MDM Beyond 1*2*3

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Baldor Electric Company

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Level 1 Plant Surveys

- Survey facility and inventory motors
- Decide what to do for each motor before it fails and tag motor
  - 2+ shifts - Replace immediately with Premium
  - 1+ shifts - Replace on failure with Premium
  - Intermittent use - Replace on failure with EPAct
  - Special motors not available from distributor - Rewind on failure

Replace with Correct Motor for Application

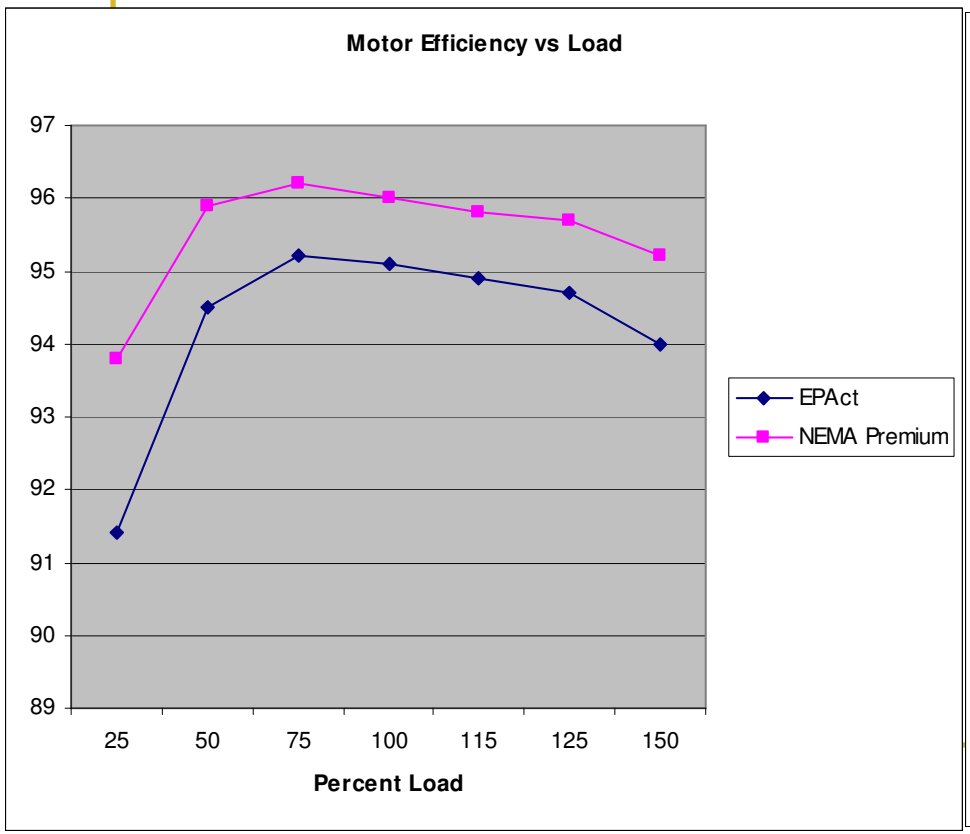
- Determine failure mode for motor
- Upgrade enclosure
- Upgrade level of environmental protection
  - Cast Iron - Severe duty or IEEE 841
  - Steel band - Washdown duty
- Correct bearings for application
- “Right-size” motor for load

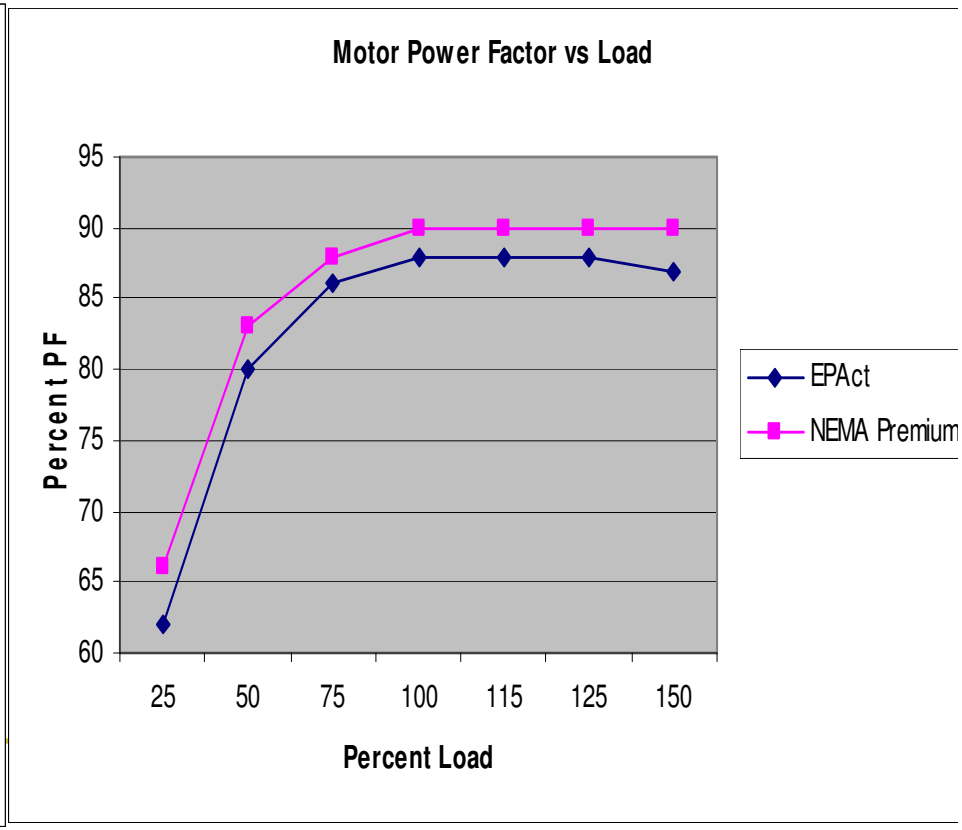
Level 2 Plant Surveys

- A more extensive survey making current measurements during operation
- Allows to “right size” motors for each application
  - Increase efficiency and power factor
  - Reduce purchase price
- Consider adjustable speed drive here or in Level 3 system analysis

“Right-size” the Motor

- Choose the correct rating for the application
  - Oversized motors have lower efficiency and power factor
  - Highest efficiency 75 - 100% of rated load
  - Service factor is for short-term operation





Level 3 Plant Surveys

- Look beyond the motor at the application during the survey
- Add adjustable speed drives on pump and fan applications
  - Process control can increase productivity
- Increased efficiency gear reducers
- Add servos for increased throughput

Plant Surveys

- Surveys may be performed by plant personnel
- Local Baldor offices available for training surveyors
- Baldor Installed Base Evaluation Team
- EASA Motor repair shops
- National Distributors
- Energy Service Companies - ESCO
- Local resources

Additional Energy Savings

- Replace single phase motors with three phase
  - Typical Single Phase 80.0%
  - Premium Single Phase 86.5%
  - Typical Three Phase 87.5%
  - NEMA Premium® Three Phase 90.2%
- Always use three phase motors when possible
- If only single phase is available – consider use of inverter and three-phase motor

Additional Energy Savings

- The most efficient motor is one that is not running
  - Turn off motors when not needed
  - Sensors on conveyors
  - PID for pumps and compressors
  - Watch number of starts on large motors
  - Soft start can reduce voltage and improve power factor

Energy Savings through the use of Variable Frequency Drives

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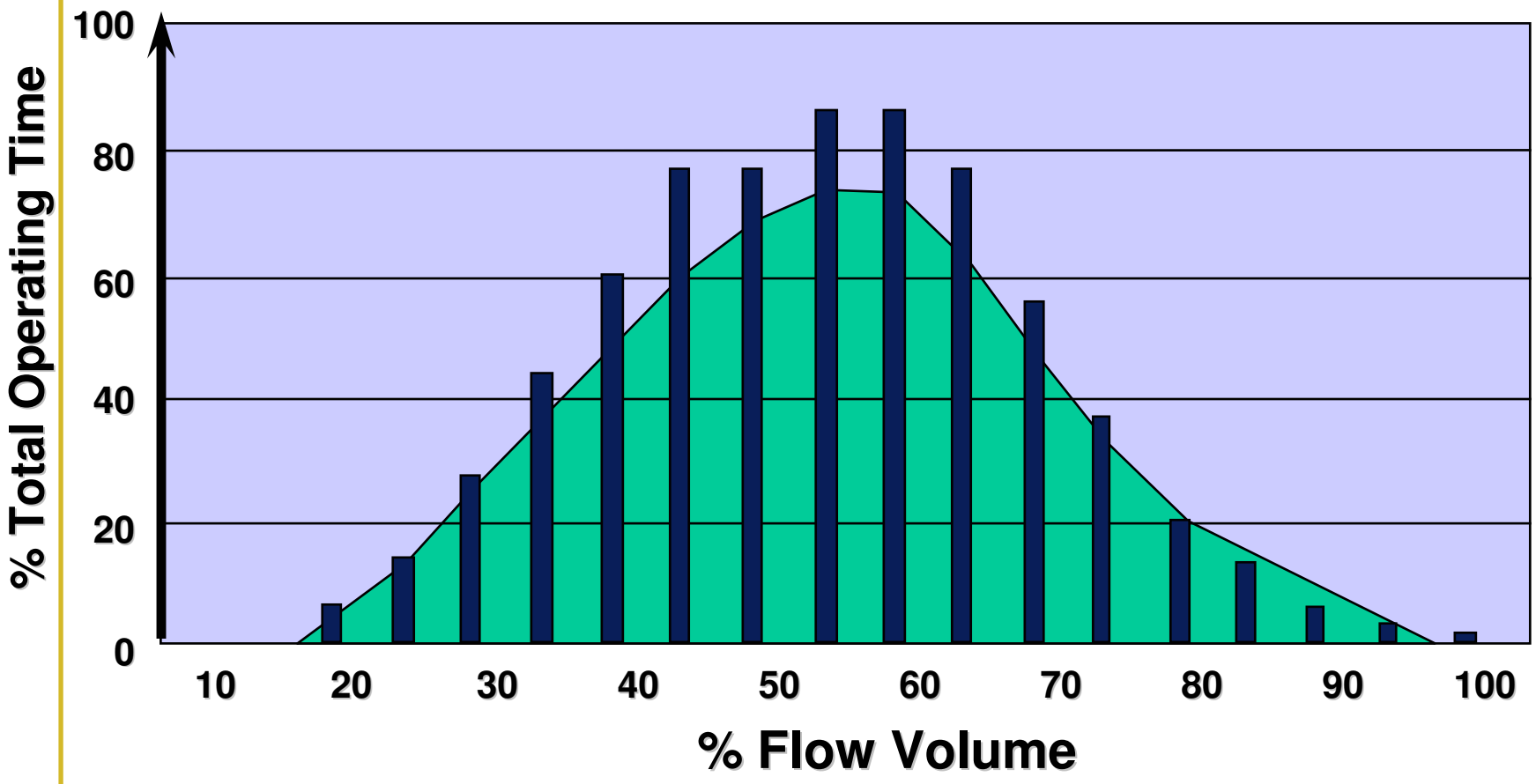
Selecting VFD's for Energy Savings and Peak Efficiency

- Define Energy Savings Opportunity
- Provide Examples
- Provide System Considerations for Applying Drives

Few applications Require 100% Pump and Fan Flow Continuously

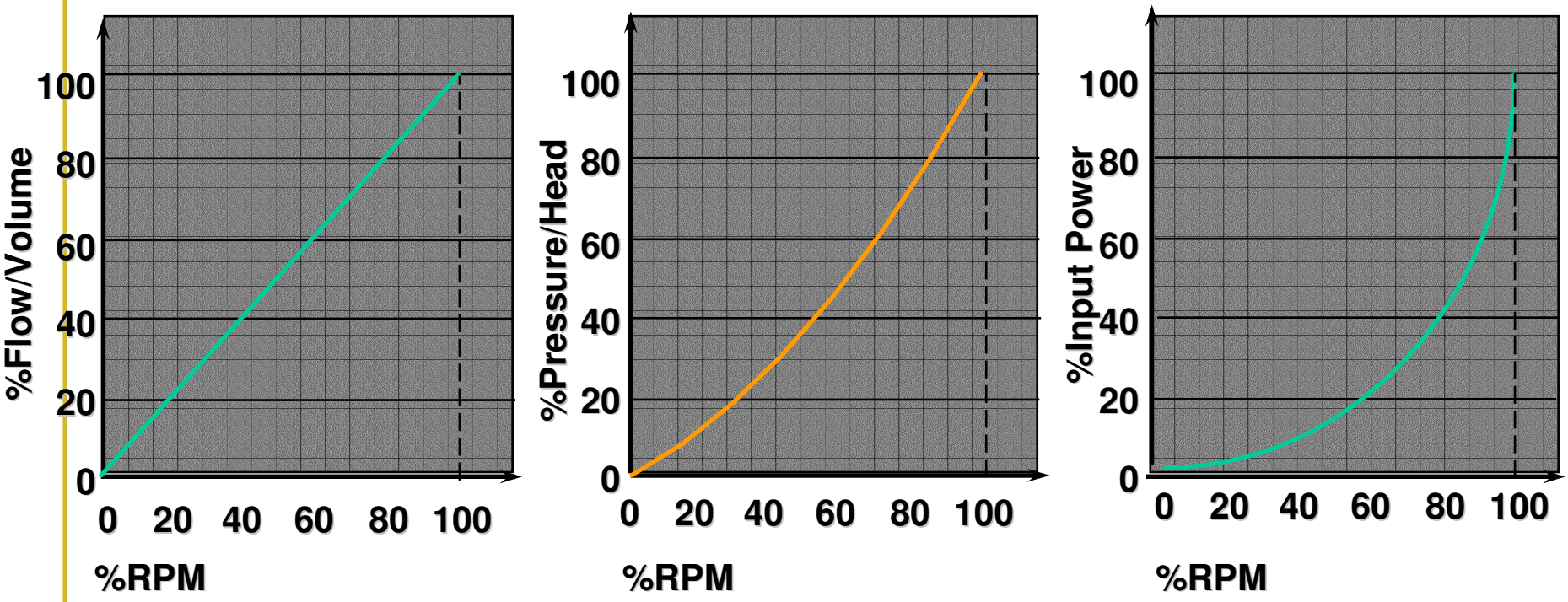
- Systems are designed for worst case
  - Emergency conditions require higher volumes
- They are sized up to next rating
  - Multiplying safety margins
- System Demand Changes
  - Weekend and Night Time Occupancies have lower needs

Typical Duty Cycle – Centrifugal Fan



Source: Electric Power Research Institute

Affinity Laws For Centrifugal Loads



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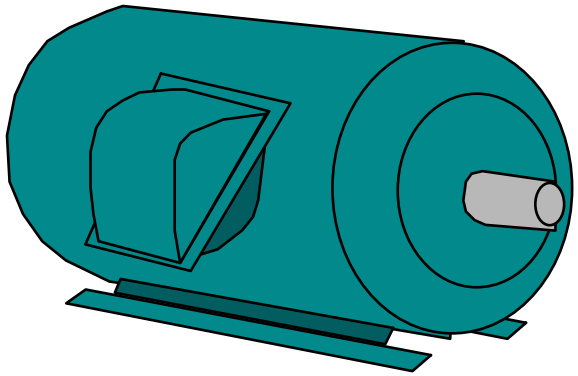
Electrical Energy Costs

100% Speed
100% Load

100 HP Induction Motor



$$(100\ HP) \times \left(\frac{1}{95\%\ eff.}\right) \times \left(.746\ \frac{kW}{HP}\right) \times (.08\ \$/kWh) \times (12\ H/Day) \times (360\ D/Year) =$$

$27,139 per year!

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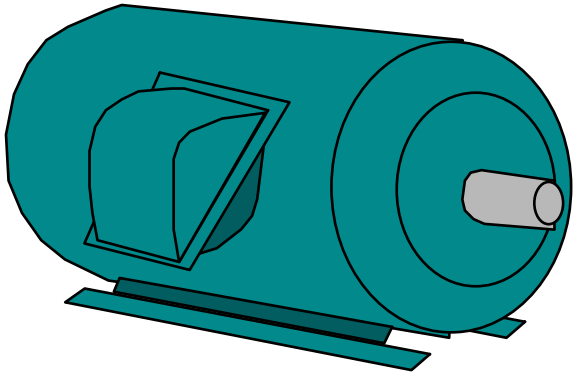
Electrical Energy Costs

60% Speed
22% HP

100 HP Induction Motor



$$(100\ HP) \times (0.22) \left(\frac{1}{95\%\ eff.}\right) \times (.746\ kW/HP) \times (.08\ \$/kWh) \times (12\ H/Day) \times (360\ D/Year) =$$

$5,970 per year!

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Annual Electrical Energy Savings

100% Speed $27,139

60% Speed $5,970

$21,169 per year!

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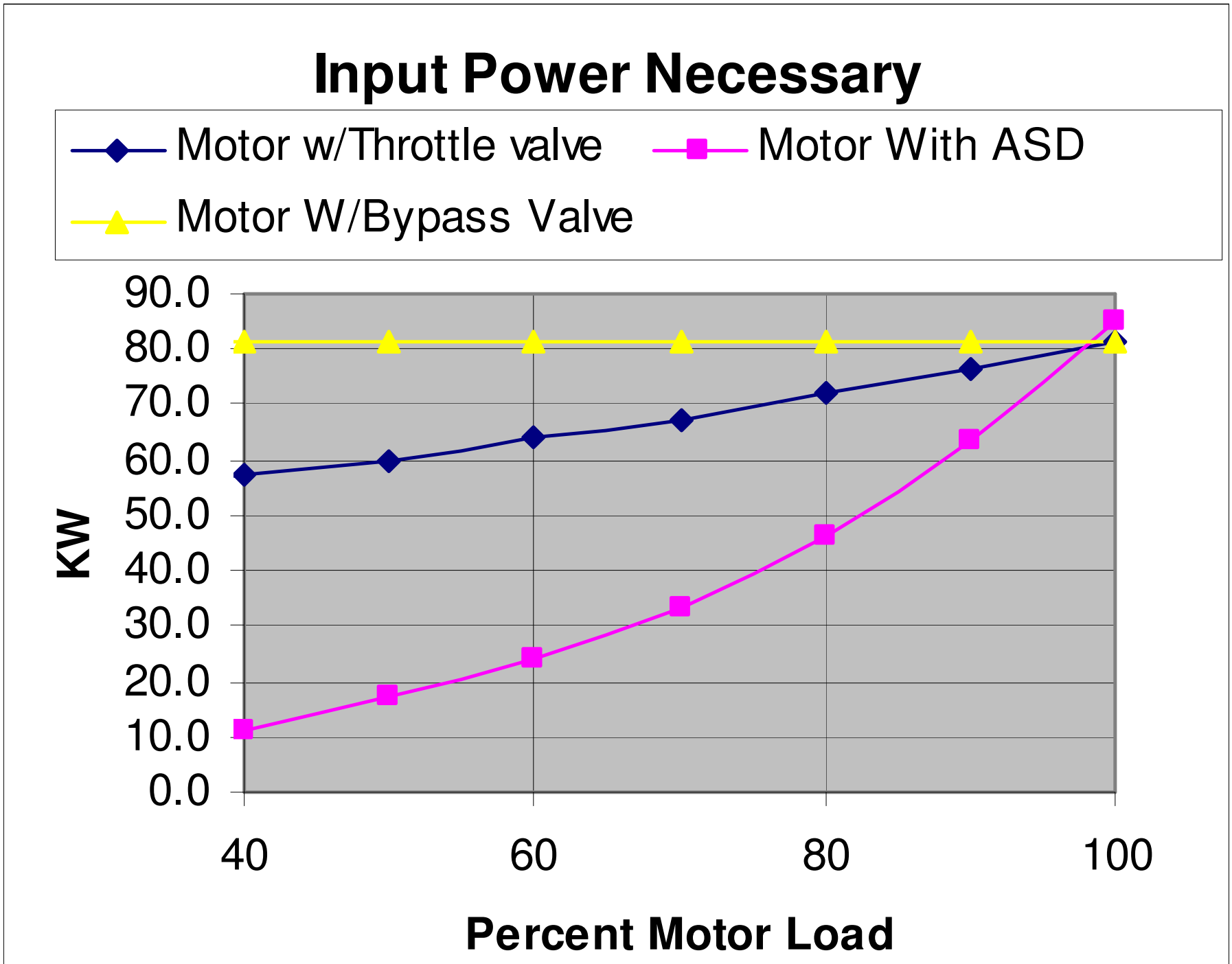
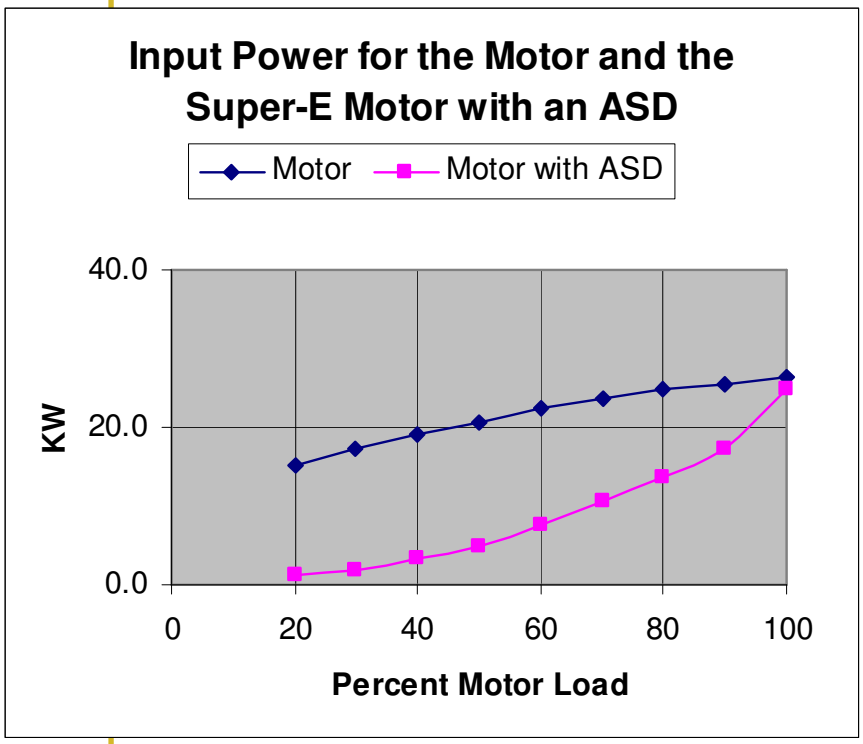
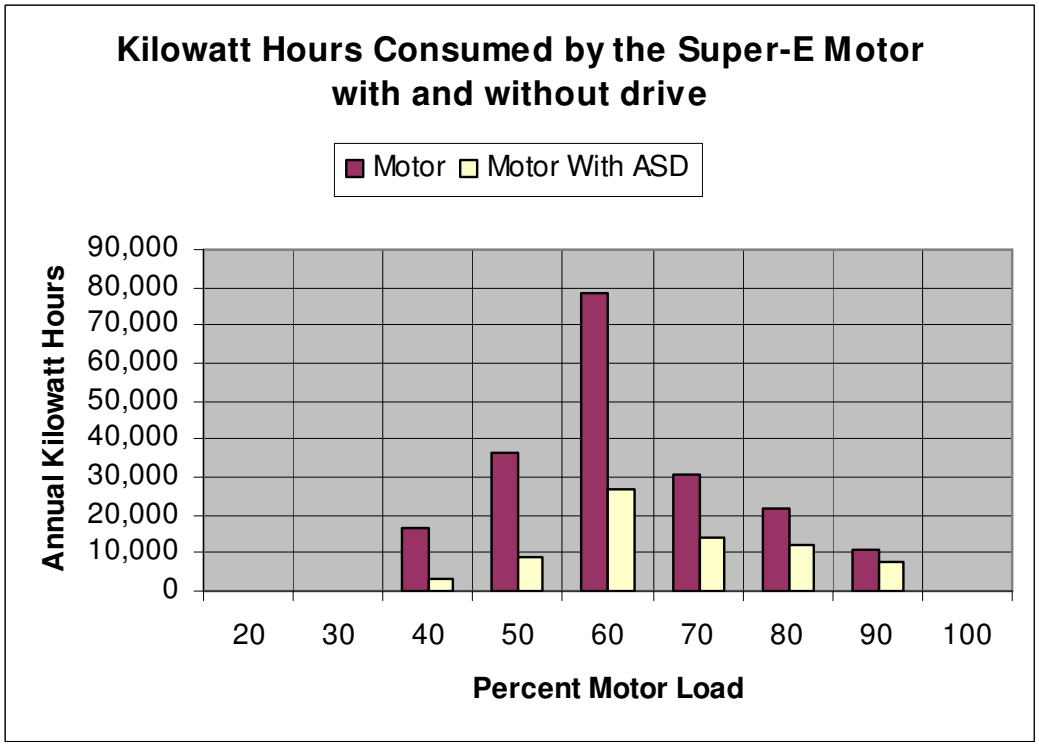
Reduced Flow May be accomplished via several methods:

- Changing Motor and/or Equipment
  - Fan belts
  - Motor base speed
  - Pump Impeller
  - Blade pitch
- Inlet Guide Vanes
- Pump Valves
- Variable Frequency Drive (VFD) – only method to take advantage of affinity laws


Input Power Necessary
Motor w/Throttle valve
Motor With ASD
Motor W/Bypass Valve
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
KW
40
60
80
100
Percent Motor Load

Analysis of ASD





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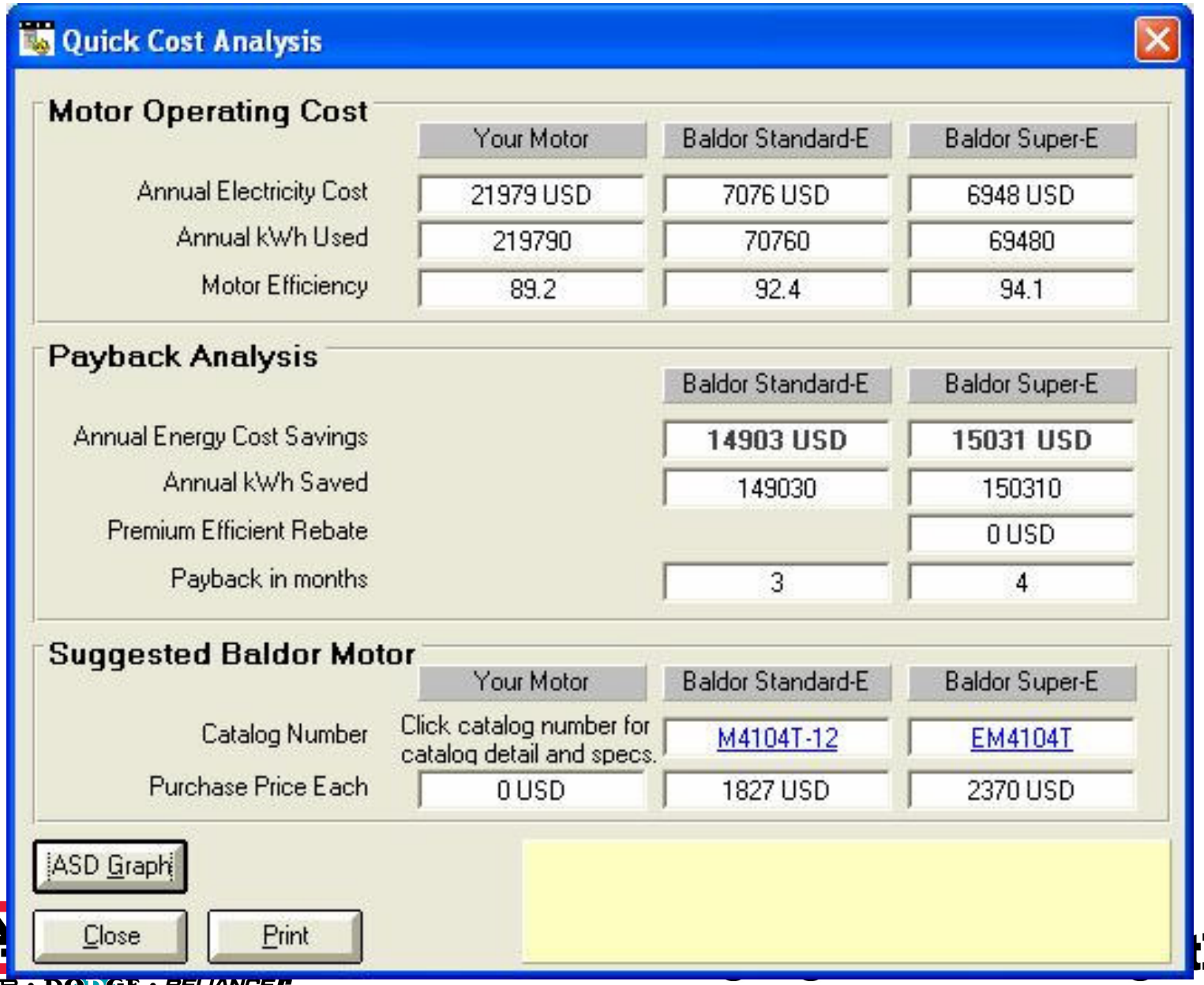
Payback with Drive



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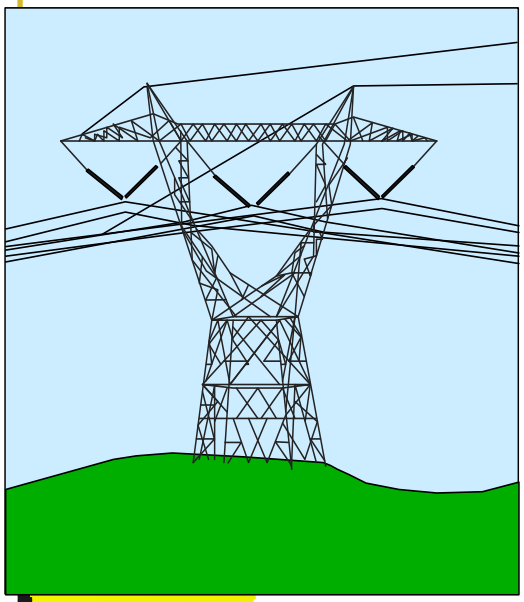
Prescriptive Rebates for Drives

- Most savings on variable torque loads
  - Pumps, fans and compressors
- Commercial and Industrial
  - HVAC and water pumping
  - Industrial process
- Constant torque loads don’t save energy
  - Conveyors, extruders, etc.

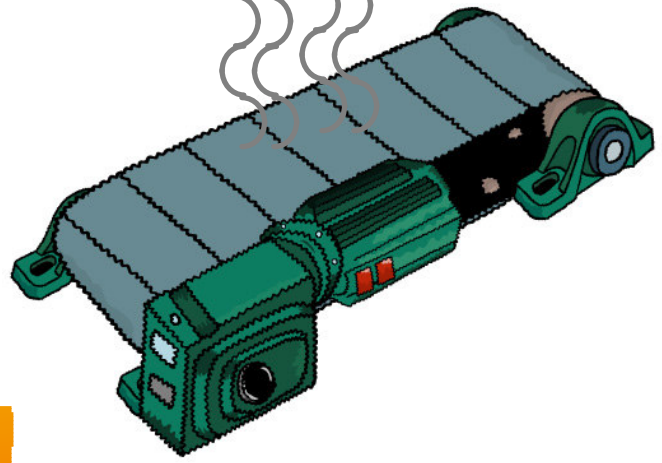
A gearmotor "consumes" a certain percentage of power when driving a given load. This is defined as "Watt Losses".



Input Power (Watts)

Watt Losses

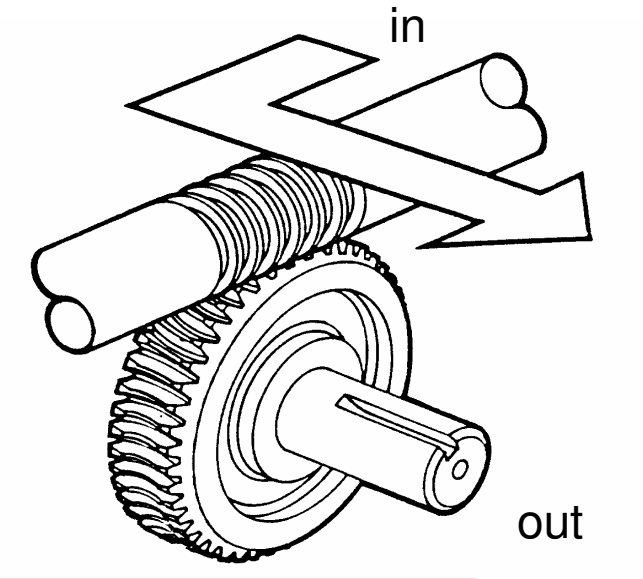
Load (Output power 1 HP = 746 Watts)

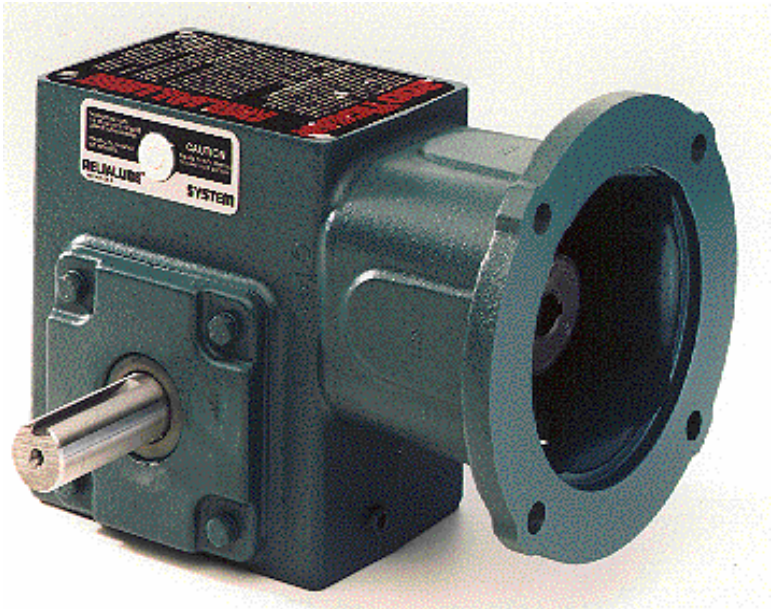


A-C Gearmotor (Some power lost during conversion)

Right Angle-Worm Gearing

- Transmits motion through steel worm running over a bronze gear
- High reductions available in single stage - compact - cost efficient
- Losses are primarily frictional due to “sliding” friction from the worm set





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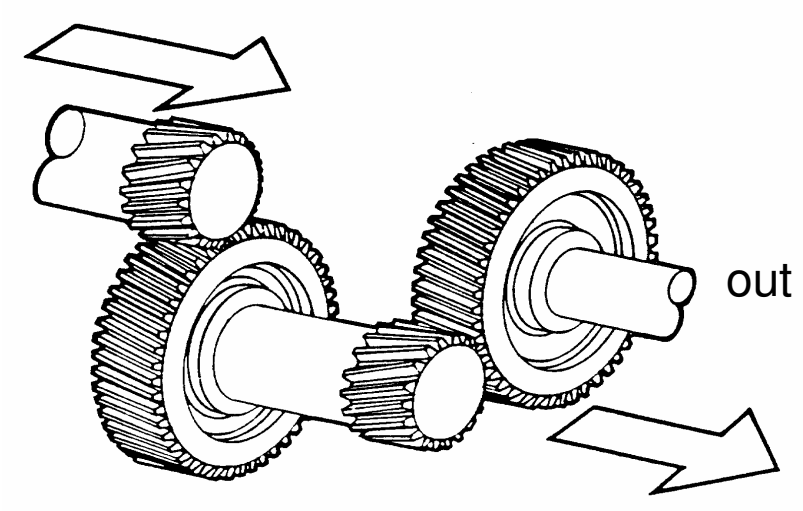
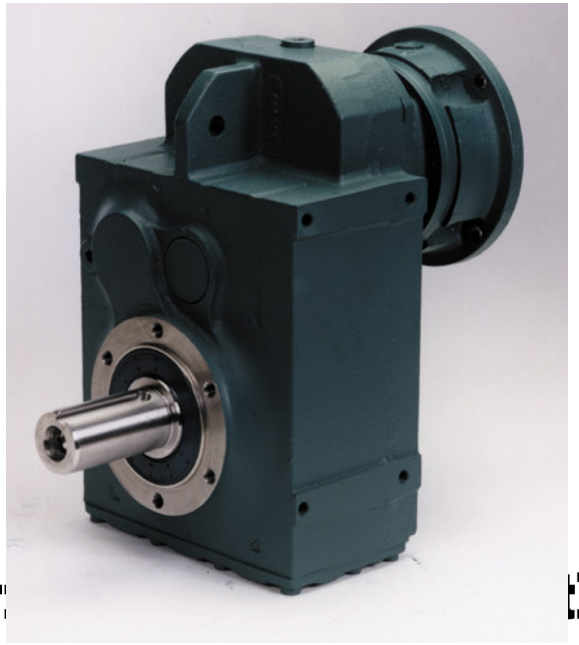
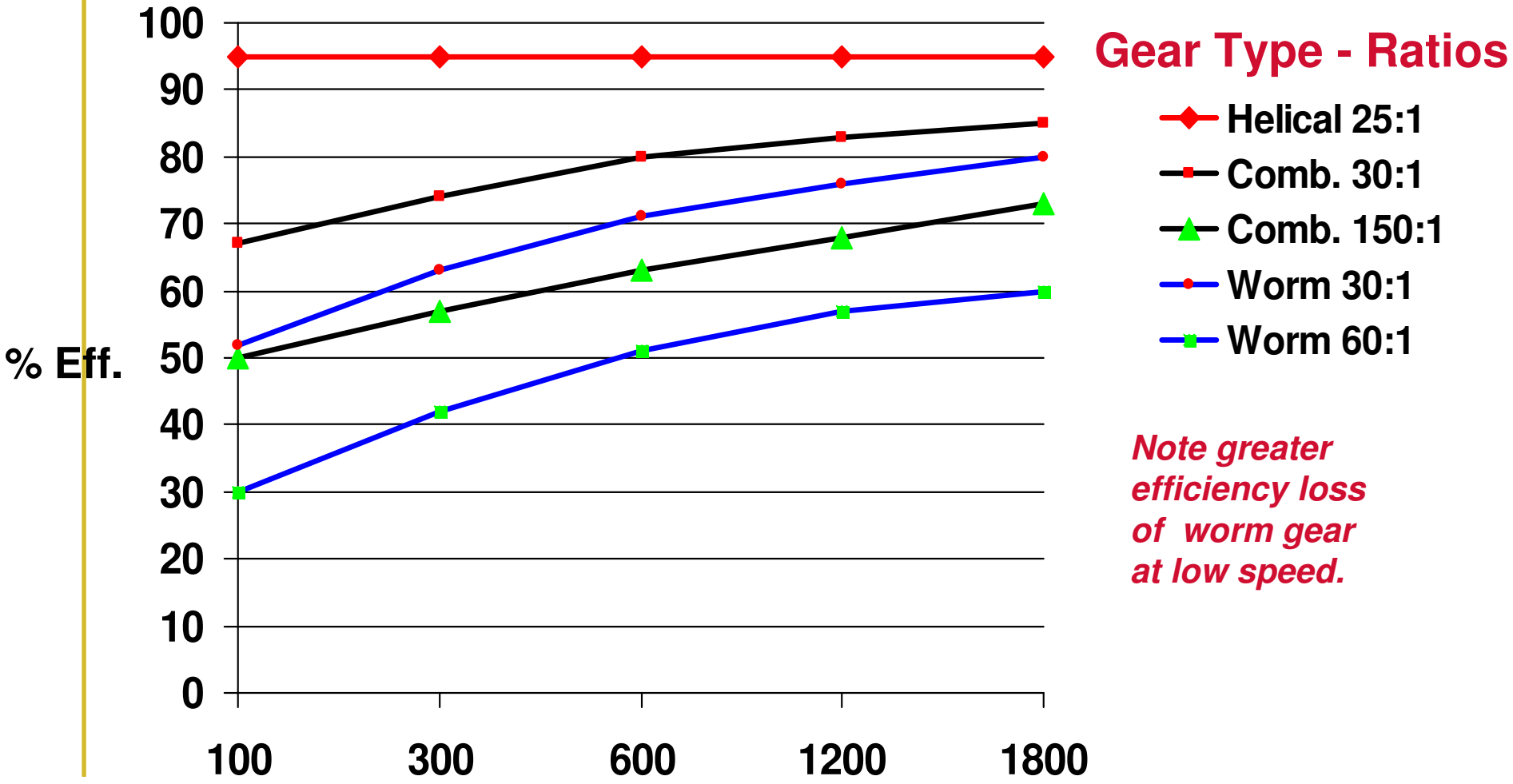
Parallel – Helical Gearing

- Transmit motion through adjacent steel gears
- Losses are primarily frictional due to “rolling contact” between the gears
- Highest efficiency - losses at 2% per gear set





Gearing Types - Efficiencies



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New Technology Development

- Improvements in NEMA Premium® efficient AC induction motor efficiency is limited by losses
- Copper rotors can reduce losses somewhat
- Super conducting motors not economically feasible below 5000 HP
- Permanent magnet rotors have lowest losses in 10 – 1000 HP range

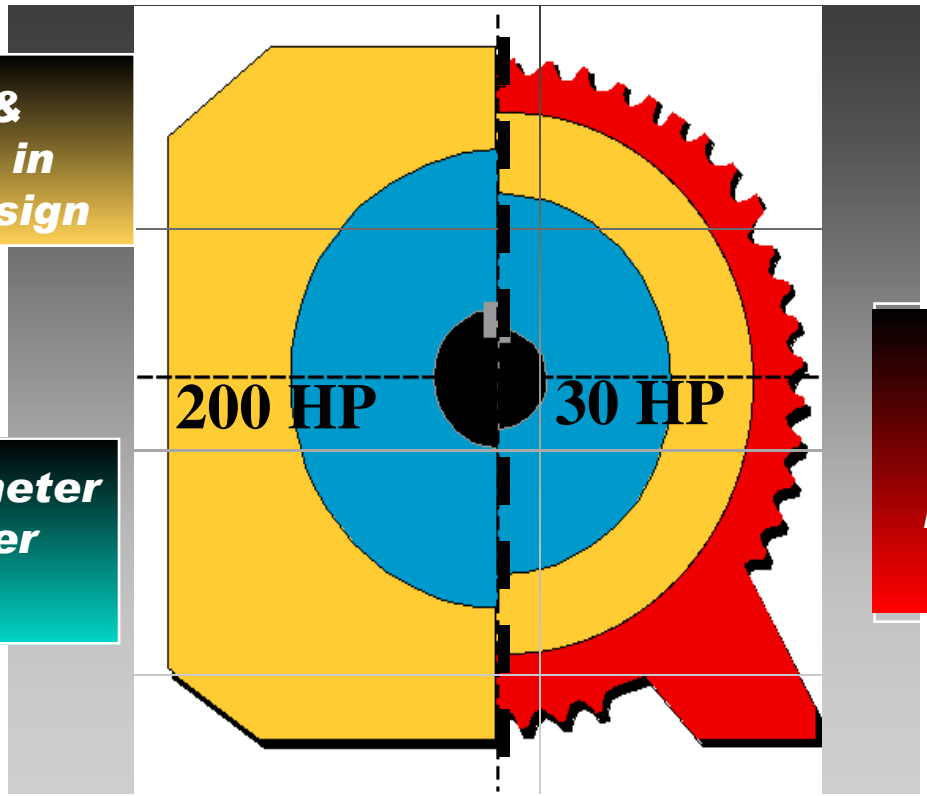
Emerging Technology

Motor Type 30 HP 4P	Efficiency	Annual Cost of operation	Annual savings
AC Ind. DOE Avg.	89.2%	$21,979	-
AC Ind. EPAct	92.4%	21,217	$762
AC Ind. NEMA Prem	94.1%	20,834	1,145
AC Ind. CU Rotor	94.5%	20,746	1,233
PM Rotor	94.9%	20,658	1,321

Higher power density for better space utilization

More copper & magnetic steel in square frame design

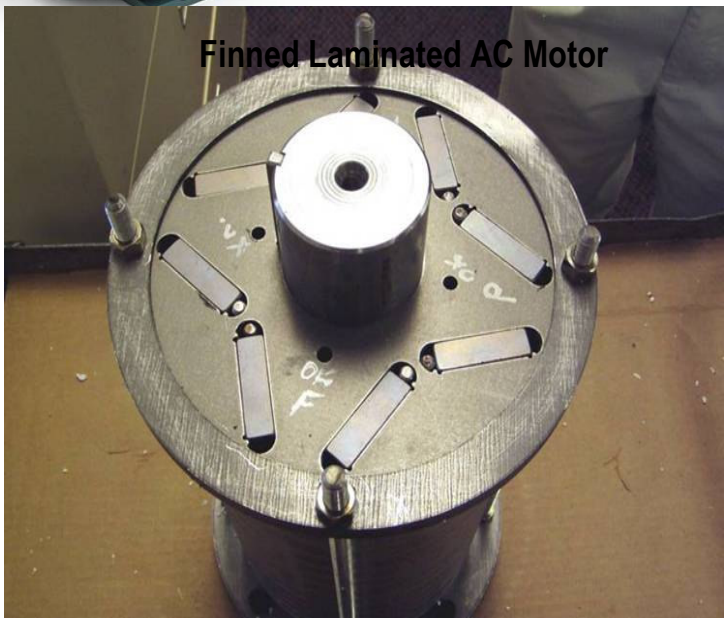
Larger rotor diameter produces higher torque



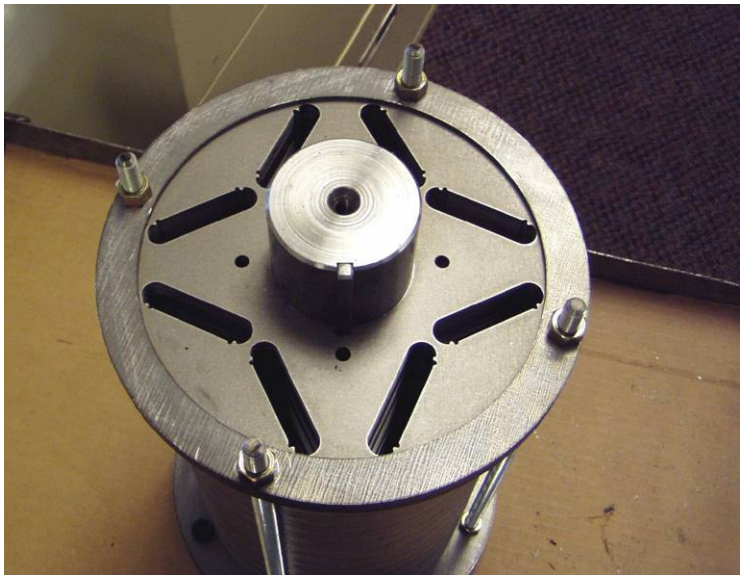
Inactive Cast Iron Frame - Reduced Heat transfer between stator and frame

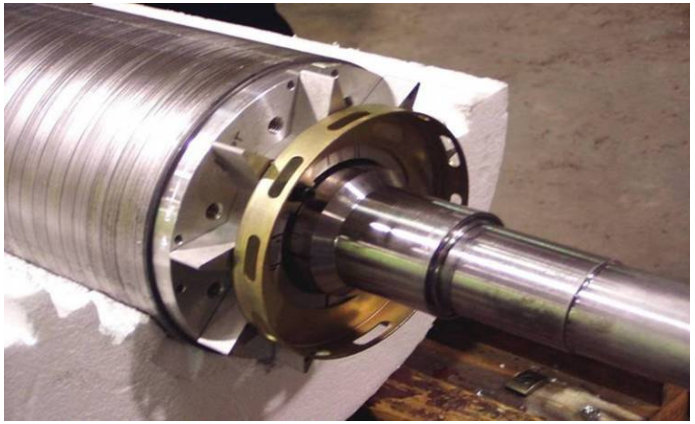
Same NEMA Shaft Height

Interior PM Development



Finned Laminated AC Motor





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Thank you

Any questions?