How to Quickly Choose the Ideal Fan System for Cooling Towers

A CEU EVENT

October 28, 2020

How to Quickly Choose the Ideal Fan System for Cooling Towers

LEARNING OBJECTIVES

- Understand fan system design considerations and solution options
- Identify key criteria used to properly evaluate the best solution for your needs
- Explore the tool provided to determine the option with greatest value for your applications

PRESENTERS

NEAL WALSH
Business Manager
Baltimore Aircoil Company

STEVE EVON
Engineering Director
NEMA Motors – Variable Speed, Specialty, & Medium AC Motors and Generators Business
ABB Motors and Mechanical

Agenda

1. Fan Drive Design Consideration and Alternatives
2. Systems Criteria
3. Tool to Quickly Assess and Determine the Best Solution
4. Conclusion and Q & A

Cooling Tower Fan Drive

DESIGN CONSIDERATION

Fan

- Torque
- HP
- Static pressure

Reliability

- Expense
- Time

Service

- Expense
- Time

Energy

- Full load motor efficiency
- Part load motor efficiency
- Mechanical transmission losses

Fan Drive Alternatives

THREE OPTIONS

Gear-drive

Belt-drive

Direct-drive

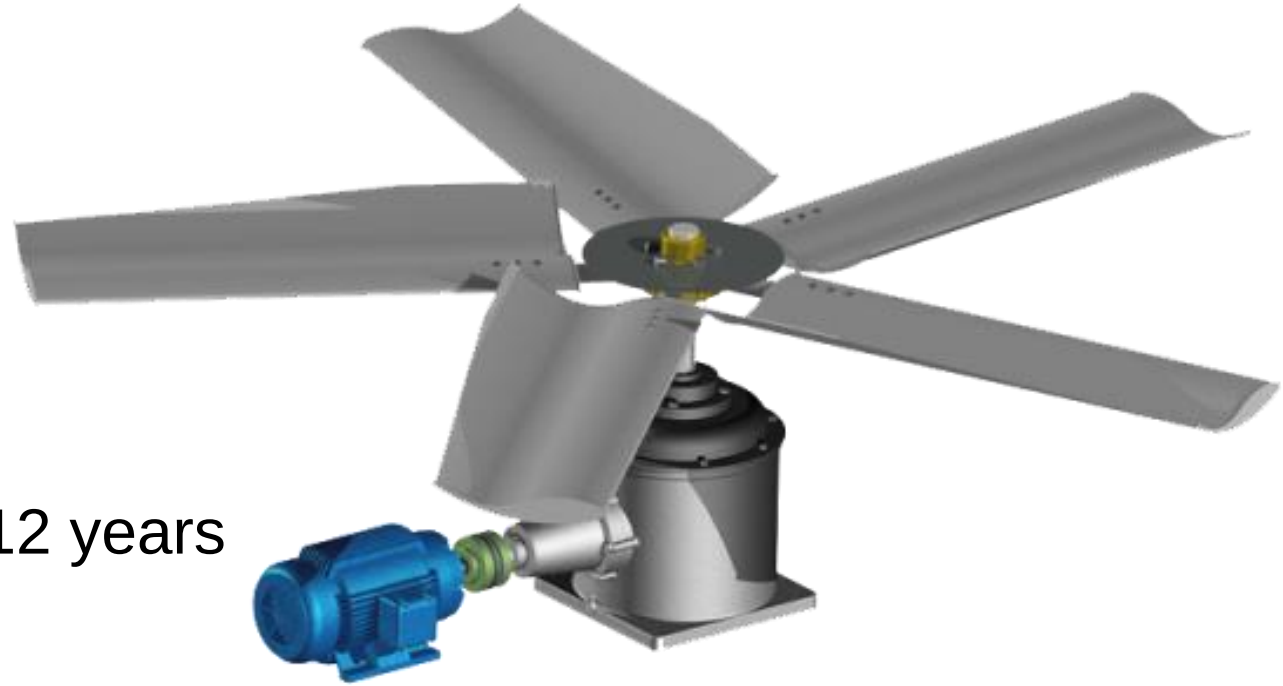
- Small HP
- Large HP

Induction Motor & Gearboxes

SELECTION CRITERIA

FAN

- 60 to 100+ HP
- >2 in ESP possible
- Axial fan



RELIABILITY

- Induction motor life: 8-12 years
- Gearbox life: 7-8 years

SERVICE

- 3 - 8 weeks
- $10,000 - $20,000

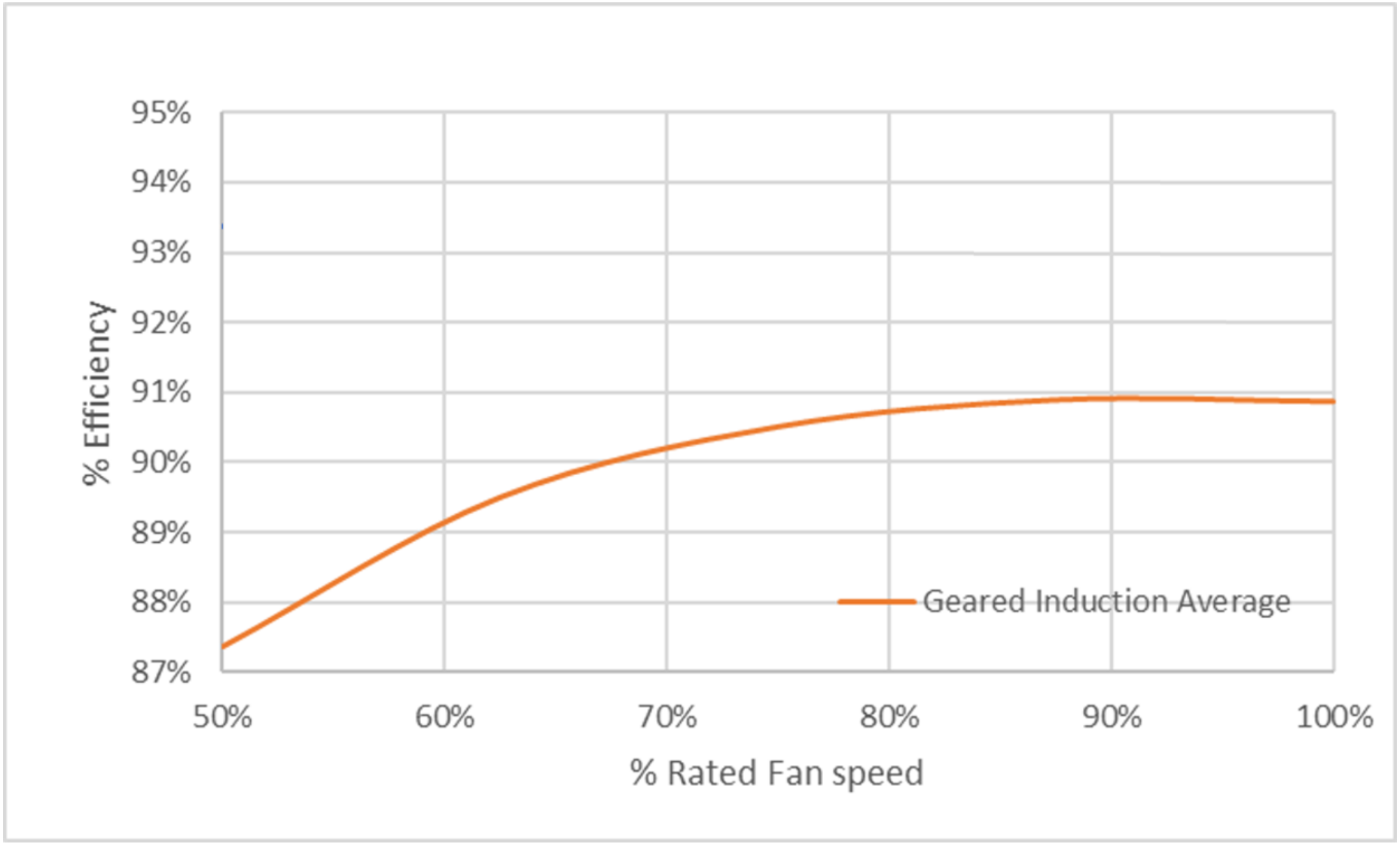
Maintenance Schedule Cooling Tower Gearbox

CONFIRM WITH CUSTOMERS

	Schedule (months)	Duration (hours)
Tighten all fasteners, including oil plug	1	1.5
Check for and repair leaks	1	1.5
Check oil level	1	1.0
Replace gear oil	6	4.0
Check gear vent is open	6	0.5
Align driveshaft and/or coupling	6	2.0
Inspect and tighten driveshaft fasteners	12	1.0
Test synthetic gear oil	3	1.0
Check driveshaft bushing and flex elements	12	1.0

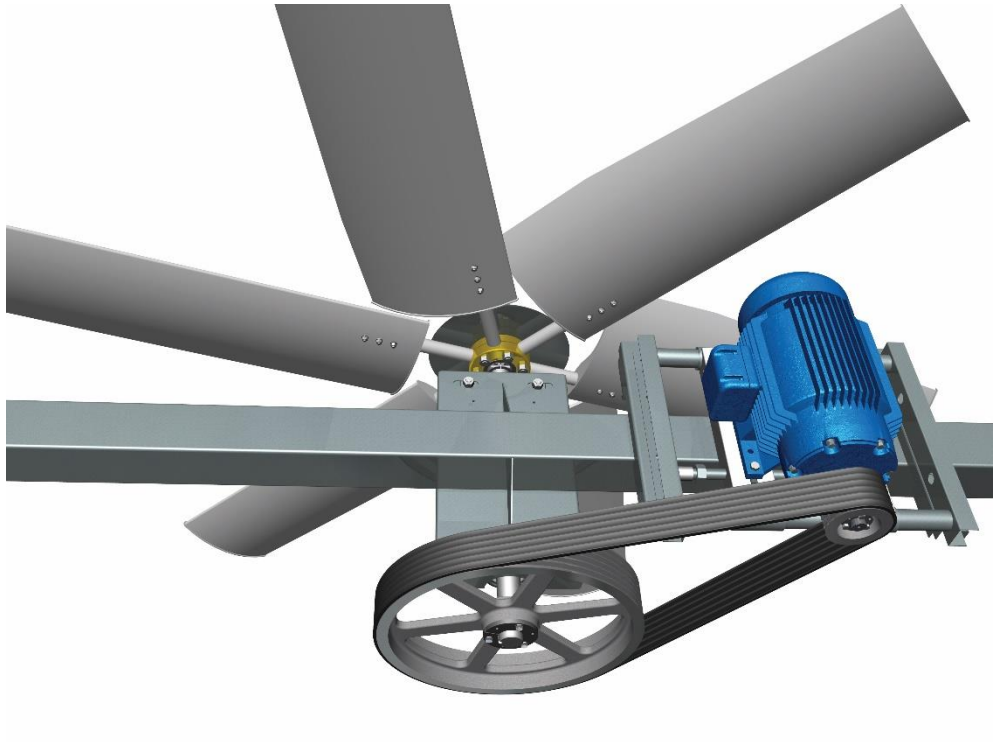
Induction Motor & Gear Efficiency

A DROP IN EFFICIENCY



Induction Motor & Belts & Sheaves

SELECTION CRITERIA



FAN

- 60 HP or less
- <0.5 in ESP
- Axial fan

RELIABILITY

- Induction motor life: 8-12 years
- Belt life: 18 – 30 mos

SERVICE

- 1 day
- $1,000 - $5,000
- Quarterly inspections

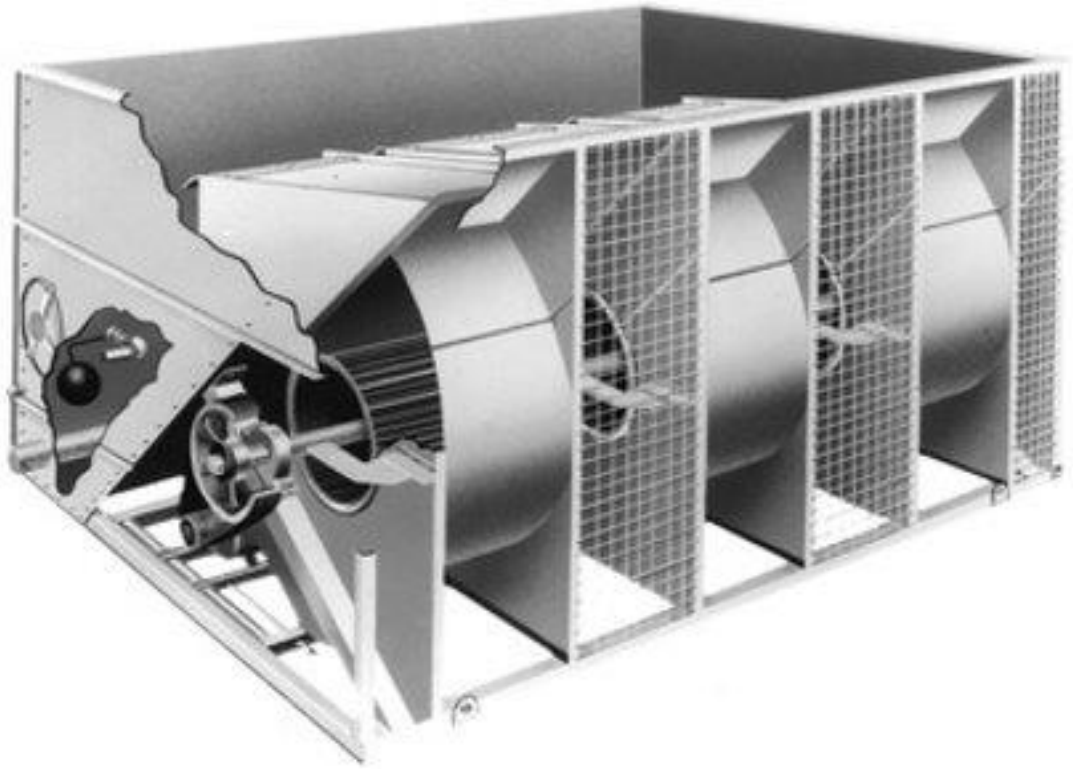
Maintenance Schedule Cooling Tower Belt & Sheave

CONFIRM WITH CUSTOMERS

	Schedule (months)	Duration (hours)
Inspect belt	1	1.0
Tension belt	3	1.0
Lubricate bearings	3	1.5
Lubricate motor base	3	1.5
Change belt	12	2.5

Efficiency of Belt & Sheave Fan Drives

COMBINATION SYSTEM VARIES



2%-5% transmission losses

2%-8% induction motor part load efficiency loss

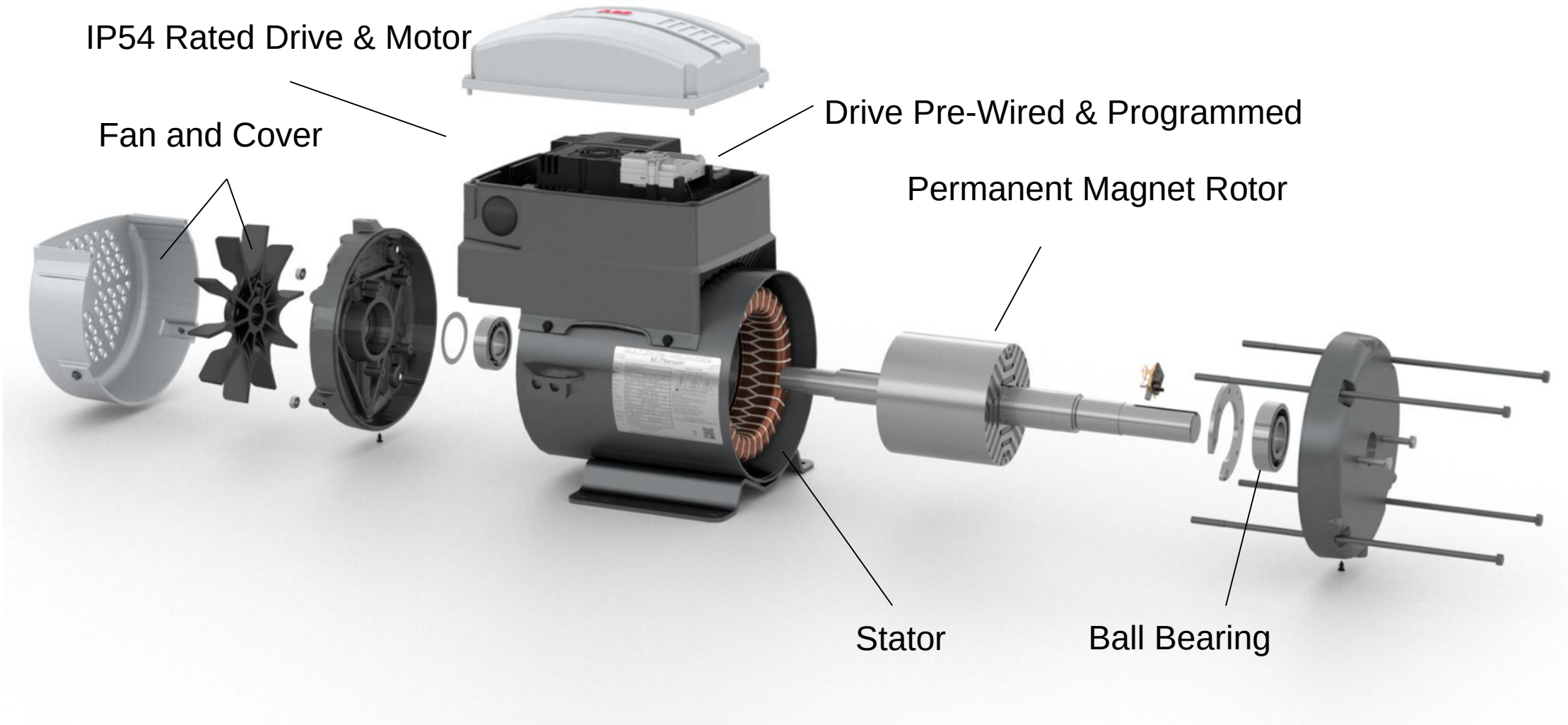
Direct-Drive Challenges with Cooling Towers

CHALLENGES IN PAST YEARS

- Saturated airstream
- Ambient temperature swings
- Large torque

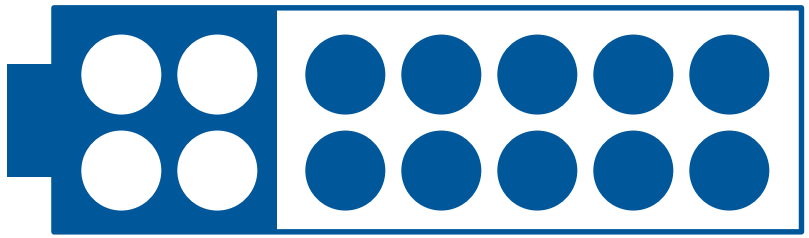
Direct-Drive

ECM TYPICAL CONSTRUCTION

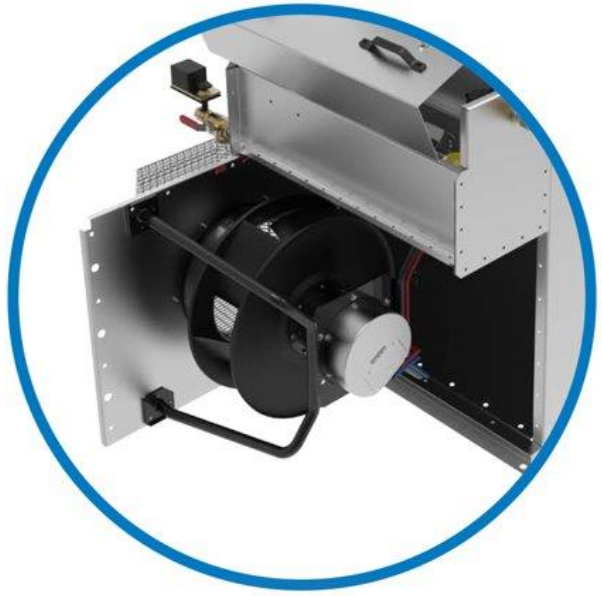


Directly Driven

ECM TYPICAL APPLICATION



Directly Driven
ECM CRITERIA



FAN
- <7.5 HP
- <1.5 in ESP with axial fans
- 5+ in ESP with centrifugal fans

RELIABILITY
- Fan array
- Motor life: 15+ years

SERVICE
- 1 day
- $5,000 - $10,000

ECM Reliability and Efficiency

SELECTION CRITERIA

- Annual service
- Low maintenance hours and cost
- No transmission losses
- Best part load motor efficiency
- Integrated controls

Directly Driven
PERMANENT MAGNET CRITERIA

FAN

- 10 to 250 HP (150 lb.-ft. to 13,000 lb.-ft.) torque
- < 1 in ESP
- Axial flow over motor for cooling
- 750 ft/min airflow over motor frame

RELIABILITY

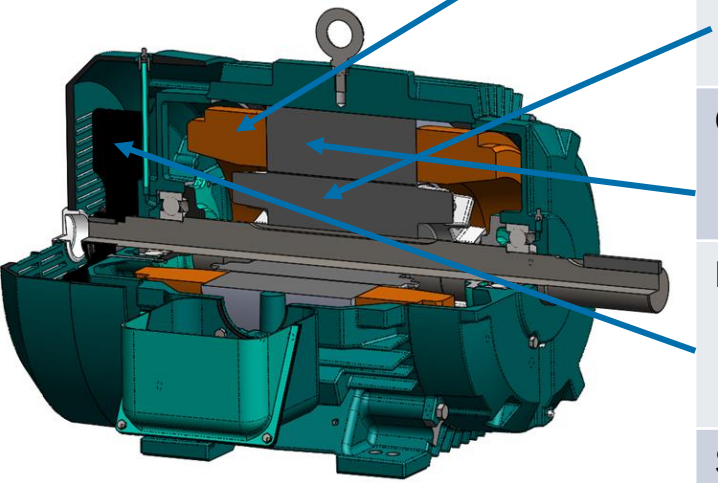
- Motor life: 12-23 years

SERVICE REPLACEMENT

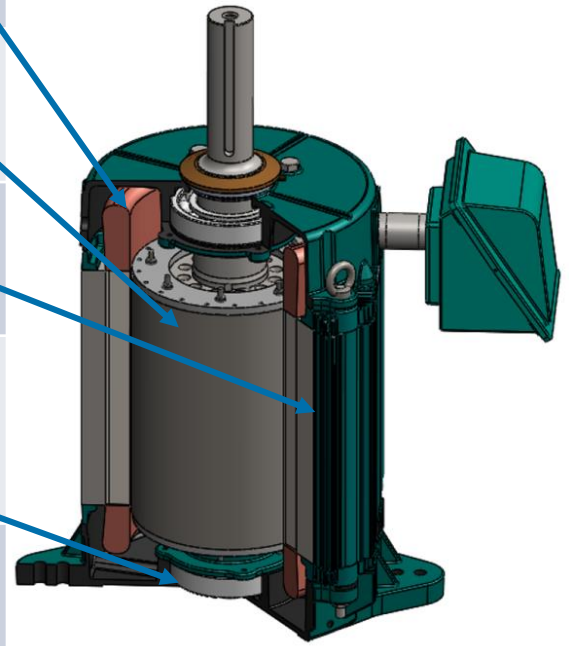
- 3-8 weeks
- $20,000 - $30,000
- Annual regrease bearings
- Low maintenance hours and cost

Motor Losses

PM DIRECT-DRIVE VS NEMA INDUCTION

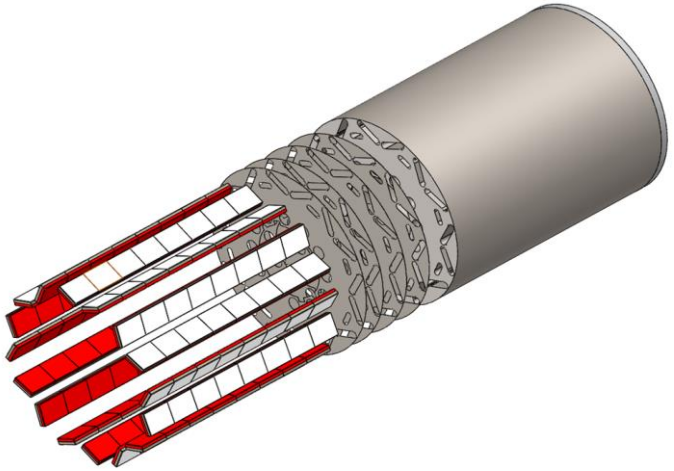


5 Categories of Motor Losses	Differences between PM Direct Drive and NEMA Induction
Stator I^2R Losses	Induction = 1188 watts (221 lb.-ft. torque) PM DD = 2974 watts (1329 lb.-ft. torque) *Higher winding resistance to produce torque.*
Rotor I^2R Losses	Induction = 613 watts PM DD = 0 watts *No current in PM rotor.*
Core Losses	Induction = 506 watts PM DD = 619 watts *More steel for high torque PM motor .*
Friction and Windage	Induction = 208 watts PM DD = 48 watts *No fan and lower speed for PM motor.*
Stray Load Losses	Induction = 434 watts PM DD = 430 watts *Similar losses for both motors*
Motor Performance	Induction: 95.0% FL Eff, 85.6% FL PF, 221 lb-ft PM DD: 93.2 % FL Eff, 86.7% FL PF, 1329 lb-ft

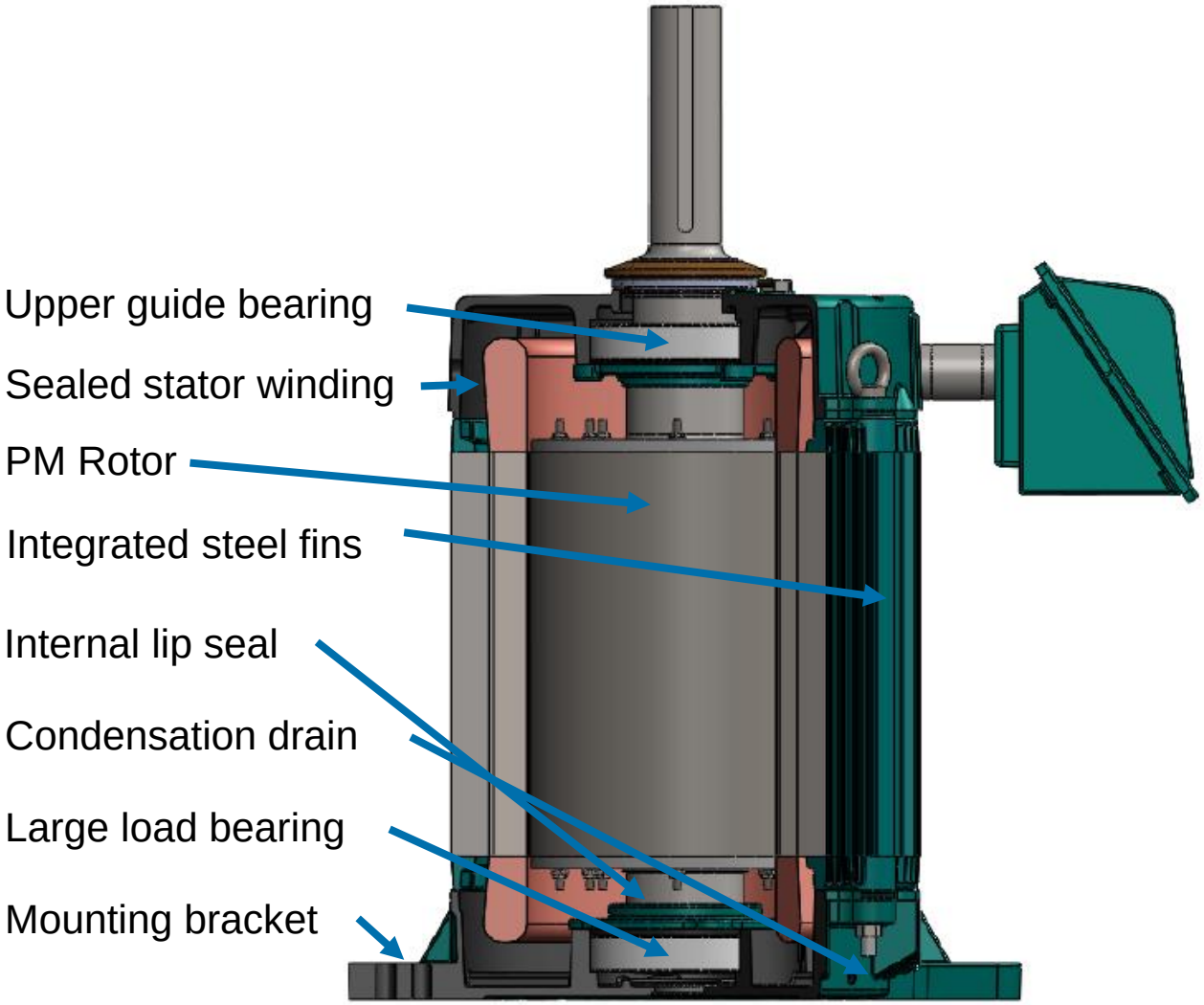


Permanent Magnet Motor

DESIGN AND PARTS

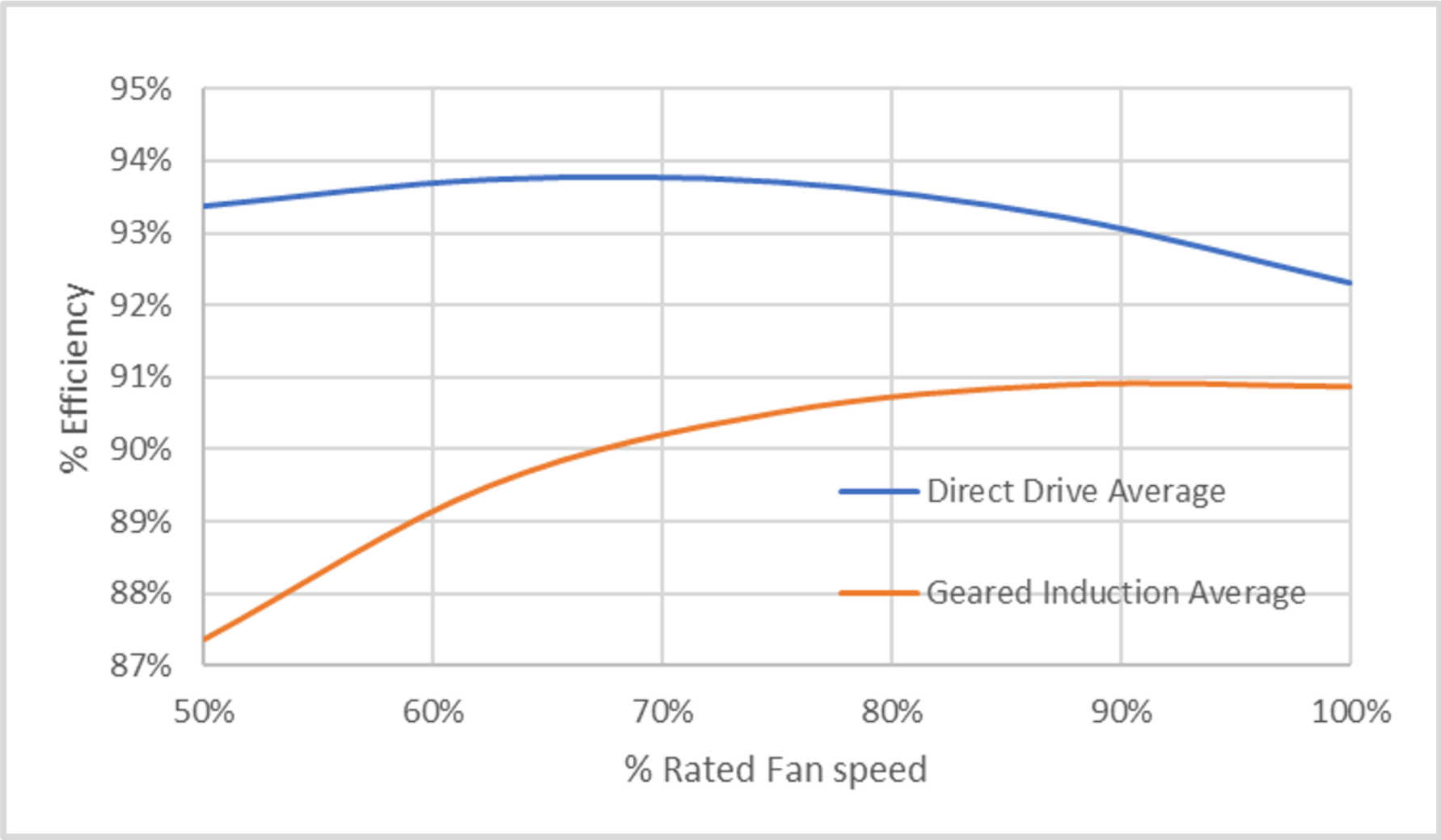


- Rotor utilizes high strength, high temperature (+200C) Permanent Magnets for long life
- Rotor construction consists of magnets block placed into slots in the steel laminated rotor
- Magnets stay magnetized for the life and do not lose strength over time



Drive System Efficiency Comparison

HIGHER EFFICIENCY WITH DIRECT-DRIVE



Fan System Analysis
A DECISION-MAKING TOOL

SERVICE COSTS

- Motor rebuild interval (years)
- Motor replacement expense (hours/$)
- Transmission system rebuild interval (years)
- Motor Rebuild/Replacement Cost (hours/$)
- Transmission system replacement expense (hours/$)

ANNUAL OPERATING COSTS

- Full and part load fan system efficiency
- Energy Costs ($/kWh)
- Full and part load fan system operation (hours)

SERVICE COSTS

- Monthly, quarterly and annual inspections (hours)
- Gear oil inspection expense ($)
- Gear oil or belt change labor and material expense (hours/$)

Conclusions

UNDERSTAND THE CHOICES AVAILABLE

- Determine owner priorities
- Complete payback calculation
- Specify CT duty design features
  - › Total field hours
  - › Confirm CTI thermal testing with selected fan drive
  - › Confirm CT-163 vibration testing compliance
  - › Confirm 104F WB motor heat rise testing

Q & A

Ask your questions in your Q & A window

THANK YOU!

NEAL WALSH
Business Manager
Baltimore Aircoil Company

Nwalsh@baltimoreaircoil.com

STEVE EVON
Engineering Manager
NEMA Motors – Variable Speed, Specialty, & Medium AC Motors and Generators Business
ABB Motors and Mechanical

Steve.evon@us.abb.com