

WellSim Control System

(type WS-CS-VFD-DB-380SH54-30-I2-BPRFUZ-IF)

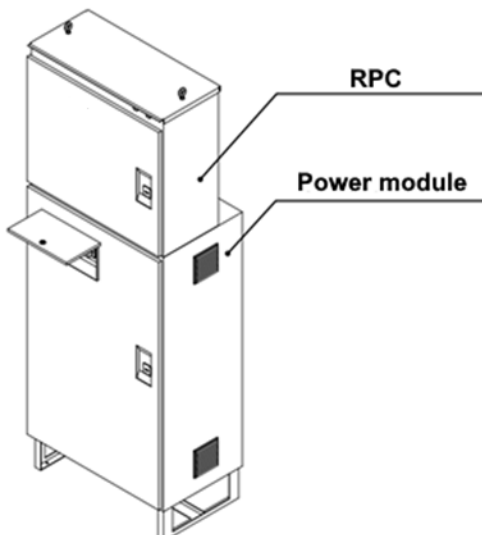
WellSim control station is customizable system designed to control sucker rod pumps (SRP unit). This is a system application that is developed to significantly reduce costs and increase oil production.

WellSim controls and diagnoses SRP unit and well condition, calculates flow rate without need to install additional flow meter, builds and analyzes dynagraphs, accounts electricity consumption, collects statistics, provides remote SRP unit management and data acquisition by SCADA system, prevents malfunctions, displays dynagraphs and other SRP unit operating parameters in a convenient graphical form on touchscreen, retains 180-day history parameters which can be assigned to SCADA system.

Main feature of WellSim is modular structure, that allows to customize it in wide range by installing additional protective, telecommunication, HMI and functional devices. Modular structure of the system allows to find a solution for any customer's needs and operating conditions.

WellSim is compatible with defined set of options, however there is an opportunity to install additional devices by agreement.

WellSim control panels are designed for harsh environment. It is easy to install and maintain. Durable casing protects electrical components from unauthorized access and vandalic activity.



Features:

- Modular structure that allows to alter configuration to match customers` needs
- Flexible management of SRP unit in real-time mode
- "Digital Technologist" Artificial Intelligence System, which diagnoses malfunctions and corrects the results of calculations
- User-friendly multilingual GUI
- Precisely measured (not simulated) values of load and position
- SRP unit equipment diagnostics in real time, measuring load on components
- Large number of Protection, telecommunication and local interface options
- Electrical parameters control
- Integrated VFD
- SCADA integration
- Secondary manual control
- RPC unit motor protection
- Reduced SRP unit equipment wear
- Detailed work history and event logs for a long period of time
- Dynamic calculation of leakage
- Wide operating temperature range

Basic specifications

Operating temperature	-50°C to +70°C
Humidity	10-90% non-condensating
Protection	IP54
Casing	Full metal segmented enclosure, vandal proof, separated access
Processor	667 MHz
RAM	1 Gb
Nonvolatile memory	512 Mb
HMI	Manual controls panel
SRP unit equipment protection	Maximum/minimum load, Low fluid load, Pump-off, Load span, Against electric grid failure, Staff protection from electric shock.
Ports	1xRS232, 2xRS485, 1xEthernet, 1xUSB, 16 digital inputs, 12 digital outputs, 8 analog inputs, 2 analog outputs
Protocols	TCP/IP, Modbus RTU, ASCII
Ethernet	10/100 Mbit/s
Compatibility	NaftaSCADA, XSPOC and other SCADA
GUI	Web-based, windows/linux/macOS compatible, LabView compatible
Nominal power	30 kW

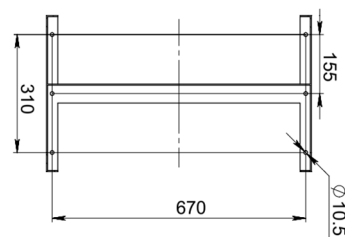
Segmented structure

WellSim consists of two modules in separated casings and can be supplied separately.

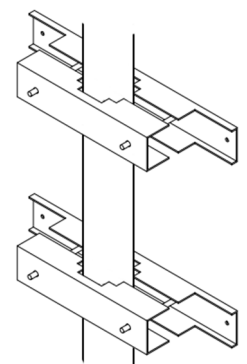
RPC module contains low-voltage control circuits and HMI elements on front panel. Controller module can work as part of third-party systems.

Power module contains hi-voltage power equipment, that can be accessed only by personnel with special training. In configurations with magnetic starter serves as SRP motor control device.

RPC is an independent device designed to work with the customer's power equipment. RPC can be installed on the roof of the power unit or on a pole.



Power module installation dimensions



RPC installation on a pole

Electrical parameters control

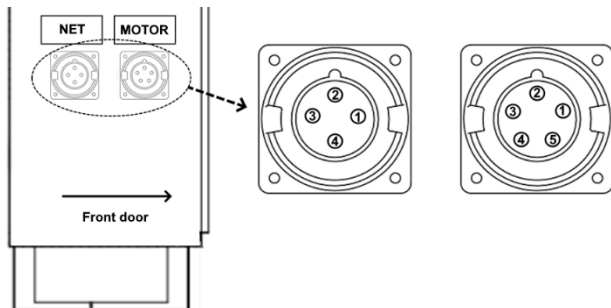
WellSim uses a wide range of devices to collect information about the condition of electrical equipment of a well. The mathematical apparatus makes it possible to use for these purposes' complex devices such as VFD, network controller or electricity meter, and simple single sensors of the rotor speed or current on the motor.

WellSim constantly monitoring:

- Motor current (total and individual phases)
- Voltage (line-to-line)
- Motor torque
- Motor efficiency
- Motor speed
- Motor temperature
- Consumed electricity
- Coefficient of balance of the structure in terms of current consumption

The instantaneous value of the current can also be used as a malfunction setpoint.

Connectors



«Net» connector

«Motor» connector

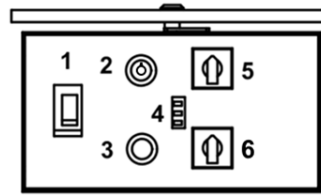
pinout

pinout

Pin	Net
1	Phase A
2	Phase B
3	Phase C
4	N

Pin	Net
1	Phase A
2	Phase B
3	Phase C
4	N
5	GND

Manual controls panel



- 1 – Automatic protection circuit breaker (main); 2 – Manual frequency setting potentiometer; 3 – Emergency stop button; 4 – Phase indicator; 5 – "Manual"/"Automatic" mode switch; 6 – "VFD/Direct start" mode switch

VFD

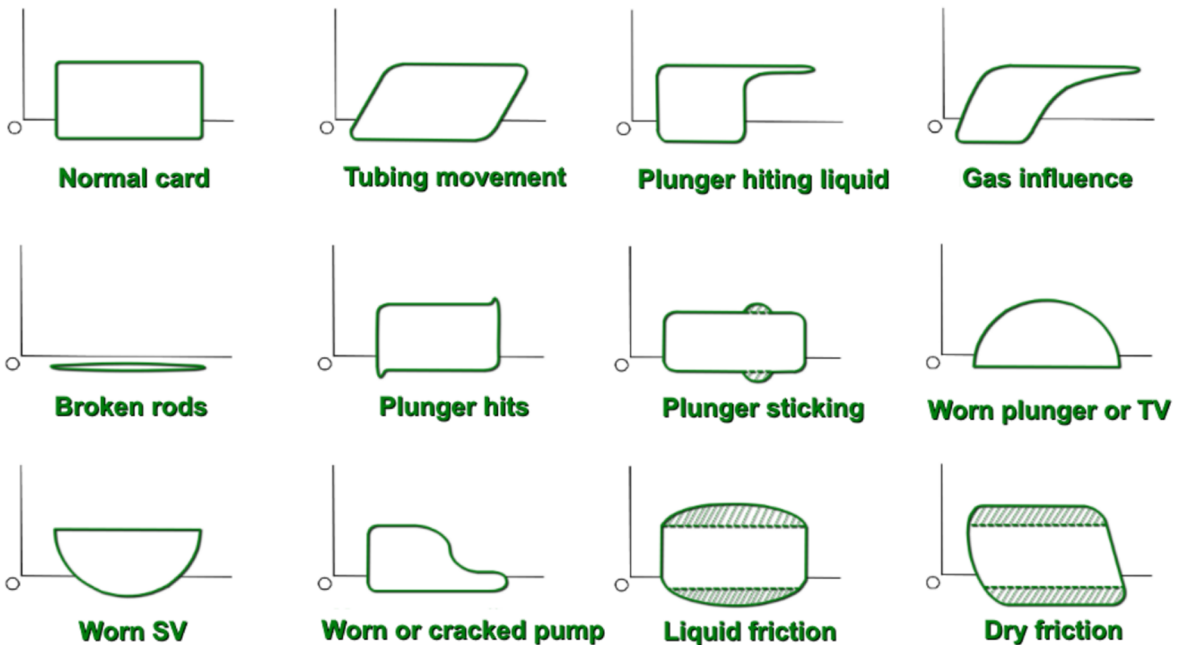
When equipped with VFD, WellSim's capabilities expand significantly. The control modes, instead of stopping for accumulation, will set a lower rotation speed for the electric motor, allowing to achieve continuous well operation.

WellSim has the ability to adjust the speed of the motor during one crank rotation, allowing to soften the impact of the plunger on the liquid.

VFD frequency converter also provides additional monitoring and motor protection.

Power range	30 KW
Protection	IP54
Protocols	RS485, USB
Variable switching frequency	1,5-16 kHz
Over voltage control	+
Supply voltage	200-240, 380-500, 550-600, 525-690 V
Supply frequency	50/60 Hz
Displacement power factor	>0.98
Output voltage	0-100% of supply voltage
Output frequency	0,2-1000 Hz
Humidity	5-95% class 3K3 (non-condensing)
Aggressive environment (IEC 721-3-3)	3C3
Max temperature	55°C

"Digital Technologist" Artificial Intelligence Module



WellSim uses artificial intelligence for early identification of malfunctions by the shape of a dynagraph card.

The neural network is trained on tens of thousands of real dynacards and recognizes malfunctions with an accuracy of at least 95%, even if the malfunction patterns are interfering with each other. In case of incorrect input of technological parameters by the operator, the module also issues a warning.

The "Digital Technologist" also determines the opening point of the traveling valve and the liquid load values to correct the controller's calculations, which allows to determine the optimal operating mode and achieve an accuracy of $\pm 1.5\%$ in calculating the pump flow rate and filling.

SRP unit management modes:

- **Automatic control of SRP unit by pump fillage (Sim-Fillage)**

WellSim by using real-time model of the well determines percentage of pump fillage. In Sim-Fillage mode WellSim disables SRP unit for certain time when pump fillage percentage reaches control setpoint. Simultaneously with control by pump fillage, WellSim controls SRP unit by emergency setpoints.

- **Automatic control of SRP unit by pump intake pressure (Sim-PIP)**

WellSim by using real-time model of the well determines value of pump intake pressure. In Sim-PIP mode WellSim disables SRP unit for certain time when pump intake pressure reaches control setpoint. When pump intake pressure is low, pump fillage will diminish in the process causing SRP unit to operate inefficiently. Simultaneously with control by pump intake pressure, WellSim controls SRP unit by emergency setpoints.

- **Automatic control of SRP unit by timer (On/Off Timer)**

When operating in timer mode, WellSim starts and stops SRP unit motor with a strictly defined interval. In this mode SRP unit operate and idle in time intervals determined by user. Simultaneously with control by timer, WellSim controls SRP unit by emergency setpoints.

- **Automatic control of SRP unit according to schedule**

Schedule mode allows to customize the schedule of shutdowns and starts of SRP unit. Simultaneously with control by schedule, WellSim controls SRP unit by emergency setpoints.

- **“Host” mode**

Host mode allows to manage SRP unit remotely by SCADA. This mode can be set independently from the others, and allows user to control SRP unit remotely as well as on-site.

- **Manual mode**

Manual mode prohibits WellSim to interfere with the SRP unit functioning. In this mode WellSim continues to collect and store data about SRP unit operations, that data can be provided to user on-site or remotely by SCADA.

- **Emergency setpoints**

Emergency setpoints mode is part of all other modes except manual mode. When emergency setpoint reached, WellSim counts continuous violations and after predetermined number of violations is reached shuts down SRP unit, trying to restart it after predetermined delay, and if it still reaches emergency setpoints, control station shutting down motor and alerts dispatcher and repair crew about malfunction.

- **LC-less mode**

WellSim allows to use information received from a motor control device or an electricity meter for calculations, allowing to work without a load cell with an acceptable decrease in calculation accuracy.