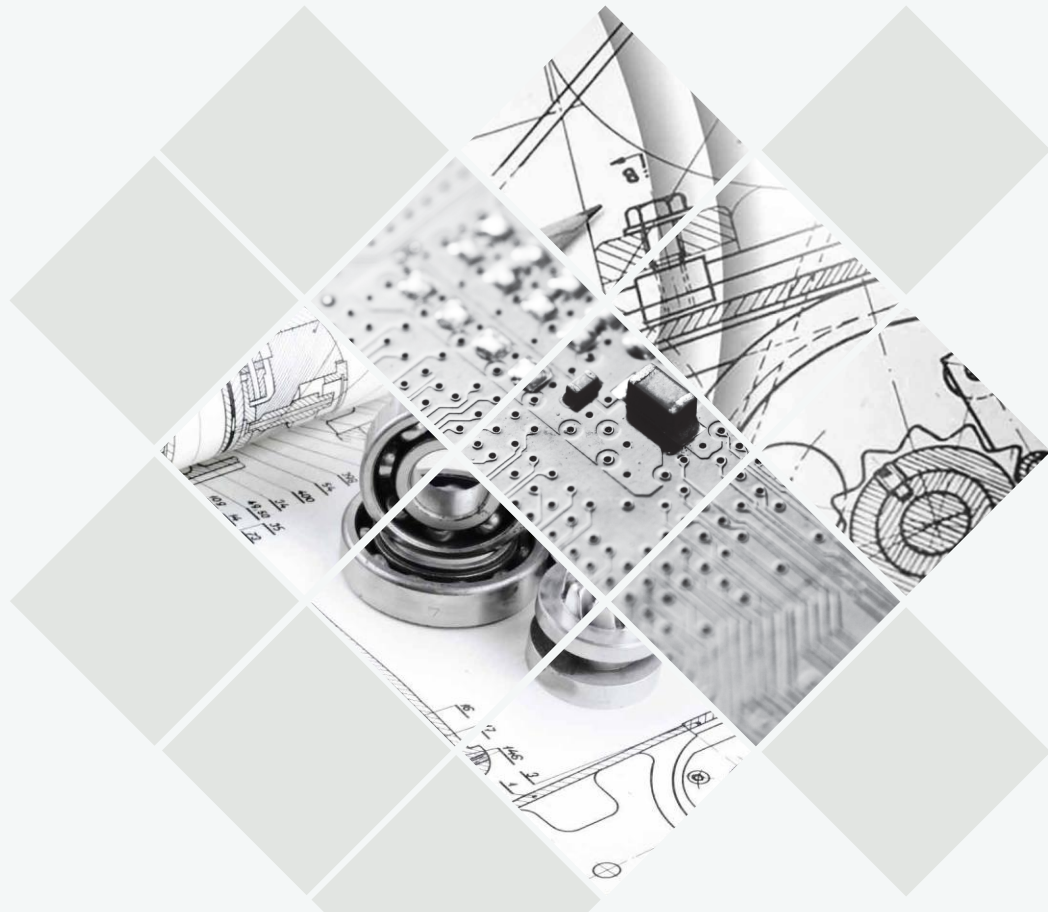


Wireless Instrumentation in Oil and Gas:

Advantages, Risks, and QuEST Capability



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Abstract

There is a growing popularity for wireless deployments in the oil and gas industry for different use cases such as videos, employee location, mobile operators, and more. However, wireless instrumentation is still an important element of discussion when it comes to process manufacturing.

This paper discusses, in brief, the history of wireless instrumentation followed by a comparison between wireless and wired instrumentation in terms of features and cost saving. The paper continues to further discuss wireless applications, advantages, risks, and QuEST capability in wireless instrumentation. The paper also discusses the potential method of reducing risks and future scope in wireless instrumentation. An interesting case study in wireless instrumentation for well optimization has been included.



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Introduction

Wireless instrumentation and automation are simple, reliable, secure, and safe. They are fast emerging as a complementary technology to wired instrumentation in the oil and gas industry.

Previously wireless solutions were not viable, nor the preferred choice for offshore monitoring in oil and gas sector due to data loss, cyber theft, and battery replacement cost.

Today much has changed. Advancements in safety, security, affordability, and maintenance within the constraints of frequency allocation enables organizations to take full advantage of the wireless technology. As upstream operations increasingly move into hazardous environments, the use of wired devices is becoming expensive and difficult. This makes the use of wireless technology in locations such as large fuel oil tanks, gantry filling station tanks, hazardous plant sites, and refineries useful, cost-effective, and safe.

History of Wireless Instruments

- Wireless is not a new technology. It is only relatively new to industrial applications.
- Until 2007, wireless process instruments were mostly in the form of single point-to-point devices or small networks. With the commercialization of sophisticated systems and large-scale networks, interoperability became a reality with evolving new standards. This opened up the market for many vendors, thus creating more options for users.

- While wireless deployments in process manufacturing took off, other use cases proved to be stronger drivers than instrumentation.
- The pervasive use of wireless technology in industrial applications is inevitable. Technology is maturing at an extremely rapid pace due to the industrial market explosion of wireless products.

Oil and Gas Use Case Scenarios that Justify Wireless Technology

Let us take a look at some of the use cases in the oil and gas industry that can benefit from wireless technology:

Installation and maintenance: By eliminating cabling and trenching, the cost of deployment is reduced by about 60 percent. While it takes days or weeks to install, scale, and commission a wired system, a wireless system takes a day or two. The simplicity of installation and maintenance of a wireless system shortens the amount of time a person spends in a hazardous location.

Personnel safety and health: During the initial flowback period, using wireless pressure sensors increases mobility and reduces risk to personnel taking readings from manual pressure gauges and reporting on production readiness.

Environmental compliance: Rising environmental requirements are a major driving factor as wireless instrumentation needs no wire installation.



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Workers mobility: Wireless technology empowers workers to do their jobs more efficiently by giving them remote access to the information they need.

Wireless vs Wired Instrumentation

Comparison by Features

Instrument/equipment	Wireless instrumentation	Wired instrumentation
Pressure transmitter	✓	✓
Flow transmitter	✓	✓
Temperature transmitter	✓	✓
Level transmitter	✓	✓
Water tank dual float level transmitter	✓	✓
Oil tank submersible level transmitter	✓	✓
Wireless base radio package	✓	N/A
Cabinet, terminal blocks, and brackets	N/A	✓
Conduit, wire, fittings, seal-offs, and brackets	N/A	✓
Installation estimates with contingency	✓	✓

Comparison by the Use of HART Technology

Wireless Instrumentation Technology

A wireless HART device is a free-standing device that eliminates the analog connection to the control system. The device can be installed anywhere in the plant without the cost of wires. The process variable (PV) and HART data are connected to the control or asset management system via a wireless HART gateway. Use of terminal blocks, cables, trays, conducting, marshaling panel, and the junction box is eliminated.

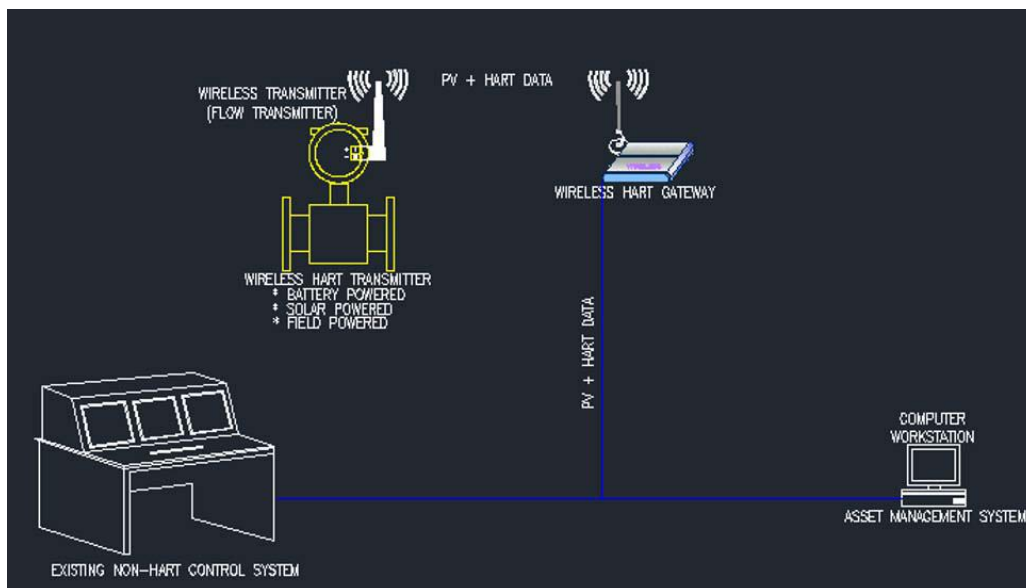


Fig 1: Wireless instrumentation network architecture

Wired Instrumentation Technology

In wired instrumentation, HART devices are connected via 4-20mA loop. The HART data is not connected to the control system in real-time,

thus limiting the value of asset investment. In such cases, terminal blocks, cables, cable trays, conducting wires, marshaling panel, junction box, and more are required.



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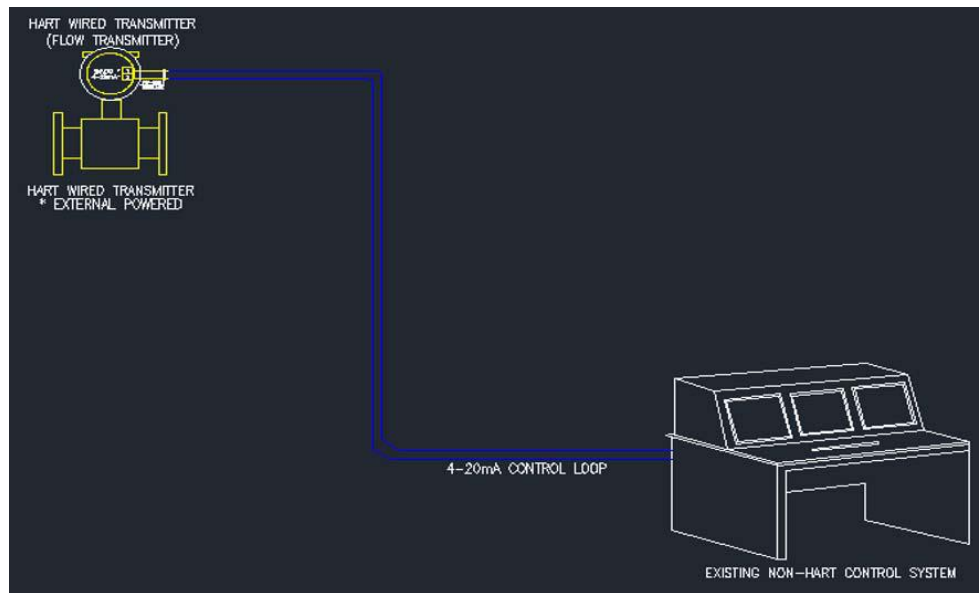


Fig 2: Wired instrumentation network architecture

Comparison by Cost Savings

Wired Instrumentation Technology (Old Way)

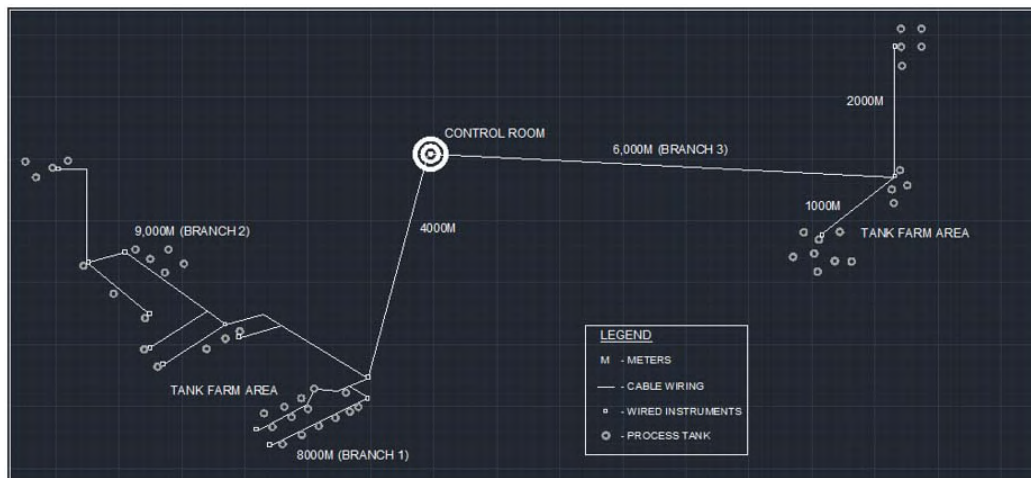


Fig 3: Wired instrumentation technology cable layout

Difficult and costly installation: Wiring assets to monitor or control in-field activities is both expensive and difficult to perform given limited resources and long distances. Wired technology requires ex-proof instruments with ex-proof instrument accessories such as terminal block, cable, cable tray, tray support, marshaling panel,

and the junction box. The counter cost of the same is 50 percent higher than wireless instrumentation and its software.

Life cycle cost considerations: Corrosion leads to severed connections, affecting visibility and access to essential plant functions. The total installation is estimated as per the table below:



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Table 1: Cost of installation for wired instruments

Total length of cables	30,000 ft.
Installation cost	\$40/ft. (approx.)
Total wired installation cost	\$1,200,000 (approx.)

Wireless Instrumentation Technology (New Way)



Fig 4: Wireless instrumentation technology layout

Cost saving: By going wireless, organizations can save on the cost of laying cables that are about 32,000 feet long, along with installation cost and its accessories such as cable tray, cable tray support, tray accessories, and the junction box. Industrial studies have shown that wireless technology delivers significant cost savings over the life of a project. Overall the cost of wireless solution can be 60 percent of the cost of wired installation in oil and gas.

The wireless technology further reduces cost by shortening the time required to install and execute a project. Installation of wireless devices in the field takes a fraction of the time needed to install a wired system. A wireless instrumentation also minimizes dependency on and coordination with subcontractors.

Table 2: Cost of installation for wireless instruments

Total length of cables	0
Installation cost of wireless instruments	\$3000/instrument (approx.)
Total no. of instruments in tank farm	15
Total cost	\$45,000 (approx.)

The following chart is a representation of the cost of installation based on the above tables (1 and 2):

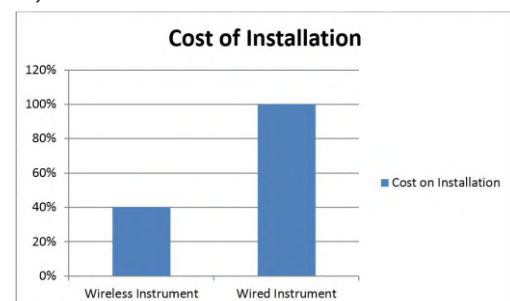


Fig 5: Cost of installation comparison chart



Wireless Instrumentation in Oil and Gas: Advantages, Risks, and QuEST Capability

A Case Study: Applying Wireless Instrumentation for Well Optimization

In North America, innovations in shale gas technology, directional drilling, and multi-stage fracturing have secured the gas supply for many decades to come. Often such upstream operations involve hazardous working conditions that require remote monitoring. Producers recognize these challenges and are implementing wireless solutions. They are also being rewarded with significant returns on their investments.

Problem: A shale gas well operated at high pressures. Any leakage in the pipe can lead to a full-scale rupture in a matter of time. It is, therefore important for the producer to detect any leakages soon to shut down the well immediately. Producers use a point gas detection technology. However, this technology is not completely reliable as it is easily influenced by unknown factors such as wind direction, speed, and relative location.

Solution: QuEST designed a gas leakage detection technology based on acoustic signatures. When the gas leaks into the atmosphere from a pipe, the pressure differential and resulting high-velocity flow create acoustic signatures in the air and the solid material of the pipe.

Using Wireless Automation with Wireless HART Technology

Wireless HART is a wireless mesh network communications protocol for process automation applications. It adds wireless

capabilities to the HART protocol while maintaining compatibility with existing HART devices, commands, and tools. Each wireless HART network includes four main elements:

- **Wireless field devices** that connect to processes or plant equipment. These devices are instruments with wireless HART built-in or an existing installed HART-enabled device with a wireless HART adapter attached to it.
- A **gateway** that provides the connection to the host network. Gateways enable communication between devices and host applications connected to a high-speed backbone or other existing plant communications network.
- A **network manager** that builds and maintains the mesh network. The network manager is responsible for configuring the network, scheduling communications between devices, managing message routes, and monitoring network health. The network manager can be integrated into the gateway, host applications, or process automation controller.
- A **security manager** that manages and distributes security encryption keys. It also holds the list of authorized devices that join the network.



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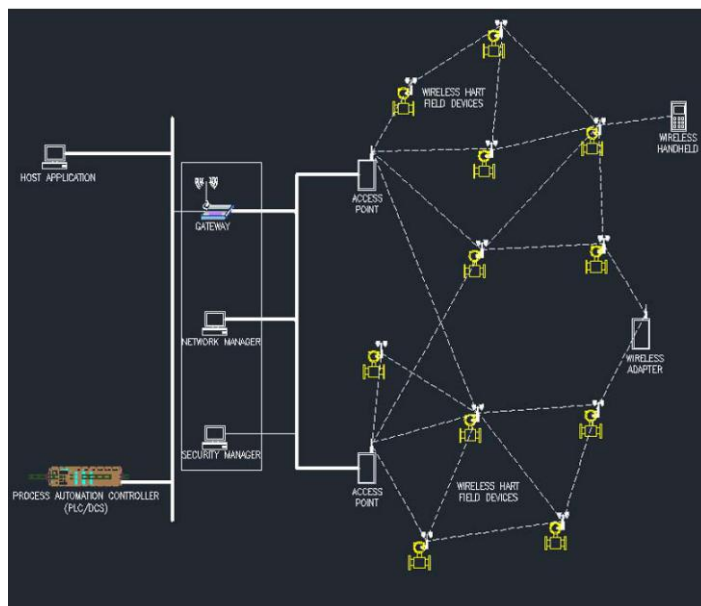


Fig 6: Wireless HART network topology

Other components of wireless HART technology include:

Repeater: The device routes wireless HART messages, but may have no process connection of its own. Its primary use is to extend the range of a wireless HART network. All instruments in a wireless HART network have routing capabilities, which simplify planning and implementation of a wireless network.

Adapter: The device plugs into an existing HART-enabled instrument to allow instrument data to pass through the wireless HART network to the host. The adapter can be located anywhere along the instrument 4-20mA cable. It can be battery-operated or powered through 4-20mA cable. Some adapters are battery-powered and use the same battery to power instruments as well.

Handheld terminal: It comes in two versions. The first version is a handheld terminal with standard HART configuration unit, just like the

one used for routine maintenance and calibration checks. The second version is used to join a new instrument to an existing wireless HART network.

HART-enabled instrumentation: The process includes field wireless instruments. Wireless instruments are available in a wide range of sensors such as pressure, flow, temperature, level, analog, switch input and output, turbine meter, and vibration inputs.

Field instruments: Anyone can choose any combination of wireless instruments in oil and gas. All instruments listed below can be selected as wireless instruments in the oil and gas industry, including the refineries:

- Level transmitter
- Pressure transmitter
- Temperature transmitter
- Flow transmitter (differential pressure type)
- Cond/ pH/ORP analyzer
- Discrete switches
- Vibration monitors



Wireless Instrumentation in Oil and Gas: Advantages, Risks, and QuEST Capability



Fig 7: Example of wireless level Instrument



Fig 8: Example of field wireless process instrument

Advantages and Risks of Using Wireless Instrumentation in Oil and Gas Applications

Advantages

- Wireless systems provide accurate digital readings to the control room that help in making correct control decisions at the well site.
- **Remote monitoring of internet of things (IoT):** Millions of connected wireless sensors for pressure, flow, level, temperature, vibration, sound, wind speed, and other parameters are installed and operated in the

industrial sector. For additional monitoring, more sensors can be installed without any hassles. The sensors connect to different higher level software platforms, both onsite and offsite. Onsite connections are often via a local intranet creating an industrial intranet of things. Offsite connections are usually made through the Internet, often via a cloud-based storage system. The higher level software platforms include control and monitoring, asset management, and specialized data analysis systems. At remote data analysis centers, sophisticated big data analytics are performed by dedicated experts to reveal patterns, problems, and solutions. Benefits of remote monitoring IoT include:

- Monitoring field activities from anywhere in the world
- Cost-effective
- Performance improvements through in time corrective actions

•Redundancy of wireless instruments:

Wireless instruments have the advantage of redundancy. For example, two wireless level transmitters are battery-operated and can be mounted on an oil storage tank. They are redundant, in terms of power. When one runs low on battery, a message is displayed on the remote control. When one transmitter fails, the other continues to transmit data without any loss of information.

Network communication can be redundant in terms of network topology (start and ring). Using tried and proven measurement methods combined with secure wireless technology and advanced power



Wireless Instrumentation in Oil and Gas: Advantages, Risks, and QuEST Capability

management techniques, producers can dramatically reduce the cost of installation, commissioning, and operation. End users implementing industrial wireless technology can expect the following benefits:

- User mobility — access data when and where users need it
- Return on investment superior to wired network
- High-speed, facility-wide connections

Risks

- **Cyber security:** Security is an issue with wireless systems. It is easy to eavesdrop, send malicious packets, or disturb the transmission. One can overcome these risks but requires solutions based on standards to exercise multiple mitigating techniques.
- **Reliability for industrial applications:** Reliability is a major concern. The case study above shows that the current family of wireless instrumentations used in well optimization is useful. However, the hardware, i.e. the sensors are yet to achieve the required level of reliability and consistency of performance.
- **Reliability in remote monitoring:** In simple applications like remote monitoring, users expect a certain degree of reliability and network availability. For example, the controls and communications for a wastewater pump station, often located far away from the central control room, have to be reliable. If sensors malfunction, then all data may be lost in the handheld terminal.
- **Battery replacement cost:** The wireless system and the sensors run on batteries that

should be replaced at regular intervals.

- **Noise:** Wireless connections are more affected by noise and interference than a copper wire. Messages can get lost and may have to resend. This makes it hard for wireless links to meet demands in real-time.
- **Loss of PV (measuring data):** In many cases, same instruments are on a single gateway. At that time there are chances of losing a PV (measuring data).

Potential Methods to Reduce Risks in Wireless Instrumentation

- **Data loss:** Use security manager in the control room to avoid measured data loss.
 - **Cyber security:** To protect from cyber risks, encrypt wireless data that is transmitted within the Wi-Fi mesh network, between mesh networks, and all client devices. This will also prevent unauthorized users from eavesdropping on any communication and manipulating information transmitted wirelessly.
- Install antivirus software on wireless client devices to prevent any primary infections. Good security practices should be enforced to keep antivirus software up-to-date, along with OS security patches.
- **Battery replacement cost:** Use rechargeable batteries for wireless instruments to reduce the cost of battery replacement.



Wireless Instrumentation in Oil and Gas: Advantages, Risks, and QuEST Capability

Future Scope

The following list of major issues and challenges suggests the future scope of research work. This, however, is not limited to the areas discussed here.

Major issues

- Energy concerns
- Security problems
- Compatibility
- Environment and building material

Major challenges

Following challenges emerge in the path of successful deployments of wireless technologies for industrial applications:

- **Design level challenges**
 - i. Simple and flexible programming abstraction
 - ii. Power and bandwidth efficient distributed signal processing
 - iii. Robustness of sensors in device failures.
- **Installation level challenges**
 - i. Selection of most suitable technologies for given industrial applications
 - ii. Optimal placement of wireless devices
 - iii. Reach inaccessible, hard-to-reach, and unaffordable parameters of a plant
 - iv. Clock synchronization
 - v. User-friendly deployments.
- **Configuration level challenges**
 - i. Enhanced data collection, expansion of security parameters, and new level of efficiency and productivity of a plant, keeping minimum “wake up” time for

- nodes
- ii. In the case of jamming, a network must automatically find the most optimal alternative path for data traffic.

- **Maintenance level challenges**

- I Maximize network lifetime
- ii. Redundancy
- iii. Openness at tools level
- iv. Interoperability-interchangeability.

QuEST Capability in Wireless Instrumentation

- **Sizing of wireless process instruments:** QuEST engineers can size up various process wireless instruments like pressure, flow, level, temperature, and analytical sensors and transmitters.

For sizing up various wireless sensors and transmitters, the following details are required: Process inputs like piping and instrumentation diagram/drawing (P&ID), general arrangement layout, installation location, distance from transmitter to a remote network, flowing material, material state, pipe material, pipe diameter or schedule, tank height, process end connection, flow range, required accuracy, upstream operation pressure, operating temperature, maximum pressure drop, specific gravity/viscosity, and environmental details.

- **Selection of wireless instruments:** QuEST can find the “best fit” wireless products for various applications like oil and gas piping, oil tank gauging, and refinery. Determine the most suitable measuring technology or



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product for an industry and calculate precisely the sizing of the measuring point.

- **Detail engineering:** Wireless engineering activities exist to provide safe, cost-effective, and quality technical services to the user. For wireless instruments, detail engineering contains instrument specification, data sheet, wireless control system specification, installation specification, drawings, instrument index, loop diagram, and interlock diagram.

- **Programming of various devices:** QuEST is capable of programming wireless handheld terminals (network hub), network manager, and security manager. QuEST is also capable of setting up process parameters for instrument's wireless HART data.

- **Installation and commissioning:** QuEST observes best practices in the industry for installing and commissioning wireless instruments to ensure a good process connection. When commissioning a smart wireless field network two things are important:

- **Wireless instrumentation:** Each wireless instrument should be configured per application properly. Each wireless instrument should have security protocols to join a unique wireless network. Verify through the smart wireless gateway that the PVs are updating at the desired rate.

- **Smart wireless gateway:** Verify if all devices connected are >99 percent reliable. Verify if all wireless instruments

are connected directly to the gateway. QuEST engineers are capable of installing various wireless instruments as per the scope. Wireless systems are commissioned as per the following method:

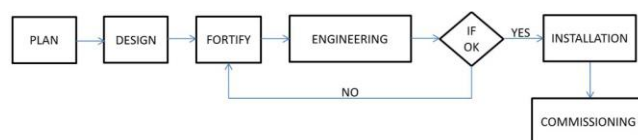


Fig 9: Wireless instrumentation execution workflow.

- **Calibration of the wireless instruments:** QuEST engineers have the capability to calibrate wireless instruments with HART multi-functional calibrator. Engineers source process data through standard HART calibrator and calibrate a particular transmitter.

About QuEST Services in Oil and Gas Sector

QuEST oil and gas engineering services provide design and development of equipment and other engineering services for equipment and related accessories for upstream. Wireless instrumentation is one of the key services offered by QuEST for its oil and gas customers.

QuEST oil and gas engineering services are provided by a pool of trained engineers with domain expertise and engineering skills, who are leveraged closer to customer sites or through an offshore development model. Customers gain the dual advantage of near site interactions as well as the cost advantage of an offshore delivery model.



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References

- Control Engineering Asia Edition May-2012
- IEC 62591 Wireless HART System Engineering Guide, Revision 3.0
- www.hartcomm.org/en.hartcomm.org
- www.Emersonprocess.com/Smartwireless
- www.controleng.com
- www.cooperindustries.com
- www.petro-online.com
- www.istockphoto.com/stock-photos
- iStock photo reference no: 14521586
- iStock photo reference no: 39891310
- iStock photo reference no: 52454850
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Author Profile



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Rupesh Dangroshia is the lead engineer for GE Water projects design and engineering (electricals and instrumentation) with QuEST Global, an engineering consulting firm that provides integrated engineering services, product design, and software testing across industries. He has been in the industry for 11+ years and specializes in handling instrumentation and electrical projects.

Rupesh joined QuEST in 2010, and since then, he has successfully executed 100+ E&I projects for GE Water and Process Technology. He also worked with Emerson, Permionics Membrane, and Doshion Veolia water solutions. At Emerson, he worked on wireless instrumentation for oil and gas and refinery projects.

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