AIR COOLED CONDENSER USERS GROUP

Alternative Fan Drive Solutions for ACC's

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September 19, 2011

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Agenda

- Brief history of Reliance
- Review of common issues faced today
- Discussion of types of motors available on an ACC today.
  - Single speed NEMA motor
  - Two speed NEMA motor
  - RPM-AC motor
  - Direct Drive Technology
- Summary Discussion
- What can we do to make it better?

Background History

- Reliance Electric established 1905
- Baldor Electric established 1920
- Reliance Electric was acquired by Baldor Electric in January, 2007.
- Baldor Electric was acquired by ABB in January, 2011 creating the largest motor manufacturer in the world. Motors today are produced under the Baldor/Reliance name.
  - 360T frame and above are built in traditional Reliance plants.
  - Laminated frame design is a Reliance design product.
  - All products built in the U.S.

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Industry Issues

"What we hear from Users"

- **Reliability is paramount…..UPTIME!**
- **Gearbox issues are problem #1**
  - **Leaking gearboxes**
  - **High ambient conditions**
  - **Bearing failures**
- **Maintenance issues**
  - **Motor lubrication**
  - **Long term storage**
- **Environmental issues**
  - **Oil disposal & frequency of change out required**
- **Efficiency**
  - **Reduce parasitic load**
  - **System efficiency**
- **Noise levels**

Single Speed Nema Motor

- Designed and built to the latest EISA standards (needs to meet latest efficiency standards)
- B rise at 1.15 S.F. sine wave and or <3300 ft. altitude (includes one frame size larger than standard)
- Across the line or VFD operation
- Designed for 2 cold/1 hot with NEMA load curve and inertia

HP	Speed	Amb	Frame	FL PF	FL Eff	Noise	Weight
200	1800	40/50	G449T	87.2%	96.2%	<82 dba	4100 lbs
250	1800	40/50	GL449T	87.6%	96.2%	<82 dba	4500 lbs
200	1200	40/50	GL449T	86.7%	95.8%	<82 dba	4500 lbs
250	1200	40	GL449T	85.8%	95.8%	<82 dba	4500 lbs

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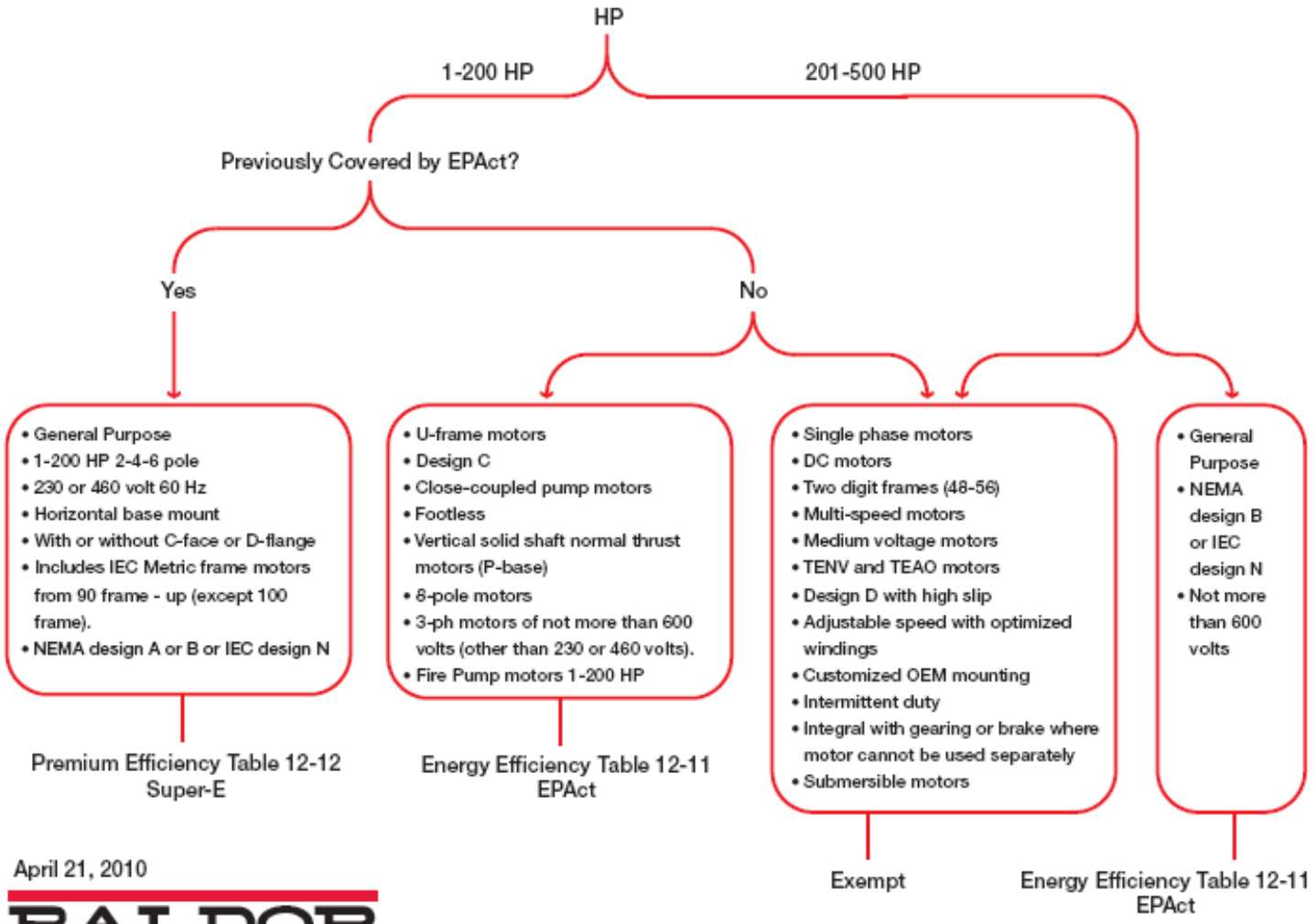
Energy Independence & Security Act of 2007



April 21, 2010

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Above reflects US regulations, Canada is slightly different

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Multi-Speed Nema Motor

- Designs do not need to meet EISA standards
- Typically 1 winding design
- B rise at 1.15 S.F. sine wave and or <3300 ft. altitude (includes one frame size larger than standard)
- Designed for 2 cold/1 hot with NEMA load curve and inertia
- Less design flexibility
- Additional active material required which could impact price by up to 50% over single speed design

HP	Speed	Amb	Frame	FL PF	FL Eff	Noise	Weight
200/ 50	1800/900	40	G449T	81.3/ 54.9%	95.2/ 92.9%	<82 dba	4500 lbs
250/ 62.5	1800/900	40	GL449T	81.5/ 55.0%	94.9/ 93.4%	<82 dba	5000 lbs

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RPM-AC Motor
Laminated Steel Frame

TEBC

DPG-FV

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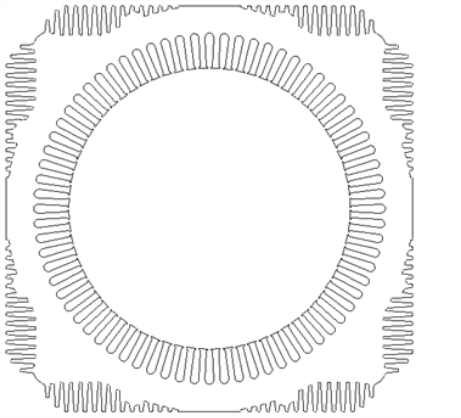
Next Generation of RPM-AC

- Frame construction
  - Frame construction consists of stack of laminations.
  - Laminations have finned surface, increasing surface area by 50%.
- Benefits of FL Design vs NEMA cast iron frame
  - No frame to stator fit.
    - Better heat transfer to cooling fins
    - Less machining
    - No frame casting
  - Higher power density
    - Smaller frame size per Hp
    - Lower Inertia



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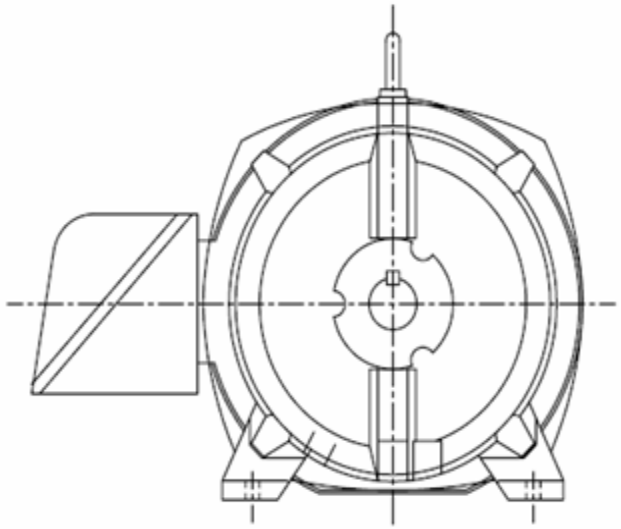
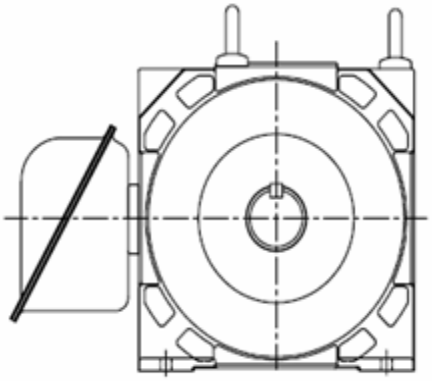
Shaft Height Comparison

75 Hp @ 1800 rpm, TEFC

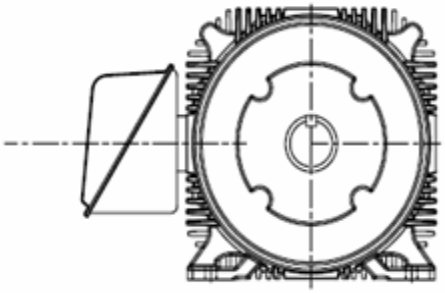
	Shaft ht.
360T	9.00”
280T	7.00”
250T	6.25”



NEMA
E360T



RPM-AC L280



RPM-AC FL250

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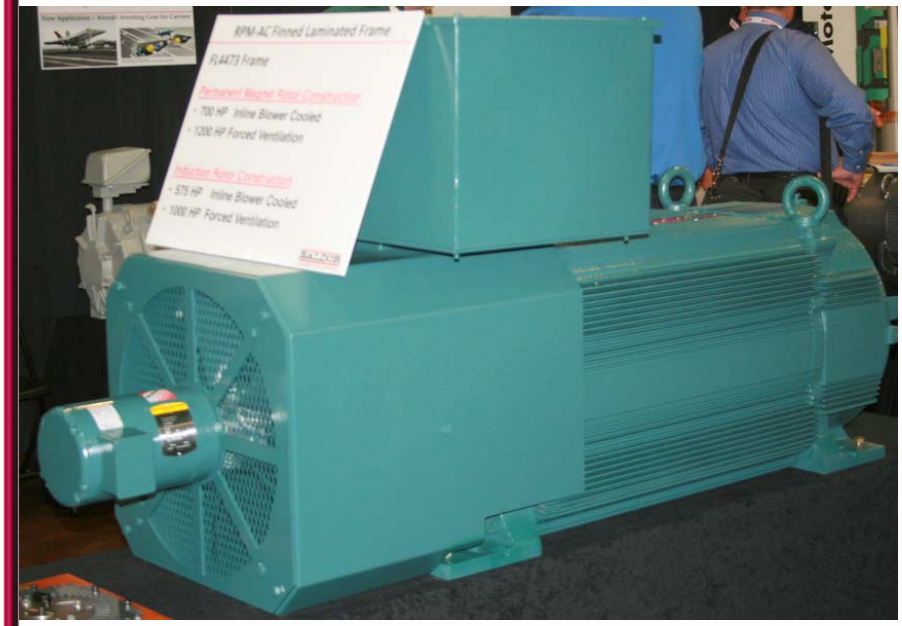
RPM-AC Motor



- Laminated frame design
- Smaller footprint and weight
- Highest efficiency induction design
- 3rd generation design
- Designed for variable speed only
- Class H materials with F rise

HP	Speed	Amb	Frame	FL PF	FL Eff	Noise	Weight
200	1800	40	FL4413	92.1%	96.6%	<90 dba	3400 lbs.
250	1800	40	FL4429	94.2%	96.8%	<90 dba	3650 lbs.

TEBC

HP	Speed	Frame	Weight
200	1800	L3203	1200 lbs.
250	1800	L3213	1350 lbs.

DPG-FV

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Motor Technology Comparison

100 HP/1800 rpm/Totally Enclosed

Rotor Type	Induction			PM		
				Surface	Interior	
Frame Type	Cast	Laminated				
Product line	VS Master	Smooth	RPM-AC	Finned		
Frame Size	405T	L2898	L2890	FL2586	FL2586	FL2578
Weight	1160 lbs	1045 lbs	900 lbs	532 lbs	532 lbs	464 lbs
lbs/HP	11.60	10.45	9.00	5.32	5.32	4.64
Amps	115	121	121	117	110	112
Power Factor	86.4%	81.4%	82.1%	90.3%	87.2%	86.0%
kW Losses	4.381	3.587	4.763	4.12	2.627	2.916
Full Load Eff	94.5%	95.4%	94.0%	94.8%	96.5%	96.20%
Rotor Inertia	26.1 lb-ft	21 lb-ft	9.7 lb-ft	4.9 lb-ft	4.9 lb-ft	4.2 lb-ft
Temp Rise	80 C	91.2 C	110 C	120 C	75 C	115 C

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Baldor Direct Drive Cooling Tower Motor

- **ENERGY EFFICIENT**
- **“GREEN” SOLUTION**

BALDOR’S DIRECT DRIVE

- Next level technology
- Industry Changing
- Environmentally friendly

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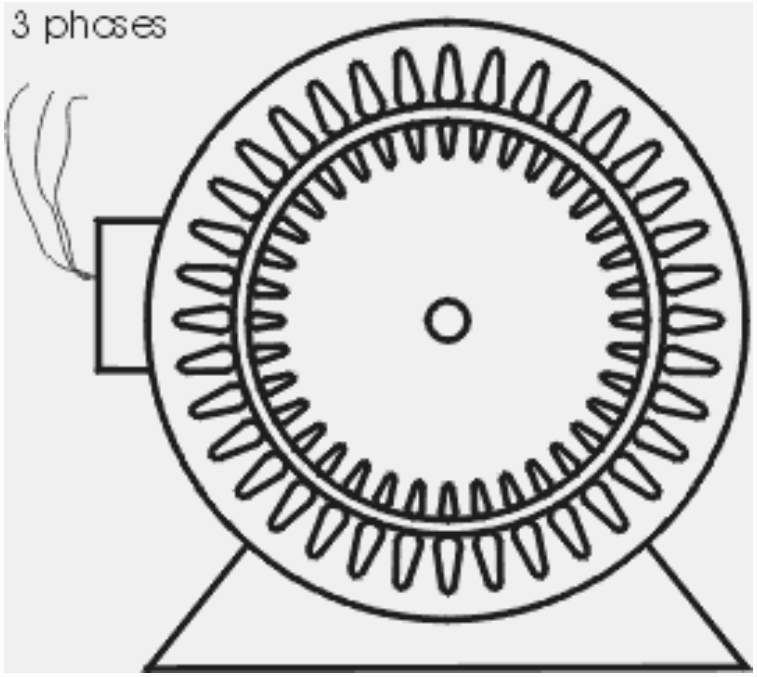
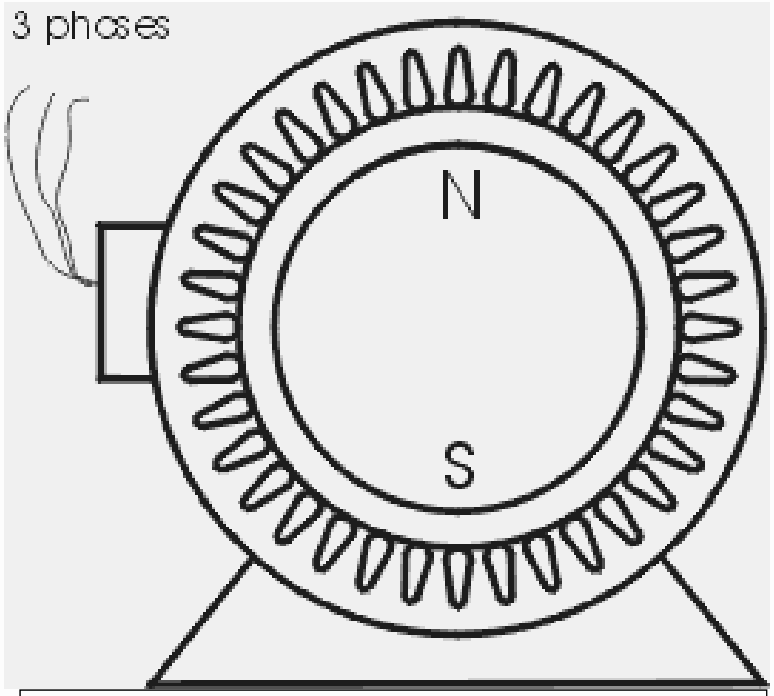
How do PM motors differ from Induction Motors?

Same:	stator, rotor diameter, 3 phase power
Different:	Induction has slip, PM is synchronous
	PM has no rotor losses, therefore – more efficient
	Induction is line start, PM requires drive or other means to start



Induction – squirrel cage motor



PM – surface

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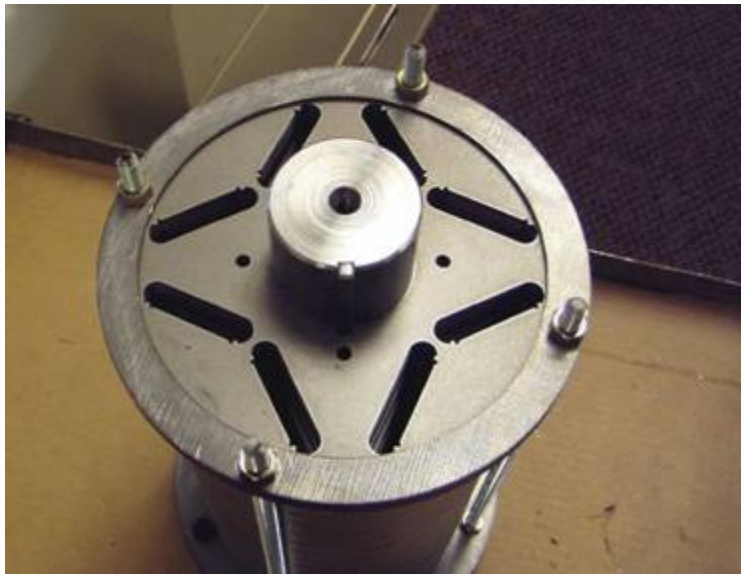
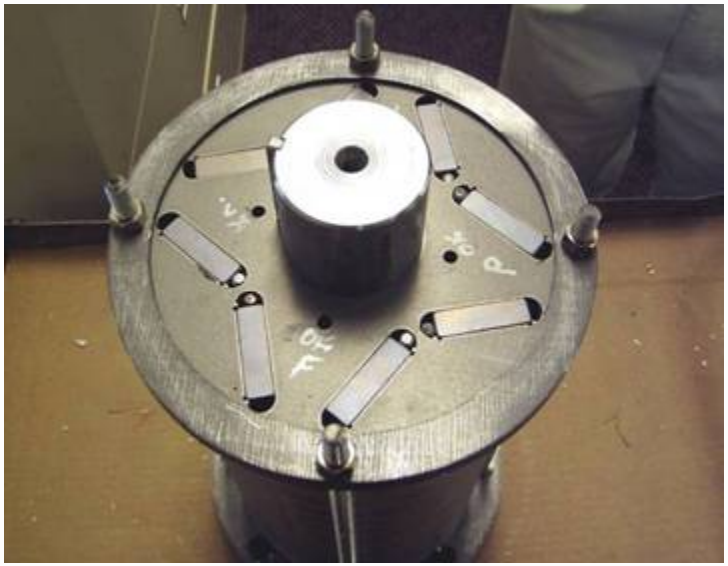
Interior PM Development

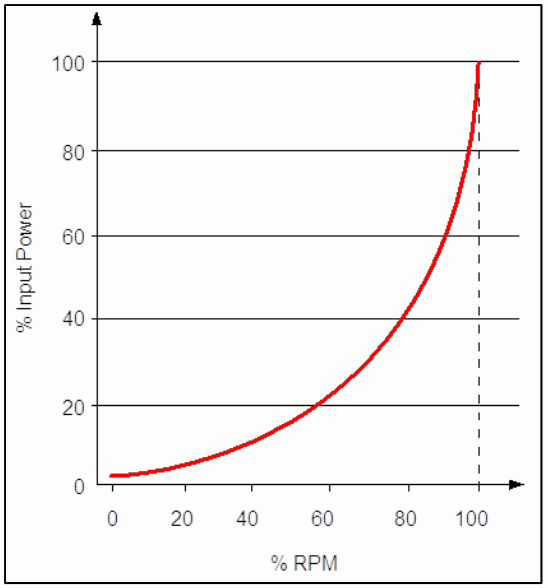
- Interior PM Rotors Have *Saliency*
- Saliency Means the Inductance of the Motor Varies with Rotor Position
  - Allows the accurate control of speed without feedback

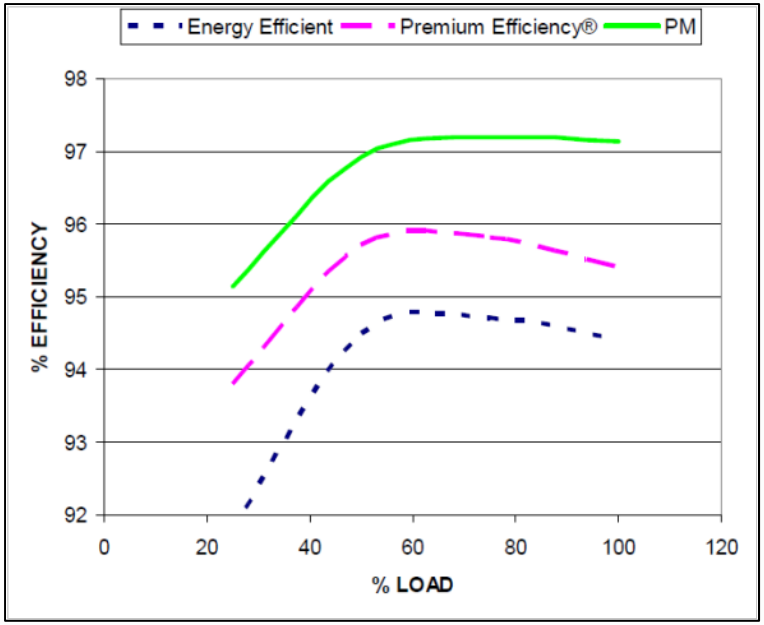




Optimized Efficiency

- **Optimized motor speed**
  - Traditional cooling towers are designed for the “Worst Case” (highest air flow) scenario
  - Running the fan at reduced speed saves energy and cost of operating the tower





- **IPM Motor Highest Industry Efficiency**
  - Permanent Magnet Motors provide the highest efficiency levels of any motor in the industrial market
  - IPM Motors are fully one band higher than premium efficient motors

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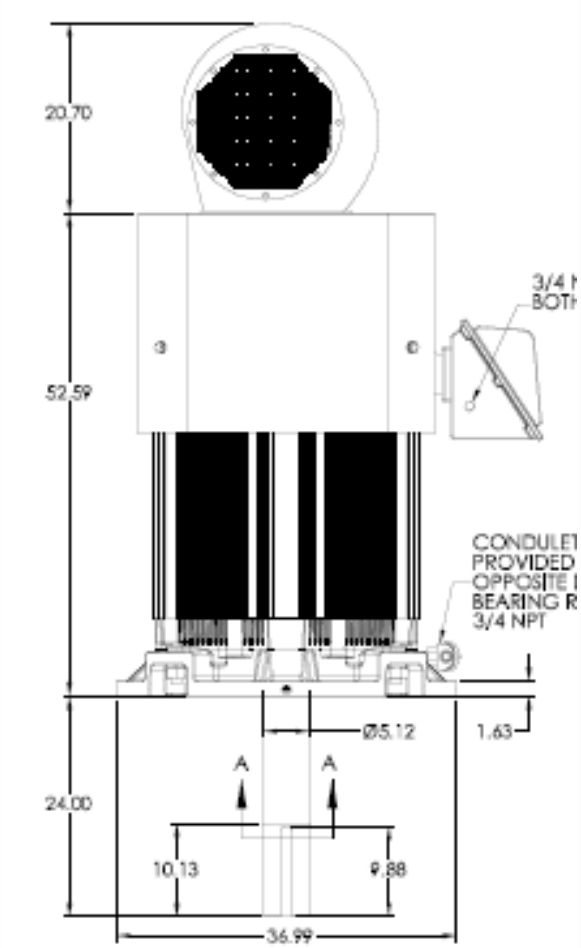
Direct Drive Motor for Cooling Towers



- Designed specifically for cooling tower service (wet or dry).
- Eliminate all mechanical items in order to provide best reliability.
- Sized based on fan load (no mechanical losses to factor in)
- The amount of air provided over the motor (fpm) for cooling has a direct relationship on the frame size of the motor. What can be done to provide more air to the motor?
- No mechanical losses involved so overall system efficiency is improved.
- Sustained efficiency - motor efficiency is consistent compared to mechanical efficiency which degrades over time as components wear.
- Without a blower, noise levels in the low 60 dba range

HP	Speed	Amb	Frame	FL PF	FL Eff	Noise	Weight
167	104	60	5832	90.0%	90.3%	90 dba	8500 lbs.

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Cooling Tower Motor

"key features as applied to an ACC"

- **Blower cooled in order to meet high torque ratings (11,300 ftlb2). Air flow switch is provided for protection against loss of air flow.**
- **Class H materials**
- **High ambient**
- **Running class B to F temp rises**
- **E-Coating**
- **Assembled "wet"**
- **Stainless steel hardware**
- **Extreme Duty Paint System**
- **Sealed insulation system based on proven experience**
- **Double row angular contact/deep groove ball bearing arrangement**
- **Large, generous bearing cavities**
- **Synthetic lubricant – 2 years between relubrication**
- **Max drive shaft diameter of 5"**
- **Extended drive shaft length**

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New Direct Drive Technology

- **Matched Performance VS1CTD drive and RPM-AC Motor**
- **Baldor VS1CTD drive is unique and is designed for variable speed operation with the IPM motor**
- **High Torque Direct Drive Motor:**
  - Laminated Frame IPM (Permanent Magnet)
  - Motor is designed as a drop in replacement for existing gearbox packages; matching bolt holt patterns (may require a mounting plate)
- **Fan couples directly to the motor shaft**

MATCHED BALDOR PERFORMANCE

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ABB Drives

World’s largest low voltage drive manufacturer

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Direct Drive Cooling Tower Benefits and Energy Savings Comparisons Summary

- **The biggest gains in energy savings occurs when the system *can take advantage* of adjustable speed/airflow, to reduce the overall Motor HP requirements for the fan**
  - **50-60% energy savings are common in wet cooling tower profiles**
  - **Applying drives on NEMA induction motors saves a similar amount of energy as with the Baldor PM direct drive motor solution**
- **Very old retrofits (such as the Clemson site) can show significant energy savings – for both PM or Induction motor upgrades if the original gear and motors were low in efficiency to start with**
  - **10-15% energy savings are possible**
- **There is minimal energy savings of the Baldor Direct Drive PM cooling tower system compared to a reasonably efficient newer installation, if the tower *cannot take advantage* of the variable speed to minimize the HP consumed to drive the fan**
  - **2% Plus or minus energy savings is the expectation** → **5-12%**
  - **The primary reason is that the efficiency of the PM motors at the very low speeds of the fan is not very high, drive losses also have to be considered**
  - **Simplified installation and reduced maintenance are the major selling points**
  - **No gear reducer to maintain.**

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Switchgear, MCCs & Drives or Starters

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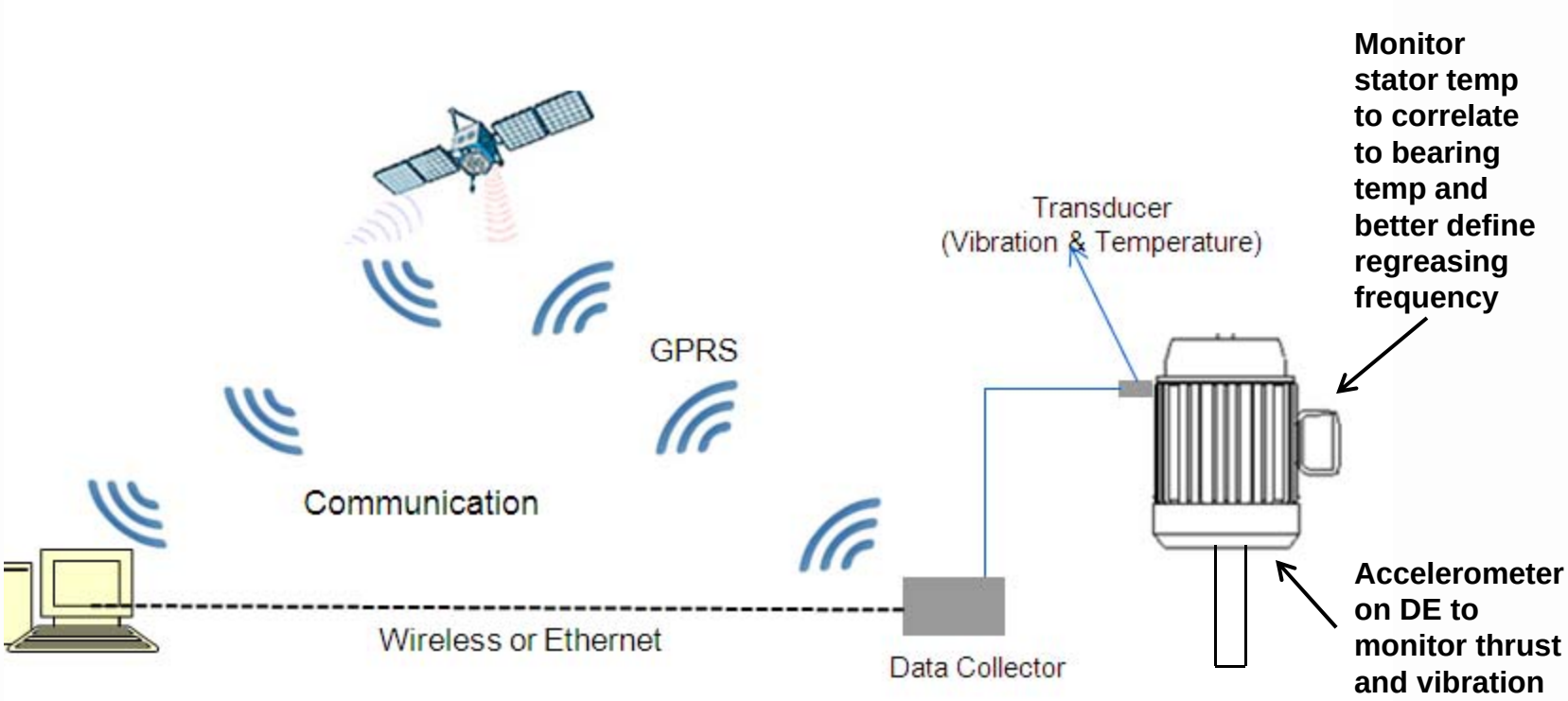
Wireless Condition Monitoring

“a better way to protect your investment”



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Closing Thoughts/Comments

- How did we get to where we are today?
  - B rise at 1.15 S.F.
- With system efficiency improvements and better reliability what is there not to like about the direct drive approach?
  - Airflow
  - Weight
- Ways to write a specification to make it more standard
  - Motor technologies have changed
- Encouraging technology development
  - Other enclosure options
  - How to get more air to the motor
  - Prototype installations
  - Higher fan speeds