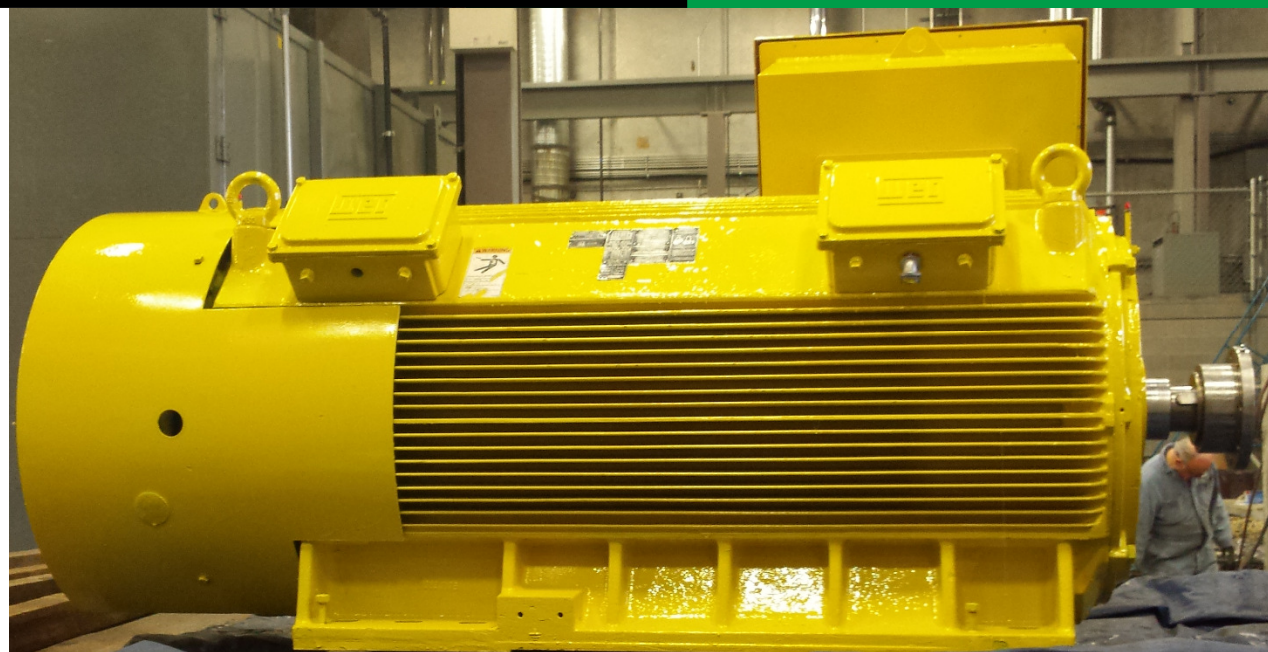




ARMATURE ELECTRIC LIMITED

PdMA Case Study – Mining Drill Motor



A Leader in Electric Motor Testing

CASE STUDY #1 DETECTING BROKEN ROTOR BAR

Mining customer was concerned about the increasing bearing noise on one of their Electric Drills. As well as performing a Vibration Analysis, we recommended performing other motor tests using the PDMA MCEMax test equipment, to give an overall motor condition evaluation



Test Procedure

Drill motor was locked out and isolated from power supply

MCEMax test equipment was set up

Static motor tests were performed with the test machine connected to the motor T-Leads that were disconnected from the soft starter

Dynamic motor tests were performed with the test machine connected to the Multilin Protection Relay



Static Test Results

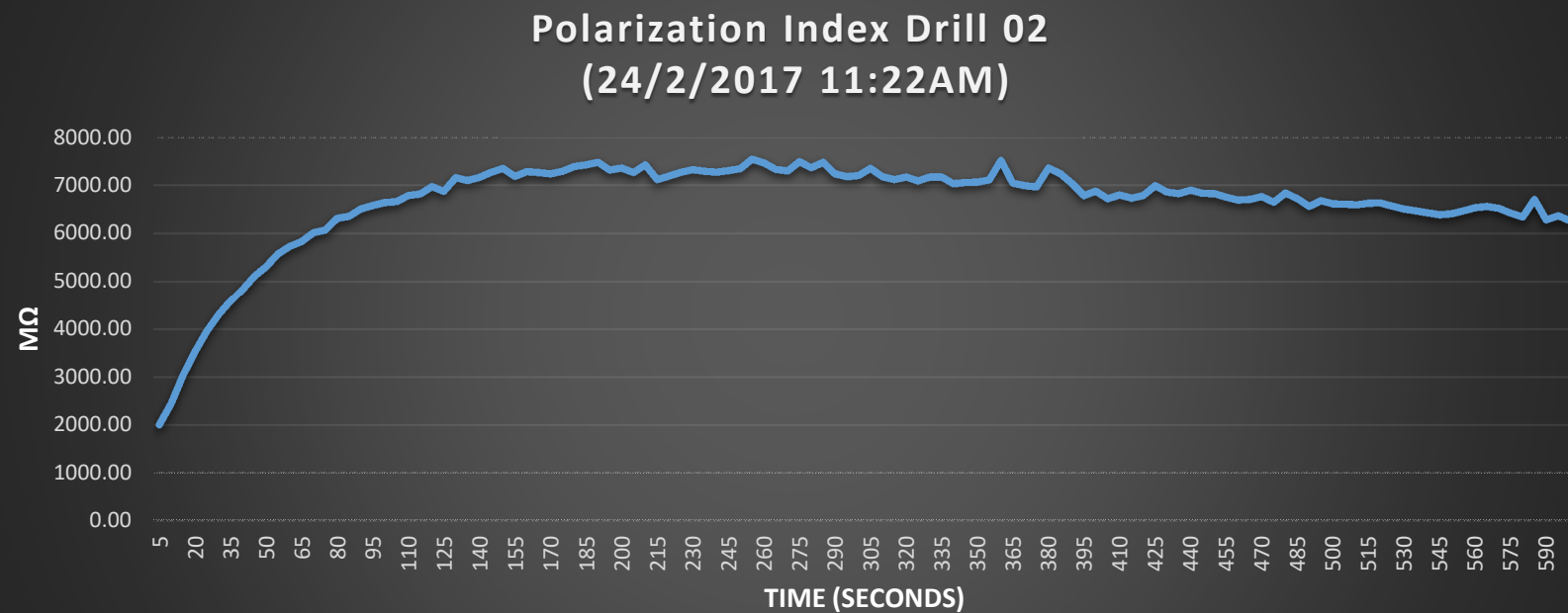
Static tests showed the stator winding to be balanced between all 3 phases, indicating no short circuits developing

Insulation resistance to ground was good, however the polarization index was low at 1.092. A healthy stator should have a PI of at least 2.0

Test Date	02/24/17
Test Time	11:22 AM
Test Location	Drive Output
User	Administrator
Tester Serial	5659
MTAP ID	
	Baseline
Frequency	1200
Charge Time	600
Voltage	5000
Motor Temp	37°C
Measured Mohm	5737.11
Corrected Mohm	4700
pF Ph 1 to Ground	56800
ohm Ph 1 to 2	0.8115
ohm Ph 2 to 3	0.8114
ohm Ph 3 to 1	0.81
mH Ph 1 to 2	55.6
mH Ph 2 to 3	56.6
mH Ph 3 to 1	55.7
Average Inductance	55.95
% Res. Imbalance	0.12
% Ind. Imbalance	1.13
D/A Ratio	1.334
Polarization Index	1.092

Polarization Index Graph

The PI graph indicated that there was some kind of moisture or contamination present in the stator winding



Power Results

Power results showed the stator was ok. Voltage and current were balanced.

VOLTAGE				
	Fund RMS	Tot RMS	C.F.	THD
Voltage 1-2	6957.07	6957.83	1.42	0.89
Voltage 2-3	6965.84	6966.56	1.43	0.82
Voltage 1-3	7000.19	7001.24	1.40	1.27
Average	6974.37	6975.21		
% Imbalance	0.37	0.37	HVF	0.00
% NEMA Derating	100.00	% NEMA Derating		100.00
Voltage 1	4031.60	4032.16	1.41	1.17
Voltage 2	4011.72	4012.08	1.43	0.65
Voltage 3	4036.64	4037.18	1.43	1.12
Average	4026.65	4027.14		
% Imbalance	0.37	0.37		

CURRENT				
	Fund RMS	Tot RMS	C.F.	THD
Current 1	36.94	36.95	1.45	1.00
Current 2	34.35	34.35	1.46	1.06
Current 3	35.26	35.27	1.45	1.00
Average	35.52	35.53		
% Imbalance	4.02	4.02		
% FLA	56.07	56.09		

IMPEDANCE			
	Real	Magnitude	Angle
Phase 1	92.05	109.13	32.49
Phase 2	100.83	116.81	30.32
Phase 3	93.97	114.48	34.83
% Imbalance	5.45		

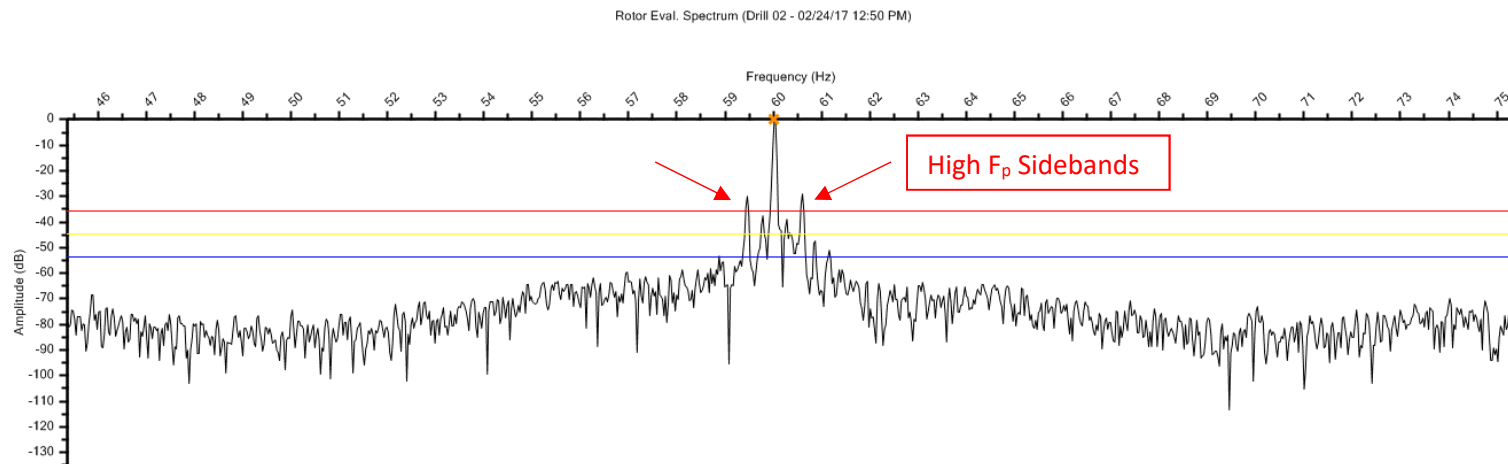
POWER				
	kW	kVAR	kVA	Pf
Phase 1	125.62	80.12	149.00	0.84
Phase 2	118.94	69.64	137.83	0.86
Phase 3	116.84	81.39	142.39	0.82
Total	361.41	231.14	429.22	0.84
Power Sequence	361.41	230.84	428.84	0.84

Efficiency	
Efficiency	91.13
HP Output	441.73
kW Output	329.53
Torque Output (ft-lb)	1294.50

SEQUENCE					
		Positive	Negative	Zero	
Voltage Ph-Ph		26.33	6974.34	0.00	
Voltage Ph-N		15.20	4026.64	0.00	
Current		1.57	35.50	19.67	
		Self	Angle	Mutual	Angle
Zero		113.41	32.53	113.41	152.53
Positive		0.80	85.13	0.83	85.18
Negative		4.82	220.98	5.46	105.18
Phase Configuration	Phase to Phase				
Phase Rotation	Clockwise				

Rotor Evaluation

Rotor Evaluation Spectrum showed high pole pass frequency sidebands around line frequency. This indicated rotor bar defects were present



Findings

After the motor was sent to Armature Electric and dismantled, the rotor bar damage was evident.

2 rotor bars were melted, and many more had twisted at the slot exit where the bars joined the end rings.

This motor had experienced many full load, across the line starts



Stator

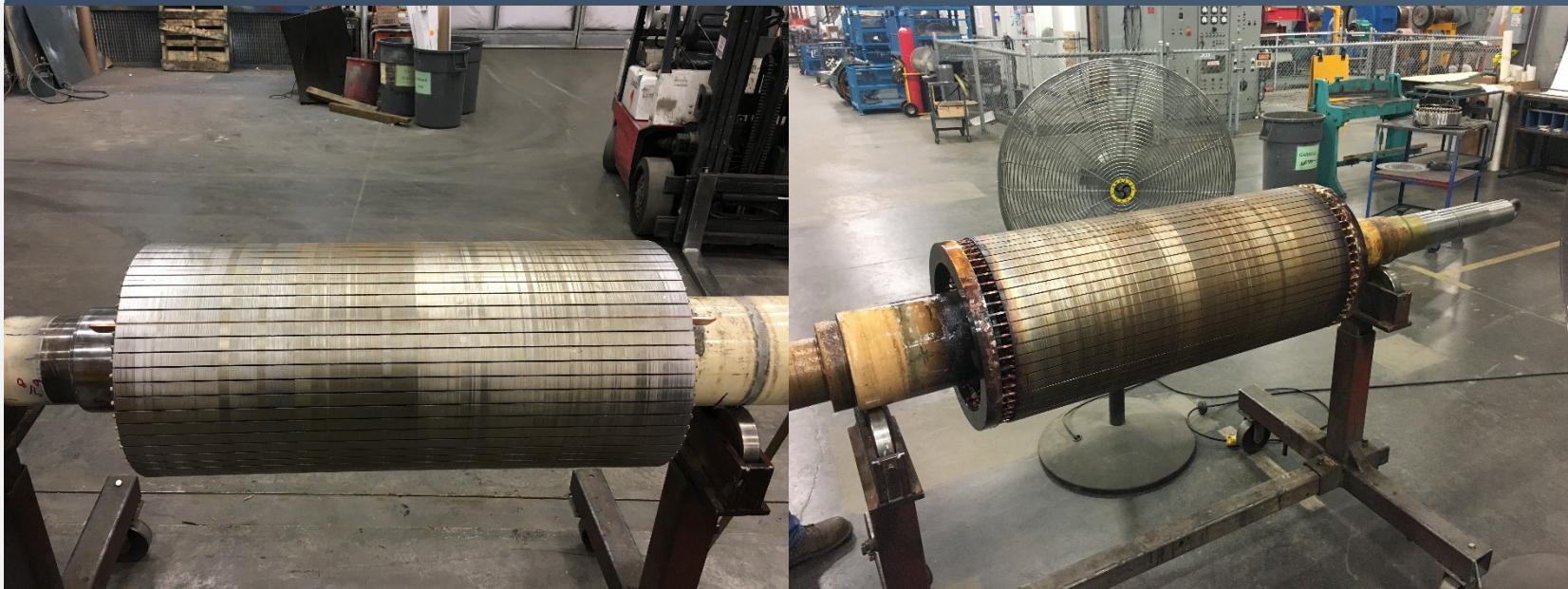
*The cause of the
low PI?*

- *Copper dust
from the
blown rotor
bars*
- *Copper
embedded to
the stator
slots*



REPAIR

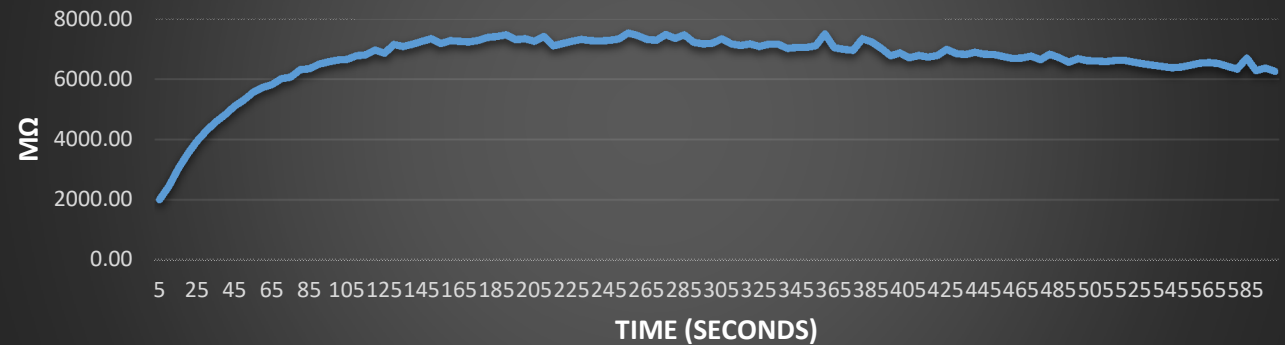
The rotor required a completely new lamination stack and re-bar.



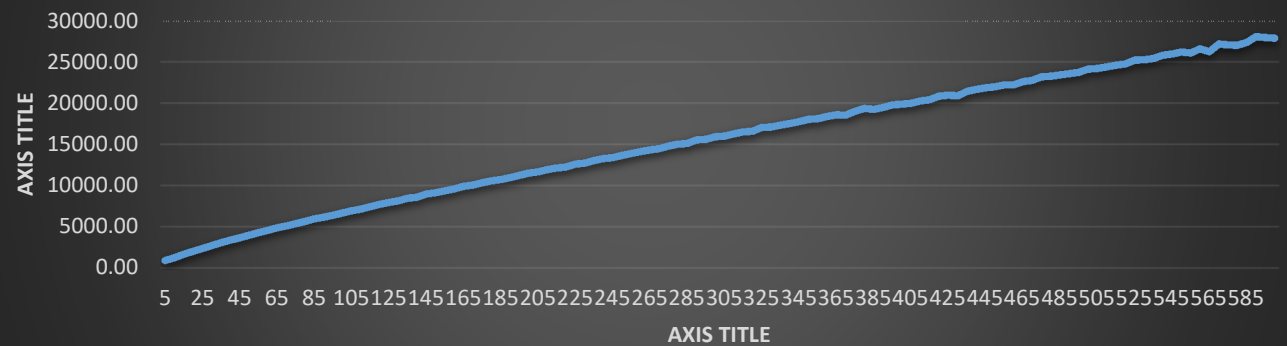
Repair

After the stator was washed, baked and the embedded copper removed, the Polarization Index greatly improved

**Polarization Index Drill 02
(24/2/2017 11:22AM)**

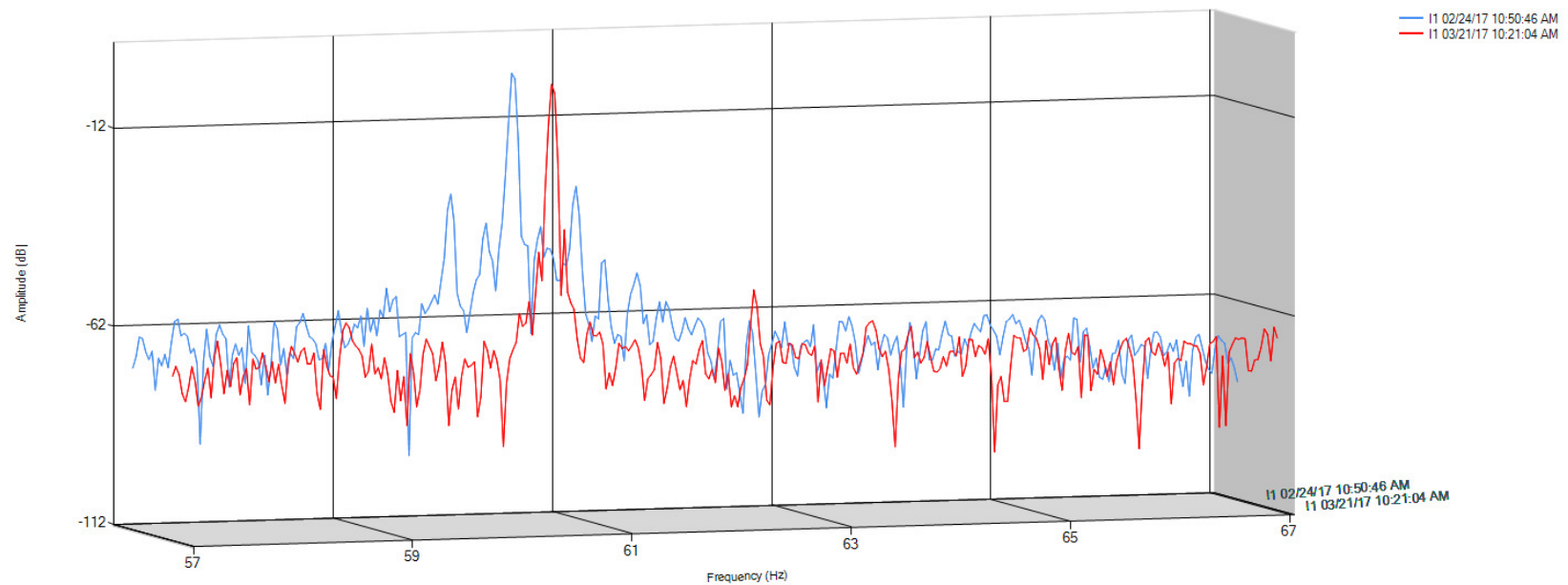


**Polarization Index
(Drill 02 02/28/17 09:15AM)**



Rotor Evaluation After Repair

With the newly laminated and re-barred rotor, another rotor evaluation was performed. Note the F_p sidebands have disappeared



Conclusion

Although it was too late for this motor, predictive trending would have picked up on this rotor fault, allowing the customer to make informed decisions about the operation of the equipment while looking into options for repair or replacement during a scheduled maintenance cycle and thereby saving thousands of dollars in repair costs and unexpected downtime.



Armature Electric Ltd, investing in technology to work with you to protect your assets.



Insulation

Power
Circuit

Power
Quality

Stator

Rotor

Air Gap



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