FLUKE Reliability

Motor Management and Energy Savings Opportunities

Best Practices Webinar Series

Meet the Speaker

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Electrical Engineer

- Motor management
- Improve process reliability
- Reduce energy costs
- Examine common motor related energy conservation measures

About Advanced Energy

- Advanced Energy is a nonprofit energy consulting firm. We work with electric utilities, government and a wide variety of public and private organizations. Our customized services include research, testing, training, consulting and program design

Advanced Energy Motors and Drives

- Motor Driven systems account for approximately 50 percent of all electricity generated in the world. Advanced Energy started work in Motors in the late 1980’s and continues work in motors today. In our internationally accredited test lab, we offer independent and unbiased services to governments, original equipment manufacturers, motor and drive manufacturers, utilities, distributors, motor repair facilities and others.

Motor System Management

Motor Management

Potential Opportunities

- The average motor easily consumes 50-60 times its initial purchase price in electricity over its typical life
- Motor purchase price accounts for only 2% of its lifetime cost; electrical energy cost accounts for the rest - 98%.
- Less than half of motor users consider energy costs in repair-replace decisions
- Facilities need guidelines to manage motors – Motor Management Policy (MMP)

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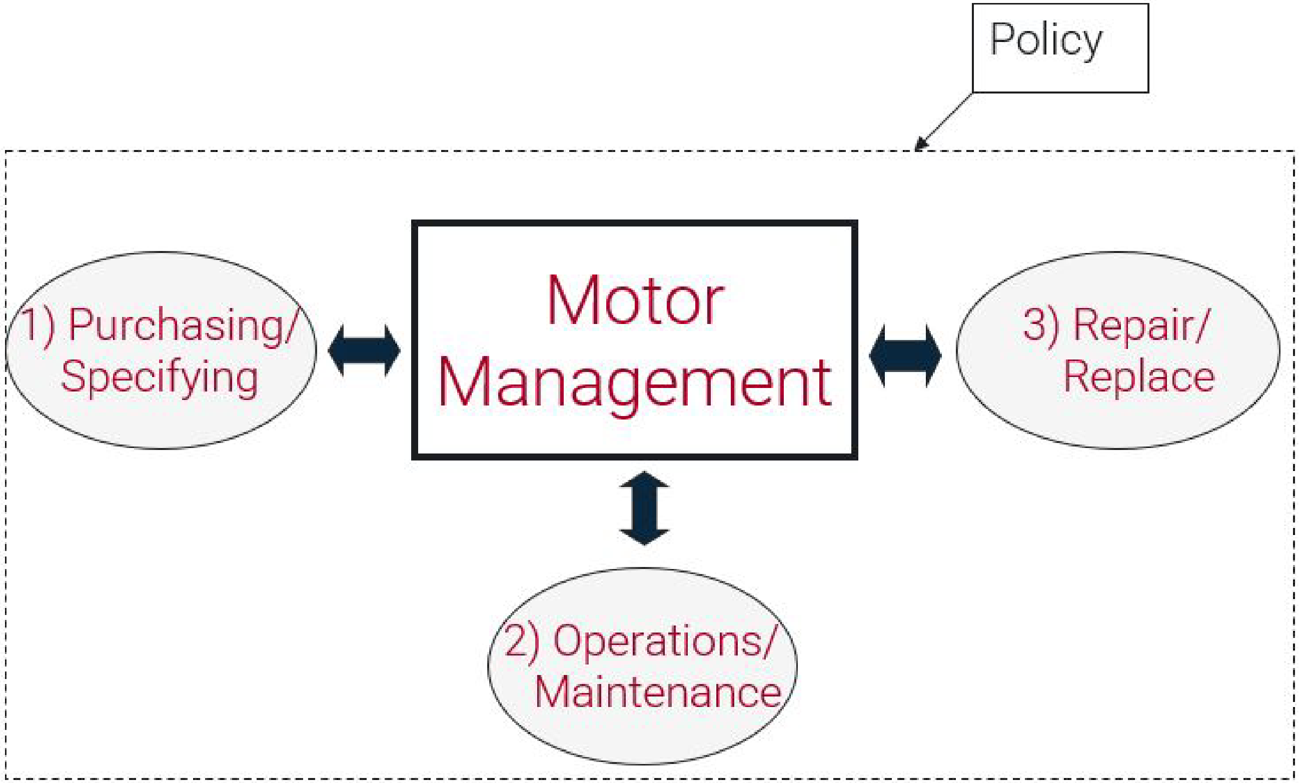
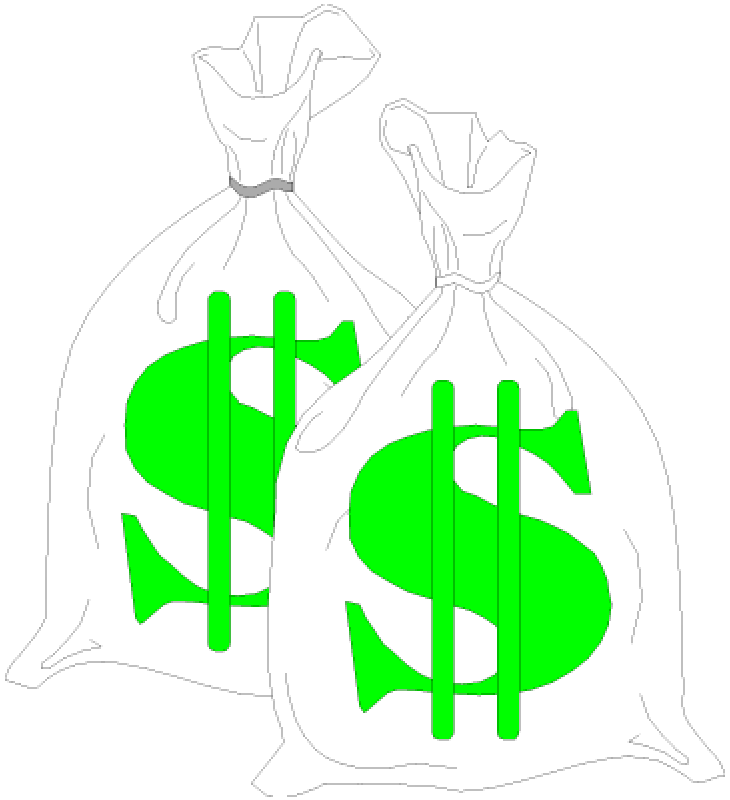
Components of Motor Management



Benefits of motor policy

- Lower operating costs
- Lower maintenance costs
- Less downtime
- Increased productivity



How to create a motor management policy

- Develop **Motor Purchase Specifications**
  - Motor purchase policy must consider lifecycle costs
  - Specify the correct motor for each application
  - Prequalify and standardize on few reliable brands

- Develop **Motor Repair Specifications**
  - Use certified motor repair shops
  - Identify and correct conditions that lead to premature motor failure

- Document **Operations and Maintenance guidelines**
  - Develop and follow sound maintenance practices

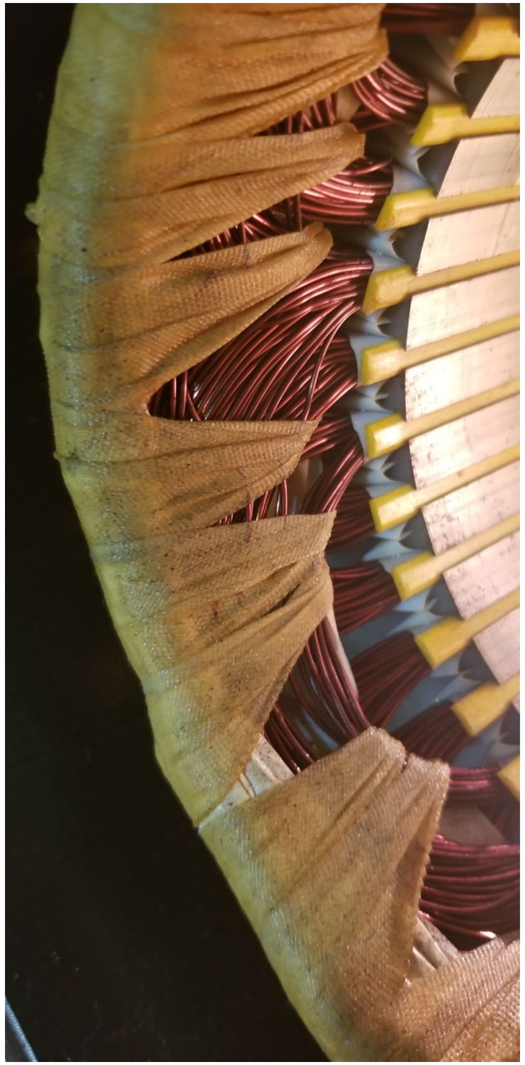
Consider Lifecycle Cost

Initial cost versus Operating cost

	75-HP Electric Motor	Car (Medium Sedan)
Initial cost	$4,249	$30,300
Annual usage	4,000-hrs	15,000-mi
Efficiency	95.0%	30-mpg
Fuel costs	$0.07/kWh	$3.728/gal
Lifetime	10-yrs	7-yrs
Annual operating cost	$16,484	$1,864
Lifecycle cost	**$169,088**	**$43,348**
Operating cost as % of lifecycle costs	**97.5%**	**30.1%**

Create a motor purchasing policy

- Standardize process with purchase specs
- Set criteria and pre-qualify vendors. Testing may be needed in some cases
- Set minimum efficiency levels for new motors
- Demonstrate the Lifecycle cost scenarios to purchasing staff

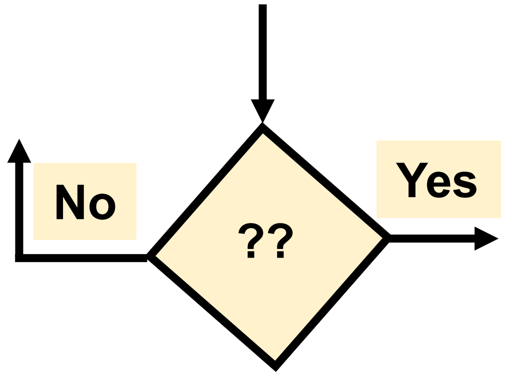


Motor repair

Ensure quality repairs to improve reliability and reduce cost

Create a motor repair policy

- Set a repair breakpoint
- Develop specifications for motor repair
    - Control repairs, control cost of repair
    - Set cost of repair criteria
    - Set burn-out temperatures
    - Request failure analysis report
    - Diagnostic and in-process test reports
- Use certified repair shops: PEV, EASA



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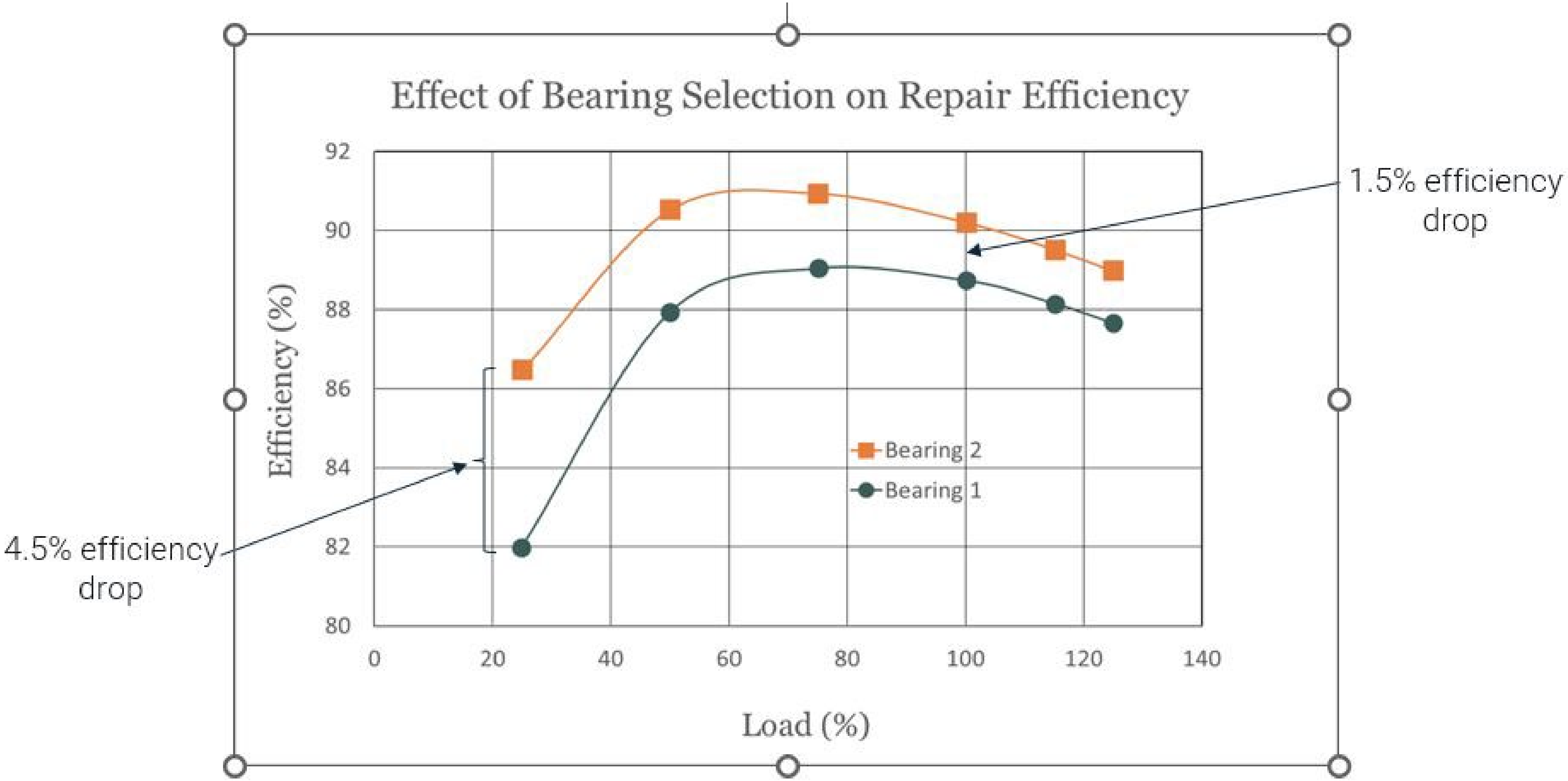
Case Study



4.5% efficiency drop
Effect of Bearing Selection on Repair Efficiency
Efficiency (%)
92
90
88
86
84
82
80
0
20
40
60
80
100
120
140
Load (%)
Bearing 2
Bearing 1
1.5% efficiency drop

Motor repair

- Motor repair facility may serve as a source of information
- Tracking motor inventory
- Failure history and mechanisms
- Vibration analysis

Use certified motor repair shops

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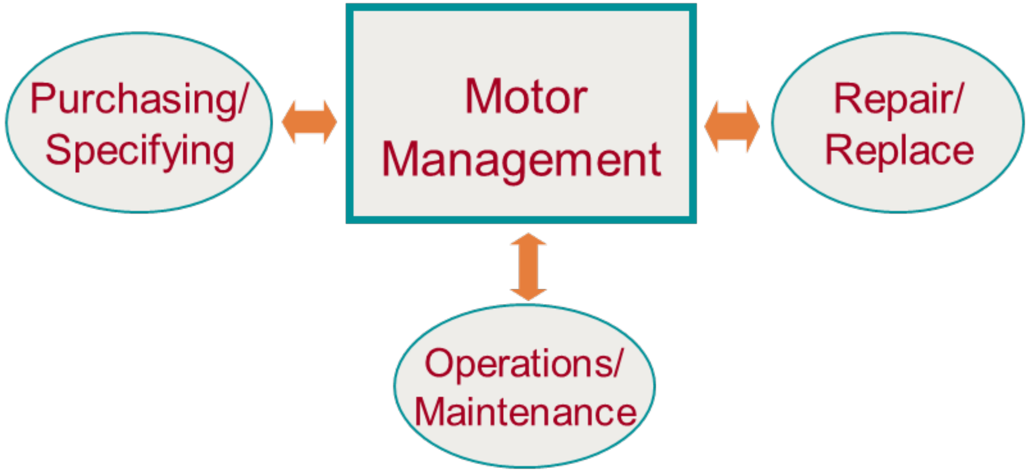
Creating the policy

- Bring all aspects of the motor management policy together
- Assess Policy Impact:
  - Record motor failure incidents
  - Track energy cost per unit production
  - Update and improve policy regularly



Summary

- Use lifecycle costs in motor decisions
- Use motor purchase and repair specifications to get the right motors and quality repairs
- Use basic and advanced preventative maintenance techniques to increase motor reliability

Motor related energy conservation measures

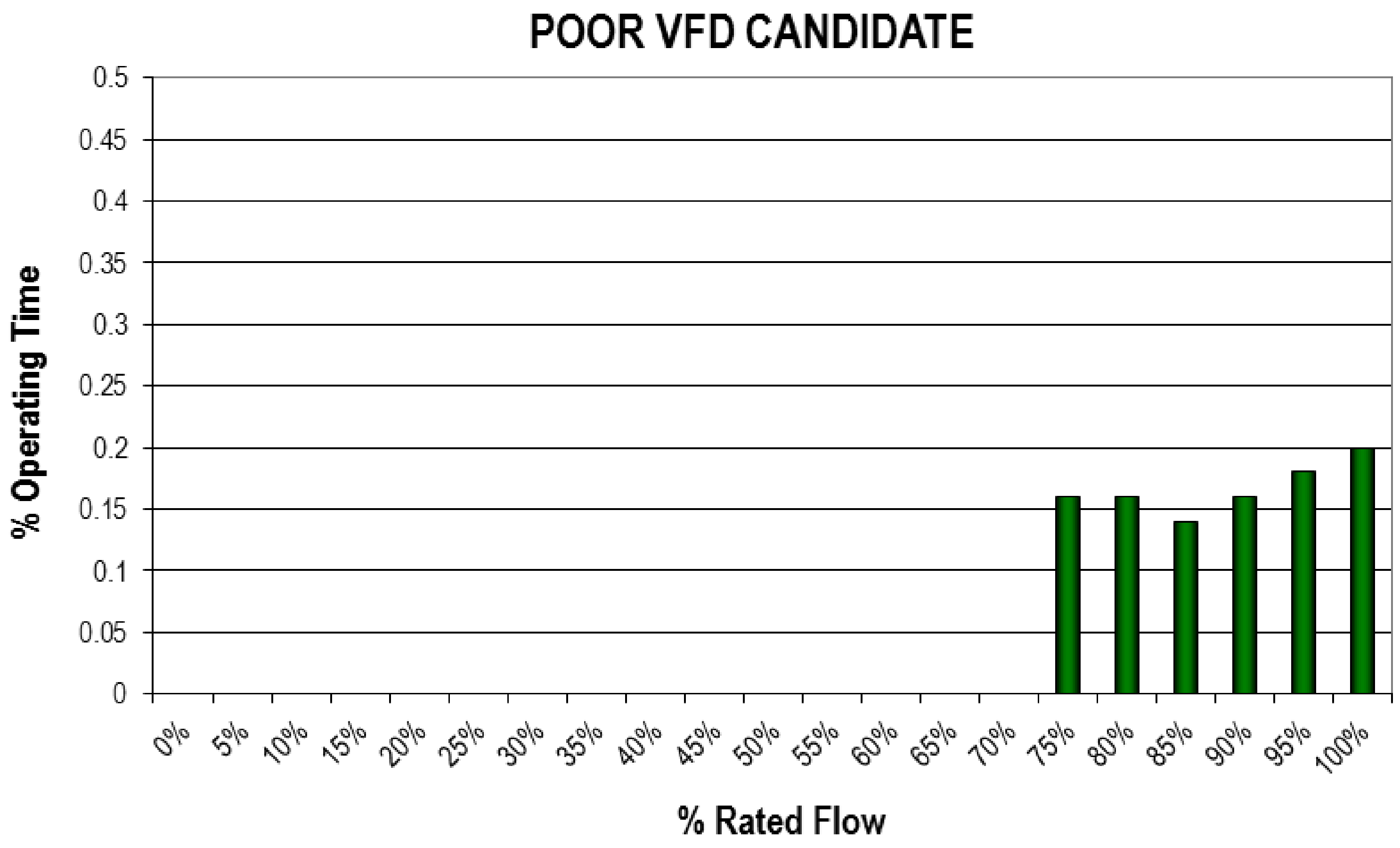
Energy Conservation Measures

- What is an ECM?
- How to spot energy savings opportunities?
- When to make a change?
- Why make the change?
- Data capture
- Simple payback analysis

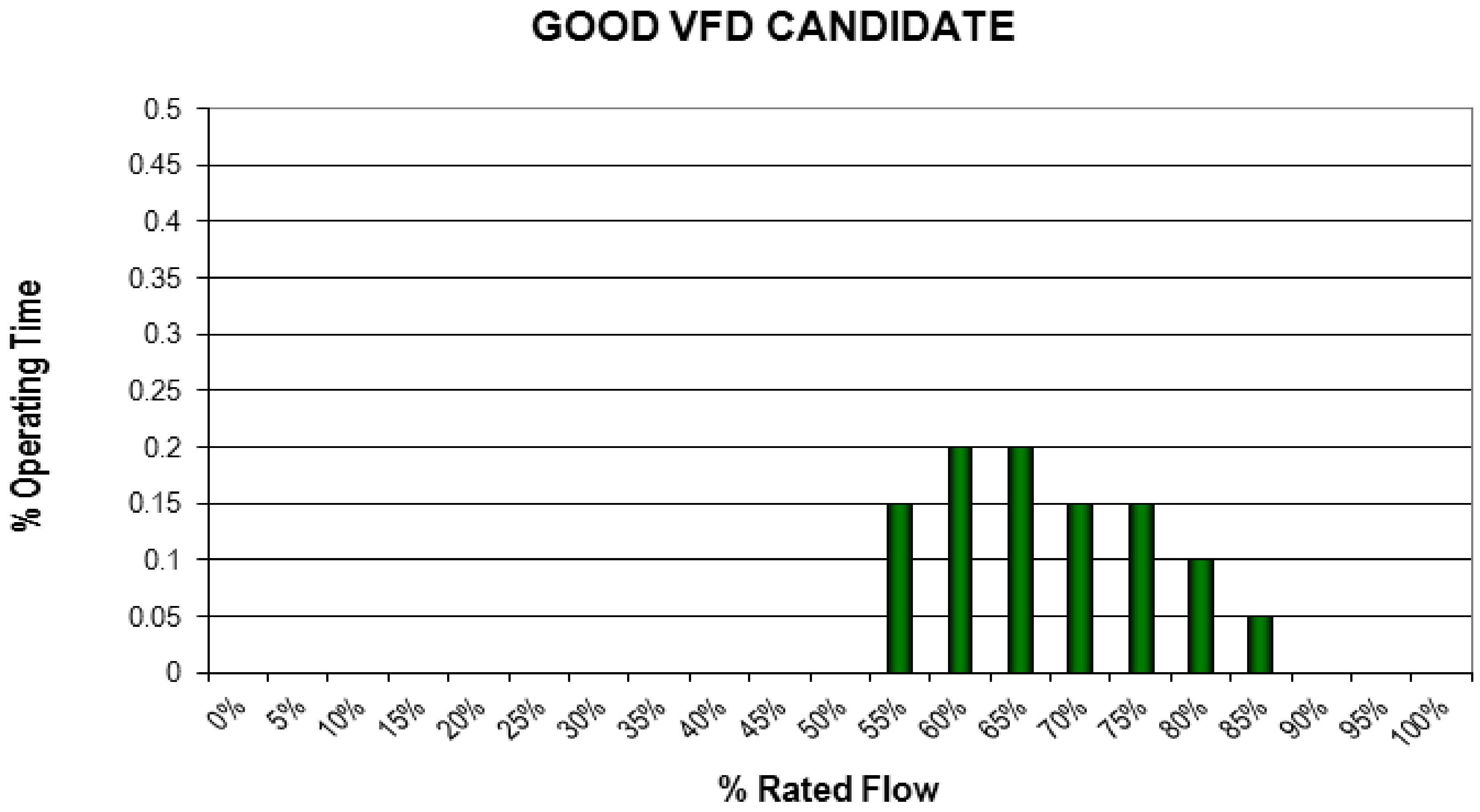
Common ECM – Add Variable Frequency Drive

- Target centrifugal loads
  - Affinity Laws
  - "Spinning" inertia loads
  - Pumps, fans, blowers
  - Linear loads not as conducive to energy savings – process line, crushers, elevators, conveyors
- Target moderately loaded applications
  - Low to moderate load – good candidate for VFD
  - High load – poor candidate for VFD
- Target highly used applications
  - 4,000 annual run hours or above – good candidate for VFD
  - Low run hours – poor candidate for VFD

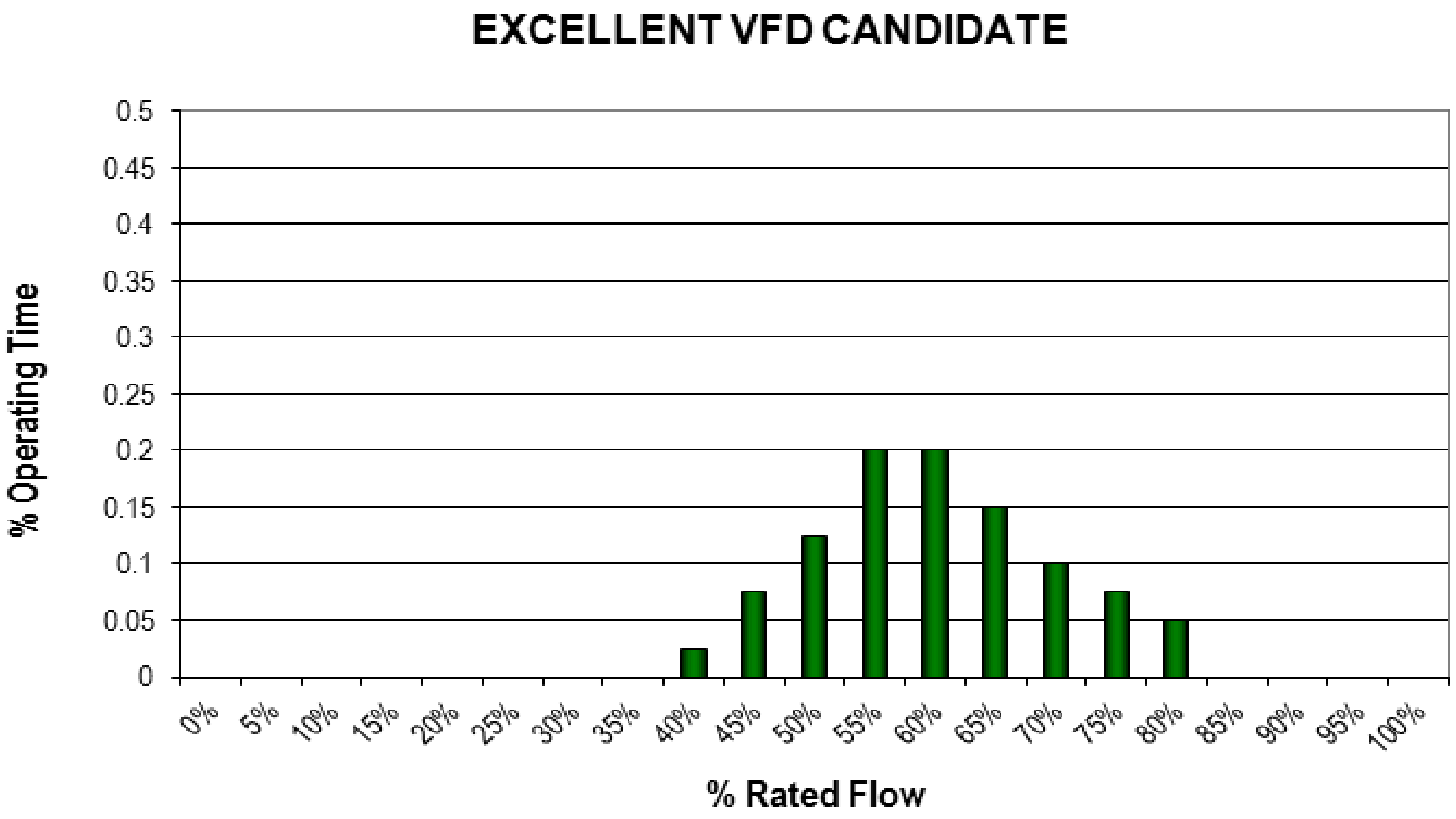
Load Cycle Profiles - Poor



Load Cycle Profiles - Good



Load Cycle Profiles - Excellent



Calculate Potential Savings

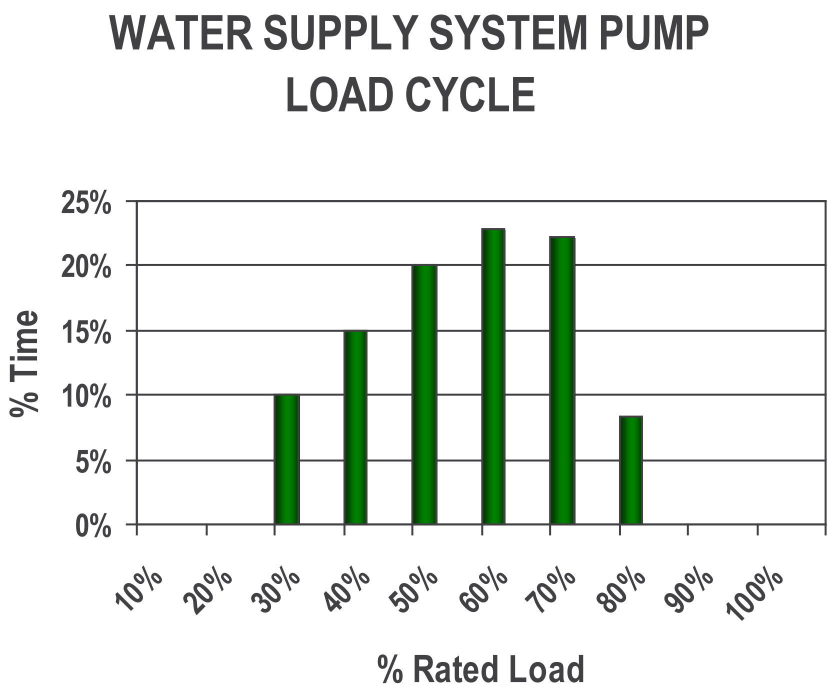
- Measure baseline energy consumption without VFD: Measure electrical demand (kW) of motor (without VFD) at each load level
- Calculate electrical demand of motor (with VFD) using application load information
- Subtract VFD kW demand from baseline demand at each load level
- Multiply demand by time at each load level and sum over the entire load cycle to find energy savings

VFD Payback

- Determine VFD purchase, installation and programming costs (VFD initial cost)
- Estimate average electric rate by dividing total electric energy bill by energy (kWh) used in that billing period
- Multiply energy savings by the average electric rate to find energy cost savings
- Divide VFD initial cost by energy cost savings to obtain simple payback period
- Compare simple payback period to threshold (generally 2-yrs)

VFD Calculation Example

- Water supply system pump
- 75-HP energy-efficient motor with fixed diameter impeller
- Outlet control valve creates constant head pressure
- Operates 24/7
- Peak water usage (75% rated) for 2-hrs each morning
- Minimum water usage (<40% rated) for 6-hrs each night
- Varying load (50-60% rated) remainder of day



VFD Calculation Example

- Pump power assumed proportional to the cube of pump load
- VFD efficiency assumed constant

75-HP x 0.746-kW/HP x (0.3)^3 x 10% Time x 8,000-hrs/yr ÷ 97% [VFD eff] = 1,245-kWh

75-HP x 0.746-kW/HP x (0.4)^3 x 15% Time x 8,000-hrs/yr ÷ 97% [VFD eff] = 4,429-kWh

75-HP x 0.746-kW/HP x (0.5)^3 x 20% Time x 8,000-hrs/yr ÷ 97% [VFD eff] = 11,536-kWh

75-HP x 0.746-kW/HP x (0.6)^3 x 23% Time x 8,000-hrs/yr ÷ 97% [VFD eff] = 22,924-kWh

75-HP x 0.746-kW/HP x (0.7)^3 x 22% Time x 8,000-hrs/yr ÷ 97% [VFD eff] = 34,820-kWh

75-HP x 0.746-kW/HP x (0.8)^3 x 8% Time x 8,000-hrs/yr ÷ 97% [VFD eff] = 18,900-kWh

- Total VFD demand = 93,854-kWh/yr

VFD Calculation Example

- Approximate motor demand calculation
  - 2,850-gpm x 60-ft [head pressure]
  - 0.746-kW/HP
  - 8,000-hrs/yr
  - Efficiency = 85% [pump] x 93% [motor]
  - P ≈ 326,000-kWh/yr

- VFD energy savings

  326,000 – 93,854 ≈ 232,000-kWh/yr

- Annual energy cost savings

  232,000-kWh/yr x $0.06 ≈ $14,000/yr

Common ECM – Add Variable Frequency Drive

- Boilers and Chillers
  - Feedwater pumps
  - Chilled water pumps
- Cooling Towers
  - Circulating pumps
  - Tower fans
- HVAC
  - Exhaust fans
  - Supply fans
  - Return fans
- Compressed Air
  - Convert single-speed compressor to VFD compressor
  - Trim load

Other common motor ECMs

- Establish a formal motor management program
- Replace older inefficient motors with premium efficient (IE3) designs
- Upgrade existing premium efficient motors with IE4 or IE5 newer technology machines
- Use cogged V-belts on belt-driven applications

Bonus content – other ECMs – Compressed Air

- Compressed Air
  - Reduce plant air pressure
  - Schedule leak detection surveys – repair leaks
  - Install zero-loss condensate drains
  - Use engineered nozzles for blowing

Bonus content – other ECMs - Lighting

- Lighting
  - Install LED bulbs and fixtures
  - Install occupancy sensors
  - Turn them off!

Questions

QUESTIONS?

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Thank you!

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Next webinar January 18: Building your Predictive Maintenance Roadmap

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