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Innovative Vertical Gearmotor Solution for Pumping Applications

Allison Carroll – Industry Business Manager

Baldor Electric: A Member of the ABB Group

• Participants are in a listen-only mode.

• To ask a question during the event, use the chat feature at the bottom left of your screen. Technical questions will be answered by ReadyTalk. Questions for our speakers can be asked at any time and will be answered during the Q&A at the end of the session.

• Visit pump-zone.com in the coming days to view the answers to all of the questions asked during the Q&A session.

• Visit pump-zone.com in the coming days to access the recording of the webinar.

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Allison Carroll

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- Industry Business Manager at Baldor Electric Company, Industry Solutions Group
- Focus is in Water/Wastewater Industry.
- Mission is to provide industry expertise, application solutions, and product knowledge to help improve processes and lower total operating costs for customers.
- 26 Years of Experience in various engineering and technical sales roles
- BSME University of Tennessee

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Our mission is to be the best (as determined by our customers) marketers, designers and manufacturers of industrial electric motors, drives and mechanical power transmission products

Taking care of our customers safely

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Our Strategy

To produce the highest quality, energy-efficient products available in the marketplace and sell them to a broad base of value-minded customers.

$$V_p = \frac{Q_p \times S_p}{C \times T}$$

Vp = perceived Value Qp = perceived Quality Sp = perceived Service

C = Cost T = Time

ABB

- Baldor is a member of the ABB Group
- 145,000 employees in about 100 countries
- $42 billion in revenue (2013)
- Formed in 1988 merger of Swiss and Swedish engineering companies
- Predecessors founded in 1883 and 1891
- Publicly owned company with head office in Switzerland
- *Largest supplier of industrial motors and drives in the world.*

ABB – 5 Global Divisions

Power Products

36,000 employees

Power Systems

20,000 employees

Discrete Automation and Motion

29,000 employees

Low Voltage Products

31,000 employees

Process Automation

28,000 employees

- ABB's portfolio covers:
  - Electricals, automation, controls and instrumentation for power generation and industrial processes
  - Power transmission
  - Distribution solutions
  - Low-voltage products
  - Motors and drives
  - Intelligent building systems
  - Robots and robot systems
  - Services to improve customers productivity and reliability

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What is the Baldor-Dodge Vertical Gearmotor?

- Integral combination of planetary gearing and high HP, low pole count induction motors
- Innovative solution to provide cost effective alternative for low speed, high HP, vertical pumping applications
- Provided as an integrated solution by single source supplier.
- Designed to fit existing pump flange
- Product line covers specific range – 6 sizes
- Final selection is specific to each individual application

Prototype in Greenville, SC

Design Based on Existing Dodge gearing product

Since 1949

- **Extensive installed base**
- **> 3000 globally**

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Where to consider Baldor-Dodge Vertical Gearmotors?

- Vertical applications
  - High pole count induction motor
  - Synchronous motors OR
  - Horizontal motor with right angle gearbox

- Low impeller speed – 100 RPM to 500 RPM
  - Ratios from 4:1 to 10:1

- High HP - 500 HP to 30,000 HP

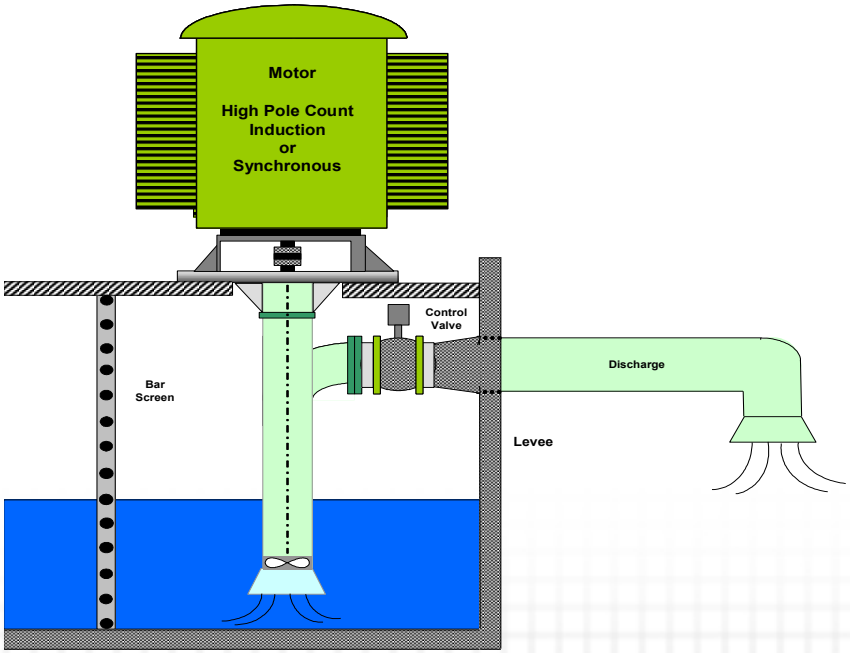
- High torque - 400,000 in-lbs to 7,000,000 in-lbs

Applications

- High capacity, Low Head, Slow Speed Pumping Applications:
  - Wastewater (1000 – 7000 HP)
  - Power Generation/Cooling Water (500 – 9000 HP)
  - Irrigation (1000 – 30,000 HP)
  - Water Transfer and Distribution (1000 – 2000 HP)
  - Flood Control (1000 – 7000 HP)
  - Desalination (2000 – 6000 HP)

Typical vertical pump driver technology

- Utilize low speed, high pole count, induction or synchronous motors
- Typical impeller speeds of 100 – 500 RPM
- Motor speed is determined by discrete # of poles



Large and Expensive

Dodge Vertical Gearmotor alternative

Typical Systems

Large high pole, low speed, synchronous motors

Vertical Gearmotor Option

Low pole induction motors and single reduction reducers

Lower cost, high efficiency, high power factor solution, providing the exact speed required in a smaller package.

Vertical Gearmotor Advantages

Utilization of standard 4, 6, and 8 pole motors

Alternative to high pole count vertical motors

- Low pole count induction motors are less expensive than high pole synchronous or induction motors.
  Typical savings of 10% to 45% depending on application.
- Higher efficiency and power factor than high pole induction motors – **lower operating costs**
- Can select exact ratio required for desired output speed
- Smaller and lighter – **reduces support structure and facility cost**
- Thrust loading can be more easily accommodated in reducer
- Simplified maintenance and better availability
- Single source and complete drive package
- Can be designed with clutches for self contained soft start

Vertical Gearmotor Advantages

Alternative to horizontal motors and right angle reducers

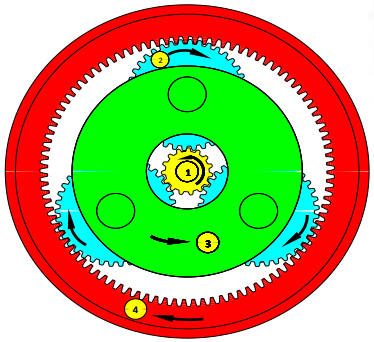
- Eliminates alignment issues between motor and reducer
- Smaller footprint
- Typically smaller and lighter – **reduced support structure and facility cost**
- Higher efficiency planetary gearing vs helical and bevel gearing
- Single source warranty and complete drive package
- Can be designed with clutches for self contained soft start

Vertical Gearmotor - Gearing

<u>Design:</u>

- Planetary gearing arrangement
  - Divides power into three paths
  - High power density
  - High efficiency (99%)

- Double Helical type gearing for lower noise and vibration
- Gear ratios selected to optimize pump speed for optimum pump efficiency/operation
- Compact design



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Vertical Gearmotor Advantages

Match output speed to Pump Design Point

- The base speed of an induction motor is set by the frequency and discrete number of poles.
- Use of gearing allows more flexibility in designing the exact output pump speed required.

Motor Pole Count	RPM @ 60 Hz	RPM @ 50 Hz
14	514	429
16	450	375
18	400	333
20	360	300
22	327	273
24	300	250
26	277	231
28	257	214
30	240	200
32	225	188
34	212	176
36	200	167
38	189	158
40	180	150

Vertical Gearmotors Product Range

Product line is sized by torque rating
HP depends on output speed with general range of
500 HP to 30,000 HP at 100 RPM to 500 RPM
Thrust bearing in gear box

Approximate Power Ratings from 800 HP to 30,000 HP (600 kW to 22,000 kW)

(Depending on System Output Speeds)

Standard Baldor•Dodge VGM Sizes / Ratings

VGM Size	Torque Rating (in-lbs)	Torque Rating (Nm)	Continuous Thrust Rating (lbs)	Continuous Thrust Rating (Kg)
Size 1	550,000	62,000	52,000	24,000
Size 2	1,000,000	113,000	83,000	38,000
Size 3	1,700,000	192,000	110,000	50,000
Size 4	2,400,000	271,000	142,000	64,000
Size 5	4,100,000	463,000	220,000	100,000
Size 6	7,000,000	790,000	320,000	145,000

Values shown are approximate rating by size.
Ratios can be produced to accommodate specific requirements.
Approximate design output speed range - 100 to 500 RPM.

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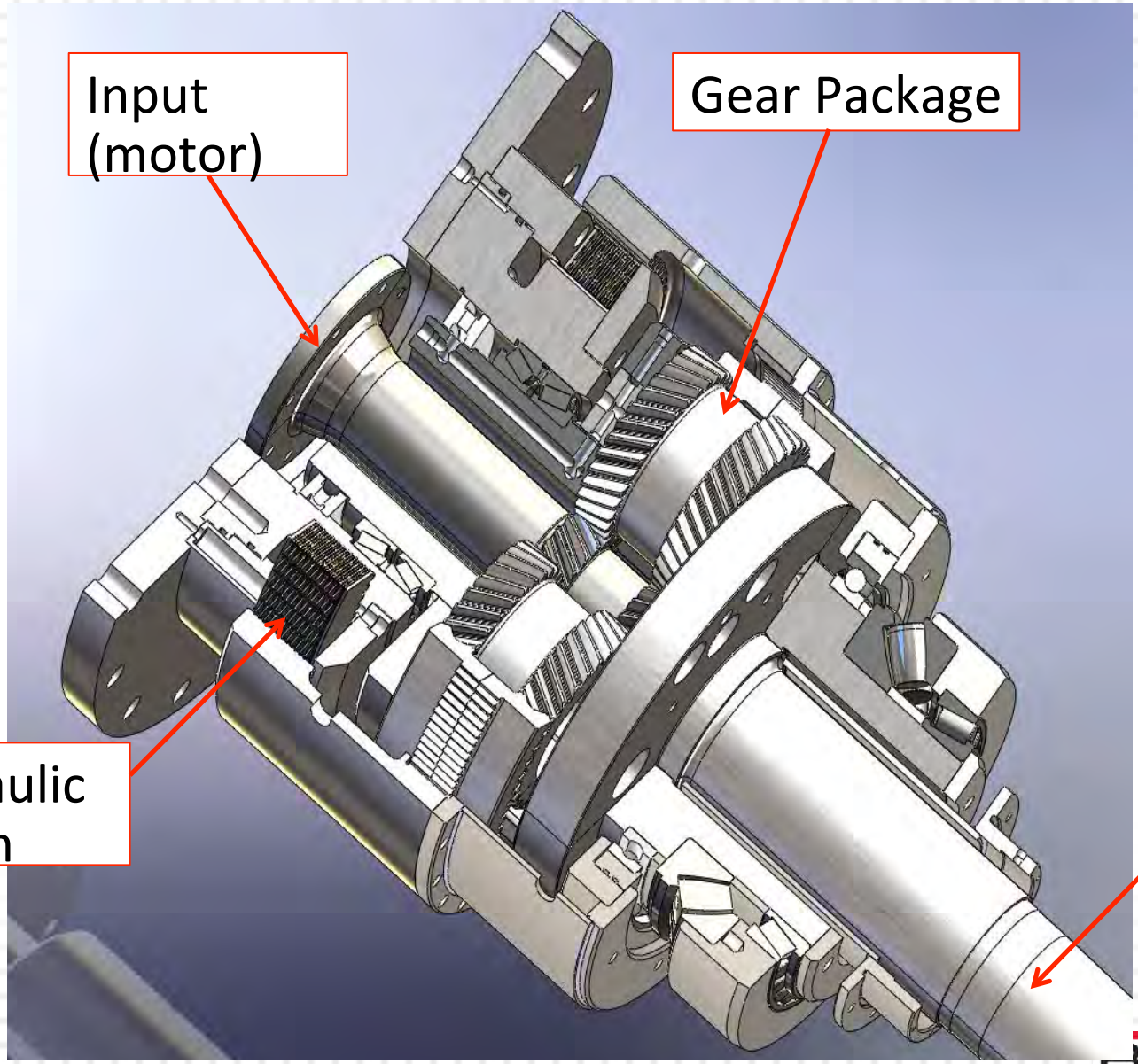
CST Operation



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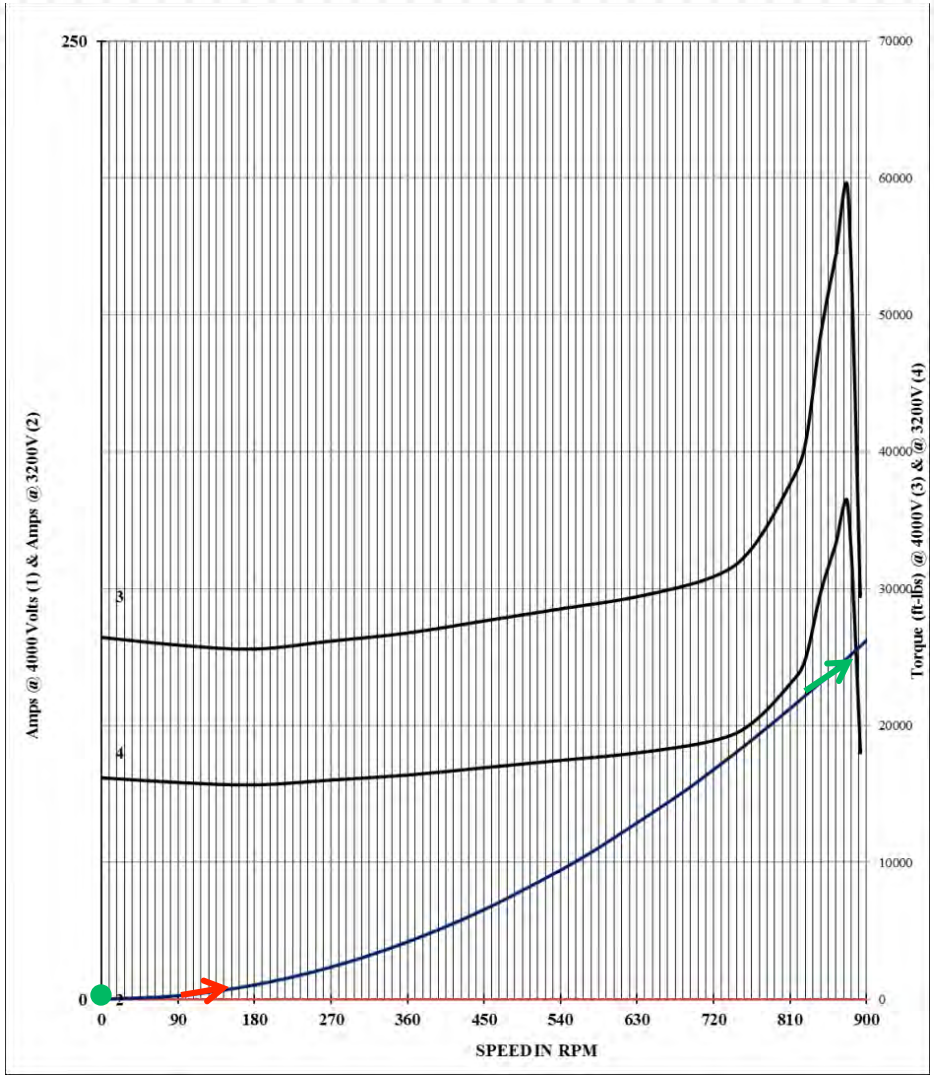
Optional Hydroviscous Clutch (CST)

Provides added benefits – In Gearmotor Functionality

- Clutch functions as a mechanical soft start
  - Eliminate need and costs for electrical soft start (such as a VFD)
  - Clutch is engaged slowly to accelerate the load at desired rate
    - Less surging and less vibration. Prevents water hammer.
- Motor starts unloaded
  - Utilize breakdown torque of motor. Special motor torque curves are not required.
  - Easier on the power grid than starting the motors under load.
  - Multiple starts are possible by disengaging clutch and leaving motor operating.
- Clutch acts as torque limiter to prevent overload damage

Example: 5000 Hp motor @ 900 rpm



- Customer RFQ was for 5000HP @ 900rpm motor (pump speed 127 RPM)
- Application: Centrifugal Pump
- Customer did not supply load curve, so one was calculated
- “Standard” LAC motor design will start this load at 80% Voltage

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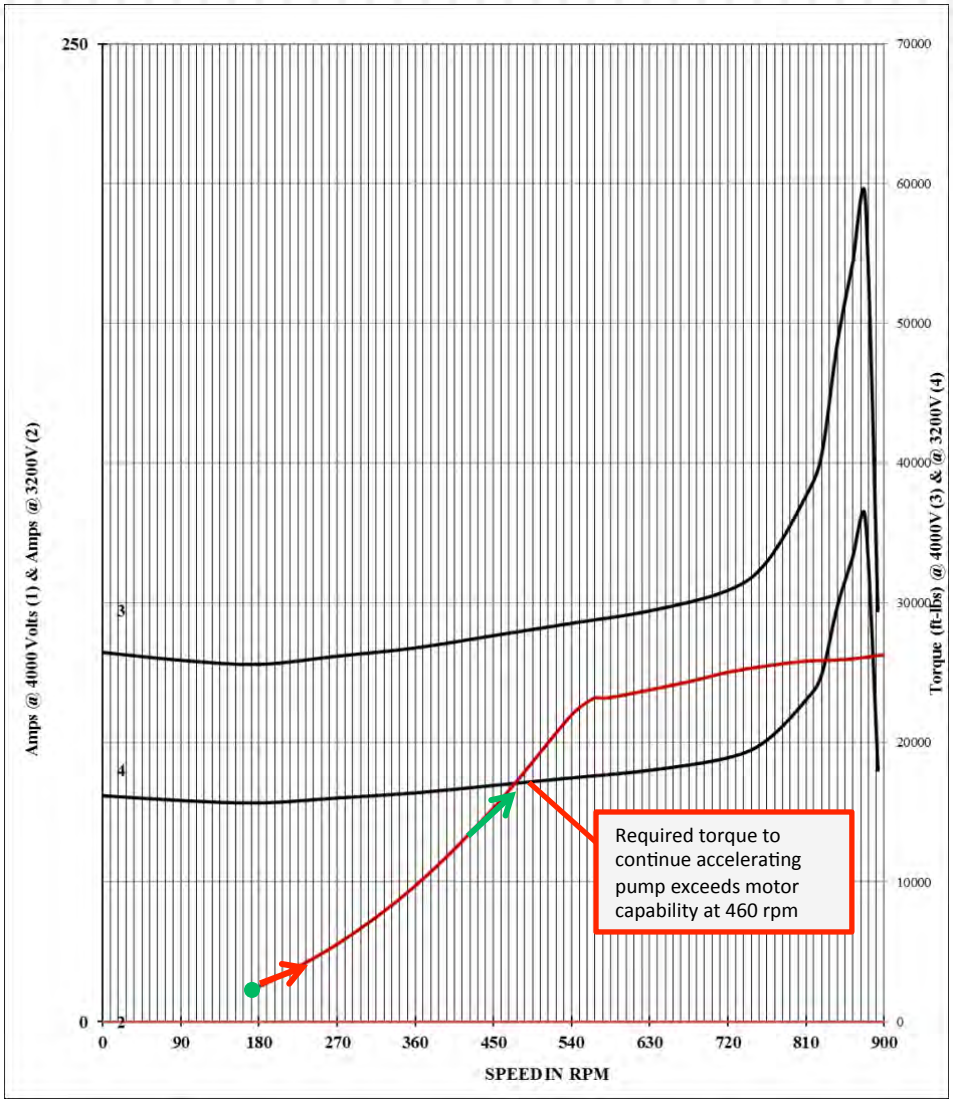
Surprise - Vertical Pump has unique load curve



- Curve has 2 distinct portions:
  - Priming
  - Pumping
- Much higher torque at lower speeds.
- “Standard” 5000 HP motor electrical design will not start this load

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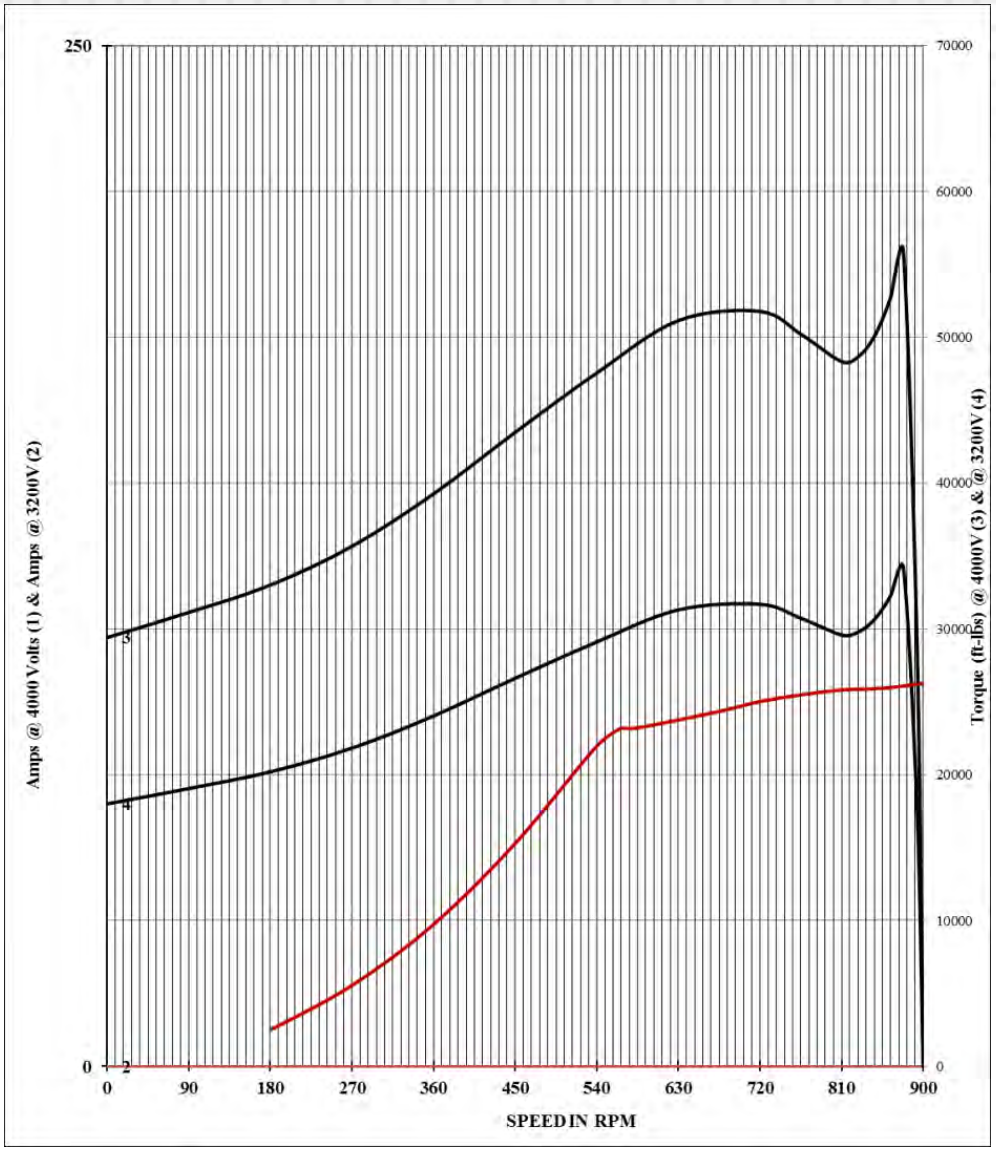
How to proceed?



- If this new load curve is to be started across the line, we need more torque at lower speeds
  - Requires custom motor
  - Double cage
  - Custom rotor bar
  - Expensive and long lead time
- Downside: Across the line starting has significant inrush (even at reduced voltage) generating significant heat losses in the motor
- Result: Motor has limited number of starts per hour
  - Not ideal for critical applications

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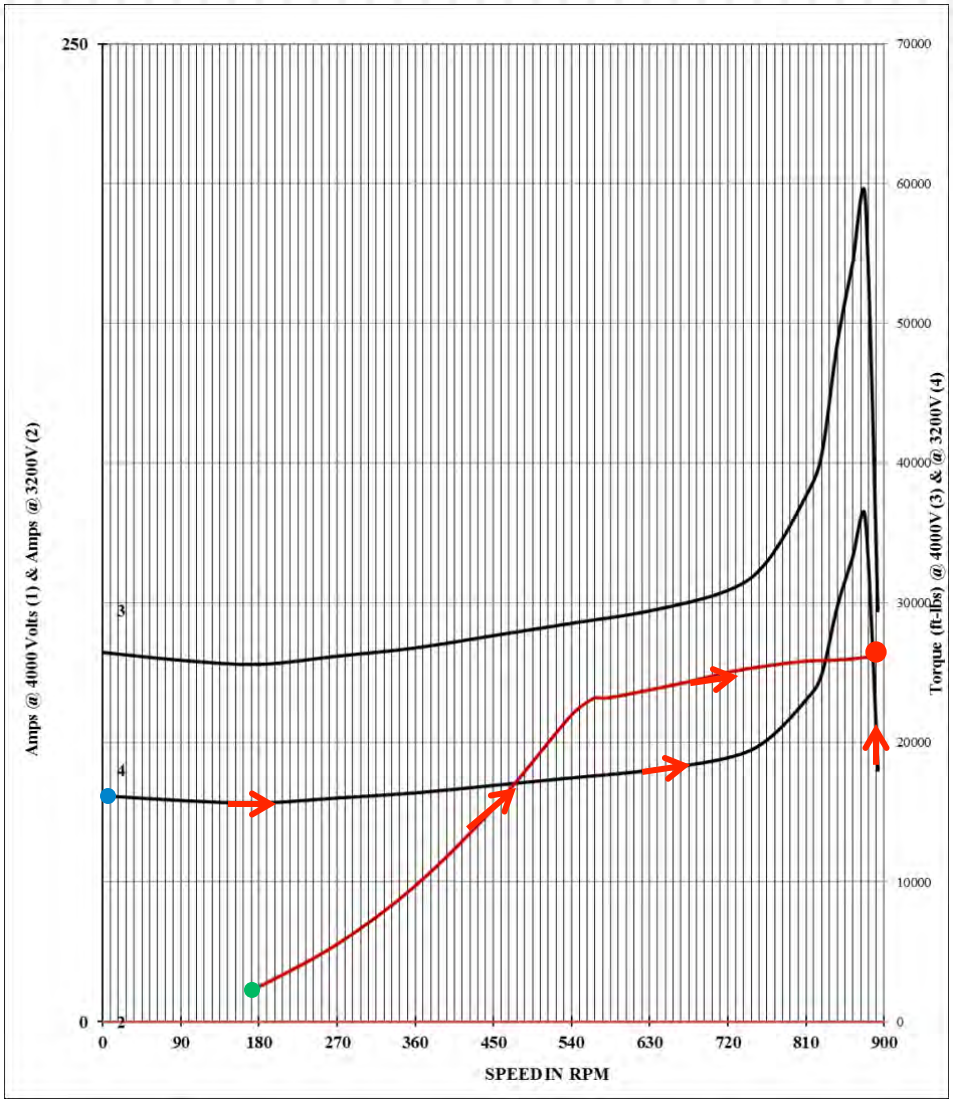
Gearmotor with CST Clutch



- Motor is started unloaded and reaches design speed
- As clutch engages, the torque backs up the curve
- Full breakdown torque is available to accelerate the pump
- Motor can provide multiple starts (not as limited)
- Standard, less expensive motor can be used

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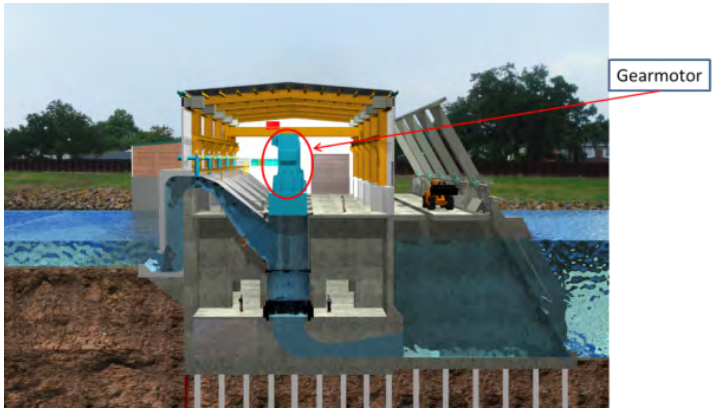
Flood Control Pump Project - NOLA

- Permanent Canal Closure Project (PCCP)
- Gearmotors supplied:
  - 10 x 5,000 HP Gearmotors – Size 5
  - 7 x 2,500 HP Gearmotors – Size 3



Total system capacity ….17 Vertical Gearmotors
24,200 cubic feet per second
Over 15 billion gallons per day

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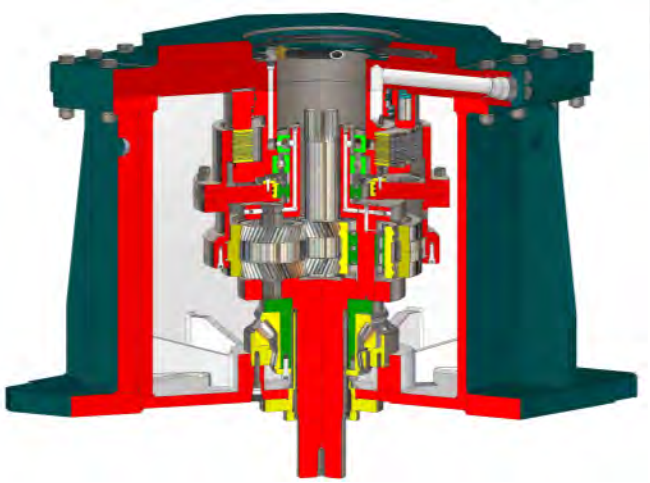
Summary

Benefits versus high pole vertical motors

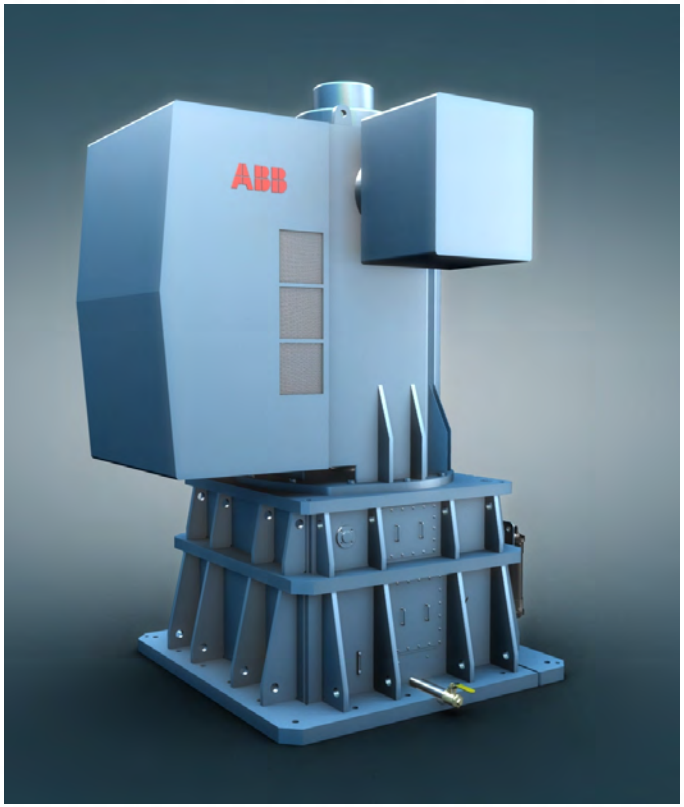
- Lower capital cost – Typically 10 % to 45% vs low speed motors.
- Higher efficiency using low pole induction motors
- Better power factor than high pole induction motors
- Smaller physical size reduces facility requirements
- Less weight reduces freight, handling and support structure costs
- Optimized pump speeds through gear ratios for system efficiency. Not limited to speeds defined by number of motor poles
- Simplified maintenance and better motor availability using standard 4-6-8 pole motors
- Thrust can be accommodated by the gearbox simplifying motor design. Lower system cost

Summary

Added benefits of VGM with CST clutch



- Minimize intake and piping damage
  - (controlled start reduces water hammer)
- Reduce total cost of ownership
- Reduce vibration with controlled start
- Improve uptime, availability, and reliability
- Enable start up of high torque pump with standard motor
- Motor starts are unloaded – easy on power grid
- Allow for multiple pump starts



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Q&A

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