# Technology Day

## Direct Drive Technology

## Bringing Reliability To Cooling Towers

October 17th, 2013

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# Topics of Discussion

- History of cooling tower initiative & present day issues
- “A Convergence of Technologies”
- Field Testing Program & Installations
- Cooling Tower Motor Design Features
- Cooling Tower Adjustable Speed Drive
- Info for Application Review

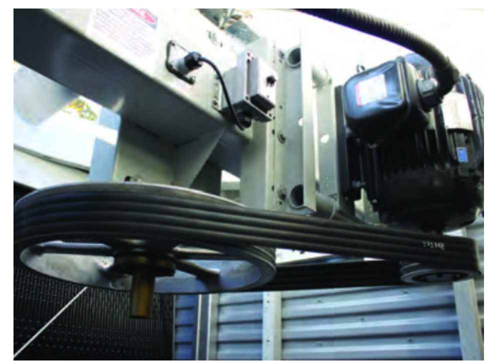
# Cooling Tower Types

## Field Erect Units



## Packaged Units





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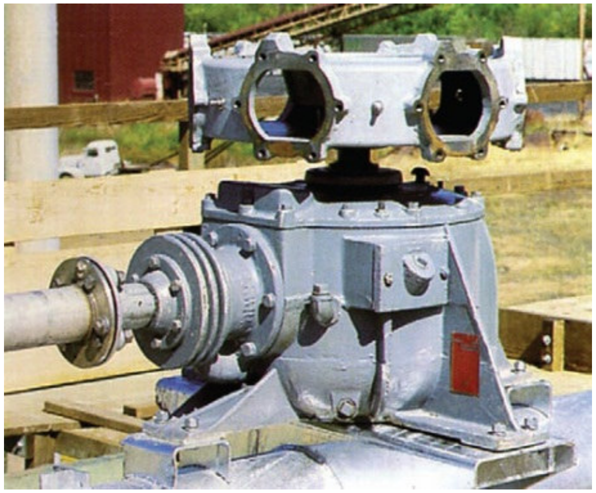
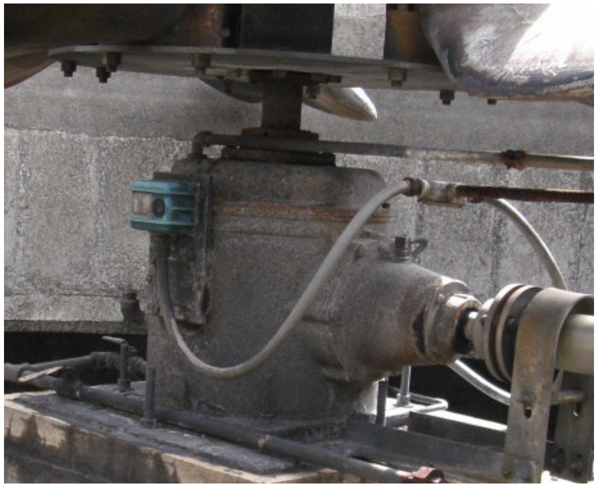
# Beginning of CT Initiative – July 2005

**Existing Gearboxes**





**New Gearbox Solution – Gear Development Project**

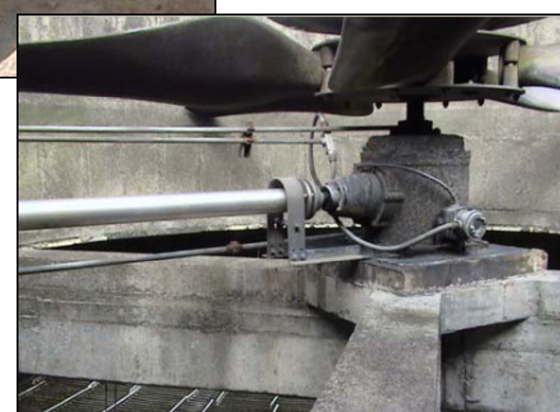
- **Better Sealing**
- **Lower Maintenance**
- **Higher Reliability**

# Industry Survey - Problems

- Mechanical Maintenance
- Lightly loaded majority of the time, inefficient operation
- Mechanical stresses with across the line starting
- Wind milling problems
- Long replacement time

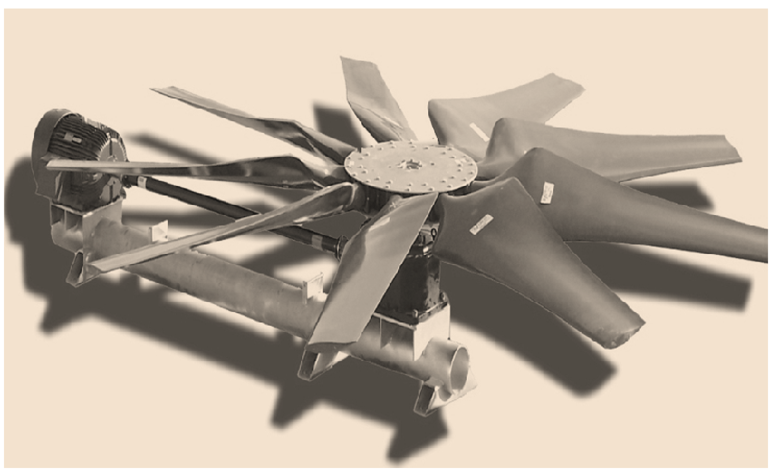


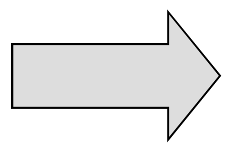




# Survey Feedback

- New gearbox? NOT Interested
- The gearbox is the problem
- Heard it before
- Develop a solution that eliminates the problem



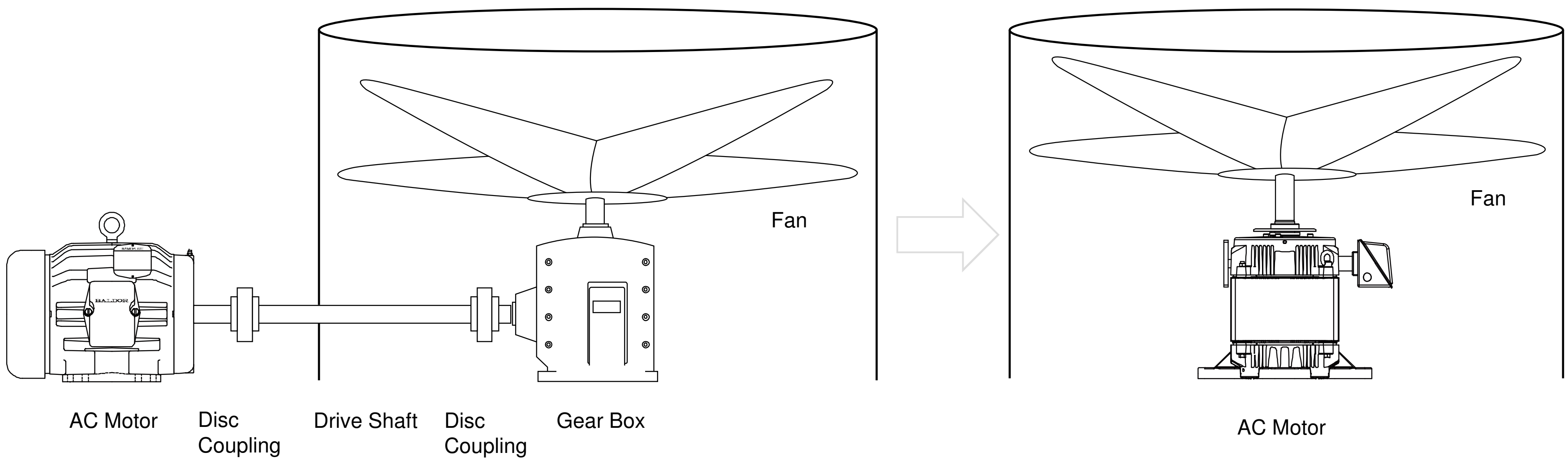


# Direct Drive Solution – PM Motor & Drive

- Matched Performance drive and motor Solution
  - Drive designed for sensorless PM motor operation
  - High Torque Direct Drive PM Motor
- Improved efficiency over standard gearbox and motor

Existing Solution

CTD Direct Drive

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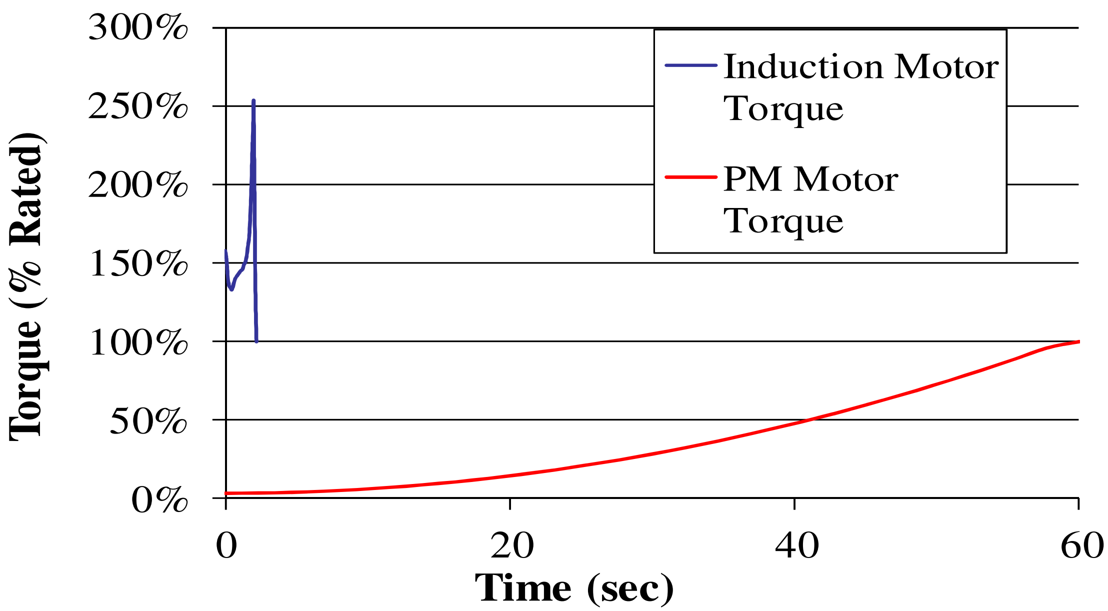
# Direct Drive Solution – Benefits

- Eliminates gearbox and associated components
- Lower installation cost
- Eliminates gear oil in the cooling water
- Improves reliability & reduces maintenance
- Runs quieter and more efficient
- Reduced mechanical stress through soft start

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# Why Now: "Technology Convergence"

- **Permanent Magnet (PM) interior salient pole rotor technology provides increased efficiency, power factor and power density improvements**
- **Power Density – Laminated frame construction**
- **PM drive technology – simplified software designed for cooling tower control without feedback requirements**

**Designed Exclusively for Cooling Tower Applications**

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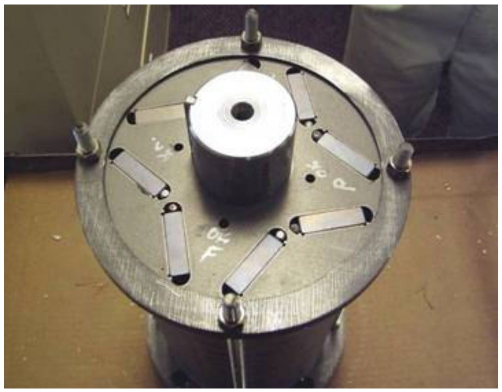
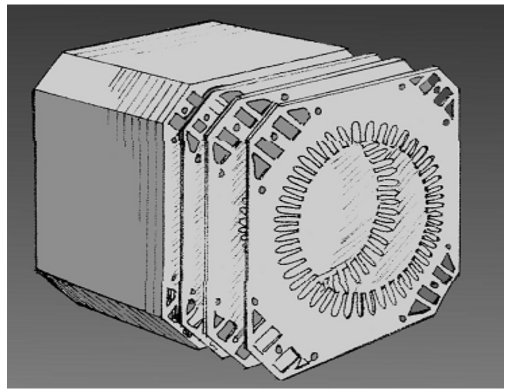
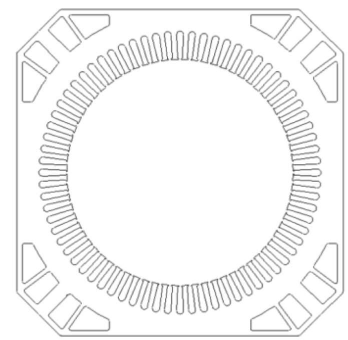
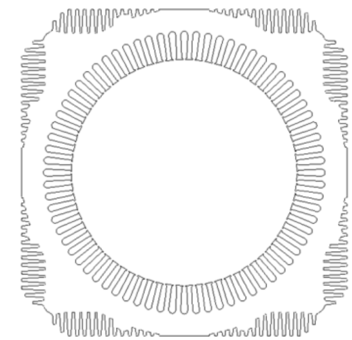
# PM Motor Improvements

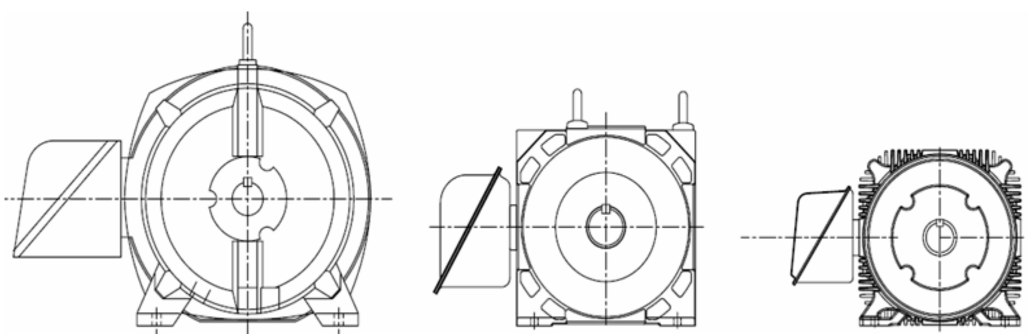
- **Motor power density and increased efficiency**











360T L280 L250

75 HP, 1800 RPM

| | |
|---|---|
| 360T | 9.00” |
| L280 | 7.00” |
| L250 | 6.25” |

# Motor Technology Comparison
# PM vs Induction at 100 HP

| Frame Type | Cast Iron | | Laminated Steel | | |
|---|---|---|---|---|---|
| Product line | NEMA | | Smooth | RPM AC FL Frame | |
| Rotor Type | Induction | | | Surface PM | **Interior PM** |
| Enclosure | **TEFC** | **TEFC** | **TEBC** | **TEBC** | **TEBC** |
| HP @ 1750 RPM | **20** | **100** | **100** | **100** | **100** |
| Frame Size | **256T** | **405T** | **L2898** | **FL2586** | **FL2586** |
| Weight | **325 lbs** | **1160 lbs** | **1045 lbs** | **532 lbs** | **532 lbs** |
| lbs/HP | **16.25** | **11.60** | **10.45** | **5.32** | **5.32** |
| F.L. Amps | **25.5** | **115** | **121** | **117** | **119** |
| F.L. Power Factor | **78.9%** | **86.4%** | **81.4%** | **90.3%** | **93.4%** |
| kW Losses | **1.116** | **4.381** | **3.587** | **4.12** | **2.396** |
| F.L. Efficiency | **93.0%** | **94.5%** | **95.4%** | **94.8%** | **96.9%** |
| Rotor Inertia | **2.42 lb-ft$^2$** | **26.1 lb-ft$^2$** | **21 lb-ft$^2$** | **4.9 lb-ft$^2$** | **4.9 lb-ft$^2$** |
| Temp Rise | **80 C** | **80 C** | **91.2 C** | **120 C** | **77.6 C** |

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# Why we haven't done it before….

## 200 HP, 120 RPM, 8753 lb-ft
## Both Motors Direct Drive – no gearbox

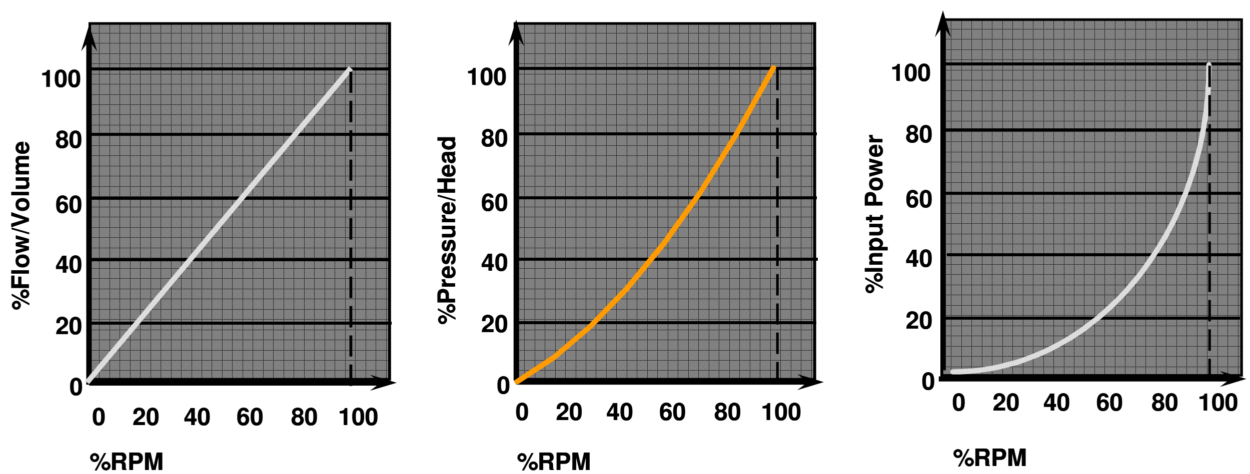
| Motor Type | Height (in.) | Width (in.) | Wt. (lbs.) |
|---|---|---|---|
| Cast Iron Frame Induction | 61 | 54 | 18685 |
| Finned, Laminated Frame Permanent Magnet | 50.47 | 37 | 7900 |

**Note Reduced Height and Weight of Finned, Laminated Frame PM Motor**

# Efficiency Evaluation

- **Affinity Fan Laws apply to Cooling Towers**
  - **Air Volume is Directly Proportional to Speed**
  - **Pressure varies as Square of Speed**
  - **HP varies as Cube of Speed**

| Speed | 100% | 90% | 80% | 70% | 60% | 50% | 40% | 30% |
|---|---|---|---|---|---|---|---|---|
| Volume | 100% | 90% | 80% | 70% | 60% | 50% | 40% | 30% |
| Pressure | 100% | 81% | 64% | 49% | 36% | 25% | 16% | 9% |
| HP Req'd | 100% | 73% | 51% | 34% | 22% | 13% | 6% | 3% |



# Example of Energy Savings (Intel facility)

## Conventional Cooling Tower Design (Single Speed Motor)

| Avg. Operating hours | | Fan Speed | Motor Hp | Motor Rating kW | Power Usage kWh | Energy cost CA Industrial 11.2 c/kWh |
|---|---|---|---|---|---|---|
| 5110 | Full speed | 225 | 50 | 37.3 | 190,603 | $ 21,348 |
| 3650 | Off | 0 | 0 | 0 | 0 | 0 |
| **8760** | | | | **Totals** | **190,603** | **$ 21,348** |

## Direct Drive Solution with ASD

| Avg. Operating hours | | Fan Speed | Motor Hp | Motor Rating kW | Power Usage kWh | Energy cost CA Industrial 11.2 c/kWh |
|---|---|---|---|---|---|---|
| 1460 | Full | 225 | 47.25 | 35.2 | 51,463 | $ 5,764 |
| 730 | 90% | 202.5 | 34.4 | 25.7 | 18,758 | $ 2,101 |
| 730 | 80% | 180 | 24.2 | 18.0 | 13,174 | $ 1,476 |
| 730 | 70% | 157.5 | 16.2 | 12.1 | 8,826 | $ 988 |
| 730 | 60% | 135 | 10.2 | 7.6 | 5,558 | $ 622 |
| 730 | 50% | 112.5 | 5.9 | 4.4 | 3,216 | $ 360 |
| 3650 | Off | 0 | 0 | 0 | 0 | 0 |
| **8760** | | | | **Totals** | **100,996** | **$ 11,312** |

Total of **$10,036** Savings per Tower per Year (47%)

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# Field Testing Program

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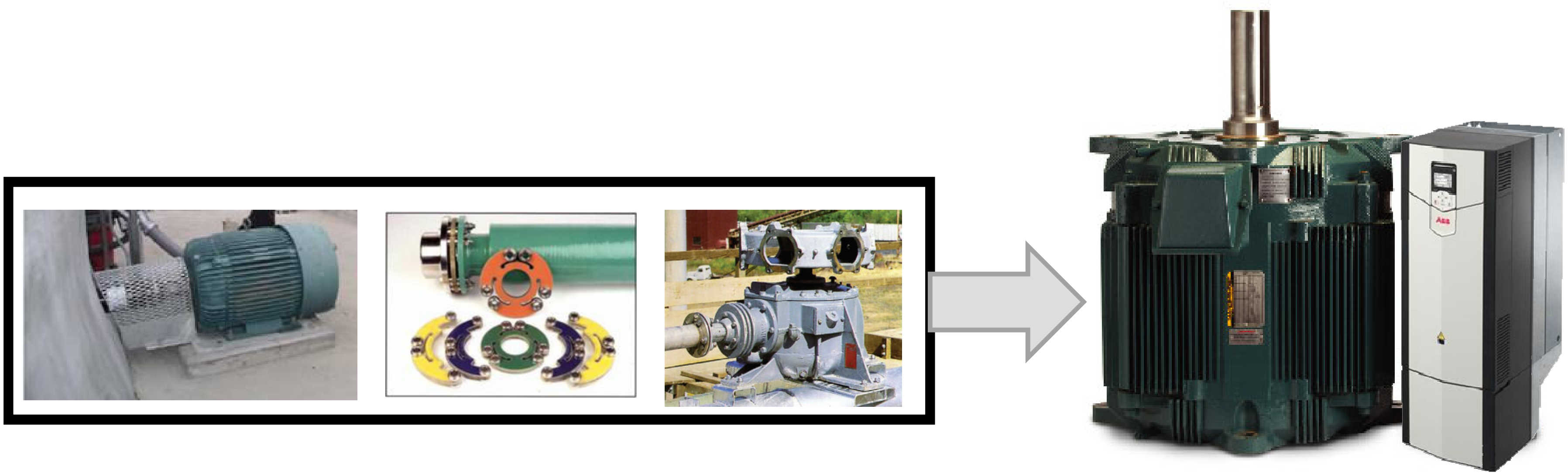
# Solution Development Project

- **Developed solution / concept and presented to CT OEM July 2007**
- **Beta Testing**
  - Presented solution to Clemson University Nov 2007
  - Installed solution June 2008 as retro-fit on existing Clemson tower
- **Third party testing (CTI)**
  - Clean Air Engineering confirmed performance data



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# Case Study

## On The Campus Of Clemson University Clemson, SC

- Constructed In 1986
- Two Identical Cells
- Fan - 18'
- Motor – 50 HP, 326T Frame, 1765/885 RPM
- Amarillo Gearbox – 155, 8.5:1 Ratio

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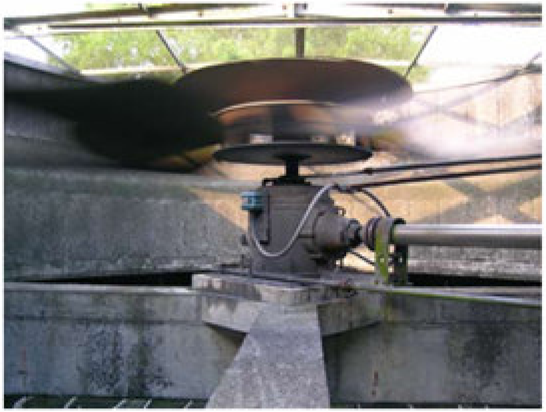
# Clemson Installation



Existing Design
Amarillo 155 Gearbox
With Drive Shaft

Direct Drive Solution
Drop-In Replacement
No Pedestal
Modification

Hudson 5 blade
18 ft Dia Fan
Mounts directly to
Motor Shaft

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# Clemson Installation Test Data

| | 2-Speed, 326T Induction Motor | RPM AC, FL4493 PM Motor |
|---|---|---|
| Fan Load | 41.5 Hp | 41.5 Hp |
| Gearbox and Couplings Efficiency | 90.2% | N/A |
| Motor Horsepower | 46.0 Hp | 41.5 Hp |
| Motor Efficiency | 90.0%* | 93.1% |
| Drive | N/A | 98.8% |
| Input kW | 38.1 | 33.6 |
| Total Efficiency | 81.2% | 92.0% |

*Published Data

4.5KW Savings

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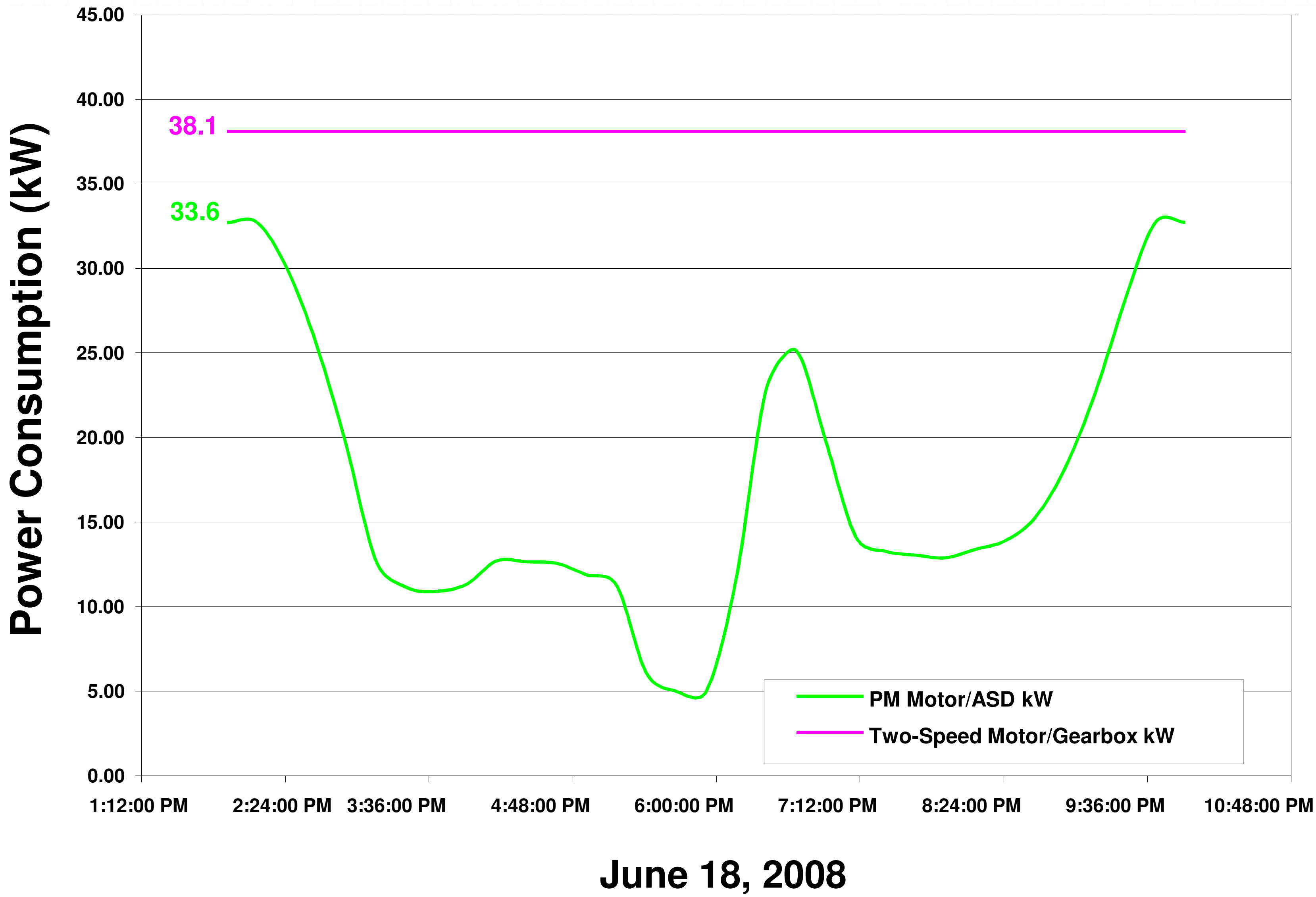
# Clemson Installation Test Data

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# Clemson Installation Test Data

| Loaded Noise Levels | | |
|---|---|---|
| Average | High Speed | Low Speed |
| Induction NEMA Motor Tower | 82.3 dBA | 74.4 dBA |
| Laminated Frame IPM Tower | 77.7 dBA | 69.0 dBA |

**Data verified by Clean Air Engineering on site at Clemson University**

- Tested per CTI standard ATC-128
- Sound pressure level measured at a distance of 5 feet

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# So What Did We Learn

- Higher System Efficiency
- Lower operating noise levels
- When performing maintenance, it is still a good practice to mechanically tie down the fan
- Gearbox Low Speed Lubrication Issues eliminated
- No Driveshaft, couplings or guards

# Clemson Beta Site Motor
## (After approx 1-year in operation 2009)

- This test motor did not have E-coat or Flinger cover over Inpro seal
- After 1-year of operation still appeared to be in good condition

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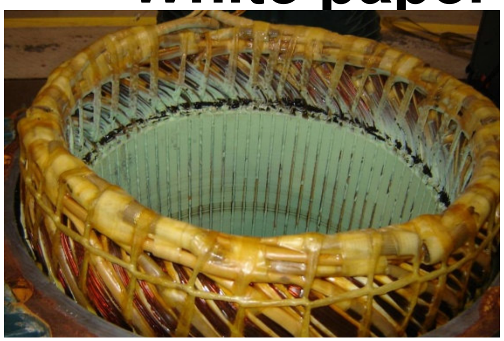
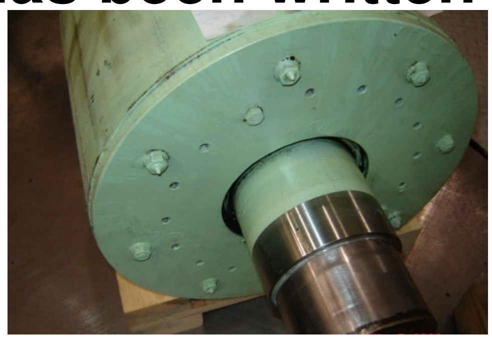
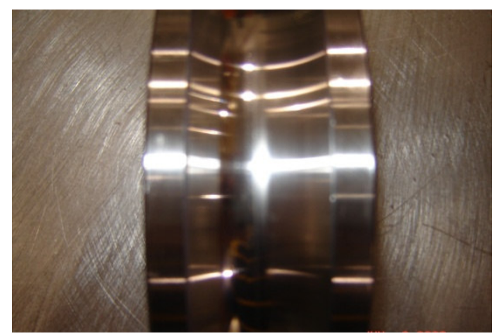
# Clemson Motor Inspection Results

- Grease was still in excellent condition
- Bearings showed only minor wear
- Ingress of contamination was minimal
- Insulation was still in excellent condition
- White paper has been written and is available

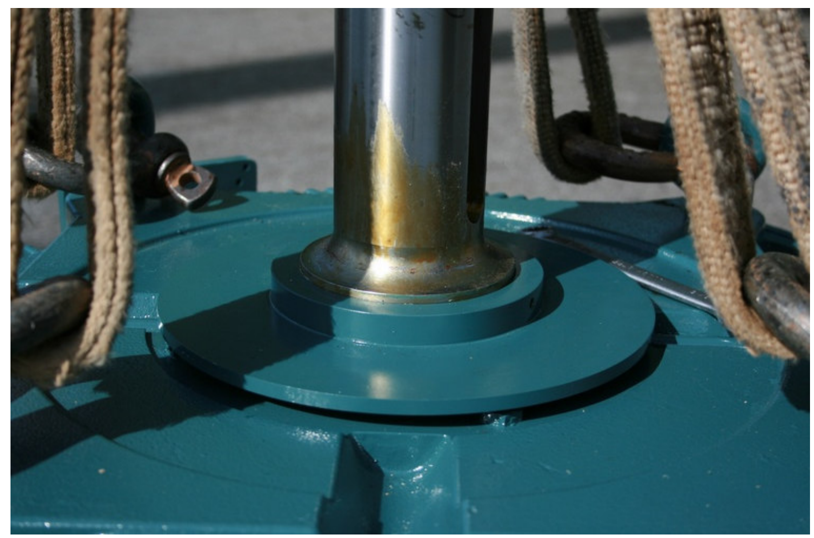




# New motor installed on site

"Additional improvements made- version 2.0"

- Now with slinger over Inpro seal
- With E-Coating
- New end bracket draft design (no pooling of water)
- Assembled "wet"
- Synthetic grease
- Improved paint system



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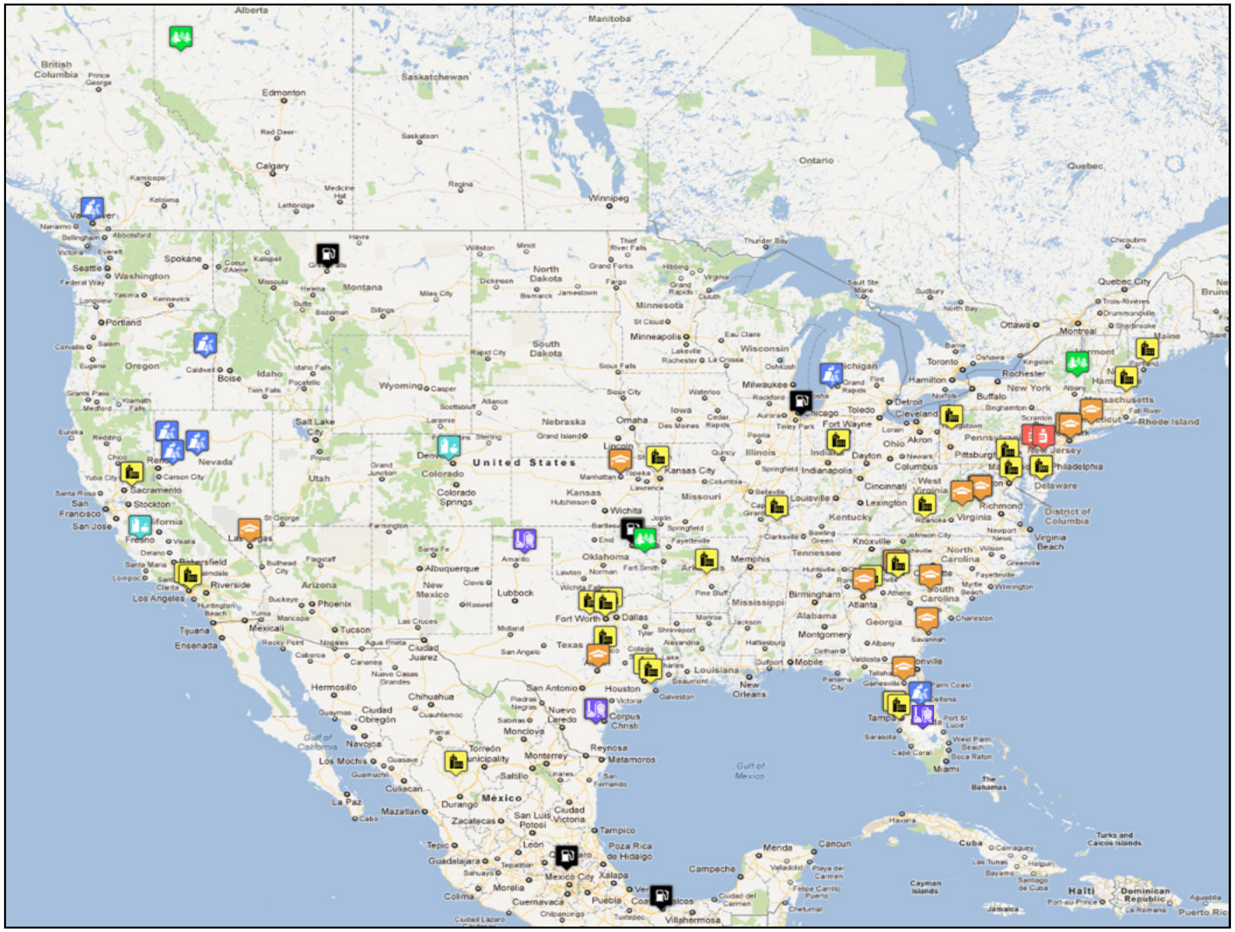
# Cooling Tower Motor Installed Base




In excess of 400 units shipped since 2008

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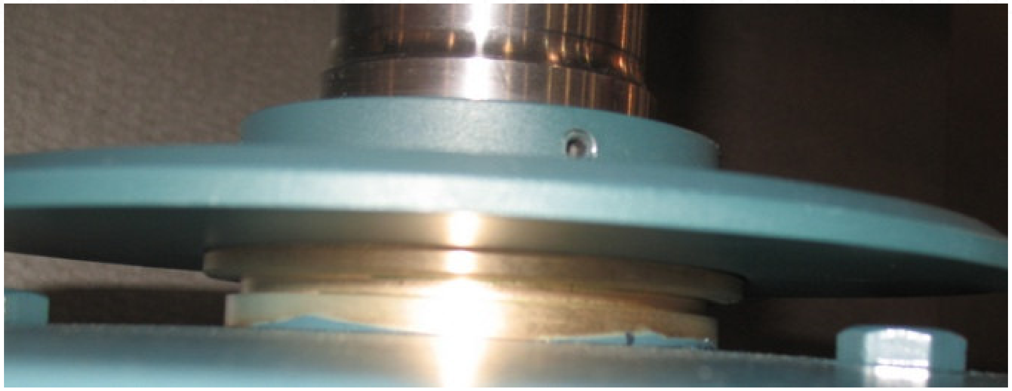
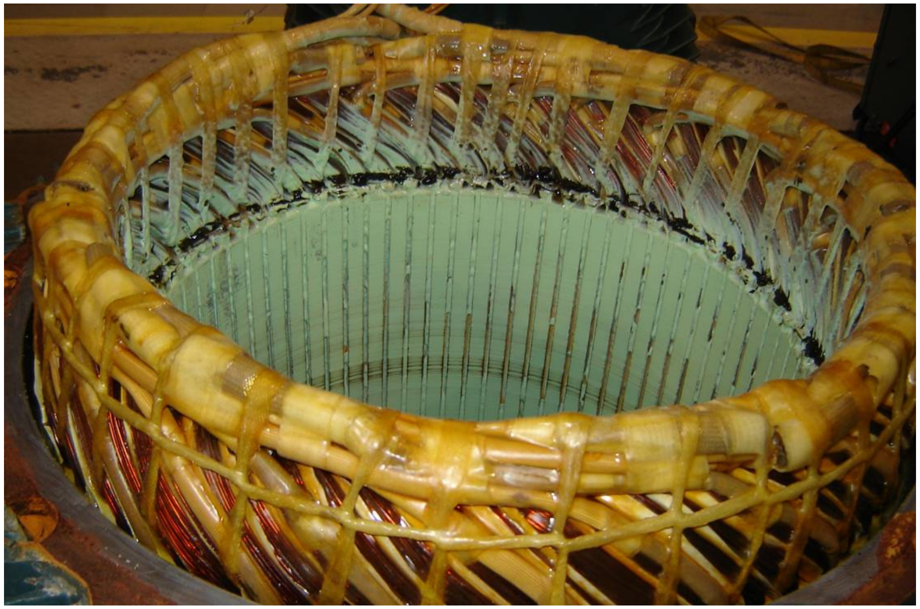
# Direct Drive Design Features

# Seal Design & Insulation System

Inpro Seal on Drive End



Slinger over Inpro Seal



Class H VPI Insulation System

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# Motor Bearings & Grease

- 100% grease fill
- Synthetic grease
- Bearing L10 life min 100,000 hrs
- Relubrication interval for smaller units is at 2 years

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# Condition Monitoring

## Torque for 100 HP @ 180RPM
## = 1000HP @ 1800 RPM
## = 2000 HP @ 3600 RPM

- **Bearing RTD's**
- **Winding RTD's**
- **Vibration detection**
- **Data Analysis Unit**
  - Data analyzed by embedded processor
  - 4 channels simultaneous vibration data
  - 5 channels temperature data
  - Wireless cell phone connection to server
  - Requires 115v wired to unit

- **Condition Monitoring**
  - Wired or wireless
  - Wireless provides accelerometer connection to server through gateway
    - Battery operated
  - Analyst software


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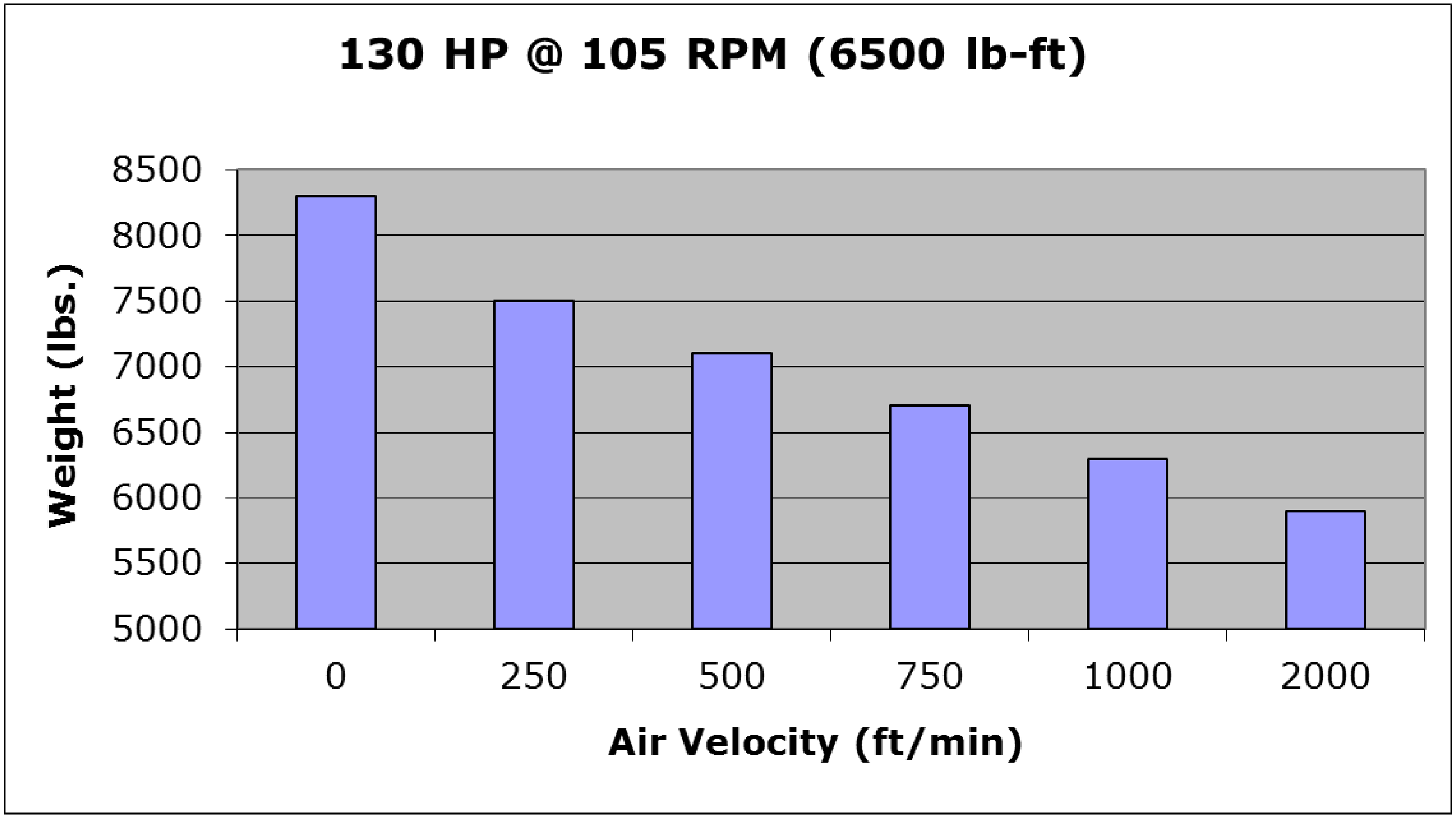
# Motor Sizing
## Air Velocity

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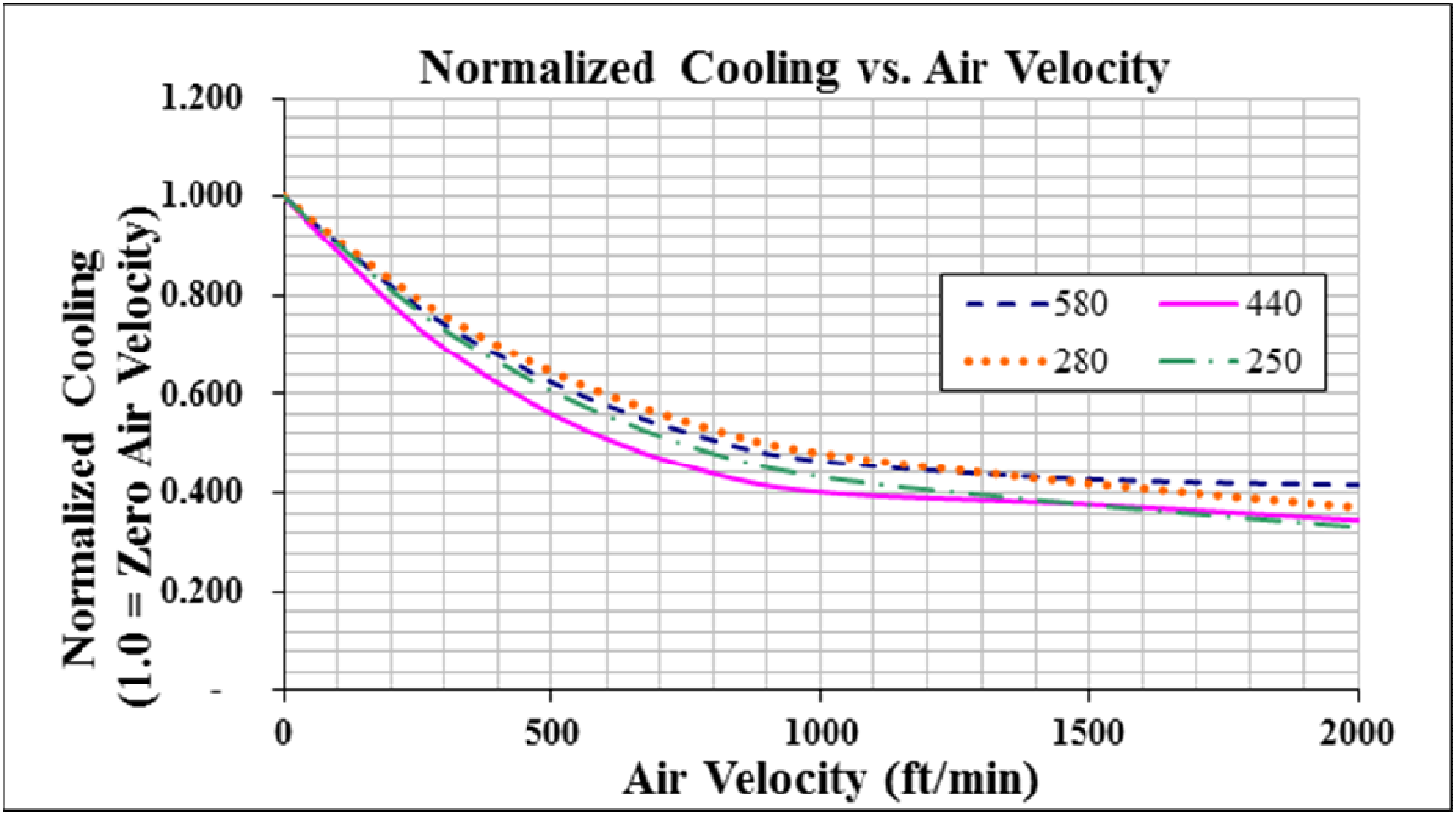
# Effects of Air Cooling

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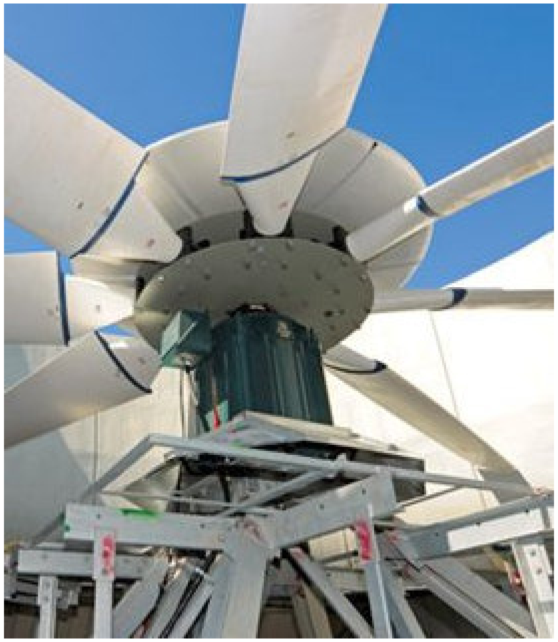
# Impact of Fan Design



The fan design used can have an impact on the amount of airflow that is available to cool the motor

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# ASD Design

# Cooling Tower Drive

- **Matched Performance Drive & Motor**
- **Proven Technology Design focused on:**
  - Ease of startup
  - Minimal maintenance
  - Efficiency of operation
- **Utilizes unique control algorithms**
  - Interior Permanent Magnet (IPM) Motor Control
  - Sensorless Vector algorithm
  - Smooth, low speed operation
  - Maximize Efficiency (optimized control to motor)
- **Reduced parameter set**
  - Application specific design for cooling towers
  - Reduced parameters set simplify startup
- **Predefined operating modes**
  - Provides automatic setup of drive

# Trickle Current Heating

- **Maintains small amount current to motor when not in use**
  - Eliminates condensation in the motor
  - Additional benefit of providing anti-wind milling torque
- **Automatic operation**
  - Manual operation available
  - Modbus coil provided for building automation control systems

NO SPACE
HEATERS REQUIRED

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# Application Considerations

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# Motor Sizing
## Know the Load


- Example (Traditional Method)
  - Fan BHP = 133 at 100 rpm
  - Add loss for speed reducer

    133 * 1.05 = 140 HP
  - Select NEMA motor > calculated HP

| HP | Synchronous RPM, 60 Hz | | |
|---|---|---|---|
| 25 | 1800 | 1200 | 900 |
| 30 | 1800 | 1200 | 900 |
| 40 | 1800 | 1200 | 900 |
| 50 | 1800 | 1200 | 900 |
| 60 | 1800 | 1200 | 900 |
| 75 | 1800 | 1200 | 900 |
| 100 | 1800 | 1200 | 900 |
| 125 | 1800 | 1200 | 900 |
| 150 | 1800 | 1200 | 900 |
| 200 | 1800 | 1200 | 900 |
| 250 | 1800 | 1200 | 900 |
| 300 | 1800 | 1200 | 900 |

- Example (Direct Drive)
  - Fan BHP = 133 @ 100 rpm
  - No speed reducer loss

    133 * 1.0 = 133 HP

**Options for 133 HP, 100 rpm Direct Drive, 250 ft/min air velocity**

| HP | Height (in.) | Weight (lbs.) |
|---|---|---|
| 133 | 48.47 | 7500 |
| 140 | 50.47 | 7900 |
| 150 | 52.47 | 8300 |

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# Guidelines for Max Motor RPM

## Based on a maximum tip speed of 12,000 fpm

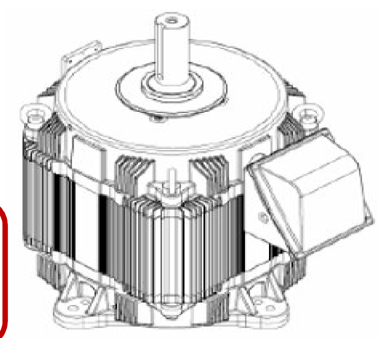
| Fan Diameter | Max RPM |
|---|---|
| 36 ft. | 106 rpm |
| 34 ft. | 112 rpm |
| 32 ft. | 119 rpm |
| 30 ft. | 127 rpm |
| 28 ft. | 137 rpm |
| 24 ft. | 160 rpm |
| 20 ft. | 191 rpm |
| 18 ft. | 212 rpm |
| 16 ft. | 238 rpm |
| 14 ft. | 273 rpm |

# Direct Drive Solution Motor Weights

| Baldor CT Motor | |
|---|---|
| Model | Weight |
| FL-2554 | 360 |
| FL-2562 | 425 |
| FL-2570 | 500 |
| FL-2578 | 570 |
| FL-2873 | 590 |
| FL-2882 | 690 |
| FL-2890 | 775 |
| FL-4472 | 1300 |
| FL-4477 | 1465 |
| FL-4485 | 1720 |
| FL-4493 | 1975 |
| FL-4402 | 2255 |
| FL-4413 | 2660 |
| FL-4421 | 2855 |
| FL-4429 | 3145 |
| FL-4440 | 3450 |

| Gearbox | Mech assy wt (lbs) | Baldor Solution | Motor Wt | Wt difference |
|---|---|---|---|---|
| Marley 22.3 | 350+16+140 = 506 lbs | FL-4472 | 1300 | 794 |
| Marley 32.2 | 1700+58+680 = 2438 lbs | FL-4429 | 3145 | 707 |
| Amarillo-175 | 825+42+330 = 1197 lbs | FL-4485 | 1720 | 523 |
| Amarillo-110 | 325+13+130 = 468 lbs | FL-2873 | 590 | 122 |
| Amarillo-155 | 675+35+270 = 980 lbs | FL-4493 | 1975 | 995 |

- Mech assy wt (Gearbox, Oil 6.4 lbs / gal, + driveshaft wt) + torque tube (2000 lbs) if app
- Typically a 33% to 2x increase in total wt over the gearbox solution



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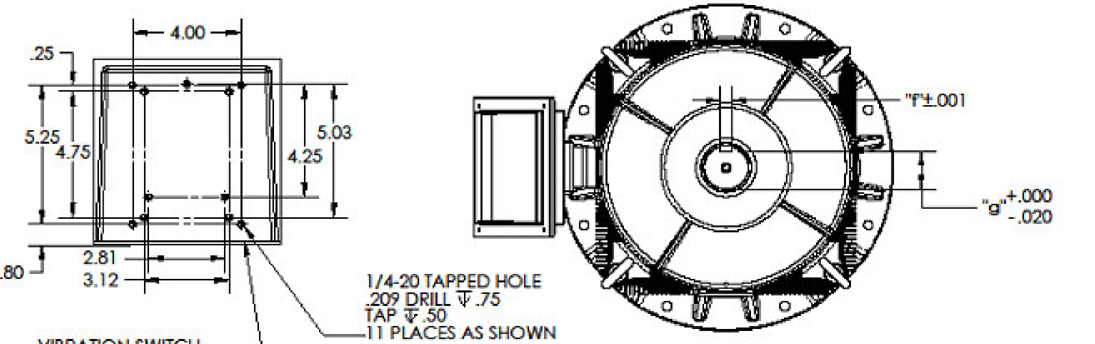
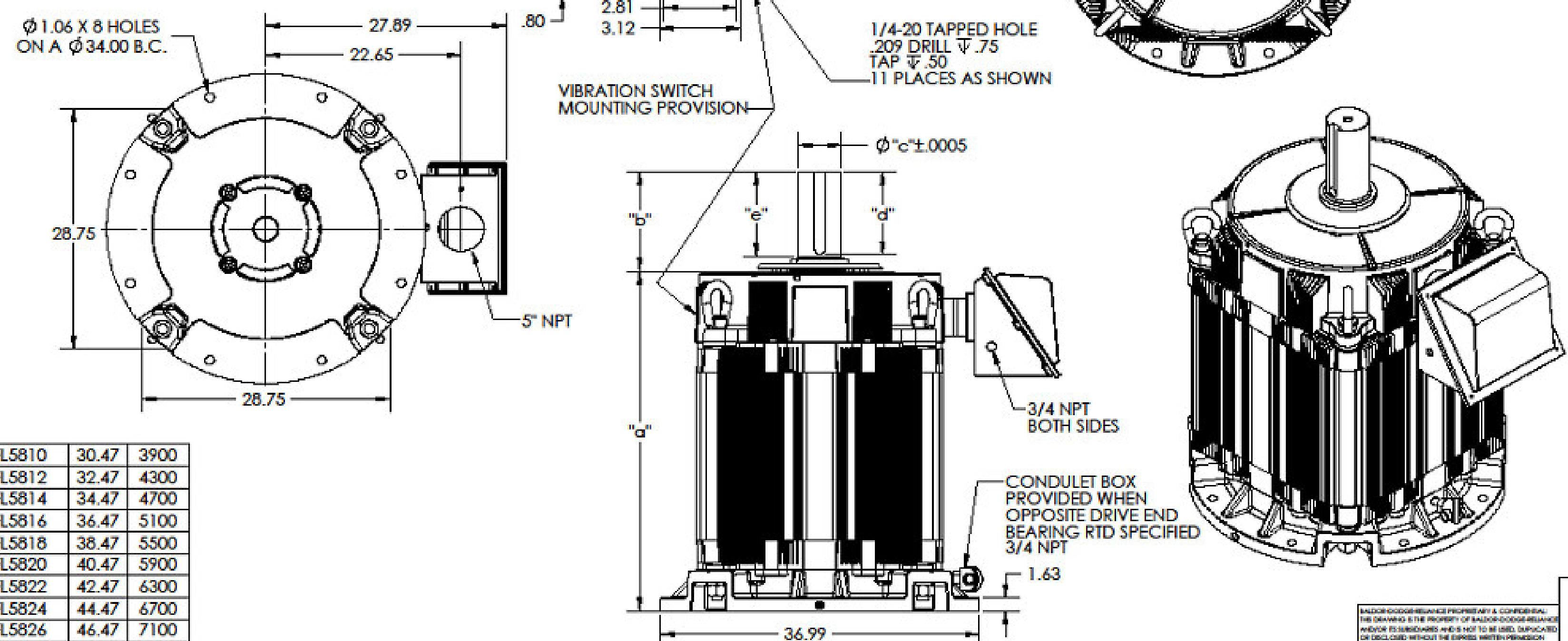
# Motor Weight

## RPM-AC FINNED FRAME VARIABLE SPEED ALTERNATING CURRENT MOTOR
## FL580Y

619609-001

**ENCLOSURE:** TOTALLY ENCLOSED
**MOUNTING:** FLANGE
**DRIVE METHOD:** DIRECT
**COOLING:** AIR OVER
**ROTOR TYPE:** PERMANENT MAGNET
**APPLICATION:** COOLING TOWER




| FRAME SIZE | "a" | wt. |
|---|---|---|
| FL5810 | 30.47 | 3900 |
| FL5812 | 32.47 | 4300 |
| FL5814 | 34.47 | 4700 |
| FL5816 | 36.47 | 5100 |
| FL5818 | 38.47 | 5500 |
| FL5820 | 40.47 | 5900 |
| FL5822 | 42.47 | 6300 |
| FL5824 | 44.47 | 6700 |
| FL5826 | 46.47 | 7100 |
| FL5828 | 48.47 | 7500 |
| FL5830 | 50.47 | 7900 |
| FL5832 | 52.47 | 8300 |

| SYM | "b" | "c" | "d" | "e" | "f" | "g" |
|---|---|---|---|---|---|---|
| B | 12.00 | 3.999 | 9.88 | 10.13 | 1.000 | 3.436 |
| A | 11.92 | 4.999 | 9.88 | 10.13 | 1.251 | 4.296 |

REV. DESC: UPDATED WEIGHT TABLE, REMOVED "MAY VARY 15%"
REV: A VERSION: 01 REVISED: 04:04:13 10/27/2010 TDR: 000000362560
MODEL NO. 619609-001
BY: MGHTLC B

BALDOR

DIM SHEET,TABULATED,RPM-AC,FL580Y,COOLING TOWER

619609-001

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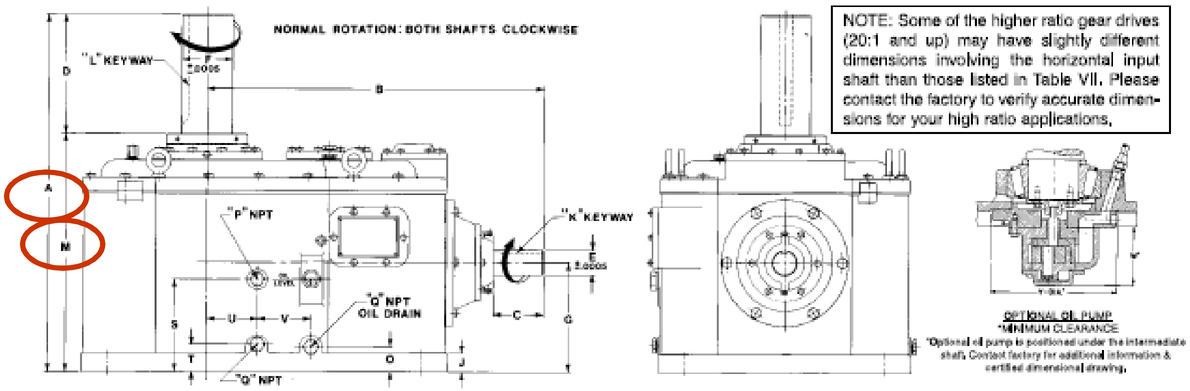
# Larger Horsepower Solutions

## Amarillo Gearbox

| size | 1008 | 1110 | 1311 | 1311W | 1712 | 1713 | 1814 | 2016 |
|---|---|---|---|---|---|---|---|---|
| wt | 875 | 1375 | 1690 | 2025 | 2125 | 2775 | 4530 | 6690 |

| | Ht less shaft | wt |
|---|---|---|
| 5810 | 30.47 | 3900 |
| 5812 | 32.47 | 4300 |
| 5814 | 34.47 | 4700 |
| 5816 | 36.47 | 5100 |
| 5818 | 38.47 | 5500 |
| 5820 | 40.47 | 5900 |
| 5822 | 42.47 | 6300 |
| 5824 | 44.47 | 6700 |
| 5826 | 46.47 | 7100 |
| 5828 | 48.47 | 7500 |
| 5830 | 50.47 | 7900 |
| 5832 | 52.47 | 8300 |




### TABLE VII - DIMENSIONS

| Model | A | B | C | C with Non-Reverse | D | E | F | G | H | J | K | L | M | N | O |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1008 | 28 1/2 | 26 | 3 3/4 | 2 1/4 | 10 | 1.874 | 3.499 | 8 1/2 | 25 1/4 | 1 7/8 | 3/8 x 3/16 | 7/8 x 7/16 | 18 1/2 | 1 1/16 | 2 1/8 |
| 1110 | 32 5/8 | 29 3/4 | 3 3/4 | 2 1/4 | 12 | 1.874 | 3.999 | 9 1/2 | 30 1/4 | 1 7/8 | 3/8 x 3/16 | 1 x 1/2 | 20 5/8 | 1 1/16 | 2 1/8 |
| 1311 | 34 3/8 | 30 7/16 | 4 15/16 | 3 1/4 | 12 | 2.436 | 4.499 | 10 1/4 | 33 1/4 | 1 7/8 | 5/8 x 5/16 | 1 x 1/2 | 22 3/8 | 1 5/16 | 1 1/2 |
| 1311W* | 35 7/8 | 30 7/16 | 4 15/16 | 3 1/4 | 12 | 2.436 | 4.499 | 11 3/4 | 33 1/2 | 1 1/2 | 5/8 x 5/16 | 1 x 1/2 | 23 7/8 | 1 5/16 | 3 |
| 1712 | 35 7/8 | 33 3/4 | 4 15/16 | 3 1/4 | 12 | 2.436 | 4.999 | 11 | 36 3/4 | 1 7/8 | 5/8 x 5/16 | 1 1/4 x 5/8 | 23 7/8 | 1 5/16 | 1 11/16 |
| 1712W* | 37 3/8 | 33 3/4 | 4 15/16 | 3 1/4 | 12 | 2.436 | 4.999 | 12 1/2 | 37 | 1 1/2 | 5/8 x 5/16 | 1 1/4 x 5/8 | 25 3/8 | 1 5/16 | 3 3/16 |
| 1712.5 | 36 7/8 | 35 3/4 | 5 13/16 | 3 1/2 | 12 | 2.936 | 4.999 | 12 | 36 3/4 | 1 7/8 | 3/4 x 3/8 | 1 1/4 x 5/8 | 24 7/8 | 1 5/16 | 1 11/16 |
| 1712.5W | 38 3/8 | 35 3/4 | 5 13/16 | 3 1/2 | 12 | 2.936 | 4.999 | 13 1/2 | 37 | 1 1/2 | 3/4 x 3/8 | 1 1/4 x 5/8 | 26 3/8 | 1 5/16 | 3 3/16 |
| 1713 | 38 1/8 | 37 1/4 | 5 13/16 | 3 1/2 | 12 | 2.936 | 5.499 | 12 | 40 7/8 | 1 1/2 | 3/4 x 3/8 | 1 1/4 x 5/8 | 26 1/8 | 1 5/16 | 1 3/4 |
| 1713W* | 39 5/8 | 37 1/4 | 5 13/16 | 3 1/2 | 12 | 2.936 | 5.499 | 13 1/2 | 41 | 1 1/2 | 3/4 x 3/8 | 1 1/4 x 5/8 | 27 5/8 | 1 5/16 | 3 1/4 |
| 1814 | 44 3/4 | 39 1/4 | 5 7/8 | 5 7/8 | 15 | 3.124 | 6.498 | 14 1/2 | 44 1/4 | 2 1/2 | 3/4 x 3/8 | 1 1/2 x 3/4 | 29 3/4 | 1 9/16 | 2 |
| 2016 | 48 5/8 | 43 3/4 | 6 | 6 | 15 | 3.499 | 7.498 | 16 | 52 3/4 | 3 | 7/8 x 7/16 | 1 3/4 x 7/8 | 33 5/8 | 1 13/16 | 2 5/8 |

Motor weight = gearbox + oil + drive shaft + torque tube

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# Resources

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# CT 841 Specification

Specification CT841 - 2012

Standard for Petroleum and Chemical Industry Definite Purpose, Severe-Duty, Totally Enclosed Air Over (TEAO) Permanent Magnet Synchronous Cooling Tower Direct Drive Motors Up to and Including 370 kW (500 hp)

1. Overview

1.1 Scope

This standard applies to Totally Enclosed Air Over (TEAO), vertical, shaft up or down variable speed, definite purpose, permanent magnet polyphase synchronous, motors up to and including 370KW (500HP), and 600V nominal, for petroleum, chemical, and other severe duty, direct drive cooling tower and air cooled heat exchanger applications. Excluded from the scope of this standard are motors with sleeve bearings and additional specific features required for explosion-proof motors.

1.2 Purpose

The purpose of this standard is to define a specification that deals with mechanical and electrical performance, electrical insulation systems, corrosion protection, and electrical and mechanical testing for severe-duty TEAO permanent magnet polyphase synchronous motors, up to and including 370 kW (500 hp), for petroleum and chemical industry cooling tower and air cooled heat exchanger applications. Many of the specified materials and components in this standard stem from experience with severely corrosive atmospheres and the necessity for safe, quiet, reliable, definite purpose, adjustable speed motors.

2. Normative references

This standard shall be used in conjunction with the following standards. When the following standards are superseded by an approved revision, the new revision shall apply.

ABMA 9-1990, Load Ratings and Fatigue Life for Ball Bearings.

ABMA 11-1990, Load Ratings and Fatigue Life for Roller Bearings.

ABMA 20-2011, Radial Bearings of Ball, Cylindrical Roller and Spherical Roller Types—Metric Design.

ASME B 1.1-2003, Unified Inch Screw Threads (UN and UNR Thread Form) including Appendix C.

ASTM B 117-2011, Standard Practice for Operating Salt Spray (Fog) Apparatus.

IEEE Std 117-1974™ (R 1991), IEEE Standard Test Procedure for Evaluation of Systems of Insulating Materials for Random-Wound AC Electric Machinery.

NEMA MG 1-2011 Motors and Generators.

NFPA 70-2011, National Electrical Code (NEC).



**Figure B.1 - Motor Data Sheet for CT841-2012**

User: ______ EPC: ______ OEM: ______

Project: ______ Location: ______ Tag No: ______

Specification: CT841-2012 ☐ RFQ ☐ Proposal ☐ As Built

Altitude: ______ ft

Ambient: Max ______ °C Min ______ °C

Area Class: ______ Group: ______ Div: ______

☐ Nonhazardous T Code: ______

Motor info:

Rating: ______ HP ______ Max RPM

Insulation: Class H, VPI Winding: Random

Enclosure: TEAO Vertical, shaft: ☐ up ☐ down

SF: 1.0 Thrust load: ______ lbs ☐ up ☐ down

Space heaters: Y / N Max surface temp ______ °C

Space heater leads: ☐ main box ☐ auxiliary box

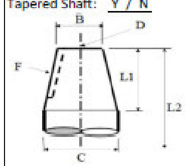
Winding RTDs, 2/ph, 100 ohm: Y / N

Bearing RTDs, 1/brg, 100 ohm: Y / N

Shaft Requirements: Straight Shaft: Y / N

Diam: ______ in +/- ______ in Keyway: X

Tapered Shaft: Y / N




B= ______ in

C= ______ in

D= ______ drill and tap

F= X in

L1= ______ in

L2= ______ in

Fan Information:

Fan Diameter: ______ ft Fan Speed: ______ RPM

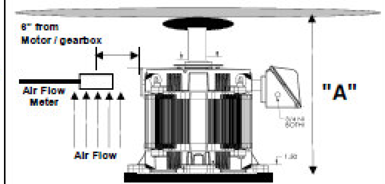
Air Flow: ______ cfm Static Press: ______ in of H2O

Fan Shaft HP: ______ HP Air Density: ______ lb/ft³

Fan Mfg: ______ Fan P/N ______

No of fan blades: ______ Height Restriction: Y / N

Dist "A" motor/gear base to bottom of fan: ______ in




For Retrofit:

Existing motor: ______ HP ______ RPM

Gearbox mfg: ______ P/N: ______

Gear ratio: ______ Match existing bolt pattern: Y / N

(If yes, supply drawing of existing gearbox)

Airflow 6" from gearbox vertical surface: ______ ft/min

ASD info:

Approximate cable length from motor to ASD: ______ ft

Drive location: ☐ control room ☐ other (specify below)

Incoming power: Phase/Hz/Volts: 3 / / 

Additional requirements / notes:

| Testing: | Required | Witnessed |
|---|---|---|
| Factory test per 9.2 | ☐ | ☐ |
| Shop inspection | | ☐ |
| Full load test | ☐ | ☐ |
| Noise test | ☐ | ☐ |
| Test with job ASD | ☐ | ☐ |

Additional testing: ______

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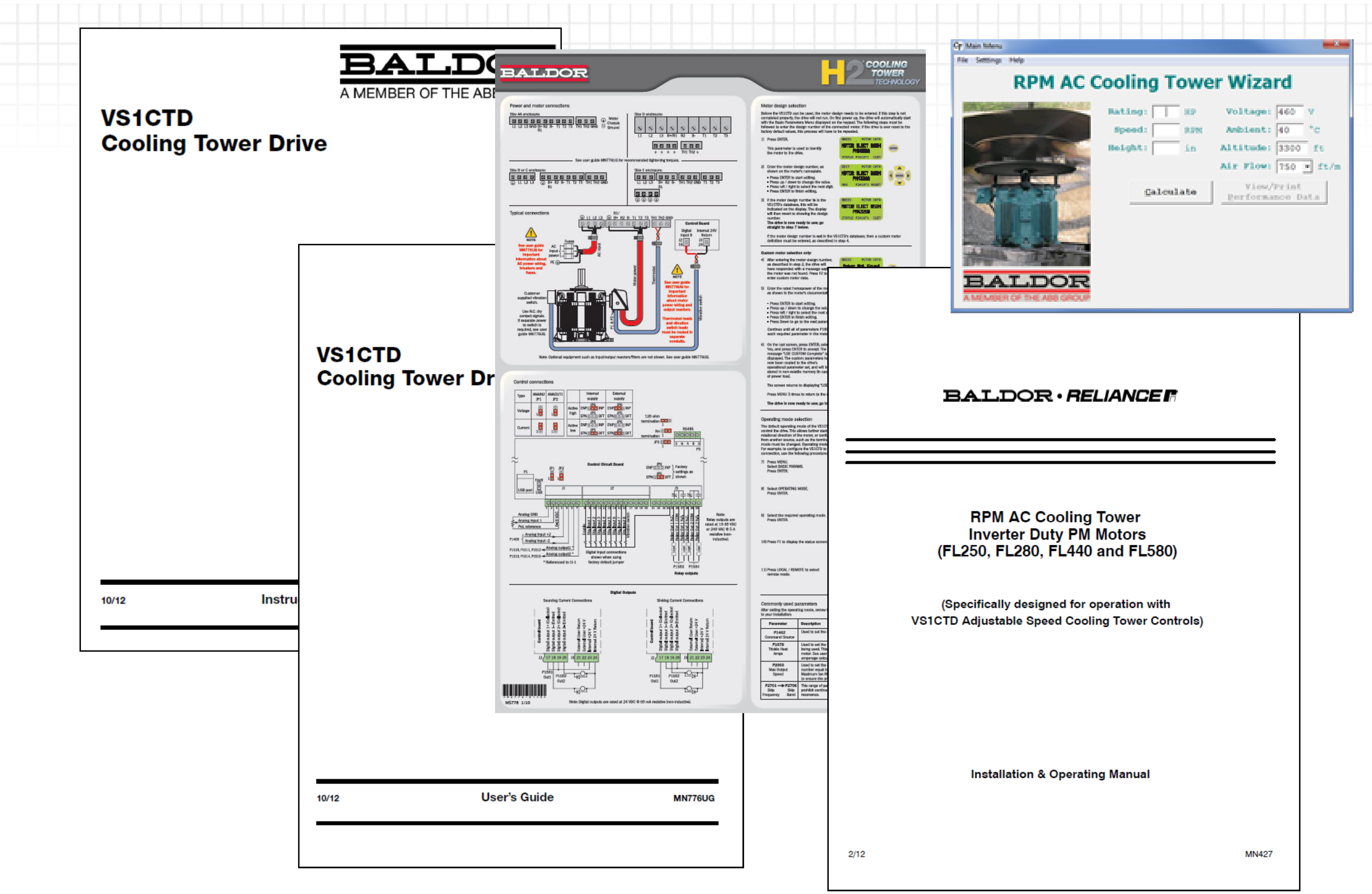


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# Summary

- ## Higher Reliability
  - Eliminate components
  - Reduce vibration
  - Reduce maintenance
  - Eliminate windmilling
- ## Lower Operating Cost
  - Higher efficiency at full speed
  - Cost savings with variable speed
- ## Lower Environmental Impact
  - No gear oil leaks in cooling water
  - Lower noise

# Thank You

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# Contact information

If you have further questions, please contact us


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