# WIRELESS WELLHEAD PID GAS FLOW CONTROL WITH FAILSAFE EMERGENCY SHUT-DOWN

Today's industrial wireless automation provides reliable Natural Gas flow control with failsafe backup shutdown.

## THE CHALLENGE

Troy Hebert is a Production Foreman from Progress Energy (a Canadian exploration and production company focused on natural gas development in the Foothills of northeast British Columbia and the Deep Basin of northwest Alberta). He was seeking a solution to save on trenching, direct burial wiring cost, and well pad startup time. McKi Wireless Solutions, an industrial automation solutions provider leveraging the latest wireless communications, was able to answer with the ideal solution.

## THE REQUIREMENTS

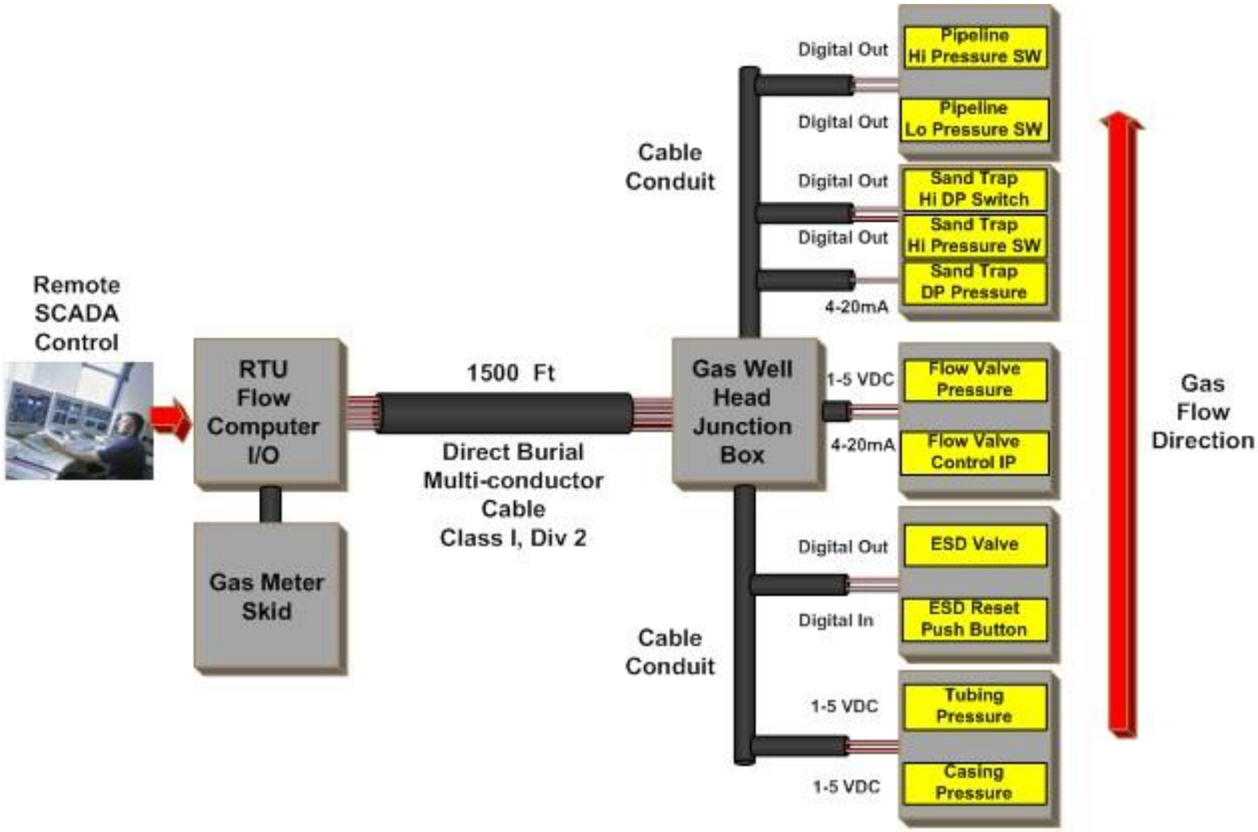
a. Design a gas flow control system, including Emergency Shut-Down (ESD).
b. Supervision of the construction, installation and commissioning of all the instrument and electrical components, and overall system design in compliance with all regulatory requirements, including Canadian Regulations for Oil and Gas Installations.
c. Each well site consists of a RTU natural gas measurement skid located approximately 500 yards from two to four wellheads with sand trap filters.

The functional specifications required Mcki Wireless to implement the following wellhead operational capabilities utilizing the industrial control concepts listed below.

- Remote SCADA gas flow control
- Remote SCADA ESD control
- Gas flow control with pressure override
- Pressure control with Sand trap DP override
- Local ESD reset
- Wellhead Casing and Tubing pressure monitoring
- Pipeline high pressure monitoring
- Pipeline low pressure monitoring
- Sand filter high pressure monitoring
- Sand filter differential pressure monitoring

To accomplish the above requirements, McKi wireless utilized the OleumTech Wireless System to replace the conventional hardwired gas flow rate control concepts. Leveraging the OleumTech wireless technology drastically reduced the initial cost by completely removing the need for long distance direct burial analog (4-20 mA) cabling. In addition, the Wireless Sensor Network System eliminated I/O analog to digital converter modules typically used in hardwired control instrumentation loops. All process variables such as temperature, pressure, and liquid levels are simply transmitted via RS Serial communication (Modbus) to and from the RTU Gas flow computer. McKi utilized the OleumTech DH2 Wireless Gateway that further reduced system complexity, cost of man-hour labor, and installation time. The block diagram below depicts a typical hardwired example of the functional specification listed above for a single gas well site.

## HARDWIRED METHOD

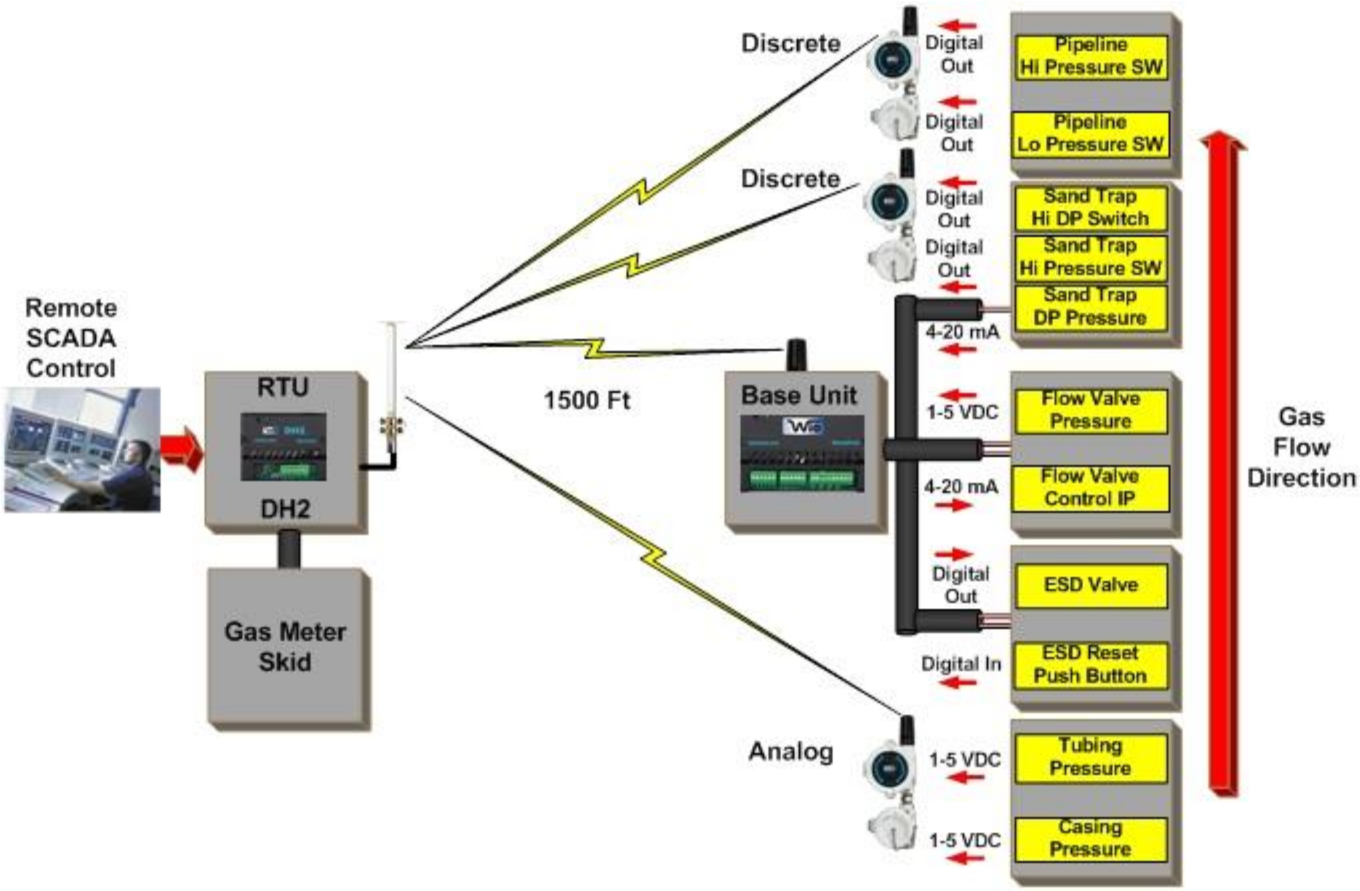



Typically, most hardwired flow control applications use a sensor to measure temperature, pressure, liquid level, or other variables, and convert the reading to a signal (typically digital, 1-5 VDC or 4-20 mA). Then, an RTU flow computer control algorithm calculates and transmits the output signal to a flow control valve IP. For example, in most homes there is a thermostat to turn on the heat when the temperature falls below the set point and then turn it off when the temperature reaches the set point. This results in the temperature changing above and below the selected set point. The same theory applies when controlling a flow control valve using mathematical algorithms that computes a change in the output flow rate measured by a RTU flow computer.

In order to comply with the functional specifications required by Progress Energy, Mcki Wireless designed the well pad sites to measure the gas flow or pressure process variable, comparing it to a set point and manipulating the gas flow rate in a way that maintains the set point when either the set point changes or a disturbance changes the process. This is achieved by utilizing Proportional Integral Derivative (PID) to control the gas flow valve and gas rate.

Mcki Wireless used an RTU that could read the wireless process variables via Serial communication, while utilizing the Modbus protocol OleumTech Wireless Gateways provide. By eliminating the I/O modules with computer-based memory locations containing IEEE floating-point representation of the process variables, they can support a much wider range of values with greater precision. In addition, if serial or wireless communication between the RTU, Wireless Gateway (connected to RTU), and wellhead Gateway are lost, the ESD valve would close automatically and the (PID) would revert from automatic control to manual and drive the output to zero making the process fail safe. In addition, once an ESD has been generated the process cannot be returned to normal until an operator arrives on site, solves the issue and initiates the ESD reset button similar to a hardwired control loop. Below is a block diagram replacing the hardwired concept with the OleumTech Wireless Sensor Network System.

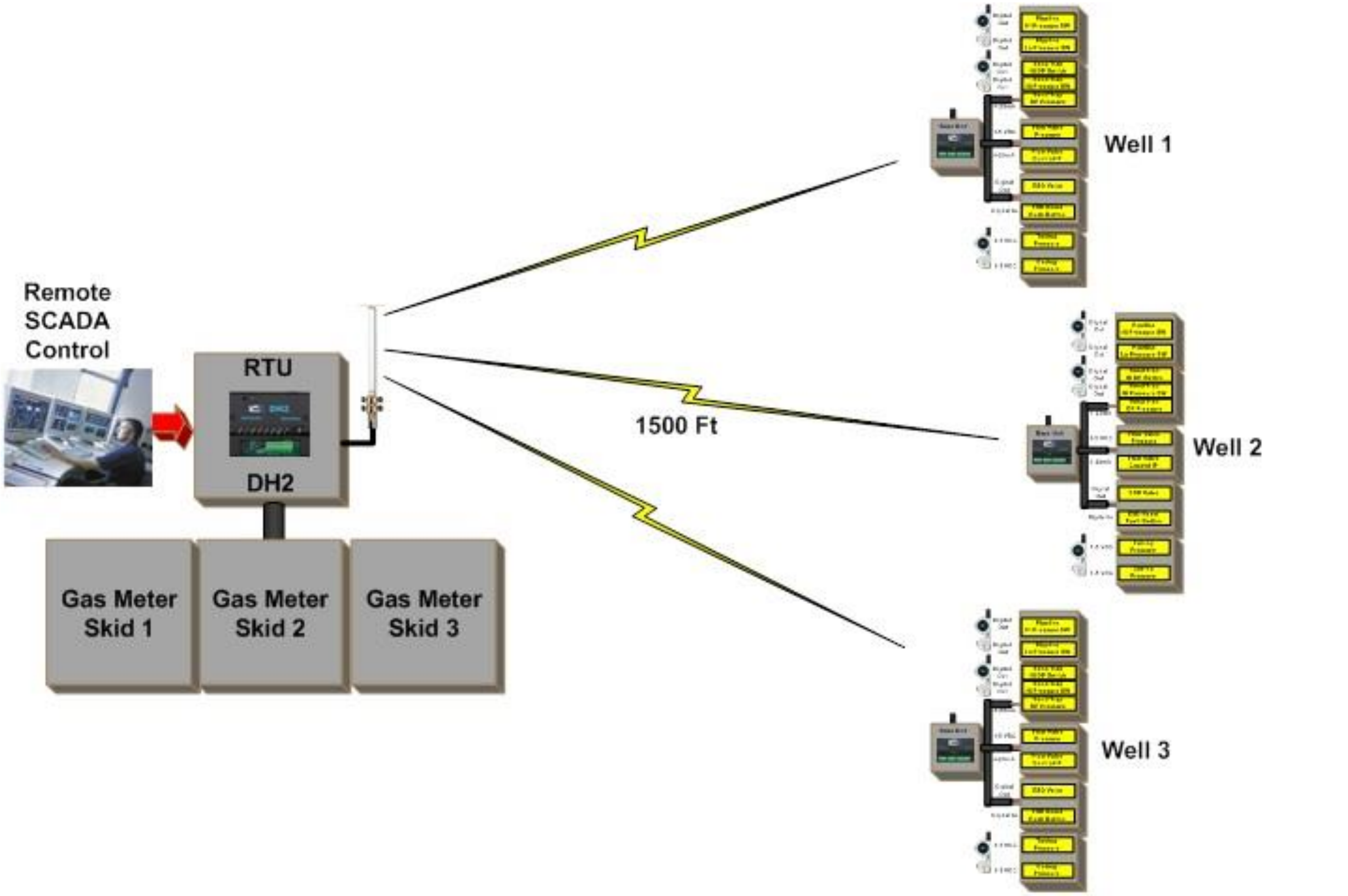
## WIRELESS METHOD



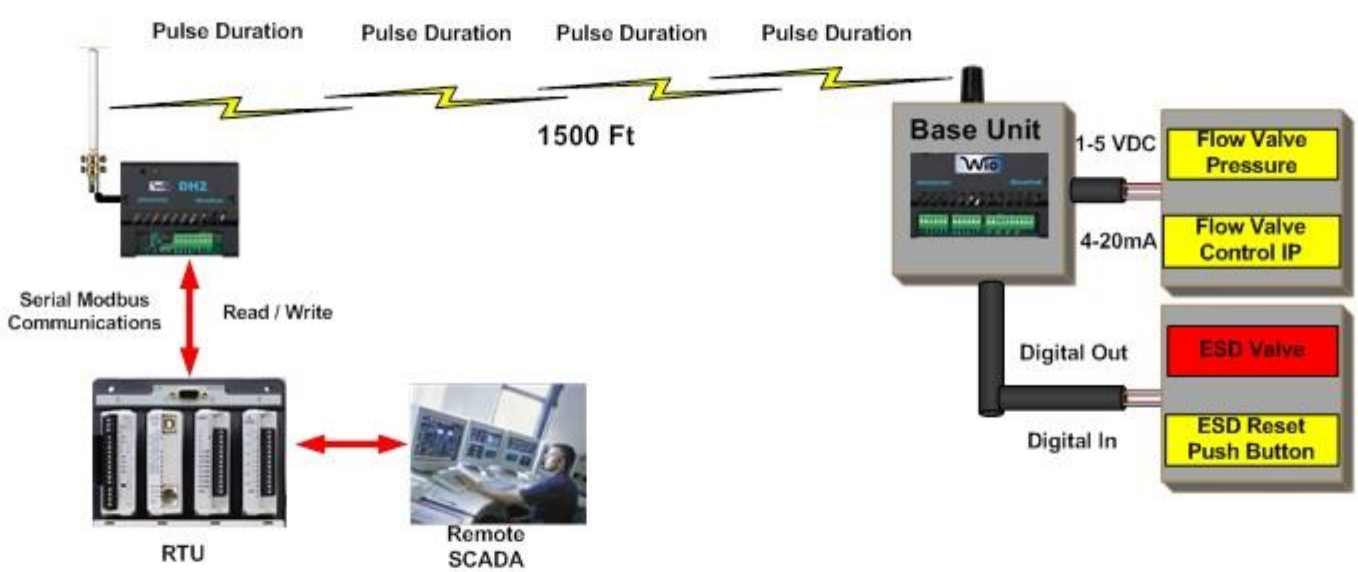

OleumTech Wireless Sensor Network System provides a low cost solution that eliminates links in the instrument loops. The cable and conduit that links the RTU to the wellhead instrumentation is eliminated. Control loop wiring and data cabling are usually in conduit or cable trays that age and fail over time. Direct burial cables are costly and time consuming. Wiring can be damaged in many ways including trenching, flooding and electrolysis; all concerns that are eliminated when utilizing wireless technology as displayed above.

Overall, environmental impact has many producers employing the multi-well concept. This is another reason McKi Wireless used the wireless concepts that saved money and time. Hardwired multi-well pads have multiples of multi-core cables, multiple junction boxes, and the RTU cost doubles with each well in I/O. The Wireless System does not require any multi core direct burial cabling. It only requires one junction box at each wellhead housing for the Wireless Gateway. In addition, overall power consumption at the wellhead Gateways is lower, making it easier to apply this application in remote locations with limited power.

## WIRELESS MULTI-PAD WELL SITE




This wireless application will ensure failsafe protection if the electronics on the RTU, DH2 Gateway, or Base Unit (Gateway stationed at the wellhead) fail or lose power, or one of the other critical process variables alarm. The theory behind this application is that all three computer-based devices remain in constant communication. This is accomplished using serial Modbus communications between the RTU and DH2 gateway utilizing the pulsed output function of the wellhead Base Unit gateway connected to the ESD valve solenoid equipment as displayed in the drawing below.



The wireless fail safe application begins with the RTU constantly writing timed pulse duration values to a Modbus register in the DH2 (RTU gateway). Once the DH2 receives the write command, it immediately transmits the data to the Base unit (wellhead gateway) located at the valve. At the same time, the wellhead gateway is transmitting flow valve pressure back to the DH2 and is being read by the RTU PID process variable. The solenoid at the valve is constantly energized thus creating a normally closed state holding the ESD valve open. If the solenoid becomes de-energized, the valve will close and shut off gas flow. This state is created by overlapping wireless pulse durations transmitted by the DH2. Consequently, if pulse duration is missed because of wireless failure, an open state occurs and the ESD valve will close. The same effect will occur if this loop was hardwired and the wire was cut or failed. The Base Unit can pulse an output for up to 25 seconds. When the Base Unit receives a new value, it starts the count over.

For example, if the Base Unit receives a pulse value of 25 seconds from the RTU every 15 seconds, a normally closed state is produced. If the Base Unit does not receive a pulse duration value, the discrete output will open at the end of 25 seconds and remain open until it receives another value.

During normal operations, the RTU receives wireless diagnostic data from the wireless devices and Base Unit. The RTU can now monitor the health of the control loop and account for all successful RF transmissions by serially reading diagnostic Modbus registers in the DH2. For example, if the wireless Flow valve pressure is programmed to transmit data to the DH2 every 10 seconds, a diagnostic counter register increments upon receiving a proper RF transmission. If the diagnostic register does not increment because of an RF failure, the RTU can generate an alarm to the SCADA system just as if the control loop was hardwired and a technician or operator can be dispatched to diagnose the alarm condition.

The following chart shows that all parts must be in operation and communication. If any part fails, the ESD valve closes regardless if it is Hardwired or Wireless.

| CONDITION | RESULT |
|---|---|
| INTERPOSING RELAY FAILS | ESD VALVE CLOSES |
| BASE UNIT FAILS | ESD VALVE CLOSES |
| POWER FAILURE AT BASE UNIT WELLHEAD GATWAY | ESD VALVE CLOSES |
| COMMUNICATION LOSS BETWEEN DH2 AND BASE UNIT WELLHEAD GATEWAY | ESD VALVE CLOSES |
| DH2 FAILS | ESD VALVE CLOSES |
| COMMUNICATION LOSS BETWEEN DH2 AND RTU | ESD VALVE CLOSES |
| RTU FAILS | ESD VALVE CLOSES |
| POWER FAILURE AT RTU | ESD VALVE CLOSES |
| CRITICAL PROCESS VARIABLES STOP COMMUNICATON (HI PIPELINE PRESSURE) | ESD VALVE CLOSES |
| NO FLOW OVER THE METER SKID DP | ESD VALVE CLOSES |