ATPOL II PERFORMANCE SUMMARY

Bottom Line Call

_________This induction motor is operating normally, no action is required.
_________This induction motor exhibits suspicious operation, trending of the induction motor is warranted.
_________This induction motor exhibits abnormal indications, action is warranted, NOW.

The bottom line calls on the report or results screen come from a very simple algorithm.

- If there are no problems with the motor an **"operating normally"** call will be made.
- If there are current variations, voltage variations and/or overload problems with the motor an **"abnormal indications"** call will be made.
- If there are problems with the motor other than those for current, voltage or load, then a **"suspicious operations"** call will be made.

Power Factor Commentary

_________Power factor exceeds 0.85.
_________Power factor is below 0.85, see detailed report.

			App. Power	Real Power	Reac. Power
	Power factor	**Impedance**	**kVA**	**kW**	**kVARS**
Phase 1	0.837	20.584	4.524	3.789	2.473
Phase 2	0.828	19.730	4.724	3.912	2.648
Phase 3	0.809	20.468	4.556	3.687	2.677
Avg/Total	0.825	20.261	13.805	11.388	7.797
% dev	1.9	2.6			

Power factor exceeds 0.85 is in normal range.

Power factor is below 0.85, this may be the result of running the motor at reduced load.
Operating the motor at below-rated power or voltage will reduce the power factor.

Current Commentary

_________Current variation is within normal limits.
_________Current variation is beyond normal limits, see detailed report.

Time			
	RMS	**Peak**	**CF**
Current 1	19.510	27.728	1.421
Current 2	20.370	29.030	1.425
Current 3	19.640	27.729	1.412
Average	19.840	28.162	1.419
% dev	2.7	3.1	0.5

THDF = 99.6

CF = Crest Factor = (waveform peak)/(waveform rms)
THDF = Transformer Harmonic De-rating Factor = sqrt(2)/CF, %

Current variation is within normal limits:

- If phase current deviations are less than 2% and the crest factor (CF) is between 1.35 and 1.45 and is generally sinusoidal.

Current variation is beyond normal limits:

- If phase current deviations are greater than 5%.

Notes about current deviation/variation:

- If the current variation is between 2 and 3%:
  Phase current varies by more than 2%; monitor for increased hot-spot temperature; do not allow to increase much more than this; consider taking steps to reduce.

- If the current variation is between 3 and 5%:
  Phase current varies between 3 and 5%; operation should be limited and temperature monitoring frequency increased (closely); variation should not be allowed to increase; steps should be taken to reduce.

- If the current unbalance is between 5 and 10%:
  Phase current variation is between 5 and 10%; operation should be stopped until cause can be determined and corrected. Continued operation may severely overheat the motor and cause subsequent failure.
  Please verify that current unbalance is the result of voltage unbalance.
  Current unbalance may be result of voltage unbalance. (Voltage unbalance can cause current unbalance anywhere from 6 to 10 times more than voltage unbalance)
  Current unbalance without a voltage unbalance indicates a problem in either the motor or the cabling to the motor, these may be winding faults. Verify with MCA.

- If the current unbalance is greater than 10%:
  MOTOR SHOULD BE STOPPED; phase current variation exceeds 10%; continued operation will lead to imminent failure; a short in the stator windings is highly likely. The high current unbalance results in unbalance of the stator magnetic field, resulting in overheating, mechanical unbalance, and vibration. In addition, the stator coils themselves are likely to vibrate, destroying the insulation and shorting the laminations.
  Please verify that current unbalance is the result of voltage unbalance.
  Current unbalance may be result of voltage unbalance. (Voltage unbalance can cause current unbalance anywhere from 6 to 10 times more than voltage unbalance)
  Current unbalance without a voltage unbalance indicates a problem in either the motor or the cabling to the motor, these may be winding faults. Verify with MCA.

Notes about CF (Crest Factor):

- If the crest factor (CF) is less than 1.35 or the CF is greater than 1.45, the current wave form is distorted.

  If CF is less than 1.35, indicates serious waveform clipping has occurred.
  If CF is greater than 1.35, indicates surging or spiking has occurred. View the waveform for surges or spikes.

  If the current CF follows the voltage CF then the fault is due the incoming power, if the current differs from the voltage CF the fault is in the motor itself.

Notes about THDF (Transformer Harmonic Derating Factor):

- If the transformer harmonic derating factor (THDF) is between 97.5% and 105%:
  THDF is acceptable, waveform is generally sinusoidal.
- If the THDF is less than 97.5%:
  A current surge may have occurred and the source should be determined and corrected.
- If the THDF is greater than 105%:
  Clipping of the current waveform may have occurred and the source should be determined and corrected.

Note: the product of the THDF and VDF should be considered as a recommended factor to be applied to the nameplate horsepower value to de-rate it to account for both the current waveform and voltage unbalance.

Phone: +62 21 5226528
Email: support@okansa.com
www.okansa.com

Voltage Commentary

_________Voltage variation is within normal limits.
_________Voltage variation is beyond normal limits, see detailed report.
_________RMS voltage differs from nameplate by more than 5%.

Time			
	RMS	Peak	CF
Voltage 1	401.600	570.220	1.420
Voltage 2	401.900	564.990	1.406
Voltage 3	402.000	563.910	1.403
Average	401.830	566.380	1.409
% dev	0.1	0.7	0.7

VDF = 100.0

CF = Crest Factor = (waveform peak)/(waveform rms)
VDF = Voltage De-rating Factor = 100 - (voltage unbalance, %)^2, %

Voltage variation is within normal limits: The measured phase voltage is balanced within ± 5% **AND** the measured voltage is within 5% of Name Plate Voltage.

Voltage variation is beyond normal limits: NEMA standards recommend that phase voltage unbalance be limited to 1%, because unbalanced phase voltage can create up 20 times more current unbalance. Current unbalance creates circulating currents which create excessive heat leading to premature winding failure. Motor with unbalance between 1 to 5% should be de-rated. The voltage de-rating factor (VDF) is listed in the detailed report.

- Motors should not be operated with more than 5% voltage unbalance.
- Motor operation is not recommended when the VDF is less than 75%.

RMS voltage differs from nameplate by more than 5% : Recommended that motors operate within 2% of the name plate voltage; under voltage creates excess current, poor power factor, reduced efficiency and excess heating; over-voltage creates lower efficiency, reduced power factor, saturation of the iron core which creates excess heat.

- If a phase voltage is greater than 1.06 times the nameplate value:
  A phase voltage surge has occurred and its source should be determined and corrected before continuing operation.
- If a phase voltage is less than 0.875 times the nameplate value:
  Phase voltage sag has occurred and its source should be determined and corrected before continuing operation.

- If the three phase average voltage level is greater than 1.06 times the nameplate value:
  The three phase average voltage level is above the maximum tolerance and a surge exists. It should be corrected before continuing operation.
- If the three phase average voltage level is less than 0.875 times the nameplate value:
  The three phase average voltage level is below the minimum tolerance and sagging exists. It should be corrected before continuing operation.

- If the crest factor (CF) is less than 1.35:
  The crest factor indicates serious waveform clipping has occurred. The source should be determined and corrected before continuing operation.
- If the CF is greater than 1.45:
  The crest factor indicates surging or spiking has occurred and the source should be determined and corrected before continuing operation. View the waveform for surges or spikes.
- If the CF is between 1.35 and 1.45:
  The crest factor indicates the waveform to be generally sinusoidal.

Note: the product of the THDF and VDF should be considered as a recommended factor to be applied to the nameplate horsepower value to de-rate it to account for both the current waveform and voltage unbalance.

Phone: +62 21 5226528
Email: support@okansa.com
www.okansa.com

Load Commentary

__________Load on the induction motor is consistent with nameplate values.
__________Load on the induction motor exceeds nameplate values, see detailed report.
__________Load on the induction motor is less than 25%.

Load on the induction motor is consistent with the nameplate values: The load on the motor is less than the nameplate values, including their service factor (SF).
Note:
If no SF is entered in the header information software assume a SF of 1.15.

Load on the induction motor exceeds nameplate values: Load on the motor exceeds nameplate value.
Note:
If SF differs from 1.15 then the software will use the value entered in the header information.

Load on the induction motor is less than 25%:
If the load on the motor is less than 25%, no rotor bar health index will be calculated and there will be an X in the box that says, "Load is insufficient to determine rotor bar health, at this time."

Phase Connection Commentary

__________Connections are normal.
__________Voltage ground reference is NOT neutral.
__________Loose connection.

Loose connections: Please verify and correct using MCA.

Rotor Commentary

__________Rotor bar health is normal.
__________Rotor bar health is questionable, see detailed report.
__________Load is insufficient to determine rotor bar health, at this time.

Summary of Rotor Bar Health				Power line dB diff.		RB Hlt Index
	Se, fund	Se, harm	Level %	Upper SB	Lower SB	
Measured	1.099	2	0.1	-70.9	-52.6	0.0994
Severity level	Rotor Condition Assessment			Recommended Corrective Action		
2	Good			None		

Se, fund	= Location of pole pass frequency fundamental, Hz
Se, harm	= Number of pole pass frequency harmonics
Level	= Sum of spectral amplitudes of pole pass frequency fundamentals and harmonics
Slip %	= SRSS sum of slip and harmonic "levels" divided by RMS level of RMS DEMOD spectra between 0 and 65 Hz.
Upper sb	= dB level of upper slip sideband of power line peak
Lower sb	= dB level of lower slip sideband of power line peak
Rotor bar health	= Estimate of the percent of broken or cracked rotor bars
RB Hlt Index	= Rotor bar health index

Rotor bar health is normal: The squirrel cage induction motor was running at sufficient load and there were no indication of rotor bars degradation.

Rotor bar health is questionable: The squirrel cage induction motor was running at sufficient load and there where indication of rotor bars degradation, review rotor bar analysis section for further details.

Rotor Severity Levels
There are seven severity levels associated with the calculation of rotor bar health index. These levels were selected in order to be consistent with diagnostic indicators found elsewhere, and in the literature. The following table presents the severity level, rotor condition, and recommended action.

If you obtain a rotor severity level of 6 or 7, please verify that the rotor damage is real as evidenced by one or more large pole pass peaks versus either of the following conditions: a high background level near the line frequency peak or the pole pass peaks riding on the shoulders of the line frequency peak.

Severity Level	Rotor Condition Assessment	Recommended Corrective Action
1.	Excellent	None
2.	Good	None
3.	Slight indication of rotor problems	Trend data
4.	Rotor bar cracks may be developing or problems with high resistance joints	Increase trending of data, trend closely
5.	One to two rotor bars cracked or broken and problems with high resistance joints likely	Increase trending and perform vibration tests
6.	Multiple cracked or broken rotor bars and end rings indicated	Overhaul ASAP
7.	Multiple broken rotor bars and end rings very likely	Overhaul or replace ASAP

If the 2nd/3rd slip harmonics are within 10% of each other:
Rotor degradation is most likely in the form of cracks.

If the slip fundamental and its harmonics all decrease:
Rotor degradation is most likely in the form of broken bars.

If there are more than three slip harmonics;
The slip (pole-pass) appears to have more than three harmonics in the demodulated spectrum. This is most likely a mechanical frequency related to rotation of some highly stressed component, such as a tight belt, a worn gear, speed reducer, or shaft whip. Multiple harmonics can also signify blow holes in cast aluminum rotors.

Load is insufficient to determine rotor bar health, at this time: The squirrel cage motor load was below 25% which is an insufficient load the identify rotor bar degradation

Stator Commentary

_________Stator health is normal.
_________Stator electrical health is questionable.
_________Stator mechanical health is questionable.
_________Turn to turn short.

Stator health is normal: There are no indications of existing or developing stator mechanical or electrical issues.

Stator electrical health is questionable: There are indications of developing winding shorts or weaknesses in the insulation to ground. **Verify and correct with MCA.**

Stator mechanical health is questionable: There are indications loose windings or stator iron.

Turn to turn short: There are indications of developing or existing turn to turn shorts. **Verify and correct with MCA.**

Rotor/Stator Air-gap Characteristics

_________Dynamic or static eccentricity indications do not exist.
_________ Indications of static eccentricity exist.
_________ Indications of dynamic eccentricity exist.

Dynamic or static eccentricity indications do not exist: There is no indication of either static or dynamic eccentricity.

Phone: +62 21 5226528
Email: support@okansa.com
www.okansa.com

Indications of static eccentricity exist: Indications are present that the rotor is not radially centered in the magnetic field. Check the rotor air gaps.

Indications of dynamic eccentricity exist: Indications are present that indicate that either the shaft is not centered in the rotor or the rotor is not concentric. It could be possible that the rotor is thermally sensitive.

Harmonic Distortion Commentary

________There is no evidence of harmonic distortion.
________There is evidence of harmonic distortion, see detailed report.

Harmonic Distortion Results:
Voltage input, from 50.018 Hz harmonics

	THD Odd %	THD Even %	+ve%	-ve %	Zero %	THD All %
Current 1	2.304	0.049	1.227	1.937	0.233	2.305
Current 2	***	***	***	***	***	2.000
Current 3	***	***	***	***	***	2.000
Voltage 1	0.430	0.031	0.231	0.330	0.156	0.432
Voltage 2	***	***	***	***	***	0.000
Voltage 3	***	***	***	***	***	0.000

Thd = Total harmonic distortion
+Ve = Positive sequence harmonic
-Ve = Negative sequence harmonic
Zero = Zero sequence harmonic

There is no evidence of harmonic distortion: Both the current and voltage waveform are relativity sinusoidal.

There is evidence of harmonic distortion: Either the voltage or the current waveform has evidence of harmonics

If Total Harmonic Distortion (THD) is less than 5%:
No significant harmonic distortion appears to exist, at this time.

If THD of odd harmonics is greater than 5%:
Either the THD or odd harmonics exceed 5%, which is usually indicative of a strong 3rd or 5th harmonic. A high 3rd harmonic in voltage means there is an induced high current unbalance with probable high neutral current; thus, the problem in the motor is most likely induced by the incoming power supply leading to excessive heating in the stator windings.

When there is a strong 5th harmonic of current, it is added to the 50/60 Hz fundamental to produce a distorted, non-linear waveform, whose affect on the motor is to oppose fundamental motor action. Excess heat created by the effect of higher harmonics results in the following main failure mechanisms: eddy-current losses in motor cores and conductors; degrading effect on motor torque output caused by certain harmonics of electronic equipment on the same circuit as the motor; and overall effect of having more current than the motor was designed to handle.

If positive sequence (+ve seq) harmonics are greater than 5%:
The positive sequence harmonics, the fundamental and 1/3 of all harmonic currents (4th, 7th, 10th, etc.), support rotation or sequencing in the same direction as normal motor action. These harmonics will actually cause the motor speed to increase while adding heat to the windings.

If negative sequence (-ve seq) harmonics are greater than 5%:
The negative sequence harmonics (2nd, 5th, 8th, etc.), oppose normal motor action and create magnetic forces on the rotor that oppose rotation, forcing the motor to work harder, drawing more current than its physical load requires. This added current could cause overheating and subsequent failure.

When a motor is subject to negative sequencing harmonic currents, the fundamental current has to increase to overcome the negative torque caused by the harmonics. This adds to the heat already generated within the motor, can cause the motor load to be reduced to save it from overheating premature failure, and can result in

Phone: +62 21 5226528
Email: support@okansa.com
www.okansa.com

mechanical impacts from the negative sequencing current induced torque that can cause bearing, coupling, and rotor damage.

If zero sequence (0 seq) harmonics are greater than 5%:
The zero sequence harmonic currents (3^{rd}, 6^{th}, 9^{th}, etc.), simply create heat, but do not affect either rotating or sequencing action. Their presence indicates non-linear loads that do not cancel, but, rather, add together in the neutral conductor.

In systems with many non-linear loads, the neutral current can actually exceed the phase current. The danger here is excessive overheating because there is no circuit breaker in the neutral conductor to limit the current, as there are in the phase conductor lines.

In a three-wire delta system, these currents actually circulate within the windings, produce heat, and increase the current load. Breakers may trip if the circulating currents cause the load to increase beyond the breaker set point.

Misalignment Indications

_________There are no indications of mechanical problems like misalignment or unbalance.
_________There are indications of mechanical problems like misalignment / unbalance. Perform vibr. survey to identify and correct the cause.

There are no indications of mechanical problems like misalignment or unbalance: There are no indications of excessive forces at shaft rotating speed.

There are indications of mechanical problems like misalignment/unbalance: There are indications of excessive forces are present at shaft rotational speeds. These may be caused by any mechanical problem on the rotating system. These faults include unbalance, misalignment, bent shaft, cracked shaft, eccentric rotor of driven machine, etc. **Perform vibration survey to identify and correct the cause.**

Bearing Commentary

_________There is no evidence of bearing problem.
_________Indications of potential bearing problems, perform vibration survey to verify.

Bearing condition					
Location	**Bearing No.**	**IR**	**OR**	**T/C**	**BS**
Drive end	SKF 6309	OK	OK	OK	OK
Opposite end	SKF 6209	OK	OK	OK	OK

There is no evidence of bearing problem: There are no indications of rolling element bearing faults.

Indications of potential bearing problems: Spectral peaks are present at non-integer multiples of rotating speeds in the high frequency spectrum. View the bearing multiplier in the header to locate the fault (software). **Confirm using Vibration analysis.**

For additional rolling element bearing analysis review **the ALL-TEST *Pro*, white paper on Rolling Element Bearing Failures.**