

3R VALVE CONTROL VALVE ASR CONTROL NARRATIVE

PART 1 - GENERAL

- 1.1 Introduction: The following information describes the 3R Valve ASR Well Control Valve System.
- 1.2 Supplemental Information: 3R Valve, LLC Control Valve P&ID (Process & Instrumentation Design) Schematic.
- 1.3 Definitions:
 - A. "ASR": Aquifer Storage and Recovery.
 - B. "HMI" is the Human Machine Interface. This is the component mounted in the face of the Local Control Panel containing text and graphics.
 - C. "PLC" is the Programmable Logic Controller. PLC's contain the control algorithms that accomplish the actual operation of the 3R Valve Control Valve. The Operator can communicate with the 3R Valve PLC via Ethernet or PLC I/O.
 - D. "H-O-A" is the HAND-OFF-AUTO selector switch (maintained) located in the face of the 3R Local Control Panel. In the HAND position, the Operator has control of the system via the "OPEN-CLOSE" selector switch. In the AUTO position, the 3R Valve system is controlled via a PLC located in the 3R Valve Control Panel.
 - E. "OPEN-CLOSE" selector switch (spring return to center) is in the face of the 3R Valve Local Control Panel. The Operator has manual control of the 3R Control Valve.
 - F. 3R Control Valve is placed during well column installation by 3R Valve, LLC.
 - G. "Well Pump" is provided by others and is NOT provided by 3R Valve, LLC.
 - H. Valve Block Actuating Solenoid, "FCV-1" is a 2 position actuating solenoid valve mounted on top of the Hydraulic Reservoir, "HR-1". The Valve Block Actuating Solenoid's purpose is to direct the Hydraulic Fluid flow and is controlled via an electrical connection from the PLC. Hydraulic Reservoir, "HR-1" is the reservoir containing hydraulic fluid.
 - I. Hydraulic Linear Piston, "P-0" is the OPEN hydraulic linear piston. Hydraulic Linear Piston, "P-C" is the CLOSE hydraulic linear piston.
 - J. Linear Potentiometer, "ZS-1" is the linear position feedback to the 3R Valve PLC for the position of the OPEN Hydraulic Linear Piston, "P-0".
 - K. BTOC : Below Top Of Casing.
- 1.4 3R Valve Skid PLC I/O:
 - A. Discrete Inputs:
 - HPU Running
 - HPU Fault
 - System in Auto
 - System in Hand
 - Power Loss
 - B. Discrete Outputs:
 - HPU Motor Call to Run
 - Open Solenoid Call to Open
 - Close Solenoid Call to Close
 - C. Analog Inputs:
 - Open Hydraulic Pressure (0-3000 PSI) : 4-20 mA
 - Close Hydraulic Pressure (0-3000 PSI) : 4-20 mA
 - Downhole Control Valve Feedback Position (0-100%) : 0-20 mA
- 1.5 Setpoints via HMI (Data Type: Integers)

- A. Well Pressure Setpoint (PSI)
- B. Well Pressure Setpoint Deadband (PSI)
- C. Well Flow Setpoint (GPM)
- D. Well Flow Setpoint Deadband (GPM)
- E. Well Level Setpoint (FT BTOC)
- F. Well Level Setpoint Deadband (FT)
- G. Open Hydraulic Pressure Cutout (PSI)
- H. Open Hydraulic Pressure Cutin (PSI)
- I. Closed Hydraulic Pressure Cutout (PSI)
- J. Closed Hydraulic Pressure Cutin (PSI)
- K. Open Interval (Sec)
- L. Open Duration (mSec)
- M. Close Interval (Sec)
- N. Close Duration (mSec)
- 1.6 Control Buttons Via HMI / OIT
 - A. Valve fully closed button – Valve Calibration.
 - B. Valve fully open button – Valve Calibration.
 - C. Start / Stop Injection
- 1.7 Injection Interlocks / Permissives
 - A. 3R Valve System Not in Auto.
 - B. 3R Valve HPU motor Not Faulted.
 - C. 3R Valve open pressure transducer out of range.
 - D. 3R Valve closed pressure transducer out of range.
 - E. 3R Valve HPU motor running too long.
 - F. Power loss.
 - G. Injection MOV not open.
 - H. Backwash MOV not closed.
 - I. Well water pressure transmitter out of range.
 - J. Injection flow meter out of range.
- 1.8 Trending Data Points
 - A. 3R Valve HPU open pressure.
 - B. 3R Valve HPU close pressure.
 - C. 3R Valve valve feedback.
 - D. Well level BTOC.
 - E. Well pressure scaled.
 - F. Well flow scaled.

PART 2—CONTROL PROCESS

- 2.1 System in OFF;
 - A. The Operator has placed the H-O-A selector switch in the ‘OFF’ position.
- 2.2 System in HAND;
 - A. The Operator has placed the H-0-A selector switch in the ‘HAND’ position.
 - B. The Operator can operate the control valve manually with use of the ‘OPEN-CLOSE’ selector switch.
 - 1. The HPU motor will start.
 - 2. A time delay relay set at one second will energize either the open or closed solenoid after the HPU has started.
- 2.3 PLC Loops:

- A. Downhole Valve Open Fully (Latch):
 - 1. If open hydraulic pressure is above Hydraulic Open Pressure Cut Out Setpoint.
- B. Downhole Valve Open Fully (Unlatch):
 - 1. If open hydraulic pressure is below Hydraulic Open Pressure Cut In Setpoint.
- C. Downhole Valve Close Fully (Latch):
 - 1. If close hydraulic pressure is above Hydraulic Close Pressure Cut Out Setpoint.
- D. Downhole Valve Close Fully (Unlatch):
 - 1. If close hydraulic pressure is below Hydraulic Close Pressure Cut In Setpoint.
- E. Well pressure plus deadband
- F. Well pressure minus deadband
- G. Well flow plus deadband
- H. Well flow minus deadband
- I. Well level plus deadband
- J. Well level minus deadband
- K. Downhole Control Valve Feedback Position.
 - 1. This instrument is calibrated (0-100%) via the HMI fully open button and fully closed button.
 - a. Fully Open Button moves PLC input bits into min scaling block.
 - b. Fully Closed Button moves PLC input bits into max scaling block.
- L. BTOC: This calculated value is used for yearly reporting, evaluating the performance of the well and controlling the backwash pump.
 - 1. Level scaled plus the length of the transducer cable from motor base plate to transducer.
 - a. Note: during startup the GC will be able to tell you this length.
- M. Motor Running Too Long.
 - 1. If HPU motor is continuously running for 20 minutes, alarm and turn of HPU motor.
 - a. This results where there is an issue building hydraulic pressure on either the open or closed circuits. Most likely from a loose fitting or hydraulic oil leak.
- N. Power Loss:
 - 1. The power from the panel has been de energized.
 - a. Start the HPU motor and provide a continual call to close command until the downhole valve is closed.

2.4 System In AUTO;

- A. The Operator has placed the H-0-A selector switch in the "AUTO" position.
- B. The PLC program shall control the operation of the downhole control valve.
 - a. Downhole control valve fully open vs closed
 - 1) If the valve is fully open, stop the call to open.
 - 2) If the valve if fully closed, stop the call to close.
 - b. Downhole control valve automation:
 - 1) Interlocks or permissives = OK.
 - 2) Start injection has been pressed via OIT.
 - Call to Open downhole control valve:
 - Well water pressure scaled plus deadband is above setpoint AND Well flow scaled minus deadband is below setpoint.
 - Start HPU motor.
 - After 1 second of HPU motor running

- feedback, energize the call to open.
 - Pulse the open per the open duration value setpoint.
 - Wait the open interval value setpoint.
 - If the well pressure plus deadband is still above setpoint AND flow minus deadband is still below setpoint, continue to provide another open pulse.
 - If the well pressure plus deadband is still above setpoint and flow minus dead is above setpoint, do not pulse.
 - Continue to run the HPU motor for 10 seconds in case of need to another correction.
- Call to Close downhole control valve :
 - Well water pressure scaled minus deadband is above setpoint OR Well flow scaled plus deadband is above setpoint.
 - Start HPU motor.
 - After 1 second of HPU motor running feedback, energize the call to close.
 - Pulse the close per the close duration value setpoint.
 - Wait the close interval value setpoint.
 - If the well pressure minus deadband is below setpoint OR well flow plus deadband is above setpoint, continue to provide another close pulse.
 - If the well pressure minus deadband is above setpoint OR well flow plus deadband is below setpoint, do not pulse.
 - Continue to run the HPU motor for 10 seconds in case of a need for another correction.