Caution
	Resistive Imbalance (%)	0	3/17/2003 1:08:51 PM	Caution
Power Quality	Voltage THD Ph-Ph (%)	1.83	3/28/2002 11:27:57 AM	Good
	Current THD (%)	1.85	3/28/2002 11:27:57 AM	Good
	HVF (%)	0.01	3/28/2002 11:27:57 AM	Good
Insulation	Stator RTG (Meg)	0.80	3/17/2003 1:08:51 PM	Severe
	PS	7.61	3/17/2003 1:22:00 PM	Good
Stator	Temp. Imbalance (%)	0.38	3/28/2002 11:27:57 AM	Caution
	Inductive Imbalance (%)	0.20	3/17/2003 1:08:51 PM	Good
Rotor	Fp Amplitude (Delta dB)	53.64	3/28/2002 11:39:30 AM	Good
	Eccentricity			
Air Gap	Peak One (Delta dB)	-9.36	3/28/2002 11:48:15 AM	Insufficient Data
	Peak Two (Delta dB)	9.93	3/28/2002 11:48:15 AM	Insufficient Data
	Peak Three (Delta dB)	28.80	3/28/2002 11:48:15 AM	Insufficient Data
	Peak Four (Delta dB)	6.78	3/28/2002 11:48:15 AM	Insufficient Data
	RIC (Eccentricity)	Not Tested	3/28/2002 11:48:15 AM	

The MCEMAX powered by MCEGold™ provides a Fault Zone Report, which is a one-page summary of the test results relevant to the six fault zones. The Fault Zone Report may be reached directly through the Fault Zones icon on the toolbar.



# Fault Zone – Power Circuit

The power circuit refers to all of the conductors and connections that exist from the point at which the testing starts through to the connections at the motor. It can include circuit breakers, fuses, contactors, overloads, disconnects, and lug connections. Research on industrial power distribution systems has shown that connectors and conductors are the source of 46% of the faults reducing motor efficiency.

The MCEMAX powered by MCEGold™ provides a unique advantage to test the power circuit and all the associated components. Many times a motor, although initially in perfect health, is installed into a faulty power circuit. This causes problems like voltage imbalances, current imbalances, sequence currents, etc. As these problems become more severe, the horsepower rating of the motor drops, causing temperatures to increase and insulation damage to occur. It is important to evaluate the resistance and inductance of a motor circuit once a motor is installed for service. High imbalances of voltage, current, resistance, or inductance could indicate problems with the motor or power circuit. Identifying minor imbalances early will eliminate catastrophic failures and headaches later.

MCEGold [Todd - MCEGold - MCEGold\_Local] Testing [Test History - Aux Hyd 102 - 000003100702840 - 1124107698]

File Options Asset Manager Message Data Windows

Site Navigator Asset Summary Name Plate Add Asset Site Condition Test History Warning Settings Test Selection Search Watch List MCE

MCE Edit View Test Warning Settings Show/Hide Options

All Tests

AC Standard	Polarization Index	RIC	Step Voltage	A	B	C	D	F	I
Test Date	5/20/1996	3/23/1998	3/29/1999	5/23/2000	5/23/2000	1/23/2001			
Test Time	9:47:45 AM	9:11:11 AM	12:32:07 PM	9:40:29 AM	9:52:46 AM	12:00:37 PM			
Test Location	Motor Leads	Motor Leads	Motor Leads	Top Overloads	Top Overloads	Top Overloads			
User	Administrator	Administrator	Administrator	Administrator	Administrator	Administrator			
Baseline									
Frequency	1200	1200	1200	1200	1200	1200			
Charge Time	30	30	30	30	30	30			
Voltage	1000	1000	1000	1000	1000	1000			
Motor Temp	40	34	42	44	44	34			
Measured Motor	770.00	850.00	430.00	450.00	550.00	840.00			
Connected Motor	770.00								
pF Ph 1 to Ground	53000.00	53000.00	52750.00	51500.00	51250.00	50000.00			
ohm Ph 1 to 2	0.18900	0.18400	0.18950	0.20950	0.20150	0.18450			
ohm Ph 1 to 3	0.18750	0.18550	0.18900	0.18950	0.18650	0.18400			
ohm Ph 2 to 3	0.18750	0.18600	0.18950	0.20600	0.20050	0.18350			
net Ph 1 to 2	1.375	1.900	1.900	2.005	2.000	1.900			
% Res. Imbalance	0.18	0.63	0.18	3.64	3.09	0.27			
% Res. Imbalance	0.18	0.63	0.18	3.64	3.09	0.27			
% Ind. Imbalance	0.42	0.42	0.59	0.42	0.42	0.42			

Trend Phase-to Phase resistance over time. If an out of tolerance condition occurs MCEGold will alert you.

All three phases of current are calculated and displayed. You are immediately alerted to any over current or imbalance condition

State History - Power Results (High Pressure Pump #3 - 4/22/2000 10:16:36 AM)

File Edit View Options Related Windows

Probe Setting: 0.100000m PFI0300 Condition Code: Good

VOL TAGE	Fund RMS	Vol RMS	C.F.	THD
Voltage 1-2	480.76	482.78	1.41	1.40
Voltage 2-3	480.90	482.92	1.42	1.41
Voltage 1-3	480.97	482.99	1.42	1.41
Average	480.88	482.93	1.41	1.40
% Imbalance	0.36	0.35	HVF	0.00
% NEMA Overload	100.00	100.00		100.00

CURRENT	Fund RMS	Cur RMS	C.F.	THD
Current 1	150.00	152.25	1.48	1.58
Current 2	152.10	154.35	1.48	2.12
Current 3	152.02	154.27	1.48	1.81
Average	151.37	153.61	1.48	1.81
% Imbalance	0.00	0.00		
% F.I.A.	100.00	101.12		

POWER	SW	KVAH	KVA	PF
Phase 1	20.24	22.59	41.43	0.86
Phase 2	20.08	22.42	41.34	0.86
Phase 3	20.09	22.42	41.34	0.86
Total	120.40	133.63	124.11	0.86
Power Temp	122.40	67.96	140.09	0.86

EFFICIENCY	SW	KVAH	KVA	PF
Efficiency	100.00	100.00	100.00	100.00
HP Output	100.00	100.00	100.00	100.00
HP Input	100.00	100.00	100.00	100.00
Torque Output	100.00	100.00	100.00	100.00

SEQUENCE	Phase	Angle	Phase
Voltage Ph. Ph	0	0	0
Voltage Ph. R	0	0	0
Current	0	0	0
Phase	0	0	0
Angle	0	0	0
Phase Configuration	0	0	0
Phase Rotation	0	0	0

MCEGold

File Options Asset Manager Message Data Windows

Site Navigator Asset Summary Name Plate Add Asset Site Condition Test History Warning Settings Test Selection Search Watch List MCE Auto Emax Fault Zones Page Export File Report

Fault Zone Report - 110671

File Edit Options

Condition Code: Caution

Fault Zone	Test Type	Date	Condition Code
Power Circuit	Voltage Imbalance (%)	Not Tested	
	Resistive Imbalance (%)	3.25 12/7/2005 2:20:22 PM	Caution
Power Quality	Current THD (%)	Not Tested	Not Tested
	HVF (%)	Not Tested	Not Tested
Insulation	Stator		
	RTG (Meg)	1800.00 12/7/2005 2:20:22 PM	Good
	PI	3.49 12/7/2005 2:08:48 PM	
Stator	CTG (pF)	64000.00 12/7/2005 2:20:22 PM	
	Imp. Imbalance (%)	Not Tested	
Rotor	Inductive Imbalance (%)	14.07 12/7/2005 2:20:22 PM	Severe
	Fp Amplitude (Delta dB)	Not Tested	Not Tested
Air Gap	Eccentricity	Not Tested	
	Peak One (Delta dB)	Not Tested	
	Peak Two (Delta dB)	Not Tested	
	Peak Three (Delta dB)	Not Tested	
	Peak Four (Delta dB)	Not Tested	
RIC (Eccentricity)	False 12/7/2005 12:41:19 PM		

Last Updated: 8/16/2006 8:38:40 AM

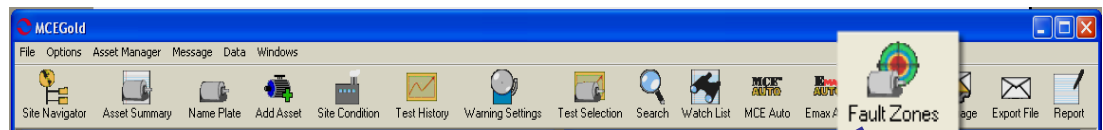
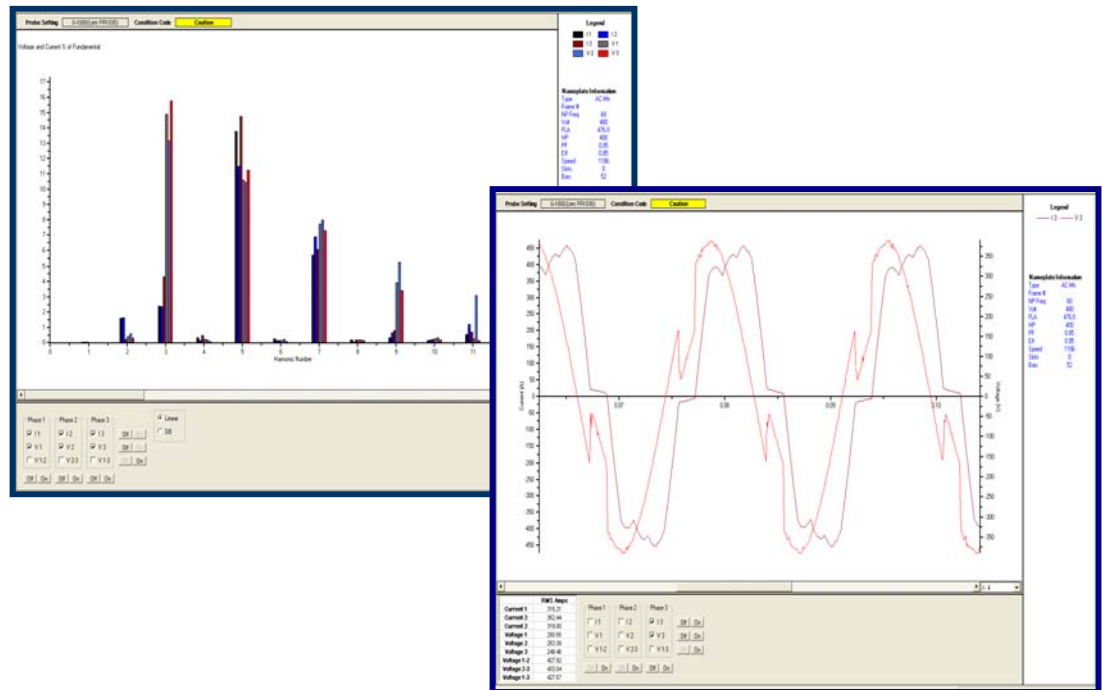
The MCEMAX powered by MCEGold provides a Fault Zone Report, which is a one-page summary of the test results relevant to the six fault zones. The Fault Zone Report may be reached directly through the Fault Zones icon on the toolbar.



# Fault Zone – Power Quality

The Power Quality fault zone focuses on the condition of the voltage and current in a motor's branch circuit. Poor power quality can greatly affect the operation and health of an electric motor. During operation several stresses are brought to bear upon key components of the motor. Variances or distortions in the voltage powering a motor results in increasing both thermal and electrical stresses to the stator windings and in some cases components of the rotor.

MCEMAX powered by MCEGold™ provides you many ways to analyze and evaluate your power quality. MCEGold not only provides you with a snapshot of your power quality, it also allows you to evaluate the individual voltage and current harmonics out to the 50<sup>th</sup> harmonic.



The screenshot shows the "Fault Zone Report" window with a table of test results. The table has columns for Fault Zone, Test Type, Date, and Condition Code. A red arrow points from the "Fault Zones" icon in the toolbar to the "Voltage THD (Ph-Ph (%))" row in the table.

Fault Zone	Test Type	Date	Condition Code	
Power Circuit	Voltage Imbalance (%)	0.38	4/22/1999 12:33:01 PM	Good
	Positive Imbalance (%)	Not Tested		
	Voltage THD (Ph-Ph (%))	5.87	4/22/1999 12:33:01 PM	Severe
Power Quality	Current THD (%)	33.75	4/22/1999 12:33:01 PM	Severe
	IMV (%)	0.03	4/22/1999 12:33:01 PM	
Insulation	RTG (Meg)	Not Tested		Not Tested
	PI	Not Tested		Not Tested
	CTG (gF)	Not Tested		Not Tested
Stator	Imp. Imbalance (%)	5.73	4/22/1999 12:33:01 PM	Good
	Inductive Imbalance (%)	Not Tested		
Rotor	Fp Amplitude (Delta dB)	Not Tested		Not Tested
	Eccentricity	Not Tested		Not Tested
Air Gap	Peak One (Delta dB)	Not Tested		Not Tested
	Peak Two (Delta dB)	Not Tested		Not Tested
	Peak Three (Delta dB)	Not Tested		Not Tested
	Peak Four (Delta dB)	Not Tested		Not Tested
	RIC (Eccentricity)	Not Tested		Not Tested

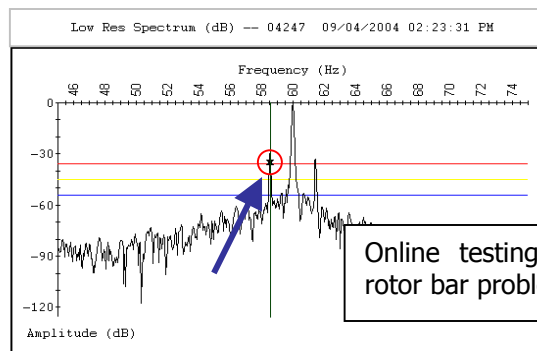
The MCEMAX powered by MCEGold provides a Fault Zone Report, which is a one-page summary of the test results relevant to the six fault zones. The Fault Zone Report may be reached directly through the Fault Zones icon on the toolbar.



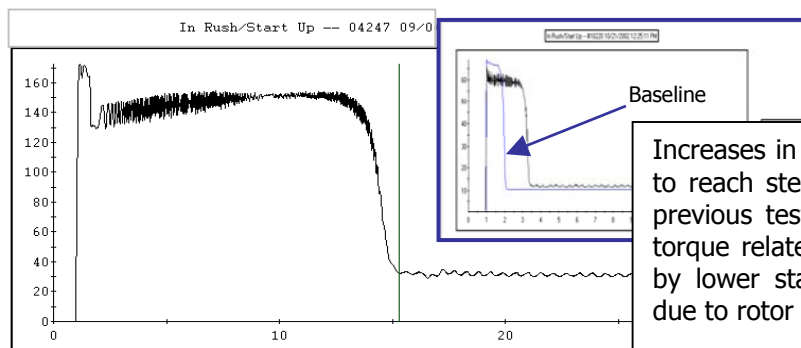
## Fault Zone – Rotor

Rotor health refers to the integrity of the rotor bars, rotor laminations, and end rings of the squirrel cage induction motors. In a joint study by EPRI and General Electric, rotor defects were estimated to be responsible for approximately 10% of the motor failures. The rotor, although responsible for only a small percentage of the motor problems, can influence other fault zones to fail.

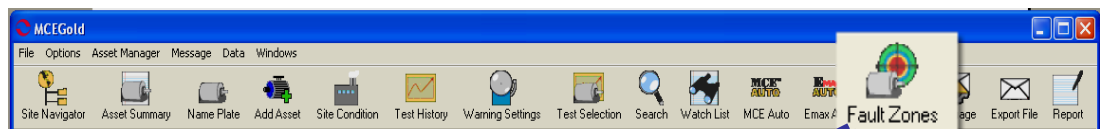
MCE™ motor circuit analysis uses inductance measurements taken from each phase of the stator windings and compares them at different rotor positions to further define the condition of the rotor. Advanced systems like EMAX provide simultaneous analysis of all three phases in its current signature analysis, which is an advantage over analyzing a single current. Using inductance measurements, current analysis, and other rotor testing technology provides the user with the ability to see very early changes in the magnetic signature of the rotor.



Online testing results indicate a severe rotor bar problem at 60% FLA.



Increases in the start-up time required to reach steady state as compared to previous tests are a result of load or torque related issues and are affected by lower start-up current and torque due to rotor defects or lower voltage.



Fault Zone	Test Type	Date	Condition Code	
Power Circuit	Voltage Imbalance (%)	0.39	4/19/2003 12:41:49 PM	Good
	Positive Imbalance (%)	0	4/19/2003 12:45:21 PM	Good
Power Quality	Voltage THD (%)	0.47	4/19/2003 12:41:49 PM	Good
	Current THD (%)	1.43	4/19/2003 12:41:49 PM	Good
Insulation	RTG (Mavg)	2100.00	4/19/2003 2:45:21 PM	Caution
	PS	1.25	4/19/2003 2:58:05 PM	Caution
Stator	CTG (gF)	185500.00	4/19/2003 2:45:21 PM	Good
	Imp. Imbalance (%)	1.18	4/19/2003 12:41:49 PM	Good
Rotor	Inductive Imbalance (%)	0.41	4/19/2003 12:45:21 PM	Good
	Ly Asymmetry (Delta dB)	32.22	4/19/2003 12:44:23 PM	Review
Air Gap	Eccentricity			
	Peak One (Delta dB)	-8.34	4/19/2003 12:49:35 PM	Insufficient Data
	Peak Two (Delta dB)	1.00	4/19/2003 12:49:35 PM	Insufficient Data
	Peak Three (Delta dB)	-5.02	4/19/2003 12:49:35 PM	Insufficient Data
	Peak Four (Delta dB)	-13.32	4/19/2003 12:49:35 PM	Insufficient Data
RIC (Eccentricity)	Not Tested			

The MCEMAX powered by MCEGold™ provides a Fault Zone Report, which is a one-page summary of the test results relevant to the six fault zones. The Fault Zone Report may be reached directly through the Fault Zones icon on the toolbar.





# Fault Zone – Stator

The stator fault zone is often considered one of the most controversial fault zones due to the significant challenge of early fault detection and the prevention of motor failure surrounding the stator windings. Stator windings are the heart of the motor, producing the rotating magnetic field, induction current, and torque to turn the rotor and shaft. This challenge is further intensified in higher voltage machines, where the fault-to-failure time frame becomes much shorter. The stator fault zone is identified as the health and quality of the insulation between the turns, coils, and phases within the slots and end turns of the electric motor.

Turn-to-turn or phase-to-phase shorts can be catastrophic to the motor and not necessarily be detected by the standard megohmmeter. Excessive inductive imbalance, resistive imbalance, vibration, partial discharge, or poor insulation quality can lead to stator failure and should be monitored regularly to prevent a shortened life of the electric motor stator. Stator analysis using EMAX technology is performed by evaluating the phase relationship of voltage and current for each of the three phases of an AC induction motor.

**VOLTAGE**

Field RMS	Full RMS	C.F.	THD
427.58	427.35	1.41	1.10
427.57	427.29	1.40	1.11
427.54	427.48	1.41	1.42
Average	427.54		
% Imbalance	0.11	0.19	0.01
% NEMA Duration	100.00		

**CURRENT**

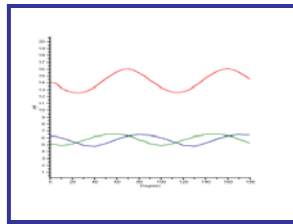
Field RMS	Full RMS	C.F.	THD
102.20	101.20	1.01	1.20
99.76	99.93	1.44	1.54
99.76	99.81	1.44	1.54
Average	100.58		
% Imbalance	38.92	38.92	
% FLA	83.71	83.78	

**IMPEDANCE**

Phase	Real	Imaginate	Angle
Phase 1	1.6	1.0	31.0
Phase 2	3.76	10.66	70.0
Phase 3	2.11	61.99	81.99
% Imbalance	43.40		

High current imbalance with a high impedance imbalance points to stator fault.

What the RIC will look like.



% Resistive and Inductance Imbalance trending higher indicates a loss of turns.

MCEGold (Todd\_1\MCEGold\MCEGold\_Local) Testing [Test History - CNDRS P]

File Options Asset Manager Message Data Windows

Site Navigator Asset Summary Name Plate Add Asset Site Condition Test History Warni

File Edit View Test Warning Settings Show/Hide Options

MCE [All Tests]

Stator	AC Standard	Polarization Index	RIC	Step Voltage
Test Date	4/1/2002			
Test Time	11:52:46 AM			
Test Location	Motor Lead			
User	Administrator			
Frequency	1200			
Charge Time	60			
Voltage	500			
Motor Temp	15	23	15	
Measured Mohm	1900.00	> 2000	> 3006	
Corrected Mohm	336.00	> 2000	> 3006	
pF Ph 1 to Ground	26250.00	26250.00	26250.00	
ohm Ph 1 to 2	0.04550	0.14500	1.40500	
ohm Ph 1 to 3	0.04650	0.14450	1.44500	
ohm Ph 2 to 3	0.04600	0.14550	1.45500	
mH Ph 1 to 2	4.250	14.000	14.070	
mH Ph 1 to 3	5.145	8.265	2.880	
mH Ph 2 to 3	4.200	9.030	6.650	
Average Inductance	4.532	8.432	8.473	
% Res. Imbalance	1.09	1.86	2.09	
% Ind. Imbalance	13.53	66.04	66.05	

MCEGold

File Options Asset Manager Message Data Windows

Site Navigator Asset Summary Name Plate Add Asset Site Condition Test History Warning Settings Test Selection Search Watch List MCE Auto Emax Fault Zones

Fault Zone Report - Back Wash Pump #1

Dir: Test - Options

Condition Code	Test Type	Date	Condition Code
Power Circuit	Voltage Imbalance (%)	0.13	3/14/2008 5:10:41 PM
	Phase Inductance (%)	0.29	3/14/2008 5:10:29 PM
	Voltage THD Ph-Ph (%)	1.31	3/14/2008 5:10:41 PM
Power Quality	Current THD (%)	1.54	3/14/2008 5:10:41 PM
	IRMP (%)	0.01	3/14/2008 5:10:41 PM
Insulation	RTG (Mega)	191.00	3/14/2008 4:37:20 PM
	PI	2.13	3/14/2008 4:50:41 PM
	CTG (uF)	79000.00	3/14/2008 4:37:20 PM
Stator	Imp. Imbalance (%)	63.90	3/14/2008 5:10:41 PM
	Inductive Imbalance (%)	26.58	3/14/2008 4:37:20 PM
Rotor	Fa Amplitude (Delta dB)	68.29	3/14/2008 5:09:10 PM
Air Gap	Eccentricity		
	Peak One (Delta dB)	Not Tested	
	Peak Two (Delta dB)	Not Tested	
	Peak Three (Delta dB)	Not Tested	
	Peak Four (Delta dB)	Not Tested	
	RIC (Counts)	Not Tested	

Last Updated: 8/16/2008 4:05:11 PM

The MCEMAX powered by MCEGold™ provides a Fault Zone Report, which is a one-page summary of the test results relevant to the six fault zones. The Fault Zone Report may be reached directly through the Fault Zones icon on the toolbar.