

VARIABLE SPEED DRIVE (VSD)

Rod Pump & Progressing Cavity Pump Applications

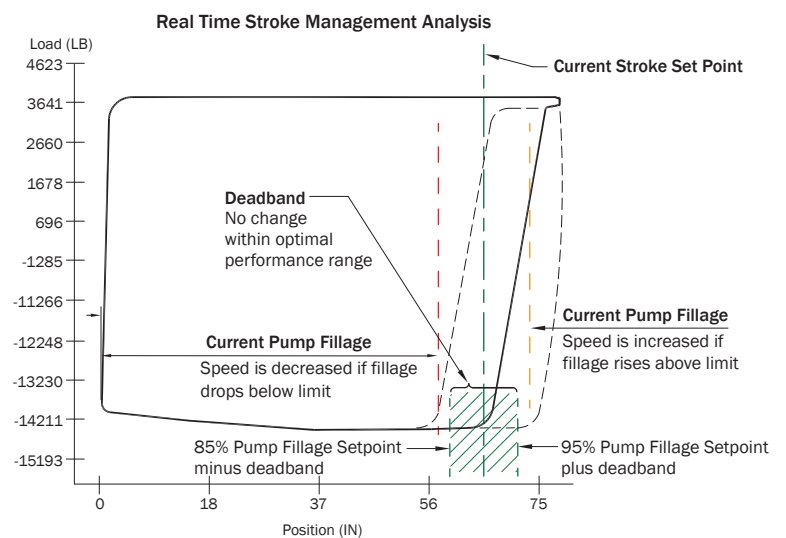
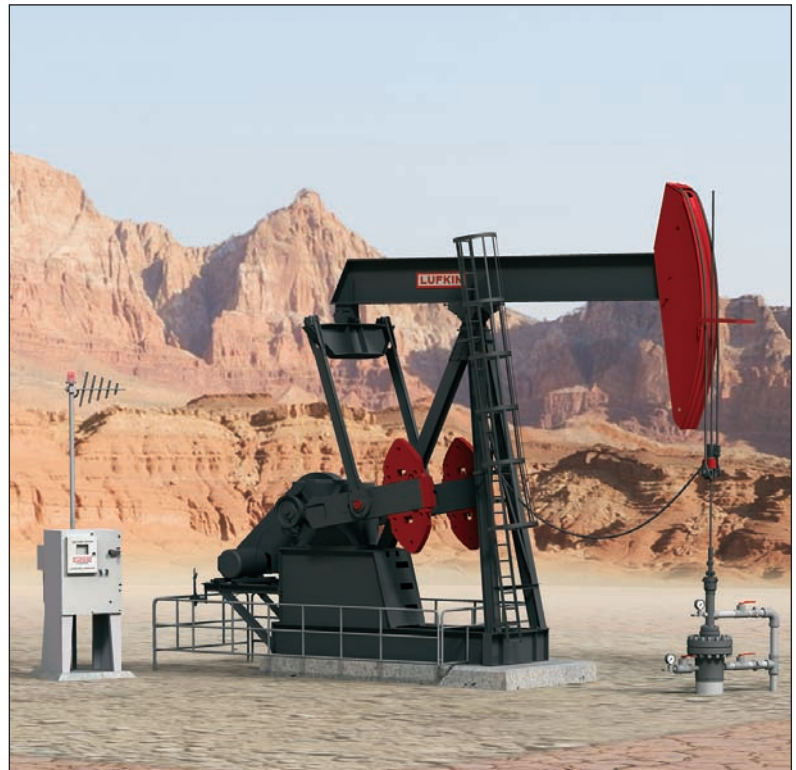
The Lufkin Well Manager (LWM) with Variable Speed Drive (VSD) adjusts the pump rate to match the well's conditions on every stroke, based upon the previous stroke. This level of ease and control provides customers with peak production while reducing their maintenance and overall operating costs.

The VSD controller is fully integrated through the LWM, eliminating the need for cumbersome setup. Everything is designed to make the operator's job easier. The LWM's Quick Start programming method allows the user to simply enter a few parameters to get the system up and running. Auto-tuning has never been simpler. The LWM takes over the task, eliminating the need to perform a motor disconnect and reconnect. Control and access to all of the LWM's features are available through the LWM keypad or SCADA interface.

Ideal for environments where your well can't be shut down:

- ✓ Sanding/ pump sticking problems
- ✓ Heavy crude production
- ✓ Steam flood operations
- ✓ Situations where shutting down would adversely affect production operations
- ✓ Speed changes without replacing sheaves

Mechanical limits and difficult pumping applications can present real challenges with equipment down-time. The VSD is developed with equipment protection and preservation in mind. By slowing a unit just enough to avoid working load violations, the VSD can help manage rod float problems and peak rod load issues with heavy oil. The LWM continually monitors the equipment and production providing the best response when a malfunction is detected. In such an event, user presets stop the pumping unit or reduce the pump rate to a predefined minimum speed. These advanced features all work together to protect both your equipment and overall investment.



The LWM continually monitors, analyzes, records and adjusts the pump speed to match any variations within the well.

Features & Benefits

- **Configuration flexibility.** The LWM VSD is an intelligent control system that integrates smoothly with RPC or PCP. This combination replaces the traditional contactor box and provides everything in one enclosure.
- **Factory-tested integration.** The Lufkin combined package of the LWM and the VSD in the same cabinet has been fully integrated and tested for compatibility. The combined package, with enhanced features, provides for simpler field installation, better service support and an assurance that the pre-wired, factory-tested cabinet has already addressed any interference issues.
- **Simplified setup.** Setup is simplified because most parameters are properly defaulted. Only items such as motor parameters need be entered.
- **Optional heater kit.** For cold climates, the LWM VSD features a thermostat-controlled heater.
- **Optional bypass contactors.** With the optional bypass, the LWM unit can detect a drive fault through Modbus communication or digital input. The user can program the delay time, and whether or not the LWM should switch automatically to normal downhole- or surface-operation mode and continue pumping the well at line frequency, cycling the well on and off at pumpoff. If not, the LWM unit will retry the allowed number of times prior to arriving at a malfunction state that will require user intervention.
- **Optional dynamic braking.** Negative torque load can occur due to normal variability in unit balance and well conditions. Thus most LWM VSD installations will benefit from a dynamic brake resistor. These assemblies dissipate excess regenerated power to keep the bus voltage from exceeding the rated limit of the drive.
- **Connect to existing NEMA D or B motors.** The VSD can operate an existing induction motor, thereby reducing installation costs associated with purchasing a new motor.
- **Optimized production and pumpdown.** Downhole or surface pump fillage is the basis for controlling speed to optimize production and pumpdown. The normal speed control algorithm is based on a programmed starting speed, and increases or decreases in speed are determined on every stroke from the dynamometer pump card.
- **Programmable upstroke/downstroke speed.** Downstroke speed can be programmed as a percentage change from the upstroke speed, and the point in the stroke at which the speed change occurs is also programmable.
- **Working-load limits for speed limiting.** If a peak or minimum working-load limit is exceeded (e.g., due to paraffin buildup or low flowline temperatures), the normal pump-fillage-speed control is overridden, and the speed is reduced in steps. On each stroke that a violation occurs, the speed is slowed an additional increment, until the violation no longer occurs. In this manner, production is optimized within the mechanical load limits established by the operator.
- **Stop on malfunction or run at minimum speed.** If any of the safety-limit violations occur, the operator has the option to continue operating at minimum speed or to stop the pump. When stopped or running at minimum speed, the unit is placed in a downtime state for the programmed downtime period. When that period expires, the unit will attempt to start up normally.
- **Optional harmonic filters.** Passive filters and active filters are offered as an accessory to reduce harmonics below 10%, thus resulting in cleaner power consumption.
- **Rod-float mitigation.** The rod-float mitigation feature provides options for minimizing or eliminating rod float on wells that experience this phenomenon. The unit is slowed when rod load drops below a programmable threshold.
- **Peak-power limiting (programmable peak torque).** In a steam-flood or steam-cyclic operation, the well cools with time, and the peak load and peak power increase with time. The LWM can be programmed with an overall peak-torque limit to protect equipment (e.g., from thermal motor overloads) and keep it operating within the limits of the system.
- **Convenient Modbus master programming and monitoring.** A keypad and LCD give the operator a way to program and monitor VSD via the LWM unit which is capable of Modbus master communications, using RS-485. This has been customized for the Lufkin VSD application so that all normal drive programming can be accomplished through the LWM keypad, or via host, thereby providing a unified interface.
- **Speed plot for 24 hours (1 minute sampling).** Speed changes during the day can be viewed with the 24-hour speed plot to view production optimization effectiveness.



Variable Speed Drive Specifications

| | | |
|---------------------------------------|--|--|
| Power Rating | 10–150 HP, 7.5–112.5 kw | |
| Power Supply | Voltage | 460 V (+10%, -20%) or 600 V (±10%) |
| | Frequency | 50/60 Hz (±5%) |
| | Phase | 3 Phase or Single Phase (Derated to 50%) |
| Rated Output | Voltage | 0 to Max input voltage |
| | Frequency Range | 0.01 – 500 Hz |
| Overload Current Rating | 150% for 60 seconds, 165% for 2 seconds | |
| Dynamic Braking Circuit | Built-in IGBT 7, External Option | |
| Motor Control | Sensorless Vector or V/Hz | |
| Protection | Built-in surge protection that meets UL 1449, Rev 3 | |
| Built-in Filter | 460 V 10-150 HP: Built-in EMI noise filter (EN5501 Class A, EN61800-3 category 3 compliant) | |
| Built-in DC Link Reactor | 460 V 25-100 HP (18.5-75 kW): Built-in DC Reactor | |
| | 460 V 125-150 HP (90-112.5 kW): Attached DC Reactor | |
| Cooling Method | Forced Air | |
| Ambient Temperature/Relative Humidity | -40 to 60°C (derate above 50°C), 0–95% relative humidity, non-condensing (as integrated package) | |
| Enclosure | NEMA 3R | |
| Altitude | Full output to 1,000 m (3,281 ft) elevation (Derate 1% for each additional 100 m (328 ft)) | |

General Specifications

- 2500+ status registers (e.g., SPM, peak/min. load, RPM, pump fillage)
- Inferred production tracking (today, 60-day history, programmable oil cut, account for pump leakage)
- Graphical LCD with keypad
- Surface and downhole dynagraph cards
 - Real time
 - 5 recent stored cards
 - Startup card
 - Pumpup card
 - Last two shutdown card groups (5 cards each)
 - Standard card
- Standard LWM communication (laptop, radio, cell phone)
- Standard 60-day plots (inferred production, runtime, peak/min. loads, polished rod horsepower)
- Last 400 point load plot
- Accurate polished rod load cell or beam transducer load input
- Accurate motor/crank hall-effect or inclinometer position input
- Valve check/pump leakage diagnostic
- Notepad
- Advanced RTU features
 - Expanded I/O capability (w/alarms)
 - Logic expression
 - Register logging
 - Register digital output/alarms
 - Register calculator
 - AGA 3/NX-19 gas flow calculation
 - Well state alarms and logging
 - Accumulator support
 - Event logs (time stamped events, shutdown log, and alarm log)
 - Coil tracking
- Complete unit can replace an existing contactor box or be used by itself for motor control on a new installation.

Dynamic Braking Resistor

The mechanical loading of a typical reciprocating pumping unit is highly cyclical. Torque loads measured at the gearbox fluctuate from positive to negative within a pumping cycle. For part(s) of every stroke, the pumping unit actually drives the motor, causing the motor to briefly act as a generator.



Lufkin has the optional dynamic braking kits (DBR) in a NEMA 3R enclosure to fit your application. These DBR packages include cooling fans and a thermal protection circuit should the DBR overheat. The DBR packages are field-installed on top of the VSD cabinet.

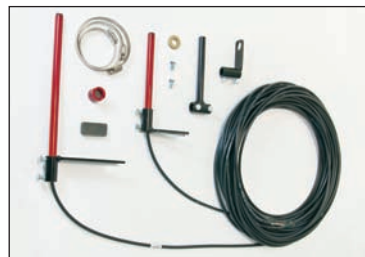
| VSD HP | Ohms | Watts |
|---------|------|-------|
| 10-25 | 21.6 | 6400 |
| 30-50 | 14.7 | 6400 |
| 60-75 | 6.0 | 6400 |
| 100-150 | 3.9 | 12800 |

LWM Rod Pump Control Accessories

Lufkin Automation offers RPC transducers to work with the LWM for all the different pumping unit types. The transducer selection allows the user to choose the accuracy of the system and consider the long-term maintenance requirements. Each transducer is designed to interface with Lufkin RPCs and is manufactured to Lufkin's quality standards.

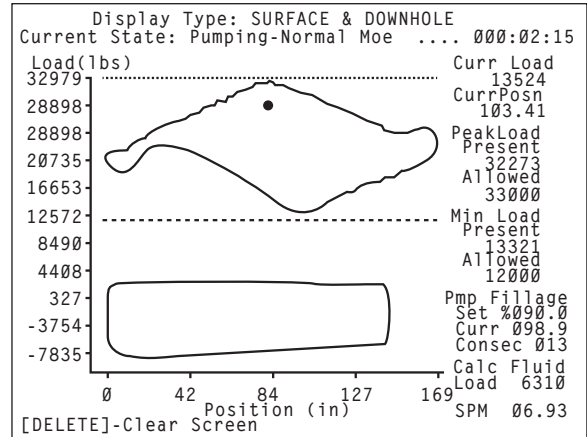


Standard Load Cell



Motor and Crank Hall Effect Transducers

Real-Time Dynagraphic Cards



Sample Status Screen

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RPC Ver. 6.14 CS: 06206EC1 07-25-2011 14:02
RPC Status Screen
RTU Address 0145
Current Well State Pumping-Normal Mode
Elapsed Time 00:07:17
Control Mode VSD-DH
Operation Mode Normal
Minimum Pump Strokes 005
Downtime 00:05(hh:mm)
Guage Off Time(GOT) 00:00
Run Yesterday 100 % 24:00 (hh:mm)
Run Since GOT 099 % 14:10 (hh:mm)
Liquid Oil Water TBGas
bb1s bb1s bb1s mscf
SWT Since GOT 0149.8 0134.9 0014.9 112.5
Yesterday SWT 0235.7 0212.2 0023.5 172.8
Inst SWT (per day) 0277.7 0250.0 0027.7 175.7
Projected SWT (per day) 0251.0 0225.9 0025.1 188.6
Pump Fillage 089.57 %
Pumping Speed 06.94 spm
VFD Speed Command 0050.0 Hz
VFD Output Speed 049.93 Hz
LUFKIN AUTOMATION [NEXT] Next Screen
    
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Quick Start

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RPC Ver. 6.14 CS: 06206EC1 07-25-2011 14:02
VSD PARAMETERS
VSD Drive Type Lufkin LFKA-1
Speed Output A01
Maximum Speed (RPM) 0090
Minimum Speed (RPM) 0000
Deadband +/- 003.00
Speed Change Stroke Delay 002
Start Up Speed (% of Full Scale) 020
Speed Increase Size (% of Full Scale) 005
Speed Decrease Size (% of Full Scale) 015
Working Peak Load Limiting (lbs ) 50000
Working Min Load Limiting (lbs ) 0
Working Peak Speed ( Hz) 0050 7.0 SPM
Working Min Speed ( Hz) 0032 4.5 SPM
Protection DT/Malfunction Control VSD/VFD OFF
Enable Disable Up/Down Stroke Speed DISABLED
Regenerative Torque Control DISABLED
[NEXT]-Next Screen
LUFKIN AUTOMATION Tel. No. (281)-495-1100
    
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