

# BALDOR®

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## Suitability of Direct Drive Motor Technology as applied to ACC's

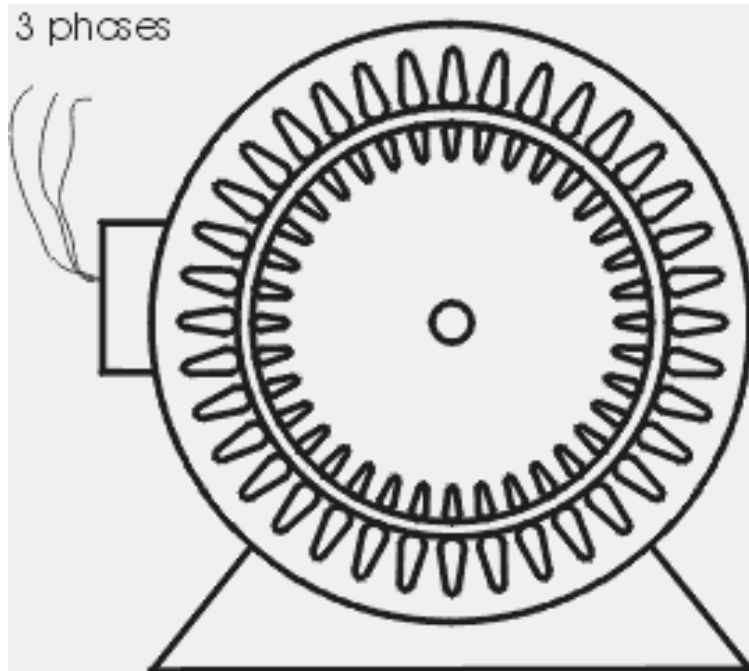
Bill Martin & Tom Weinandy

# Agenda

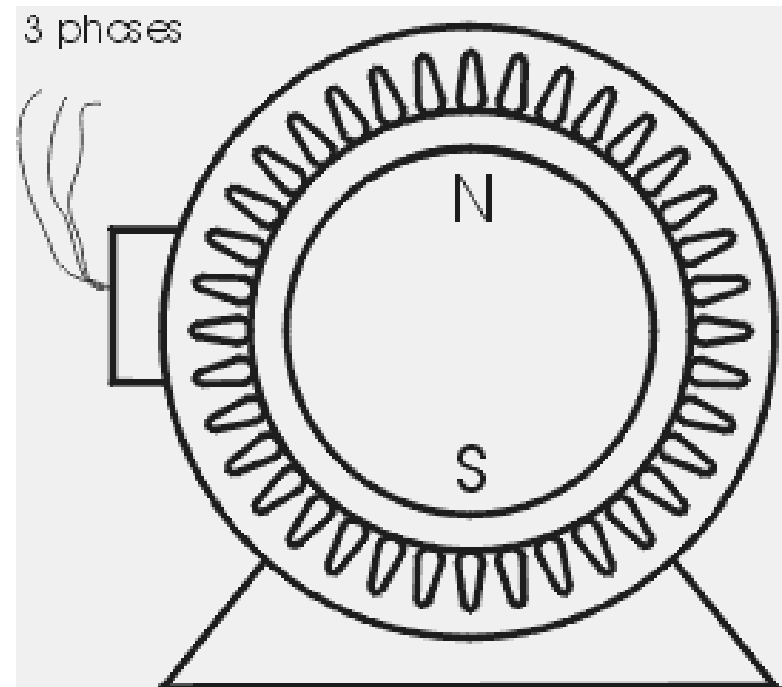
- **Refresher from last year – high points**
  - › What is the technology
  - › Installations to date
- **Common Questions**
  - › Motor Sizing
  - › VFD benefits
- **What is different about the ACC application**
  - › Motor design today/future
  - › Protecting your investment

# 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



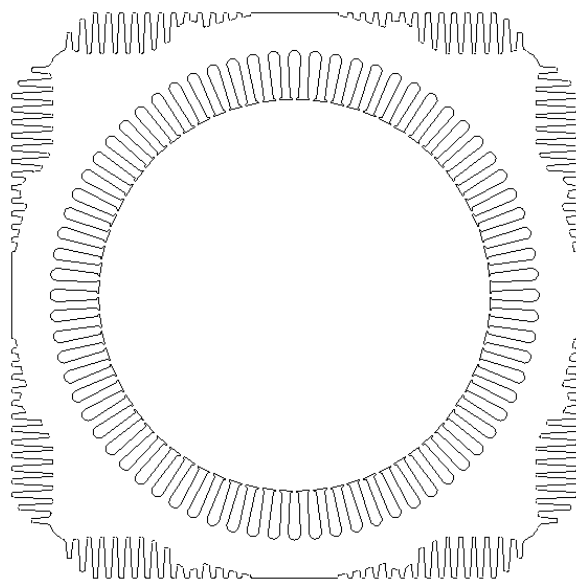
PM – surface

# Improvements in Motor Technology

## Finned-Laminated Frame Construction & PM Technology

- Addition of Cooling Fins Increases the Surface Area for Heat Dissipation
- Typical Power Increase from 20-25% Over Smooth Lamination
- Rotor losses eliminated

58 lams /inch



# Background

## New Solution – Direct Drive



- Slow Speed, Permanent Magnet Motor
- Replaces Induction Motor, Gearbox, Drive Shaft, Couplings
- Designed for the Harsh Environment

# EQUIVALENT RATING

**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

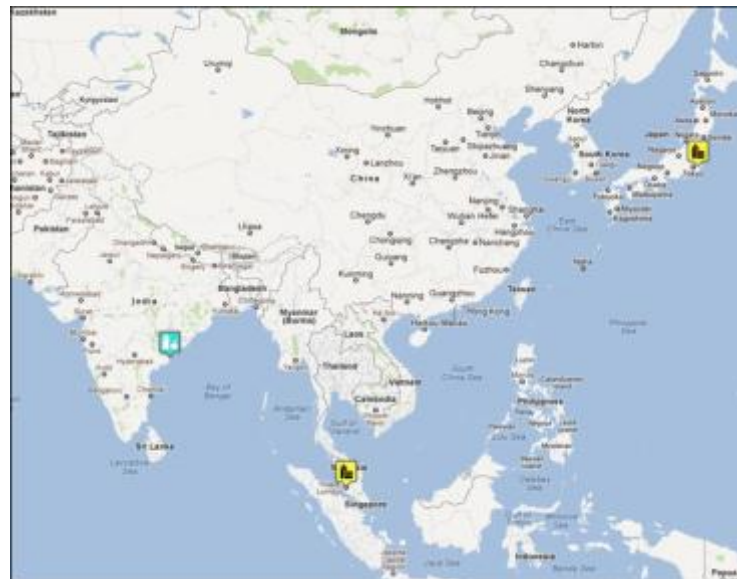
**Note Reduced Height and Weight of Finned, Laminated Frame PM Motor**

# Installations



Application	Units	HP
Industrial	114	10-200
School/University/Hospital	93	15-100
Commercial	86	40-125
Geothermal/Power Gen	52	30-200
Other	12	75-175

**113 Field Installations  
357 Physical Cells**



## MAP LEGEND

-  Commercial Buildings
-  Universities
-  Paper Products
-  Power Generation
-  Petrochemical
-  Pharmaceutical
-  Food & Beverage
-  Chemicals & Fertilizer

# Installations





# Motor Sizing

## Know the Load

### ■ Example (Traditional Method)

- Fan BHP = 133 at 100 rpm
- Add loss for speed reducer
  - $133 * 1.05 = 140 \text{ HP}$
- 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
  - $133 * 1.0 = 133 \text{ HP}$

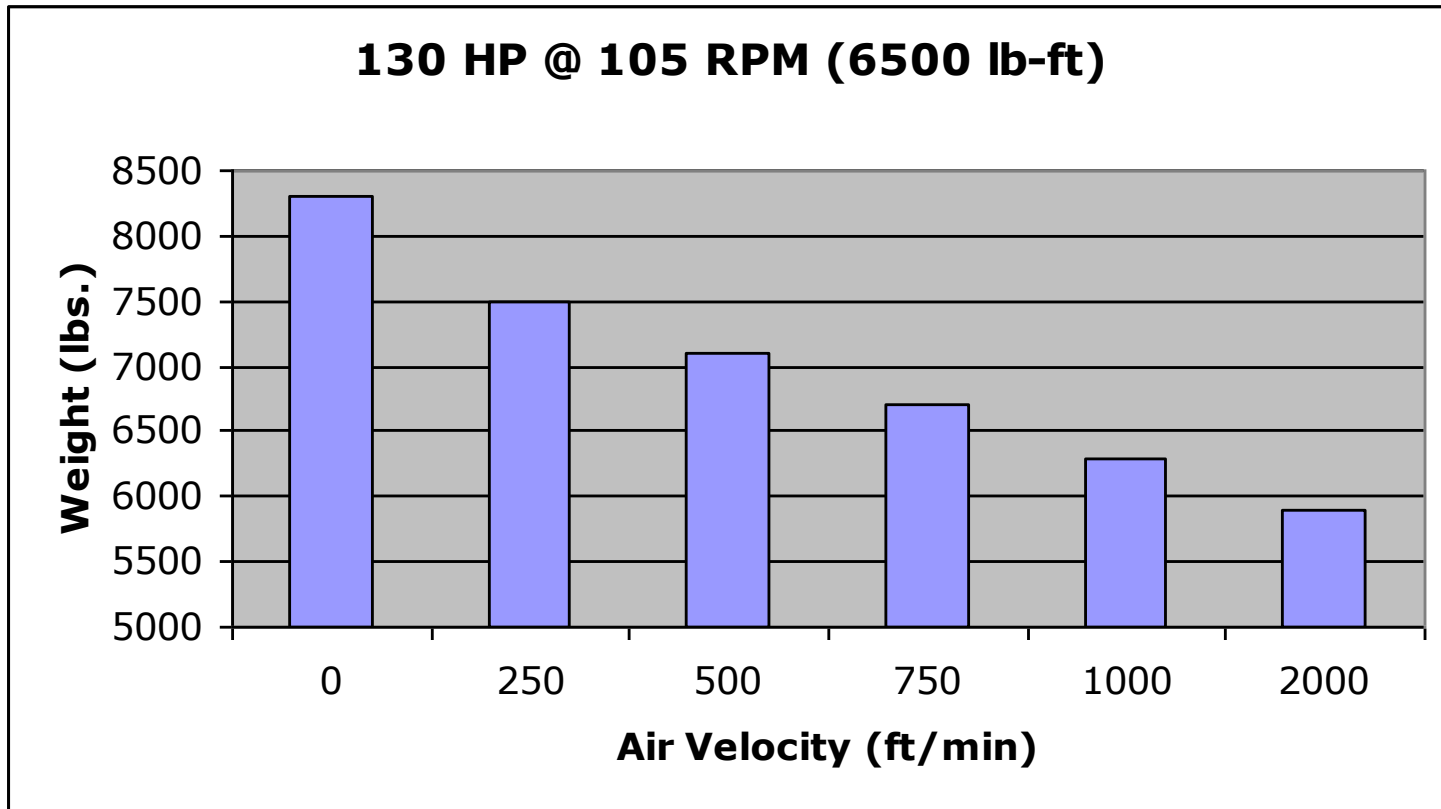
### Options for 133 HP, 100 rpm Direct Drive, 250 ft/min air velocity

HP	Height (in.)	Weight (lbs.)
133	48.47	7500
140	50.47	7900
150	52.47	8300
200*	52.47*	8300*

\* Requires 1000 ft/min

# Motor Sizing

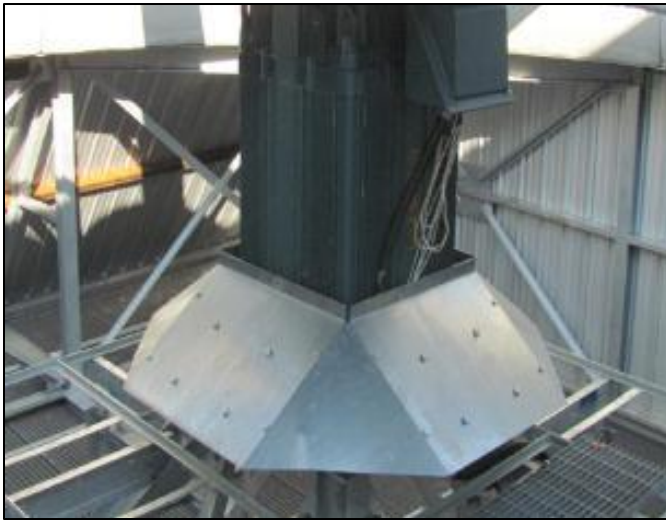
## Air Velocity



- Cooling Air Is Provided By The Cooling Tower Fan Itself
- The Higher The Air Velocity, The Smaller The Motor
- Smaller Motors Result In Lower Initial Installation Costs

# Motor Sizing

## Increasing Air Velocity



# Airflow Testing

## Airflow Testing: (Reference Appendix G)

- Using a Hot Wire Anemometer we measured airflow at various locations around the Fan and existing motor.
- The motor was running at Low Speed (Fan RPM = 48.5), so the high speed air velocity will be calculated knowing that there is linear relationship between rpm and air velocity

Distance from Fan Blade Tip (ft)	Measured Low Speed Air Velocity Average (ft/min)	Calculated High Speed Air Velocity Average (ft/min)
0'	388	775
6'	615	1230
9'	550	1100
12'	250	500
At Seal Disk Where motor would be mounted	140 100	280 200

Note: Open grating design







# VFD Benefits

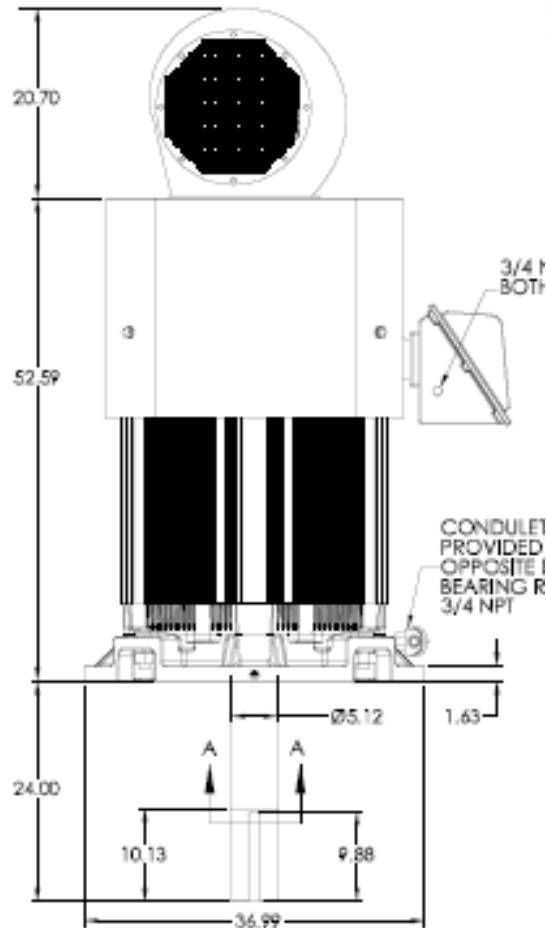
- **Energy Savings**
- **Acts as a space heater**
- **Provides sensor less control (reliability)**
- **Brake**
- **RTD Feedback**
- **Resonance avoidance**
- **Reduced transient torque / starting current**



# ACC Drive Motor (today)

- **Blower cooled in order to meet high torque ratings (12,000 ftlb2). Air flow switch is provided for protection against loss of air flow.**
- **Class H materials**
- **Ambient (40-60 deg C)**
- **Running class B to F temp rises**
- **Stainless steel hardware**
- **Extreme Duty Paint System**
- **VPI insulation system based on proven experience**
- **Generous bearing cavities with large oversized bearings**
- **Synthetic lubricant for extended lubrication cycles**
- **Extended drive shaft length**
- **4140 shaft material**
- **No feedback device is required**
- **Bearing RTDs and accelerometer**
- **Weight is 8300 lbs.**

# Direct Drive Motor for ACC



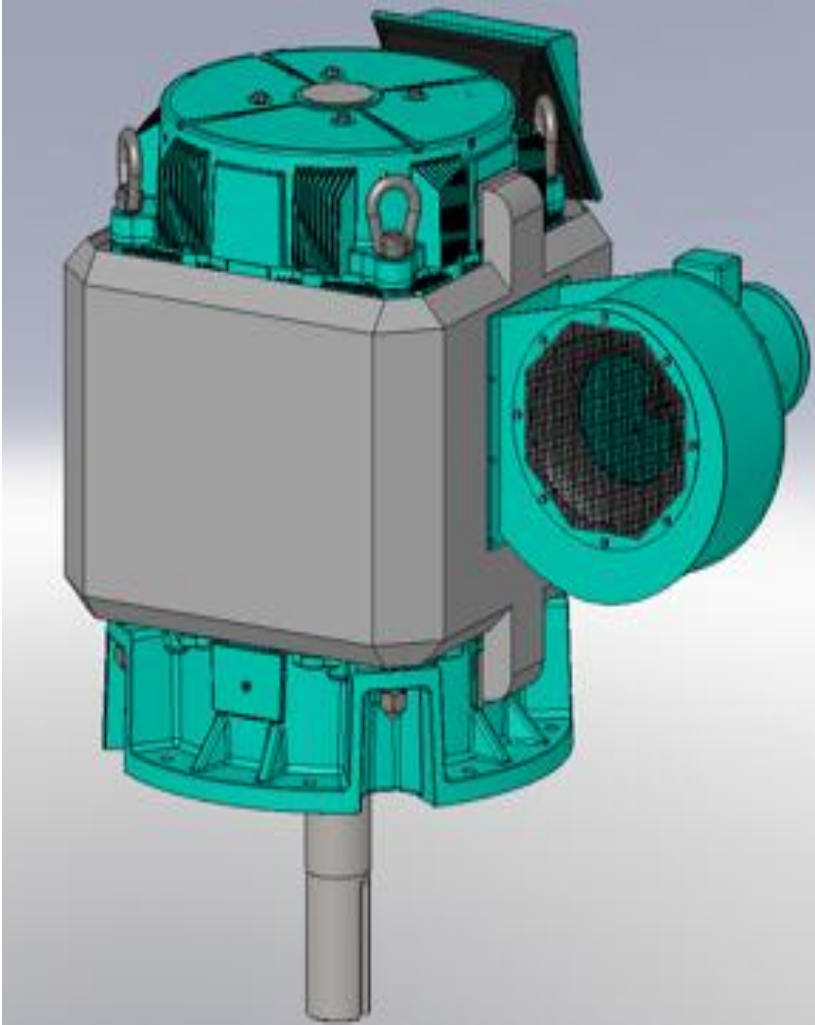
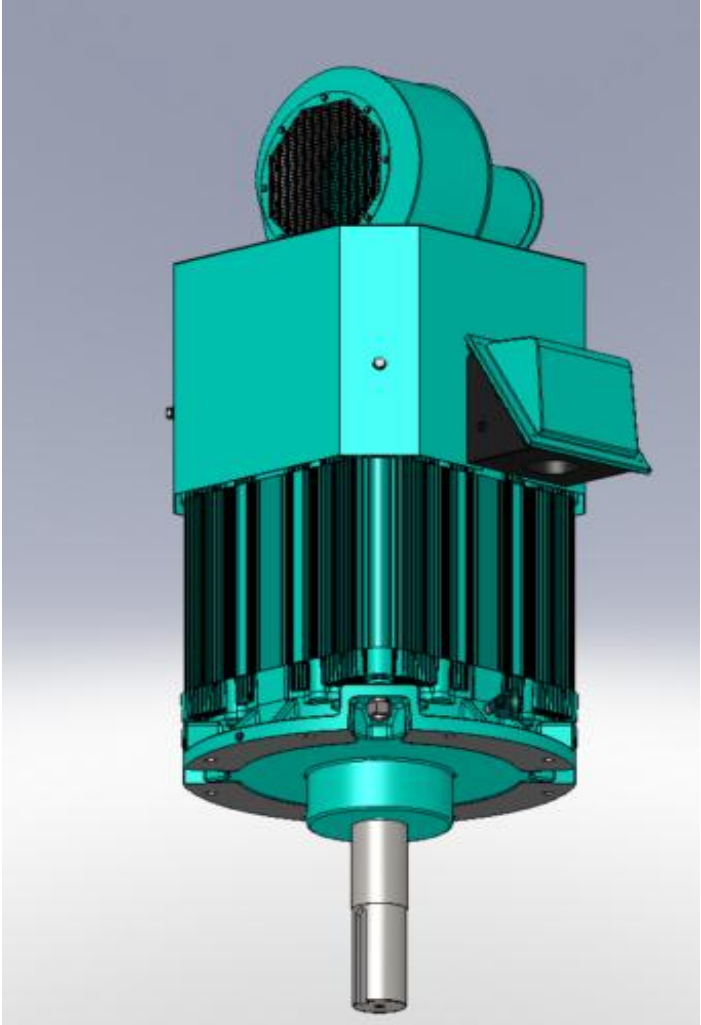
- Designed specifically for ACCs
- Eliminate all mechanical items in order to provide best reliability.
- System efficiency is improved.
- Sustained efficiency - motor efficiency is consistent compared to mechanical efficiency which degrades over time as components wear.
- 85 dba with blower; 60 dba without blower

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

# ACC Drive Motor (future) Discussion

- **Identified weight difference**
- **Motor enclosure (based on noise level)**
  - › Open
  - › TEWC
- **Mechanical design to improve bearing loading**
- **Shaft diameter 6.5” max**
- **Shaft length extension up to 30 inches?**
- **Torque capabilities to 13,000 lb-ft<sup>2</sup>**

# Configurations for ACC



# Protecting Your Investment - Monitoring

- **RTDs**

- Allow continuous monitoring of motor winding and bearing temperatures
- Can identify abnormal condition long before a thermostat would trip
- Will help to optimize lubrication cycle for bearings

- **Accelerometers**

- Allow continuous monitoring of motor/fan vibration
- Can identify abnormal condition much quicker than a vibration switch
- Allows trending to predict maintenance for outage service

- **Wireless technology available today**