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The Engineer’s Guide to Industrial Wireless Measurement

2014 EDITION
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Ho Howe Tian  
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1 – Why Wireless?

1. Why Wireless?

While wireless technology has been around for over 100 years, the Process Industry has been incorporating wireless measurements into their operations for about 5 years. In a short period of time, wireless technology (specifically, IEC 62591 (WirelessHART) has been incorporated into Process operations to solve some of their toughest problems. The following section discusses the opportunities and benefits that wireless technology provides to EPC’s and the Process Industry.

1.1 Wireless Offers OPEX Savings

Plants face many critical business challenges ranging from production issues such as reliability, efficiency, throughput and safety & environmental to the higher level challenges related to personnel and financial results. These challenges are not specific to wireless customers, but exist at every site.

A single event such as an unplanned shutdown can impact several business performance metrics. An unplanned shutdown directly reduces throughput and capacity utilization. Startups & shutdowns consume energy and increase the energy intensity of the plant.

Repairs and start up costs impact maintenance index and operating expense cash. Higher costs and lower throughput impact return of capital, income and margin. In addition, there may be unwanted emissions and safety incidents.

Improvement to many key business performance measures can be directly tied to energy efficiency, equipment performance and environmental or safety issues.
In many cases these unplanned shutdowns are unavoidable due to the lack of timely and actionable information. This could be because this information wasn’t identified during the plant design as critical to operation. In addition, generating this information might be cost prohibitive due to structural or physical constraints such as height, obstacles or moving equipment. Often, plant personnel are gathering information manually, which interferes with work they could be doing to improve performance.

By automating the collection of data, wireless eliminates manual information gathering and unlocks tremendous amounts of information which helps reduce costly shutdowns. It may be through an early warning to a reliability engineer that a bearing in an essential motor is failing, a notification to the Utilities Manager about hot and cold spots in the furnace or a notification that the temperature in the heat exchanger is drifting.

**Safety showers** are monitored continuously and video is used to watch the area. HSE is automatically alerted to an incident.

**Tanks** have a secondary measurement that alerts for high conditions. Ground is also monitored for leakage and alerts are sent immediately to the control room to stop large spillage.

Reliability engineer is alerted that a **motor** may be experiencing early signs of **bearing failure**. Switch to backup motor before failure.

Hot and cold spots are detected in the **furnace** and utilities manager is notified. Operator is notified that the temperature in the **heat exchanger** is drifting and notifies maintenance before shutdown required.

**Outlet water temperature** is measured and operator is alerted before excess is discharged.
1 – Why Wireless?

Wireless enables the right information to get to the right users when they need it. Many of these users may be people such as reliability engineers or quality or safety engineers who may not traditionally be impacted by controls instrumentation, but they have real pains that wireless can solve. They may need information real time or just on-demand in the control system, or in a separate application specific to their job. Or this could replace information that is being logged manually – freeing up field operators to focus on more critical tasks. They key is that lack of information is no longer a barrier to achieving business results. Emerson offers our Smart Wireless technology to help unlock the information that users need.

Before wireless, most users had either 4-20mA data, data collected manually on operator rounds or no information on their process or equipment. Many of the diagnostics available in their HART devices is unused because their host systems cannot support it. The biggest use case that we’re seeing for wireless is the case where no data is currently available and these blind spots are causing pains within the organization. With wireless, we can add new data points very cost effectively or get the intelligence of your existing field devices including diagnostics, alarms, and high value functionality like statistical process monitoring back into your control system or historians and asset management systems.

1.1.2 Wireless Reduces Project Cost, Time & Complexity

The process industry is being squeezed from many directions. And much of it is people driven. The challenges of the past such as global competition, optimizing production, regulatory compliance are all still there, but the people challenge has come into focus as key for running a safe, reliable and highly productive plant.

The technology that is being installed in plants today has more features and greater capabilities. Plants are becoming larger: petrochemical plants are giving way to petrochemical COMPLEXES. This make a lot of business sense because the waste of one process is fuel or feedstock for the next. We see the operation becoming more complex because of plant interdependencies. On the people side, the process industry has a record number of people at retirement age and as these people are leaving they are taking a WEALTH of experience with them. In many cases, these jobs aren’t being backfilled. This is leading to today’s workers being stretched to cover more and more.

In developing parts of the world, plants are being built where there may be little or no ready trained work force. These plants are being built in some very remote parts of the world where many experienced people don’t want to go. The result of this is a knowledge and experience void, with more going out, less coming in. And this is a global phenomenon. All of us are being asked to do more with less.

During project execution, various contingencies often tend to cause delays and lead to slippages in plant start up date. These contingencies are: late modifications, late package vendor data, constant changes to I/O database, adding instrumentation, moving instrumentation, changing instrumentation type and human error and simple mistakes.
With wired systems, a significant amount of equipment is needed and work must be done to design and install the equipment. All this equipment such as controllers, I/O, marshalling cabinets, junction boxes and wired devices significantly add to the complexity of the project.

**1.1.3 Wireless Makes Projects Scalable**

As the project scope changes, even if the original design allowed a margin for additional requirements, it can quickly run out of capacity. Junction boxes only allow a certain number of connections; changes to equipment can quickly use up capacity that was designed-in, which then causes problems.

Emerson’s Smart Wireless Gateway 1420 allow for up to 100 points. If additional points are needed, simply add additional Smart Wireless Gateways.

**1.1.4 Wireless Is A Proven Technology**

With over 1 billion hours of operating experience, on 8700+ networks and tens of thousands of devices in both offshore and onshore applications, Emerson’s Smart Wireless Networks have gained rapid acceptance in the industry and are a trusted technology of choice.

In past technology shifts, it wasn’t the technology itself (such as microprocessors or digital communications) that drove the shift; it was applications that took advantage of the technology to deliver value. Similarly, the adoption of wireless technology will be driven by the ability to more easily and cost-effectively extend and manage the flow of information around the plant.
Wireless technology is not a complete replacement for wires, at least not for a while. But it is already enabling new tools that give you the freedom to solve problems you could not cost-effectively address in the purely wired world. The possibilities are limitless. Imagine a plant where...

- Safety relief valve emissions are monitored for more effective regulatory compliance
- Safety showers are monitored 24/7 so help can be dispatched immediately
- Wireless vibration sensors give you a real-time indication of equipment reliability every day, not just once a month/quarter/turnaround
- The status of previously unmonitored plant equipment such as on-off valves is known and historized in real time, providing a safer, more productive operating environment
- Operators don’t have to make “clipboard rounds” to collect data
- Diagnostics in all HART devices – including those that couldn’t be accessed before – are available for asset management
- Workers can access desktop applications and perform tasks wherever they are – including viewing and responding to alarms from the field
- The locations of personnel and physical assets in the plant are tracked at all times
- You can broadcast messages to specific groups of workers wherever they are
- Security systems track and ensure authorized plant access
- Video systems not only patrol the fence line, but keep a cost-effective eye on the process
- Corrosion in equipment and piping is monitored by wireless sensors

Many of these applications are possible today without wireless technologies, but wiring costs or technical limitations make them impractical. Cost-effective and easy-to-integrate wireless technology can overcome these barriers, enabling you to gain better insight into your plant – and ultimately make your workforce more productive.
Maximizing the benefits of wireless technology will come from putting it to work in multiple applications. These opportunities typically fall into three categories:

1. **Plant and process information**, including **extended plant and asset** information, stranded diagnostics, and extending the “walls” of the Plant

2. **Workforce productivity**, including **remote** and mobile operations and maintenance, automated work flow management, and mobile worker communications

3. **Business and plant management**, including **physical plant security**, video monitoring and surveillance, and people and asset tracking

### 1.2 Wireless Applications

#### 1.2.1 Applications for Plant and Process Information

The more you know about the process, physical assets, and overall operations of your plant, the safer and more profitable your business can become. More (and better) measurements mean more opportunities for reducing operational costs and improving quality, throughput, and availability.

In addition, new environmental and safety requirements have been established after many of today’s facilities were built, and plants have struggled to get access to measurement and diagnostic information that could ease compliance.

So, why aren’t more plants “measuring up”? Too often, the cost or difficulty of adding new measurements has outweighed the perceived benefits. With traditional wired technologies, distance or complexity can make connecting the measurement point to a control system, asset management system, maintenance system, or data historian impractical or cost-prohibitive.

Wireless technology removes the barriers of traditional wired solutions and gives you unprecedented access to data that was previously out of economic or technical reach. Imagine, for example, the benefits of additional temperature measurements to detect “cool spots” in steam lines, or the advantages gained by cost-effectively instrumenting a remote tank farm.

This access to additional data includes not only process measurements, but instrument and equipment information as well.

For example, millions of smart HART-based devices in the field today have some level of diagnostics capability. Unfortunately, many plants don’t have the infrastructure to receive HART data into the appropriate system. Since only a fraction of these devices are digitally monitored, the potential gain from accessing such “stranded” diagnostics is significant.

With wireless technology, the data doesn’t have to be stranded anymore. Existing wired HART devices can be upgraded with a wireless adapter to transmit diagnostics information back to the control room or maintenance shop, where appropriate personnel can take corrective action as needed. Process control signals continue to be communicated over the wired connection.

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Capabilities like these open the door to a broad range of applications – from monitoring pressure relief valves and stacks continuously to avoid environmental excursions and the ensuing fines, to monitoring corrosion in pipelines and vessels or vibration in mechanical equipment. And with safety always a top concern in plants, knowing the real-time status of more plant equipment is critical.

The possibilities are almost limitless. All you have to do is think of all the things you’ve always wanted to measure but couldn’t justify the investment. Chances are that now you can.

1.2.2 Applications for Workforce Productivity

In an era when an aging workforce and loss of experience are among the most pressing business problems process manufacturers face, wireless technology provides a means to empower next-generation plant workers just as cell phones and PDAs have empowered the mobile business person today.

Even during normal operations, it’s not uncommon for a large plant to have hundreds of people working throughout the plant, often far from their control rooms, maintenance shops, or offices. The new wave of wireless tools will dramatically improve the productivity of these people by providing instant access to information that they otherwise would have had to cover considerable distance to get to, or take valuable time from other plant personnel to find out.

For example, although technology has enabled operators to perform many of their control and monitoring duties from the comfort and safety of the control room, there are still times when they have to go out into the field. Some companies routinely have their operators make rounds to see firsthand how the plant is running. By providing remote access to control and asset-management systems, a ruggedized wireless PC can greatly enhance the efficiency of these people as they will be able to immediately relate what they see to what is happening to the process and take quick corrective action.

When operators are in the field, there may be no one in the control room watching for alarms. But with wireless access points throughout the plant, operators can use these PCs or similar tools to access critical process information, historical data, graphics, and other key functions that normally reside in the control room or elsewhere in the plant. That includes viewing and acknowledging alarms from wherever operators are.

New wireless technologies can also improve worker communications. While many plant workers already use an older wireless technology – walkie-talkies – for short-range communications in the field, combining a plant-wide wireless broadband network with Voice over Internet Protocol (VoIP) technology can extend communication reach as well as enabling “smart” communications. For example, you could broadcast messages to specific teams based on the IP address of each worker’s radio. Often when customers evaluate traditional hardwired PA systems they realize that such systems cost a lot more than putting in a wireless infrastructure that allows
VoIP communications. The other advantage of this wireless approach is that you now have a platform that allows you to implement other applications that require a Wi-Fi coverage.

Maintenance workers can also benefit from these applications. Wireless tools such as handheld communicators allow these workers to access maintenance work orders, instructions, and other information on the spot, and to immediately track or report inspections, tests, and repairs.

To be deployed in the process industry, however, applications like these must address issues such as harsh, industrial environments, high RF interference, bandwidth allocation, and sharing the airspace with higher priority control information from wireless field networks.

1.2.3 Applications for Business and Plant Management

Wireless applications such as personnel and asset tracking, as well as wireless video surveillance for security and safety, have changed the way offices, hospitals, warehouses and retail stores operate. These applications can also solve business needs inside process environments, such as improving safety and security.

Wireless allows affordable access to information for better insight into what’s happening, especially for safety and security. For example, it’s easy and cost-effective to add wireless cameras where it would be too difficult, costly, or risky to trench or wire.

Many plants are already using wireless technologies to improve security. Wireless closed-circuit television cameras and RFID-equipped access badges enable intelligent security monitoring and control – from restricting access to specific areas based on levels of security, to tracking attempts to violate security protocols and helping security managers identify potential vulnerabilities and improve systems. Wireless applications can also enable you to monitor hazardous applications in order to reduce risk to plant personnel.

Wireless location technologies allow you to quickly find and track inventory and valuable assets – even workers -- moving inside and outside the plant. Time spent looking for assets can be dramatically reduced, which can have significant benefits during major turnarounds, emergencies, and new construction projects. Being able to quickly locate each worker also offers safety and productivity benefits.
Wireless Standard

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2. Wireless Standard

2.1 Wireless Portfolio

Wireless portfolio can be classified into two areas

- **For plant and process information applications.** Wireless field network products are based on the WirelessHART standard, approved in September 2007. This standard was developed under the guidance of the HART Communication Foundation (HCF) through the combined, cooperative efforts of HCF member companies, leaders in wireless technology and the input of industry users.

- **For workforce productivity and plant and business management applications.** At the wireless plant network level, the architecture uses commercial standards such as IEEE 802.11 Wi-Fi, the emerging 802.11s Wi-Fi mesh standard, and 802.16 WiMAX to leverage the advantages of these readily available, widely supported technologies.

The approach should be based wholly on open standards so you can choose standards-based solutions without being tied to a specific technology or Vendor.

2.1.1 Wireless Technologies for Field Networks

Wireless Field Networks have specific requirements which are different from those of a Plant Network. Field Networks are focused on process applications like measurement or sensing, process control and diagnostics. Requirements include:

**Process Applications** – sensing, condition monitoring, control and diagnostics

**Bandwidth** – Short, high priority communications

**Security/Reliability** – must coexist and perform in dynamic, harsh plant environment

**Power Management** – Intrinsically safe power solutions optimized for user & process safety lasting at least 5 years

**Standards** – IEC-approved WirelessHART (802.15.4) is driven by Process community

2.1.2 Wireless Technologies for Plant Networks

Wireless plant networks have requirements that are unique and different from wireless field networks. Plant networks implement applications like video, voice and people or asset tracking. Requirements include:

**Bandwidth** – High; multiple applications must share the service

**Security/Reliability** – Industrial security and robust coexistence are essential

**Power Management** – Devices can be line powered or recharged daily

**Standards** – Driven by IT community (802.11, WiMAX...)

2.2 WirelessHART Standard

Conceptually, WirelessHART networks are one special type of wireless sensor network. Although it bears many similarities with other wireless standards, such as ISA100.11a, WIA-PA (China Standard), Bluetooth [2], ZigBee [10], and Wi-Fi [4], WirelessHART differentiates itself from them in many other aspects.
Wireless sensor network has received extensive study recently [13, 18, 17, 21, 22, 12]. Different from generic wireless sensor networks which assume that sensors are deployed randomly and abundantly, the deployment of WirelessHART network is deliberate and has only limited redundancy. In a generic sensor network, many sensors may be deployed in the same area and perform the same function. However, in a WirelessHART network, sensors are usually attached to field devices to collect specific environmental data, such as flow speeds, fluid levels, or temperatures. A reading from a sensor is not necessarily replaceable by that from the nearby sensors. More importantly, generic wireless sensor networks are self-configurable and have no strict requirements on timing and communication reliability. To meet the requirements of wireless industrial applications, WirelessHART uses a central network manager to provide routing and communication schedules. Thus WirelessHART is essentially a centralized wireless network. WirelessHART, Bluetooth and ZigBee share a very obvious feature: they all operate in the unrestricted 2.4GHz ISM radio band, which is available nearly globally.

On the other hand, they distinguish from each other in many other aspects. Both WirelessHART and Bluetooth support time slots and channel hopping. However, Bluetooth is targeted at Personal Area Networks (PAN), whose range is usually set to 10 meters. Furthermore, Bluetooth only supports star-type network topology, and one master can only have up to 7 slaves. These limitations make it awkward to apply Bluetooth in large industrial control systems. In contrast, WirelessHART supports mesh networking directly. The topology of a WirelessHART network can be a star, a cluster or a mesh, thus providing much better scalability.

Both WirelessHART and ZigBee are based on the IEEE 802.15.4 physical layer. While ZigBee uses the existing IEEE 802.15.4 MAC, WirelessHART goes one step further to define its own MAC protocol. WirelessHART introduces channel hopping and channel blacklisting into the MAC layer, while ZigBee can only utilize Direct Sequence Spread Spectrum (DSSS) provided by IEEE 802.15.4. Thus, if a noise is persistent, which is not unusual in industrial fields, the performance of a ZigBee network might degrade severely.

By changing the communication channel pseudorandomly, WirelessHART can limit the damage to minimum. Just like ZigBee, Wi-Fi does not support channel hopping either. In addition, power consumption is not a concern for Wi-Fi. Thus, Wi-Fi is not a good fit for industrial environment as well.

It is noteworthy that ISA SP100 [7] committee is also working on wireless standards for industrial applications. However, the standard is yet to be published.

2.3 WirelessHART Architecture

Figure 2.3a illustrates the architecture of the WirelessHART protocol stack according to the OSI 7-layer communication model. As shown in this figure, WirelessHART protocol stack includes five layers: physical layer, data link layer 1, network layer, transport layer and application layer. In addition, a central network manager [19] is introduced to manage the routing and arbitrate the communication schedule.

2.3.1 Physical Layer

The WirelessHART physical layer is based mostly on the IEEE STD 802.15.4-2006 2.4GHz DSSS physical layer [5]. This layer defines radio characteristics, such as the signaling method, signal strength, and device sensitivity. Just as IEEE 802.15.4 [5], WirelessHART operates in the 2400-2483.5MHz license-free ISM band with a data rate of up to 250 kbits/s. Its channels are numbered from 11 to 26, with a 5MHz gap between two adjacent channels.
2.3.2 Data Link Layer

One distinct feature of WirelessHART is the timesynchronized data link layer. WirelessHART defines a strict 10ms time slot and utilizes TDMA technology to provide collision free and deterministic communications. The concept of superframe is introduced to group a sequence of consecutive time slots. Note a superframe is periodical, with the total length of the member slots as the period.

All superframes in a WirelessHART network start from the ASN (absolution slot number) 0, the time when the network is first created. Each superframe then repeats itself along the time based on its period.

In WirelessHART, a transaction in a time slot is described by a vector: [frame id, index, type, src addr, dst addr, channel offset] where frame id identifies the specific superframe; index is the index of the slot in the superframe; type indicates the type of the slot (transmit/receive/idle); src add and dst addr are the addresses of the source device and destination device, respectively; channel offset provides the logical channel to be used in the transaction. To fine-tune the channel usage, WirelessHART introduces the idea of channel blacklisting. Channels affected by consistent interferences could be put in the black list. In this way, the network administrator can disable the use of those channels in the black list totally.

The actual channel number is used as an index into the active channel table to get the physical channel number. Since the ASN is increasing constantly, the same channel offset may be mapped to different physical channels in different slots. Thus we provide channel diversity and enhance communication reliability. Figure 2.3.2a describes the overall design of the data link layer which consists of six major modules as described in the follow subsections.

2.3.2.1 Interfaces

The interface between the MAC and PHY layer describes the service primitives provided by the physical layer, and the interface between the MAC and NETWORK layer defines the service primitives provided to the network layer.

2.3.2.2 Interface Timer

Timer is a fundamental module in WirelessHART. It provides accurate timing to ensure the correct operating of the system. One significant challenge we met during the implementation is how to design the timer module and keep those 10ms time slots in synchronization. The specific timing requirement inside a WirelessHART time slot is depicted in Figure 2.3.2.2a and the implementation issues are addressed in Section 4.

2.3.2.3 Communication Tables

Each network device maintains a collection of tables in the data link layer. The superframe table and link table store communication configurations created by the network manager; the neighbor table is a list of neighbor nodes that the device can reach directly and the graph table is used to collaborate with the network layer and record routing information.

2.3.2.4 Link Scheduler

The functionality of the link scheduler is to determine the next slot to be serviced based on the communication schedule in the superframe table and link table. The scheduler is complicated by such factors as transaction priorities, the link changes,
and the enabling and disabling of superframes. Every event that can affect link scheduling will cause the link schedule to be re-assessed.

2.3.2.5 Message Handling Module
The message handling module buffers the packets from the network layer and physical layer separately.

2.3.2.6 State Machine
The state machine in the data link layer consists of three primary components: the TDMA state machine, the XMIT and RECV engines. The TDMA state machine is responsible for executing the transaction in a slot and adjusting the timer clock. The XMIT and RECV engine deal with the hardware directly, which send and receive a packet over the transceiver, respectively.

2.3.3 Network Layer and Transport Layer
The network layer and transport layer cooperate to provide secure and reliable end-to-end communication for network devices.

![Figure 2.4a – WirelessHART Mesh Networking](image)

As shown in Figure 2.4a, the basic elements of a typical WirelessHART network include: (1) Field Devices that are attached to the plant process, (2) Handheld which is a portable WirelessHART-enabled computer used to configure devices, run diagnostics, and perform calibrations, (3) A gateway that connects host applications with field devices, and (4) A network manager that is responsible for configuring the network, scheduling and managing communication between WirelessHART devices.

To support the mesh communication technology, each WirelessHART device is required to be able to forward packets on behalf of other devices. There are two routing protocols defined in WirelessHART:

- **Graph Routing:** A graph is a collection of paths that connect network nodes. The paths in each graph is explicitly created by the network manager and downloaded to each individual network device. To send a packet, the source device writes a specific graph ID (determined by the destination) in the network header. All network devices on the way to the destination must be pre-configured with graph information that specifies the neighbors to which the packets may be forwarded.

- **Source Routing:** Source Routing is a supplement of the graph routing aiming at network diagnostics. To send a packet to its destination, the source device includes in the header an ordered list of devices through which the packet must travel. As the packet is routed, each routing device utilizes the next network device address in the list to determine the next hop until the destination device is reached.

2.3.4 Application Layer
The application layer is the topmost layer in WirelessHART. It defines various device commands, responses, data types and status reporting. In WirelessHART, the communication between the devices and gateway is based on commands and responses. The application layer is responsible for parsing the message content, extracting the command number, executing the specified command, and generating responses.

2.3.5 Security Architecture
WirelessHART is a secure network system. Both the MAC layer and network layer provide security services. The MAC layer provides hop-to-hop data integrity by using MIC. Both the sender and receiver use the CCM* mode together with AES-128 as the underlying block cypher to generate and compare the MIC.
The network layer employs various keys to provide confidentiality and data integrity for end-to-end connections. Four types of keys are defined in the security architecture:

- **Public Keys** which are used to generate MICs on the MAC layer by the joining devices.
- **Network Keys** which are shared by all network devices and used by existing devices in the network to generate MAC MIC’s.
- **Join Keys** that are unique to each network device and is used during the joining process to authenticate the joining device with the network manager.
- **Session Keys** that are generated by the network manager and is unique for each end-to-end connection between two network devices. It provides end-to-end confidentiality and data integrity.

![Figure 2.6a – Keying Model](image)

Figure 2.6a describes the usage of these keys under two different scenarios: 1) a new network device wants to join the network and 2) an existing network device is communicating with the network manager. In the first scenario, the joining device will use the public key to generate the MIC on MAC layer and use the join key to generate the network layer MIC and encrypt the join request. After the joining device is authenticated, the network manager will create a session key for the device and thus establish a secure session between them.

In the second scenario, on the MAC layer, the DLPDU is authenticated with the network key; on the network layer, the packet is authenticated and encrypted by the session key.

### 2.4 References

3 Security, Reliability & Co-Existence

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Wireless instrumentation has been available for some time in a single vendor format. Having identified HART as a good basis for a wireless instrument network and that an ISM band offers a simply installation method (no license required and standard radios available). Major instrument vendors and organisations such as the HCF (HART Communication Foundation) carried out customer surveys and not surprisingly (they were the same customers) each received the same top three requirements.

Make it Secure

Every one is aware of security these days and it was not surprising this was a top requirement. Not only do we need to encrypt data to stop someone reading it and making a financial benefit but we need to authenticate the data to make sure it has not been changed since transmission.

Make it Reliable

Experience with wireless commodity product (WiFi – Blue tooth – mobile phones) has shown some wireless applications do not provide the availability required in process plant. We need a network which can monitor itself and repair problematic pathways automatically and in good time.

Make it Resistant To Interference

Concerns that radio frequency interference between wireless solutions could affect the reliability of essential communications. An open, standards-based wireless architecture from Emerson Process Management and Cisco Systems addresses these concerns by using mesh network technology and other methods to provide high levels of communication reliability at both the field-network and plant-network levels.

3.1 Security

WirelessHART security features include:
- Security is “built-in” and cannot be disabled
- Utilizes Standard AES-128 bit encryption
- Ease of use (automatic functions)
- Only the final device can decrypt and utilize the data

WirelessHART networks have two main categories:
- Data Protection (Confidentiality, Integrity)
- Network Protection (Availability)

3.1.1 Data Protection

1) Authenticate Instruments

The WirelessHART sensor network provides:
- A 128-bit Join Encryption Key is used to keep data sent and received during the joining process private
- The Join Key also serves as authentication to the security manager that the device belongs to the network
- The Join Key is treated separately from the other keys to enhance security
- Join Keys can either be unique to each device or common to a given WirelessHART network
2) Encrypt Messages
The WirelessHART sensor network provides end-to-end AES-128 bit encryption from the source to the consumer with Individual session keys.

3) Check Message integrity
- The WirelessHART sensor network provides message Integrity checking
- Checks data sent over the wireless network has not been altered
- Add an Message Integrity Code (MIC) to each packet
- The receiving device checks the MIC to confirm the contents of the packet have not been altered
- Allows you to be sure messages are not altered by external agents

3.1.2 Network Protection
1) Denial of Service
   - Saturate the network with – Join Requests data
   - Join request ignored for unidentified / unauthorized devices
   - The Network manager has a list of authorized instruments
   - Need to be authorized device
   - A counter logs failed join requests – and alert site security if there is increasing number of join failures

2) Replay Attack
   - Keep the network busy handling data
   - Read data and repeat it onto the network
   - The message is ignored since the Counter at the network layer is time slot dependant
   - The replay has to happen in the same time slot (10msec)
3) Clone an instrument
- Clone an authorized instrument and join the network
- This is prevented since the Gateway can rotate the join key regularly
- Clone may have correct UID and TAG but cannot know new join key

3.2 Reliability
99.9% reliability is achieved by:
- Managing power thru efficient data sending and smart updates
- Build redundant paths thru MESH Network
- Management of Network thru the Gateway

3.2.1 Managing Power Thru Efficient Data Synchronization and Smart Updates
To achieve an efficient communications protocol each of the network instruments must have a common sense of time to avoid data collisions and synchronise transmission and receipt of data. Timely access to the network is achieved by dividing time into slots and distributing these time slots to individual instruments.

With time synchronisation each instrument is aware of the sequence of channels used during the channel hopping procedure ensuring that the transmitting and receiving instruments are not only time synchronised but frequency synchronised too.

WirelessHART has other technologies to optimise power usage – such as condition reporting (send an alarm when it is tripped) and smart reporting (alter data rate based upon condition). So that you can optimize the data sending according to your process.

3.2.2 MESH Network and Redundancy
The mesh network provides the most robust topology for a wireless network as there are multiple redundant pathways to get data from source to destination – reliability is one of the top concerns for process industries.
1) Self-Building Mesh
   • Simplified commissioning
   • Automatic features
     – Time Slot allocation
     – Path selection

2) Self-Healing Mesh
   • Redundant communication paths (no ACK from message)
   • More instruments = more redundant pathways

WirelessHART devices also report the condition of their power supply so that if they are battery powered the battery can be replaced before it is exhausted.

3.3 Co-Existence
Using an Unlicensed band (ISM) means that there is no need to license the radio on the plant – however you have to co-exist with others. Compromise between being a good neighbour or good worker. WiHART has several co-existence strategies:
   • Channel assessment. Sample a channel before you use it to make sure no one else is transmitting at the same time
   • Send short messages (10 m sec) so less chance of a collision
   • Channel hop on each message to reduce risk of a collision
   • Black list a channel known to be used by others for long periods.

3.2.3 Management of Network thru the Gateway
The Network Manager in the Gateway builds and maintains the MESH network. It identifies the best paths and manages distribution of slot time access (WirelessHART divides each second into 10msec slots)  Slot access depends upon the required process value refresh rate and other access (alarm reporting – configuration changes)
## Wireless Project Introduction

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4. Wireless Project Introduction

WirelessHART is a global IEC-approved standard (62591) that specifies an interoperable self-organizing mesh technology in which field devices form wireless networks that dynamically mitigate obstacles in the process environment. This architecture creates a cost-effective automation alternative that does not require wiring and other supporting infrastructure. WirelessHART field networks (WFN) communicate data back to host systems with reliability demonstrated in the field in excess of 99% and are capable of both control and monitoring applications.

The similarities between WirelessHART and HART allow wireless devices to leverage the training of existing process organizations, minimizing change and extending the benefits of automation to end users who previously could not justify the costs associated with typical wired capital projects. This opportunity and long-term benefit justifies the addition of new end users including maintenance, safety, environmental, and reliability, in the FEED (Front-End Engineering and Design) of new projects. Additionally, by removing many of the physical constraints of wiring and power (as well as reduced weight), wireless networks provide new flexibility in project execution.

4.1 Definitions

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<tr>
<td>Host System</td>
<td>Any system accepting data produced by the WirelessHART Field Network (WFN). This could be a DCS, PLC, RTU, Data, Historian, asset management software, etc.</td>
</tr>
<tr>
<td>Join Key</td>
<td>A 128 bit security key used to authenticate wireless field devices when joining the network, including encryption of the join request. A common Join Key may be used among all devices on a given network, or each device may have a unique join key. (Note: When displayed in hexadecimal format via a browser or handheld, this results in a 32 character hexadecimal field).</td>
</tr>
<tr>
<td>Network ID</td>
<td>An integer between 0 and 36863 that distinguishes one WirelessHART network from another. Each gateway at a facility or location should be programmed with a unique Network ID. All authenticated wireless field devices with the same Network ID will communicate on the same network and gateway.</td>
</tr>
<tr>
<td>Update Rate</td>
<td>The user specified interval at which a wireless field device will detect a measurement and transmit the measurement to the gateway (i.e. sample rate). The update rate has the largest impact on battery life due to the powering of the device sensor. Update rate is independent of radio transmissions required for mesh peer-to-peer communication, “hopping” via multiple devices to transmit a measurement back to the gateway, and downstream communications from the host system to the wireless field device.</td>
</tr>
<tr>
<td>Ancillary Device</td>
<td>Any device that does not contain a measuring sensor or output to the process for actuation.</td>
</tr>
<tr>
<td>Gateway</td>
<td>Enables communication between wireless field devices and host applications connected to an Ethernet, Serial, or other existing plant communications network; management of the wireless field network; and management of network security. Conceptually, the gateway is the wireless version of marshaling panels and junction boxes. The gateway functionality may also exist in native WirelessHart I/O cards with field radios.</td>
</tr>
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### Terminology Definition

<table>
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<tr>
<th>Terminology</th>
<th>Definition</th>
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<tr>
<td>Wireless Adapter</td>
<td>Enables an existing 4-20 mA, HART-enabled field device to become wireless. Adapters allow the existing 4-20 mA signal to operate simultaneously with the digital wireless signal.</td>
</tr>
<tr>
<td>Wireless Field</td>
<td>Field device enabled with a WirelessHART radio and Devices software or an existing installed HART-enabled field device with an attached WirelessHART adapter.</td>
</tr>
<tr>
<td>Wireless Field</td>
<td>A self-organized network of wireless field devices that Network automatically mitigate physical and RF obstacles in the process environment to provide necessary bandwidth for communicating process and device information in a secure and reliable way.</td>
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<tr>
<td>Wireless Repeater</td>
<td>Any wireless field device used to strengthen a wireless field network (by adding additional communication paths) or expand the total area covered by a given mesh network.</td>
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### Abbreviation Description

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<tr>
<td>AMS</td>
<td>Asset Management System</td>
</tr>
<tr>
<td>CSSP</td>
<td>Control Systems Security Program</td>
</tr>
<tr>
<td>DCS</td>
<td>Distributed Control System</td>
</tr>
<tr>
<td>DD</td>
<td>Device Descriptor</td>
</tr>
<tr>
<td>DSSS</td>
<td>Direct-Sequence Spread Spectrum</td>
</tr>
<tr>
<td>FAT</td>
<td>Factory Acceptance Test</td>
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<tr>
<td>FEED</td>
<td>Front End Engineering and Design</td>
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<tr>
<td>HMI</td>
<td>Human Machine Interface</td>
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<tr>
<td>LOS</td>
<td>Line of Sight</td>
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<td>NFP</td>
<td>National Fire Protection Association</td>
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<tr>
<td>PFD</td>
<td>Process Flow Diagram</td>
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<tr>
<td>P&amp;ID</td>
<td>Piping and Instrument Design</td>
</tr>
<tr>
<td>PLC</td>
<td>Programmable Logic Controller</td>
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<tr>
<td>RF</td>
<td>Radio Frequency</td>
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<tr>
<td>RSSI</td>
<td>Received Signal Strength Indicator</td>
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<td>SIT</td>
<td>Site Integration Test</td>
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<td>SPI</td>
<td>Serial Peripheral Interface</td>
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<td>SPL</td>
<td>Smart Plant Layout</td>
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<tr>
<td>TSMP</td>
<td>Time Synchronized Mesh Protocol</td>
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<td>TSSI</td>
<td>Temporal Single-System Interpretation</td>
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<tr>
<td>UDF</td>
<td>User Define Fields</td>
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<tr>
<td>WFN</td>
<td>WirelessHART Field Network</td>
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### 4.3 Project Concepts

#### 4.3.1 Pre-FEED

During the Pre-FEED phase, consideration must be given to available technologies and an assessment made as to the applicability to the specific project and application. It is during this Pre-FEED phase that WirelessHART should be considered as a candidate technology, along with other protocols including HART, Foundation Fieldbus, and Profibus.

During the Pre-FEED phase, spectrum approvals for the end-user and any intermediary locations should be verified. Refer to Chapter 9 Wireless Spectrum Governance for more details.

An integrated approach should be used for incorporating wireless into a project. Wireless should be merged with the established procedures for a wired project.
The key consideration is to use the right field device technology for the right application and expand consideration for possibly new end user communities during the FEED process.

**Right Technology for Right Application**  
*Wireless HART* is designed for both control and monitoring applications. Most current use cases emphasize monitoring applications due to conservative adoption of technology to meet the needs of a conservative industry. The use of wireless control applications is continuing to evolve with the introduction of discrete output devices for performing simple control functions. The table below provides a high level summary for selection of the right protocol when factoring in loop criticality; cost to engineer and implement; and location of field devices relative to main process areas and host systems.

![Figure 4.3.1a – Selecting the Right Protocol](image)

**4.3.2 Technology Evaluation**  
The project should establish design rules to define which measurement and control points are *Wireless HART* appropriate in order to enable consistent and efficient engineering for subsequent project phases.

The technical authority will make a decision to use wireless based on the following high level criteria:

- Economic Assessment
- Potential applications
- Potential operational savings
- Potential benefit of new measurements providing additional process insight
- Benefits of adding measurement not previously considered feasible for inclusion in the automation system due to economics or practicality – example: monitored safety showers

- Benefits of flexibility in project execution – example: ease of moving or adding I/O points during construction to cost effectively manage onsite changes

The economics of installing field wiring has primarily limited the benefits of automation to process control and safety applications with additional points added over the life of the plant to resolve critical problems. Since *Wireless HART* does not require wires for communication or power, the financial hurdle rate that determines if a point is automated or not is redefined.

Special consideration should be given to understand the automation needs of new process plants to ensure they meet stricter safety, environmental, reliability and performance criteria. Below are a few examples:

- Many new plants are designed to operate with fewer personnel. Upgrading simple gauges to wireless field devices can automate the manual collection of data from the field in order to increase worker productivity and reduce exposure to hazardous environments.
- Many existing facilities have been modified in order to meet emerging environmental regulation. Real time monitoring of volatile organic compound release (VOC) from pressure safety valves and the conductivity and temperature of effluent waters can ensure environmental compliance.
- Remote monitoring of safety showers and gas detectors during construction and operation can provide new levels of safety response.
- New environmental regulation often requires redundant monitoring systems on assets like tanks that were not required in the past. *Wireless HART* can provide a cost effective, reliable secondary communication method and monitoring method.
- Monitoring of steam traps and heat exchangers can provide real time information for minimizing plant energy consumption.

Cost effective field information accessible via *Wireless HART* field devices enables non-traditional end users of automation to be considered in the FEED and Design Phases. A designer should be aware of initiatives for safety, environmental protection, energy consumption, and reliability in addition to the traditional considerations for process automation.
WirelessHART provides a unified infrastructure for extending the benefits of automation to multiple plant initiatives without the need for multiple forms of I/O infrastructure.

4.3.3 FEED

Key deliverables exist for wireless in the FEED, for example: cost estimating, design guidelines, and specifications.

Cost Estimation

Vendors of WirelessHART field devices may have cost calculators and capital project studies that can be referenced and compared to support the cost justification of wireless into a project or an all wireless project. For a large capital project, wireless can reduce capital costs by switching wired monitoring points to wireless.

Design Engineers should assess and incorporate the following factors in their project cost estimating calculation model:

- Reduced engineering costs (including drawing and documentation, and Factory Acceptance Test (FAT))
- Reduced labor (field installation, commissioning, supervision)
- Reduced materials (terminations, junction boxes, wiring, cable trays/conduit/trunking, power supplies, and control system components)
- Reduced cost of change order management (including adding, removing, and moving field devices)
- Reduced project execution time (including commissioning of wireless field device simultaneously with construction)
- I/O capacity management (each WirelessHART gateway essentially provides spare I/O capacity)

Design Guidelines for WirelessHART

During the FEED process, all project stakeholders should be made aware of the capability and benefits of WirelessHART so that design engineers can identify potential candidate applications. The project should develop a wireless design and circulate to all project stakeholders.

For example, the process design engineer can use a set of criteria such as the simplified table in Figure 4.3.3a to identify candidate wireless applications.

Ideally, Candidate WirelessHART applications are identified during the early process design phase during FEED. This could be during Process Flow Diagram (PFD) and Piping and Instrument Design (P&ID) Diagram development. However, if an early decision is not taken this should not preclude the use of the technology later in the project.

![Figure 4.3.3a – Example Criteria](image)

The basis for design should be shared amongst all stakeholders so that other technical design authorities can identify potential wireless applications and benefit from the installed wireless infrastructure. Furthermore, this process ensures consistent implementation across all design authorities and allows for an efficient decision process to use wireless.

Points to consider when setting guidelines:

- Determine which categories of points are eligible to be wireless: safety, control, monitoring, and local indication.
- Determine if new users are eligible for automation: process efficiency, maintenance, reliability, asset protection, health/safety/environmental, and energy management.
- Determine percent spares required and necessary spare capacity.
- Factor in distance considerations between gateways and wireless field devices. Distance considerations are elaborated on in Chapter 5, Installation Guidelines.
Specifications
Specifications for WirelessHART field devices are mostly the same as wired HART devices. See Appendix B WirelessHART vs. Wired Hart Comparison for key differences. HART instrumentation specifications are the foundation for WirelessHART specifications. The fundamental differences with regards to the ISA-20 specifications are output signal, power supply, update rate, protection type/enclosure. Specifications not included in this short list are either included with the IEC 62591 WirelessHART standard, small deviations from HART that require optional attention for the specification process, or are unique to a field device vendor.

Figure 4.3.3b is a comparison of fundamental differences in the specifications:

Figure 4.3.3b – Key Differences Between Wired and WirelessHART

IEC 62591 WirelessHART is an international standard for wireless process devices. The standard includes advanced provisions for security, protocol, and other features and therefore specification of such attributes covered in the standard are not necessary.

Appendix A provides example specifications for a WirelessHART gateway and wireless adapter that can be generically specified as transceivers/receivers.

4.3.4 Detailed Engineering
During the detailed engineering phase of a project, the engineer must account for WirelessHART devices per the guidelines established in the FEED, add wireless specific fields to the project database, and conduct wireless field network design procedures to ensure best practices are implemented.

Sort the Points
Using the wireless guidelines established in the FEED, the design engineer should do a sort of all points in the project database to identify which are eligible to be wireless. For example, if monitoring is deemed to be an eligible category, these points should be sorted from the control and other points. Afterwards, further requirements of the field devices can be applied. For example, some control and monitoring points may be excluded from wireless eligibility because the required update rate exceeds either the desired life of the battery or the capability of the field device.

Typical safety and control update rates may require 1 second or faster. There is a trade-off for wireless devices between update rate and battery life; the faster the update rate, the lower the battery life will be. The current recommendation is that an application should have a time constant satisfied by an update rate that supports a battery life of multiple years for reduced maintenance. However, faster update rates can be considered if the wireless device will be powered externally, an energy harvesting device, or if battery maintenance is not a concern for that application.

1. Values in table are typical and representative.
2. The trend with wireless field device vendors has been to provide intrinsically safe protection.

This difference is noted in the best interest of the reader to support due diligence.

Additionally, it is recommended that the update rate of the measurement be three times faster the process time constant. As an example, a typical update rate for measuring temperature changes with a sensor inside a thermowell can be 16 seconds or longer given how much time is required for heat to penetrate the thermowell.

Database Field for Wireless Network Assignment
Each wireless field device must be assigned to a specific gateway that manages a specific wireless field network. There must be a corresponding field that indicates the association of the field devices to the gateway. Without this information, the wireless field device will not be able to receive the proper security information to join the intended wireless field network nor the proper integration into the host system from the gateway.

Each gateway will manage its own wireless field network and can have an assigned HART Tag like any HART device. Each wireless field network in a plant must have a unique Network ID to prevent devices from attempting to join the wrong network. In order to ensure the desired security level is achieved, a decision must be made whether to use a common join key for all devices in a given field.
network, or unique join keys for each field device. The combination of these two parameters provides identification and authentication down to the field device. Below are examples of a gateway HART TAG, Network ID and Common Device Join Key.

The Join Key is the most important parameter for implementing security. A user can know the Gateway HART TAG and the Network ID for the network the gateway manages, but without a Join Key, a wireless field device cannot join the network. The design engineer should be sensitive to the security policies of the design firm and the security policies of the future owner/operator and, as a minimum, treat the Join Key with the same sensitivities as a password for a server to a DCS or database. For this reason, storing the join key as a field in a design database is not prudent.

Fields should be added to the project database to indicate that a field device is wireless and its association with a gateway using the gateway HART TAG or other labeling convention. Parameters required to be managed confidentially should be controlled in a secure means in alignment with established security policies. Staff members with IT security or process security responsibilities are well suited to provide consultation into the handling of sensitive information.

Finally, the design engineer should be aware of available WirelessHART devices. Many come with multiple inputs that can satisfy the total number of points in a project with fewer devices. For example, several vendors have a multiplexed WirelessHART temperature device that reduces costs.

**Network Design**

Once wireless candidate devices have been identified in the instrument database the field network design can begin. Ideally wireless points should be organized by process unit and by subsection of process unit as typically depicted in a master drawing. This information can be used to determine the number of gateways required. Additional gateways can be added to ensure spare I/O capacity per guidelines or other project requirements. From here, the gateways should be logically distributed throughout the process unit like marshaling panels. Wireless field devices should then be assigned according to which gateway is closest or by which gateway is assigned to the process unit subsection in which the field devices reside. Once this is complete, network design best practices should be checked to ensure the network will be reliable. This will be covered in detail in the WirelessHART Field Network Design Guidelines.

Drawings should be created per existing standards. In most instances, a wireless field device is treated identically to a wired HART device. Most drawings do not indicate wires or the type of communication protocol, thus nothing unique needs to be done for wireless field devices. The section on Ancillary Device Requirements provides examples unique to WirelessHART such as gateways and wireless adapters. Fundamentally, it will be up to the design engineer to adhere to or provide a consistent convention that meets the needs of the contractor and the owner operator as is true for wired HART projects.

Existing HMI (human-machine interface) design guidelines for integration also apply to wireless with no change required since data points connected from the gateway into the host system are managed like any other source of data.

**4.3.5 Factory Acceptance Test**

Factory Acceptance Tests require establishing a connection between the Gateway and the Host Systems. WirelessHART gateways typically have standard output communication protocols that directly connect to any host system. The design team should keep a library of these integration options for reference.
4.3.6 Installation

In general, WirelessHART device are installed exactly like wired HART devices. Emphasis should always be placed on making the best possible process connection for accurate measurement. The self-organizing mesh technology in WirelessHART enables wireless field devices to self-route through the process environment and reroute when the environment changes. Always consult the instruction manual of the WirelessHART device for specific considerations. This is covered in detail in WirelessHART Field Network Design Guidelines.

WirelessHART adapters are typically installed on an existing HART enabled device or somewhere along its 4-20 mA loop. Always consult the manual of the WirelessHART adapter for specific considerations.

WirelessHART gateways are typically placed 6 feet (2 meters) above the process infrastructure (typically above cable trays) and located in the process unit where the maximum number of direct connections with wireless field devices can be achieved. Gateways may have an integrated or remote antenna for installation flexibility.

WirelessHART repeaters are typically mounted 6 feet (2 meters) above the process infrastructure and should be located in areas of the wireless network that need additional connectivity.

It is recommended to install the gateway first in order to allow host system integration and wireless field device installation and commissioning to commence in parallel. Wireless field devices can be commissioned as soon as process connections are in place and a device is joined to a network. Once the wireless device is activated with proper configuration, update rate, and security provisions for Network ID and Join Key, it will form a network that compensates for the current condition of the process unit and will adapt as the unit is built. The project manager can have wireless device installation occur in parallel with construction to maximize project time buffers or pull in the project completion date.

4.3.7 Commissioning

WirelessHART gateways segment the commissioning process. Since gateways connect the wireless field devices to the host system, WirelessHART devices can be commissioned to the gateway to ensure proper connectivity independently of verifying integration into the host system.

A wireless loop check can confirm connectivity from the wireless field device through the gateway to the host system. Interaction with the process and the WirelessHART device can confirm the device is operational.

4.4 Document Requirements

4.4.1 Drawings

Every project will require the establishment of local standards for implementing consistent documentation.

See Documenting in Intergraph SPI 2009 for a complete treatment of documentation.

4.4.2 ISA Documentation


Key points:
1. There is no difference in the symbol between a HART, FF, and a WirelessHART device. An instrument is an instrument.

2. The line style for indicating a wireless signal is a zig zag and not a dash.

Below is an image from the ISA-5.1 document showing some comparative examples. Please reference ISA-5.1 for complete details.

Figure 4.4.2a – ISA 5.1 Wireless Drawing
3. The implementation of WirelessHART requires far fewer components, making drawings simpler.

4.4.3 Control Narrative
Define in the FEED phase and ensure this is implemented with design guidelines.

4.4.4 Instrument Index/Database
See Documenting in Integraph SPI 2009 for recommendations for additional fields not typically included in wired HART specifications.

4.4.5 Instrument Data Sheets
Use standard data sheets created for wired HART devices. Update the following fields to reflect WirelessHART:

<table>
<thead>
<tr>
<th>Specification Field</th>
<th>Typical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Update rate</td>
<td>1, 2, 4, 8, 16, 32, 64+</td>
</tr>
<tr>
<td>Power Supply</td>
<td>Intrinsically safe, field replaceable battery</td>
</tr>
<tr>
<td>Communication Type</td>
<td>IEC 62591 WirelessHART</td>
</tr>
</tbody>
</table>

No special ISA or other specification sheets are required as the same sheets can be used to specify HART, FOUNDATION Fieldbus, or WirelessHART. See Appendix A for a specification sheet example for a WirelessHART gateway.

4.4.6 Material Requisitions
Given the need for security and RF emissions, vendors must acquire approvals for importation to the country of end-use for compliance with local spectrum regulation and encryption regulation. The vendor can verify whether importation compliance exists for any given country.

The batteries are commonly made using a high energy compound using Lithium Thionyl Chloride. The Material Safety Data Sheet or equivalent should always be available as well as awareness of any shipping restriction; notably most countries do not allow the transportation of lithium batteries on passenger aircraft.

4.4.7 Manufacturer Documentation
Every WirelessHART device should have the proper documentation, including manual, as would be expected with a wired HART device.

4.4.8 Project Management

**Subcontractor Scope Management**
Wireless enables simplified subcontractor scope management. Packages can be easily tested and commissioned separately, requiring only minimal integration and testing to occur. Additionally the subcontractors will also benefit from fewer components and engineering. Tender contracts should be amended to recognize reduced complexity and eliminated work.

**Project Scheduling**
1. Review schedules to recognize:
   - Limited infrastructure installation and hence reduced material and installation scope
   - Remove some electrical and instrumentation checkout processes
2. Amend contracts to reflect simplified installation handover processes
3. Simplify installation schedule management
4. Reduce material coordination management and simplified construction schedule
   - Eliminated scheduling and expediting associated with marshaling cabinets
5. Schedule should reflect eliminated activities and simplified FAT, SAT and SIT (site integration test) on areas where wireless has been extensively deployed

**Responsibility and Skills Matrix**
- Amend Roles and Responsibility matrix to reflect reduced/eliminated responsibilities
- Ensure engagement of all project stakeholders/sub-contractor so that wireless can be applied efficiently to improve schedule and material costs

**Managing Project Variations**
For project change orders and other late design changes, wireless should be considered as the primary solution unless other design considerations exist. Using wireless will result in the fewest changes to the documentation, I/O layout and other detailed design as well as faster commissioning since you can move wireless devices without having to also re-engineer the wiring.
4.5 Field Device Requirements

4.5.1 Support for WirelessHART Functionality

All WirelessHART devices support methods to allow remote access to device configuration, backwards compatibility with existing field communicators, full implementation of WirelessHART security provisions, and WirelessHART interoperability.

4.5.2 Device Diagnostics

HART Diagnostics

WirelessHART devices contain similar or a subset all of the diagnostics of wired HART devices. Expect configurable alarms and alerts for both the process, the device, and the battery. Diagnostics information should be available through HART commands as well as accessible through Device Descriptions (DD) either locally through a field communicator or remotely using asset management software.

Wireless Field Device Network Diagnostics

Every WirelessHART field device should have diagnostics that indicate if a device is connected to a network or not.

Wireless Field Device Power Diagnostics

Wireless field devices may have one of three power options: battery, energy harvesting (including solar), or line power. Batteries will have a life determined by the update rate of the wireless field device, network routing for other wireless field devices, and efficiencies of the sensor and electronics. Typically, the primary consumer of power is the process sensor and electronics in the wireless field device. Using the WirelessHART radio or acting as a repeater for other WirelessHART field devices requires minimal power. Wireless field devices report their battery voltage and have integrated low voltage alarms such that the user can either schedule maintenance or take a corrective action.

Gateway Network Diagnostics

Gateway network diagnostics should indicate whether field devices are connected and functioning properly, and if devices are missing from the network. In order to be connected properly, proper bandwidth must be allocated based on the update rate of the device. A device connected but with service denied may indicate a device has an update rate that is too fast for the network capability or the network conditions. With gateways capable of holding 100 devices or more, clear indication of device availability is crucial.

Additionally, gateways should be able to detect, regardless of host system integration, the connectedness of a wireless field device. This information should be continually updated and indicate if a device is not connected for network or device reasons. Simple device states should be made available for integration into the host system regardless of output protocol from the gateway to indicate online/offline status.

4.5.3 Field Device Power

Wireless field devices may have one of three power options: battery, energy harvesting (including solar), or line power and there may be several options with each category.

Batteries

The most common will be the use of a battery for low power field devices due to ease of deployment. Most vendors will use battery cells incorporating Lithium Thionyl Chloride chemistry since it has the highest energy density, longest shelf life, and widest working temperatures that are commercially viable. Although typical cells look like battery cells for consumer electronics, precautions should be taken to ensure batteries are safely transported and introduced into the process environment. Refer to vendor documentation for safe handling practices.

Below are requirements for batteries:

- Batteries cells should be assembled by a manufacturer into a battery module to ensure safe handling and transportation.
- Battery module should prevent a depleted cell being introduced in circuit with a charged cell, which can cause unintended electrical currents and heat.
- Battery module should provide ease of replacement. Battery replacement should take minimal time and training.
- Battery module should be intrinsically safe and not require removal of the wireless field device for replacement.
Battery module should prevent intended and unintended short-circuiting that could lead to heat or spark.

Battery module should be designed for the process environment with mechanical properties that provide drop protection and operation over normal process temperatures expected for devices.

Battery modules should come with necessary Material Safety Data Sheets (or equivalent) and warnings and be disposable per local governmental regulation.

Battery module should not be capable of connecting to consumer electronics or non-designed applications to prevent a high-capacity supply from being connected to incompatible electrical systems.

Battery modules should be applicable to several WirelessHART field devices to maximize inventory management efficiencies in the local warehouse for spare parts.

The design engineers of the wireless field network and end users should use update rates that maximize the life of the battery module and minimize maintenance.

**Energy Harvesting**

Vendors may provide energy harvesting options as alternatives to batteries that may include solar, thermal, vibration, and wind solutions. Current energy conversion techniques for thermal and vibration are relatively inefficient. In many cases, energy harvesting solutions also utilize rechargeable batteries to maintain constant back-up power supply. Today’s rechargeable batteries have a life expectancy of only several years during which they can maintain a full charge and are often sensitive to temperature change for supplying power and recharging.

Below are requirements for energy harvesters:

- Energy harvesting device should have a designed connection to the wireless field device.
- Energy harvesting device should have means for providing multiple days of back-up power in the event the energy source is discontinued for several days.

Energy harvesting device should be mounted such that it is not negatively impacted by changes in the season, process conditions, and according the vendor recommendations.

Energy device should be intrinsically safe and installation should follow local practices for low voltage wiring.

Energy harvester should have the means for the user to know the state of the device via the wireless field device.

The lifetime and maintenance of rechargeable batteries should be understood and incorporated into a maintenance routine.

**Wired Power**

A wired power option for wireless field devices is an emerging option from vendors since the cost of local power can be less than the cost of a control signal wire with power or a power module. Some WirelessHART Adapters may harvest power off of the 4-20 mA loop to wired HART device. Some applications with high power sensors may need to be wireless to meet a communications specification, but require more power than a battery or energy harvester can provide.

Below are the requirements for a wired power option:

- WirelessHART adapters harvesting power from the 4-20 mA signal of the wired device should not affect the 4-20 mA signal during normal operation or failure mode.
- Low voltage powered wireless devices (<30 VDC) should be capable of operating over a range of voltages – example: 8-28V using standard low voltage wiring practices.
- Wired powered option may require the use of Intrinsically Safe barriers between the DC voltage source and the wireless field device.

**4.5.4 Field Device Security**

Security is a new consideration for wireless field devices that is driven by an increased focus on the protection of critical infrastructure by governments and other security authorities.

Below are the requirements for wireless field device security:

- Wireless devices should be compliant with all WirelessHART security provisions including correct usage of Network ID and Join Key.
• The user or unintended user should not be able to physically or digitally read the Join Key from the wireless device. The Join Key(s) should be treated as confidential and subject to the requirements of any local security policy.

• The wireless device should be receptive to security changes initiated by the gateway, including Network ID, Join Key, and the network, session, and broadcast keys that validate packets sent through the network and prevent tampering and eavesdropping.

• The gateway and any management program connected to the WirelessHART network through the gateway should protect all security parameters according to a local security policy.

• Wireless field devices should not have a TCP/IP address in order implement a layered security policy. The exception is the gateway with a TCP/IP connection to the host system via a firewall.

4.5.5 Approvals
Every WirelessHART device must have the appropriate hazardous area approval to meet the conditions of the process environment as well as the appropriate spectrum and encryption approvals. Spectrum and encryption of wireless signals are regulated by government agencies, such as the FCC in the United States. Typically, verifying with the WirelessHART device manufacturer that the device has proper approval for importation into the country of usage is sufficient. Spectrum and encryption approval are a procurement issue and do not represent a design parameter like a hazardous area approval.

4.5.6 Accessibility
WirelessHART devices are subject to the same mechanical and electrical specifications as wired HART devices is they operate in the same process environments.

Below are general requirements for WirelessHART field devices:

• WirelessHART adapters shall extend the benefits of a WirelessHART network to wired HART devices that may or may not be operated on a 4-20 mA loop.

4.6 Ancillary Device Requirements
An ancillary device is defined as any device that does not contain a measuring sensor or output to the process for actuation. These include wireless gateways, local indicators, wireless repeaters and/or WirelessHART adapters.

4.6.1 Gateways
The gateway enables communication between wireless field devices and host systems connected to an Ethernet, serial, or other existing plant communications network. WirelessHART manufacturers have typically chosen to integrate the network manager, security manager and access point functionalities into one product. Conceptually, the gateway is the wireless version of marshaling panels and junction boxes.

Below are the requirements for a WirelessHART gateway:

• The gateway should provide an easy to manage solution for enabling gateway, network management, and security management functionality.
• Gateway should have controlled access for a security policy. Gateway should have multiple user accounts with differing access to critical security and configuration parameters such that there can be secure network administration.

Gateway should have multiple output protocols to ensure integration to a range of host applications. In any given process facility, there can several types of DCS, PLC, and data historians requiring multiple protocols. Multiple output protocols allow convenient connectivity with a standard gateway.

• The gateway should support multiple connections and, in effect, act like a server. Typical WirelessHART applications require data to be sent to multiple host applications in order to provide data to multiple end users.

• The gateway should support the secure transfer of all protocols over an Ethernet connection through a robust encryption process.

• Gateway should be interoperable and support the network management of WirelessHART devices from multiple vendors.

4.6.2 Wireless Repeaters

There are no special requirements for a WirelessHART repeater. If a repeater is a WirelessHART device with a configurable update rate, then minimizing the update rate shall maximize the life of the battery module without impacting the network reliability.

If a vendor chooses to develop a WirelessHART device for the specific purpose of acting as a repeater, then that repeating device should be managed like any other WirelessHART device and subject to all the specifications of a WirelessHART device. WirelessHART adapters can be used effectively as repeaters if local power or a wired HART device is available.

4.6.3 WirelessHART Adapters

WirelessHART adapters connect to wired HART devices that are not inherently wireless and provide parallel communication paths through the 4-20 mA loop and the WirelessHART field network. There are four main use cases for WirelessHART adapters:

• Access HART diagnostics that are not accessible due to limitations of the host system which may not detect the HART signal on the 4-20 mA loop.

• Provide wireless communications for HART devices which are not natively wireless.

• Enable device information to be accessed by multiple users who may not have direct access to the control system. In this scenario, the 4-20 mA signal is sent to the control room while the WirelessHART signal is used to access parametric and diagnostics data by maintenance or other personnel.

• Act as a wireless repeater.

Below are the WirelessHART Adapter specifications:

• Adapter should not affect the 4-20 mA signals under normal operation or in failure mode.

• Adapter should operate like any other WirelessHART field device in the WirelessHART field network.

• Adapter should have a HART Tag.

• Adapter should pass through the wired HART device process variable as well as remote access for configuration and calibration.

• Adapter should employ the same security functions and methods as a standard WirelessHART device.
## Installation Guidelines

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5. Installation Guidelines

The WirelessHART network specification enables a reliable, secure, and scalable architecture. Contrary to legacy systems and point-to-point wireless networks, WirelessHART is a truly scalable automation technology that gets more robust as more devices are added to an existing network. Design guidelines support the deployment of small networks with less than 10 WirelessHART devices for monitoring and control, as well as installations supporting thousands of devices.

This section includes recommendations to support the long-term, sustainable adoption of wireless applications including WirelessHART as well as Wi-Fi, Wi-Max, and more.

The best practices for network design are applicable for networks operating with mix of WirelessHART devices for monitoring and control with update rates from 4 seconds to 3600 seconds (60 minutes). Please see the section Designing for Control for additional considerations when including 1 second update rates.

A site survey is not normally required or even possible in the case of a Greenfield site.

WirelessHART is built upon the HART standard; therefore minimum differences exist between the usages of wired and wireless devices. The minimal need for wires also means there are fewer engineering details to manage and fewer engineering parameters to introduce. This section provides a thorough discussion of WirelessHART Field Network Design.

The following can be applied to small projects requiring a single gateway or a large project requiring several gateways.

5.1 WirelessHART Field Network Design

There are three key steps for designing a network:

- Scope – Decide if you need to divide wireless field networks by process unit or subsection of a process unit. Factors include: Number of devices in the process unit
- Update rates need for wireless devices
- Capacity of gateway

- Design – Apply design rules to ensure optimum connectivity.
- Fortify – Identify and correct any potential weaknesses in the network design.

The three basic steps apply for all process environments in all industries, although the context may vary slightly depending on the physical structure of the process environment. The basic steps also apply regardless of the vendor of the WirelessHART device. Since WirelessHART networks become stronger the more devices are added, the Scope step is the most critical for high density applications.

WirelessHART is designed for both control and monitoring. WirelessHART is the most appropriate communications protocol for many monitoring and some control applications when considering the overall cost and technical considerations. In general, control with WirelessHART is appropriate for most cases of open loop control that would require manual interaction with the process and some cases of supervisory control for set point manipulation and process optimization. Applications for closed loop regulatory control of a critical loop may be evaluated case by case.

5.2 Design Resources

Contact your respective WirelessHART vendor for automated design tools to aid:

- Network Design
- Gateway Capacity Planning
- Device Type Availability and Battery Life Estimation

The same design rules that govern the segmentation of wired HART networks apply to WirelessHART. From a very simple perspective, all process facilities have an architecture that organizes the infrastructure as well as the automation and the people. WirelessHART not only self-organizes to the process environment, but also to this inherent organization of the process facility. For example, the process facility shown in Figure 5.3a is organized into 7 process units that are separated by roads.
If the process facility is not an outdoor production environment, there is still a natural organization that should be used for scoping networks. For example, power plants and biopharmaceutical manufacturing facilities are typically completely enclosed with multiple floors. One option is to scope WirelessHART field networks to a floor. If there are 7 floors, then there are potentially seven WirelessHART networks.

The benefits of scoping a WirelessHART field network to a process unit are:

- Aligns the data flow from the WirelessHART device through the gateway to the Host System with existing data architecture.
- Aligns WirelessHART tagging convention with wired HART tagging convention.
- Aligns WirelessHART documentation practices with the process unit and support device location. If you know device A is on Network A and in process unit A, then one should not look in process unit B to find device A.
- Aligns work processes of managing WirelessHART device life cycles with wired HART life cycles including organizational responsibilities.
- Sets reasonable expectations for range between WirelessHART devices. Most process units do not have a footprint greater than a few hundred feet (<0.2km) by a few hundred feet (<0.2km).
5 – Installation Guidelines

While scoping the number of networks and gateway placement, the design engineer should factor in considerations for gateway capacity and spare capacity. At a minimum, each process unit should have its own gateway with spare capacity for problem solving in real time. If a project is small and application focused, then typically a single gateway is required if the total number of points is less than the capacity of the gateway. If the project is large or has wireless field devices with update rates faster than 4 seconds, then following is the process of determining the total number of gateways and modifying the scope of a network.

1. Filter the Instrument Index List by process unit and determine how many I/O points are in each process unit that are wireless so that the WirelessHART networks can be segmented by process unit.
   a. For example, out of 700 total I/O points, let’s assume process unit A has 154 wireless points requiring 154 WirelessHART devices. We need to determine how many gateways are needed. Note that some WirelessHART devices support more than 1 wireless point and so there may be instances when fewer devices are required to satisfy the number of measurement points. A key example is a WirelessHART temperature transmitter where 2 or more temperature elements are used as inputs.

2. Identify the necessary update rate of each WirelessHART device to meet the specifications of the application as well as battery life.
   a. Typical WirelessHART devices can update from 1 per second to once per hour.
   b. Update rate should be 3-4 times faster than the time constant of the process for monitoring and open loop control applications.
   c. Update rate should be 4-10 times faster than the time constant of the process for regulatory closed loop control and some types of supervisory control.
   d. The faster the update rate, the shorter the battery life. Use an update rate that meets the needs of the application, but does not oversample in order to maximize battery life.
   e. Update rates faster than 4 seconds can impact the total number of wireless devices that can be put on a gateway. Consult the specification of the gateway vendor for additional constraints and consultation.

3. Determine the capacity of the gateway determined by the maximum update rate to be used in the network. Be conservative and assume all devices are operating at the same, fastest update rate network for the purpose of estimation. Example output: 100 WirelessHART devices per gateway if all devices are updating every 8 seconds or slower and the gateway can support 100 devices at 8 seconds.
   a. Note that some gateway vendors have advanced capacity planners that can provide detailed capacity estimate based on the required updates of individual update rates. WirelessHART networks can support a mix of device types and update rates. The method outlined here is a simple method that determines max capacity with very limited design information.

4. Determine and apply any guidelines on spare capacity. If the design rules for the project state I/O components should have 40% spare capacity, then note this value for the following calculation.

5. Use the following calculation to determine the number of gateways needed:

   \[ \#\text{gateway} = \text{ROUNDUP}\left(\frac{\text{Total WirelessHART devices in process unit}}{\text{gateway capacity} \cdot (1 - \text{spare capacity requirement})}\right) \]

   For the example above, three gateways are needed.

   \[ \#\text{gateway} = \text{ROUNDUP}\left(\frac{154}{100 \cdot (1 - 0.40)}\right) = 3 \]

   This formula can be entered into Microsoft Excel.

6. Scope the number of required gateways into subsections of the process unit. If more than one gateway is needed per process unit, then the design engineer should segment the networks such that the gateways are distributed in the field like marshaling panels and junction boxes. In Figure 5.3b, the master drawing, the process unit has 16 subsections labeled L-2 through L-17 that should be logically segmented for coverage by gateways. Not every gateway needs to have the same number of wireless points. If redundant gateways are to be used, then double the number of gateways based on the output from the above formula.
5 – Installation Guidelines

This example shows three WirelessHART gateways supporting three WirelessHART networks in the same process. This is analogous to having three FOUNDATION Fieldbus segments in the same process unit. In this example, the process unit subsections were grouped horizontally instead of vertically to minimize the distance of the process unit. A key consideration is that the gateways, regardless of manufacturer, should always be in the process space for which they supply I/O capacity.

Below is an image of what not to do:

Do not place all gateways in the same location just because connecting into the host system is convenient. The next section on network design will show this is inefficient and can lead to unreliable networks in the long term. The gateway should be centralized to the field network to maximize the number of connections to wireless devices.

WirelessHART networks can be logically aligned with existing documentation and automation engineering practices following this procedure.

Key things to remember:
- Scoping is the most important design rule. Use it to ensure wireless capacity, long term scalability, high reliability, and alignment of WirelessHART devices and management with existing process facility, organization, and work practices.
- Every WirelessHART gateway in a facility must have a unique Network ID to properly segment the WirelessHART field networks.
- The output from the scoping phase should be a scaled drawing showing the relative locations of assets and processes to be automated and potential integration points for the WirelessHART gateways.

5.3 Designing Effective Device Range

The following design rules are intended to be very conservative and are based on real-world deployments of WirelessHART field networks. The effective range of a device is the typical linear distance between WirelessHART field devices when in the presence of process infrastructure. Typically, if WirelessHART devices have no obstructions between them, have clear line of sight (LOS), and are mounted at least 6 feet (2 meters) above the ground, then the effective range with 10 mW/10 dBi of power is approximately 750 feet (228 m). Obstructions decrease the effective range. Most process environments have high concentrations of metal that reflect RF signals in a non-predictable manner bouncing the signal off of the metal of the surrounding environment. The path of an RF signal could easily be 750 feet (230m) even though the neighboring device separation is only 100 feet (31m) away.
Below are three basic classifications for effective range in the process environment:

- **Heavy Obstruction** – 100 ft (30 m). This is the typical heavy density plant environment. Cannot drive a truck or equipment through.
- **Medium Obstruction** – 250 ft (76 m). This is the less light process areas, lots of space between equipment and infrastructure.
- **Light Obstruction** – 500 ft (152 m). Typical of tank farms. Despite tanks being big obstructions themselves, lots of space between and above makes for good RF propagation.

- **Clear Line of Site** – 750 ft (228 m). The antenna for the device is mounted above obstructions and the angle of the terrain change is less than 5 degrees. Some WirelessHART vendors provide options and techniques for obtaining even further distances for long distance applications.

These values are practical guidelines and are subject to change in different types of process environments. Conditions that significantly reduce effective range are:

- Mounting field devices close to the ground, below ground, or under water. The RF signal is absorbed and does not propagate.
- Mounting field devices inside or outside of a building relative to the main network and gateway. RF signals do not propagate well through concrete, wood, etc. Typically, if there are wireless devices nearby on the other side of the enclosure, no special design rules are needed. If there is a high volume of WirelessHART devices isolated from the network by an enclosure, consider scoping a network inside of the facility. Small, fiberglass instrument and device enclosures often deployed in very dirty or harsh environments show minimal impact on propagation of RF signal and can be used. Large Hoffman-style metal enclosures will prevent RF signals and are not recommended without additional engineering considerations.

The low power nature of WirelessHART devices allow operation for several years without replacing a battery module, but also limit the output power of the radio and maximum range. Because WirelessHART devices can communicate through each other to send messages to the gateway, the self-organizing mesh naturally extends the range beyond that of its own radio. For example, a wireless device may be several hundred feet or meters away from the gateway, but power efficient “hops” through neighboring devices closer to the gateway ensure reliable, extended range.

The effective range is used to test the validity of network design by applying the following design rules.

There are 4 fundamental, recommended network design rules.

1. Rule of 5 minimum – Every WirelessHART network should have a minimum of 5 WirelessHART devices within effective range of the gateway. Networks will work properly with less than 5 WirelessHART devices but will not benefit from the intrinsic redundancy of a self-organizing mesh network and may require repeaters. In a well formed, well designed network, new WirelessHART devices can be added to the interior or perimeter of the network without affecting operation or extensive consideration for design.

Figure 5.4a is a simple design examples process unit and 4 WirelessHART devices have been placed with a gateway on a scaled process drawing. The red circle around the gateway represents the effective range of the gateway. We see in this example, the Rule of 5 Minimum is broken in that there are only 4 devices within effective range of the gateway. This network will likely perform to specification, but it is optimal to fortify for long term scalability and reliability by adding more devices.
2. Rule of 3 – Every WirelessHART device should have a minimum of 3 neighbors within effective range. This ensures there will be at least 2 connections and the potential for connections to change with time.

Continuing on from the previous example, we fortified the network by adding another field device within the effective range of the gateway and added another device as another measurement point. Now the red circle represents the effective range of the WirelessHART device that does not have 3 neighbors. For reliability, it is essential for every WirelessHART to have 2 paths during operation to ensure a path of redundancy and diversity. The Rule of 3 when designing ensures concentration of devices.

4. Rule of Maximum Distance – Wireless devices with update rates faster than two seconds should be within 2 times the effective range of wireless devices from the gateway. This rule maximizes speed of response for monitor and control applications requiring high-speed updates.

5.4 Applying Network Design Recommendations

WirelessHART devices are located according to their process connection. Only an approximate location is required for location on the scaled drawing since the self-organizing mesh technology will adapt to conditions as they exist and change from the point of installation. The design rules ensure a concentration of WirelessHART devices for ample paths between the devices. This allows the self-organizing mesh to optimize networking in a dynamic environment.

When the Rule of 3 is broken, it can be fortified by adding more devices. As networks grow, Rule of 5 minimum and Rule of 3 become irrelevant as there are many devices in the process space. Rule of Percentages becomes dominant for large networks to ensure there is ample bandwidth for all devices in the network. Below is an example of when Rule of Percentages is broken.

3. Rule of Percentages – Every WirelessHART network with greater than 5 devices should have a minimum of 25% of devices within effective range of the gateway to ensure proper bandwidth and eliminate pinch points. WirelessHART networks can work with as little as 10%, and actual implementation may yield less than 25%, but experience shows this is a practical number. Example, a 100 device network implies 25 within effective range of the gateway.

a. Networks with greater than 20% of wireless devices with update rates faster than 2 seconds should increase the percentage of devices within effective range of the gateway from 25% to 50%.
A deviation from the rule of percentages can be resolved in several different ways. Below are three options to fortify this network design, each with its own consideration:

1. Add more devices within the effective range of the gateway. While this is a good solution, there may not be more points of value within effective range of the gateway.

2. Move the gateway into a more central location relative to the distribution of WirelessHART instrumentation. In this case, there may not be a convenient host system integration point at the center of the network.

3. Add another gateway. This increases overall capacity for the process unit, addresses the needs of that specific concentration of field devices, and ensures long-term, trouble-free scalability. There may still be the issue with convenient host system integration point as with option 2.

The addition consideration provided in this text ensures higher path stability that can be confirmed once the network is deployed. Most WirelessHART vendors provide the means to verify after installation.

5.5 Minimizing Downstream Messages for Wireless Output Control Devices

Digital control signals sent from a host system to a wireless output control device via the gateway require a downstream message. In order to minimize the time for the downstream message to arrive at the wireless control device, downstream messages initiated by non-control applications should be minimized. Maximum downstream message time form gateway to wireless control device is independent of the update rate and should be no more than 30 seconds when network design best practices are followed.

Techniques for limiting miscellaneous downstream messages:

- Limit remote configuration of wireless devices when control is in service.
- Limit device scans by asset management software.
- Limit other actions that require a remote poll and response from the wireless field device.

The update rate of the wireless control device determines how fast the host system receives notification the control command was received and executed.

5.6 Spare Capacity and Expansion

During a typical project there is often a requirement to provide installed spare hardware (marshaling, I/O cards, terminations) and additional spare space. Typically these figures could vary between 20-30%. The consideration when designing with wireless is different as no cabinetry marshaling, I/O cards, and terminations are required. Additional gateways can be added to the network to increase capacity.

5.7 Fortifying

It is recommended to stress test the network design by altering the effective range of devices in order to identify potential weaknesses in the network design. To stress test the network, reduce the effective range of the devices in 10% increments.

For example, suppose an effective range of 250 feet (76m) was used for initial design. Reducing effective range by increments of 25 feet (8m) (10%) could reveal where the weak spots will exist. It is the discretion of the network designer to determine what level the network will be stressed; there is a limit of diminishing return.

The example shown in Figure 5.8a reveals that one WirelessHART device fails the Rule of 3 under a 20% stress test of the effective range. Effective range is set to 250 feet (76m) for the design test on the left and 200 feet (61m) for the stress test on the right.

The self-organizing mesh technology allows for more WirelessHART field devices to be added to a network for the purposes of automation, and provides the means for simple design correction also exist. A stress failure can be fortified by moving the gateway location, adding a new gateway to segment the network, adding more devices or adding repeaters.

Repeaters are an alternative to support the fortification of a network. Instead of another WirelessHART device with a specific measurement purpose, any WirelessHART device can be used specifically for the purposes of providing more connection within the network.
Figure 5.8a – Example Process: Standard Design (Left). Stress-Tested (Right)
# Host System Integration

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6. Host System Integration

Standard protocols should be used to ensure the most cost effective installation – examples include OPC, Modbus TCP, Modbus RTU, HART IP, etc. The WirelessHART gateway should convert data from the WirelessHART field network into the desired protocol and physical layer needed for integration into the host system.

6.1 Wireless Host System

Data from WirelessHART field networks can be integrated into any existing host system. However, many wireless automation applications are not for control or process monitoring and may not be required to be accessed by the DCS or PLC system. This information may be useful to non-control room based personnel including reliability engineers, maintenance personnel, and energy engineers. Careful consideration should be observed for determining which information should be placed on control operations screens to prevent the dilution of critical information.

For example, suppose a wireless field network is used to replace a manual inspection round where a maintenance technician manually collects temperature and vibration data from a series of pumps and then manually enter the collected data into a data historian. Using WirelessHART, Figure 6.2a shows one possible way the gateway can be integrated into the application, in this case a historian, for the automated collection of data.

For WirelessHART networks that support users in different roles, the potential exists for each end user to have their own application for collecting and analyzing data. For users who manually collect data, WirelessHART provides the missing piece to automation.

For long term scalability, where there may be 1000’s to 10,000’s of WirelessHART devices in a single plant. It is important to have a coordinated effort and standard process to enable end users with different roles and responsibilities to share the I/O capacity of gateways. Representatives from maintenance, utilities, operations, health/safety/environmental, and asset management can share WirelessHART network resources.

An architecture to consider is a centralized historian and centralized asset management program shown in Figure 6.2b. In this scenario, multiple gateways are connected on the same Ethernet network and server. The data from multiple WirelessHART networks is sent to a centralized historian that can then be connected to the applications for each of the end users. In this way, host system resources can be shared, all WirelessHART instruments can report to the same asset management solution, uniform security policies can be enforced, and end users can see WirelessHART data in applications specific to their roles.

Developing a host system integration and data management strategy is essential to maximizing return on investment for wireless that is adopted on a large scale. Successful implementation means that
data is going to the right people and being turned into information for action. Often times, multiple users will see the same data, but in the context of their applications. This also means that every time a new WirelessHART device is introduced to the plant, host system and integration issues do not need to be solved again and again.

WirelessHART is truly scalable; WirelessHART devices can be added to a network without disrupting operation and more gateways can be added to increase I/O capacity. This ability allows automation to be added and expanded to solve problems without large project budgets once wireless network infrastructure is in place. For example, a WirelessHART device can be connected in minutes, configured in minutes, and integrated in minutes if a host system strategy is in place.

### 6.2 Host Integration

Integration of data originating from the wireless gateway into a host control system is normally performed in one of two ways - through native connectivity directly to the host system or using standard protocols such as Modbus or OPC.

For native connectivity including vendor specific I/O cards, contact the host vendor.

OPC and Modbus are non-proprietary protocols and use standard data exchange and integration techniques to map data from the gateway into the host control system. Typical data that is mapped to the host are process variables (PV, SV, TV, QV), time stamps (if using OPC), and overall device status. Diagnostic information is typically passed to an asset management system via Ethernet. Check with the gateway vendor for compatible asset management packages.

Often, existing host systems can be a combination of legacy DCS and PLC components and modern data management solutions such as data historians. WirelessHART gateways should support multiple connections into multiple host systems over multiple protocols. This enables WirelessHART networks to support modernization of an existing host system. For example, suppose the existing DCS has no spare capacity and can only receive the 4-20 mA signal from wired HART devices.

A WirelessHART network could be connected to the DCS to bypass the need for more Analog Input Cards to receive more process variables, while in parallel, HART diagnostics flow to an asset management program from existing wired HART devices with WirelessHART adapters. This type of modernization project could enable incremental modernization with an older host system and when the scheduled turnaround occurs to upgrade the DCS, the existing WirelessHART networks would transition to the new host system (see Figure 6.3a for an example transitional architecture).

A key output from working with host system administrators is an integration strategy to incorporate a plant-wide wireless infrastructure.
If doing a small application, a key output is the physical locations of where to connect the gateways. These will be needed for the network design process.

Key Outputs for Network Design:
- Identifying a host system administrator and system integrator who supports integration of WirelessHART data into the host system.
- Potential physical connection points for WirelessHART gateways.

6.3 Interoperability
Converting WirelessHART data from the gateway into standard protocols like Modbus and OPC ensures interoperability of all WirelessHART networks with all host systems. Host systems based on proprietary protocols will be more difficult to implement, maintain, and expand.

6.4 Host System Support for WirelessHART Functionality
A WirelessHART gateway typically performs all management of the WirelessHART network and manages communications to and from the WirelessHART field devices. The host system should not require any special software to support the WirelessHART field network.

6.5 Configuration Tools
WirelessHART devices are based on the HART protocol; therefore, existing HART Field Communicators will work for configuration of the field devices. Field Communicators will require the proper device descriptor for configuration, which is the same for any other new HART device, wired or wireless. Host system configuration will be dependent on the host system. HART vendors with asset management software may extend the benefits of remote management from wired HART to WirelessHART devices connected to the gateway.

6.6 Control System Graphics
Not all data collected from the WirelessHART field network belongs on the operator screen as part of control system graphics. The risk is that non-pertinent information distracts the operator from critical information.

The host system integration should be configured such that data from a WirelessHART field network is delivered to the proper end-user even though network resources are shared. To give some examples:
- Data collected on consumption of power from rotating equipment should go to the utilities manager.
6 – Host System Integration

- Data collected on vibration spectrums of rotating equipment should go to asset management.
- Data collected on temperature alarms for rotating equipment should go to operators in a non-intrusive way and to the reliability manager.

Properly defining an integration strategy will ensure an efficient collection of data from Wireless HART network and dissemination to proper end-users. Many end users not typically receptive of the benefits of automation have application specific databases into which data is manually collected and uploaded. With the ability to integrate WirelessHART data using standard interface protocols, these existing end-user specific databases can be automatically populated.

6.7 Node Addressing and Naming Conventions

A WirelessHART device should follow naming conventions of wired HART devices.

6.8 Alarms and Alerts

Alarms and alerts should be directed to the appropriate end-user and their associated application and software. Alarm and alert dissemination should be reflective of the end user and their responsibility.

6.9 Maintenance Station

WirelessHART devices provide internal diagnostics and process variables like any wired HART device. Additional local diagnostics for network connectivity should be accessible locally via a HART Field Communicator with the correct Device Descriptor for the WirelessHART field device.

The WirelessHART gateway should also provide additional diagnostics for network performance. The data from WirelessHART devices will not propagate to the host system if the data is deemed questionable from either a HART diagnostic or due to an extended delay in reception at the gateway from the WirelessHART field device. The gateway can notify the host system if communication problems exist. Additionally, the gateway is responsible for WirelessHART network management and network diagnostics.

Diagnostics between the gateway and the host system will depend on the host system and the gateway.

6.10 Historian

Historic Data collection can be treated the same as any conventional source (e.g. OSIsoft PI or any DCS historian package).
# Factory Acceptance Test

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7. Factory Acceptance Testing

The key deliverable of a factory acceptance test (FAT) is the integration of data from WirelessHART instruments into the host system via the gateway. The scope of the FAT should be agreed with the end user. Typically only a subset of the field devices and gateways to be installed is used during the FAT.

7.1 Factory Staging

The following are basic requirements for factory staging:

- A sample of all applications, gateways and WirelessHART devices is present.
- Approved test plan, test procedure and test acceptance criteria.
- HART Field Communicator and user interface to the WirelessHART Gateway.

7.2 Assumptions

Below are assumptions for the FAT:

- Network topology testing is covered as part of the Site Acceptance Test.
- WirelessHART network design does not need to be tested at the factory if network design recommendations are implemented. The conservative nature and ability to fortify the network upon installation with repeaters ensures high confidence of reliable operation.

7.3 Factory Acceptance Test (FAT) Requirements

The following are key requirements of a factory acceptance test:

- Physical connection between the gateway and the host system is verified. Can the gateway be accessed from the host system with the proper security policy in place?
- Protocol connection between the gateway and the application that resides on the host system is verified. Can the data seen in the gateway be seen in the application? Can the standard parameters be properly mapped?
- Gateway can support all necessary connections to all required applications with appropriate timing.
- Device Descriptor (DD) for all field devices in any asset management solution is tested. This ensures the correct DD is installed and valid. This is especially important for WirelessHART devices that are new to the market.

7.4 FAT Procedure

Since there are no physical IO modules, software testing is performed by simulation of I/O at the processor level. This level of simulation is adequate to verify the application software within the host control system.

As per IEC 62381 standards on factory acceptance testing, general guidance as described for testing of bus interfaces and subsystems shall apply. A subset of instruments (at least one of each type) shall be connected to the gateway as a proof of concept demonstration of integrated system functionality. This test should ideally verify the connectivity of the field device to the gateway and from the gateway to the host systems.

Where physical devices will not be tested at the factory, emulation of the interface will be performed if required.

Below is a high level procedure for performing a FAT:

1. Power the gateway
2. Add one of each type of WirelessHART device to the network and verify proper connectivity.
   All gateway fields for data from the WirelessHART device should be properly populated.
3. Create first physical connection to the first required host system application.
4. Verify connectivity between the gateway and the host system application.
5. Integrate necessary data from each sample WirelessHART device into the Host System Application.
   a. Optional additional procedure is to change process variables in the WirelessHART device through direct stimulation or through simulation. All devices, once properly connected to the gateway, should integrate identically over protocols like Modbus and OPC.
6. Repeat steps 4-6 while adding host system connections to the gateway until all expected
connections the gateway are complete.

7. Test integration into an asset management solution if applicable.
   a. Verify each WirelessHART device can be properly accessed and configured via the asset management solution.

8. Add any additional procedures to verify control narratives and monitoring narratives.

7.5 Site Installation Guidelines

Installation practices for WirelessHART devices follow very closely the installation practices of wired HART instruments. Since there are no wires, WirelessHART devices can be installed as soon as the asset or infrastructure is in place and secure.

Network Installations

Always install the gateway first so that integration and field network installation and commissioning can occur in parallel.

Field devices can be commissioned into the gateway and then commissioned into the host system application.

In general, WirelessHART devices are installed per the practices of wired HART devices. Always consult the product manual.

WirelessHART devices close to the gateway should always be installed and commissioned first to ensure connections for potential devices that cannot directly connect to the gateway. This is the easiest way to establish the self-organizing mesh.

WirelessHART devices can be installed in close proximity to each other without causing interference. The self-organizing mesh scheduling of WirelessHART ensures devices in close proximity to each other are silent, talking to each other, or talking on different RF channels when other devices are communicating.

If a WirelessHART gateway antenna or WirelessHART device antenna is to be mounted near a high power antenna of another wireless source, then the antenna should be mounted at least 3 feet (approximately 1 meter) above or below to minimize potential interference.

Lightning Protection

The installation manuals of all WirelessHART devices should be consulted prior to installation.

In general, WirelessHART devices should not be the tallest feature in the plant to maximize protection against lightning.

Ensure adequate protection is provided between the WirelessHART gateways and host system connection as a lightning strike could damage more than just the WirelessHART gateway. Redundant gateways should never be co-located to provide diversity of location in the event a single WirelessHART gateway is struck by lightning.

In general, wireless devices may provide better protection of the system than wired, as the energy from a lightning strike will not be able to travel through the wiring and cause potential damage to other components.

Standards such as NFPA 780 provide classification for zones of protection from lightning as well as techniques for proper implementation.

Wireless Connection Test Procedure

Before beginning the wireless connection test procedure, verify the WirelessHART device has basic connectivity to the network either through the gateway interface, a local user interface on the device, or a local connection via a HART Field Communicator. If the device is not joining the network within a reasonable time period, verify the presence of power and the use of proper Network ID and Join Key. This assumes the gateway is installed properly, powered and accessible, that the network is designed per best practices, and that there are devices to which the new device being commissioned can connect.

1. Wait a minimum of at least 1 hour from initial powering of the WirelessHART device before performing the wireless connection test procedure. This dwell time ensures the device has had time to make several connections for self-organization. Multiple devices can be tested at the same time, and since they rely on each other, it is optimal to have as many on the network as possible for initial connection testing.
2. Verify that network diagnostics indicate the device has proper bandwidth. The gateway should have an indication.

3. Verify each device has a minimum of two neighbors. The gateway should have an indication.

4. Verify device reliability is 99% or greater. Statistics may need to be reset and recertified to remove any anomalies incurred during start up and not indicative of long term performance. Allow at least 1 hour for the network to gather new network statistics.

5. Verify sensor configuration per the loop sheet or other form indicating designed configuration.


7. Repeat for each device in the network.

If a device does not pass the wireless connection test, then follow these basic steps:

1. Wait until entire network is built and operating for 24 hours before considering further action. This will give the gateway time to maximize its self-organization for best communication. If 24 hours is too long to wait, allow a minimum of 4 hours.

2. For the non-compliant device, verify proper path stability and RSSI values. Path stabilities should be greater than 60% and RSSI should be greater than -75 dBm. Wireless control devices and devices with update rates faster than 2 seconds should have a path stability of 70% or greater. If all the devices on the network have very low path stabilities, but high values for RSSI, this could be an indication of broadband interference.

3. Look at the location of the non-compliant device in the network. Verify there is not a broken network design rule or an unexpected installation resulting in poor RF signal propagation.
   a. Add repeaters if necessary to fortify the network if the device is isolated from the network with poor connections.

4. Verify the device has proper power and is working properly as a sensor.

5. Verify the device update rate is not faster than the fastest allowed by the gateway.
   a. Either reduce the update rate of the field device or increase the fastest allowed update rate on the gateway.

**Network Checkout Procedure**

Below are basic steps for checking out a network. Allow a minimum of 4 hours for the network to self-organize (24 hours is preferred):

1. Verify that all devices connected pass the wireless connectivity test. The gateway should have an indication.

2. Verify a minimum of 15% of devices are directly connected to the gateway. The design parameter is 25%; the minimum acceptable is 10%. Networks with more than 20% of devices with update rates faster than 2 seconds or wireless control devices have a design parameter of 50% and 40% should be connected after installation. The gateway should have an indication.

3. Verify overall network reliability is greater than 99%. The gateway should have an indication.

**Loop Checkout / Site Integration Tests**

Once WirelessHART devices are connected to the gateway and the network is checked out, the loop checkout may not be necessary in the traditional sense.

Wireless connection testing verifies each field device has the proper configuration. Since there are no wires to get confused and swapped, there is no need to do the traditional loop check. Alternative loop checks could be to ensure each field devices is reporting to the correct gateway and each gateway is connected into the correct host system. Traditional applications of sensor stimulus can be performed for confidence, but are less valuable in a pure digital architecture if there is complete assurance a field device was commissioned with the correct tag and configuration.

**Bench Simulation Testing**

Each WirelessHART field device is compliant with the IEC 62591 protocol which has provisions for simulation. Each device can be put into a simulation mode. Bench simulation testing should also verify that all HART Field Communicators have the proper configuration and device descriptors (DDs) for accessing the local user interface of field device when in the field.
Provision of Spares
Below are the recommended spares to have onsite:

- Spare lightning arrestor components for gateways, if lightning protection is used.
- Spare gateways should be kept according to spares policy for host system equipment (e.g. I/O cards). Configurations for gateways should be convenient for rapid replacement if necessary.
- Spare battery modules
- Spare field devices as determined by the policy for wired field devices. Consideration should be given for additional devices to be used as repeaters if necessary.

Removal of Redundant Equipment
Repeaters used temporarily to fortify a network can be removed and reused if the WirelessHART network grows to a point where repeaters are no longer needed.

Maintenance Practices
Maintain each WirelessHART device per the manual for the device.

The network will self organize and provide alerts for changes requiring intervention. The gateway should have an indication of performance issues in the network or field devices.
Project Documentation for Wireless Instruments

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</table>
8. Project Documentation for Wireless Instruments

WirelessHART devices can be fully documented in Intergraph SPI with minimal customization. Below is an example of how to document WirelessHART in a logical, linear order and assumes the reader is skilled in working with Intergraph SPI. This is just an example to illustrate the methodology. Ultimately it is the responsibility of project management to create and reinforce the application of standards and guidelines within the project environment.

8.1 User Defined Fields

The first step is to create user defined fields that allow for the accounting of WirelessHART engineering parameters that are necessary for defining if a point is wireless and how that point will be connected to a network.

The following global User Defined Fields should be created:

Field Type refers to the type of value that can be entered for the value of the UDF. In the case of all the WirelessHART parameters, these are all just CHAR (or characters, also meaning text). Likewise, the Length refers to the max length that can be entered into the field.

If the user chooses, SPI rules can be created such that these custom fields only appear for points that are HART or checked to be WirelessHART. This minimizes exposure to non-pertinent information for non-WirelessHART devices.

8.2 Filtered Views

A custom view of the Instrument Index will be useful for applying design guidelines for selecting what instruments are to be wireless as well as seeing the organization of networks. Below is a sample view leveraging the User Defined Fields shown in the previous section.

The “Criticality” and “Update rate” should be foundations for any engineering guidelines that determine whether a device is WirelessHART. Some low criticality loops may have update rates faster than 4 seconds, and should be included with the design guidelines. Because WirelessHART devices primarily run on batteries, WirelessHART may not be suited for all fast update rate applications.

At a high level, using the “Criticality” and “Update Rate”, engineers can determine whether a device should be WirelessHART. If wireless, the device will need to be associated with a gateway. If a device can only be specified as a wired HART device and requires a WirelessHART adapter, then the “WirelessHART Adapter” tag information should be defined.
Every WirelessHART field network should be validated against network design best practices. “Network Design Layout” provides a reference field to link to the drawing on which network design best practices were checked.

8.3 Creating Instrument Types

Early in the process, symbols and instrument types should be defined and a WirelessHART instrument library should be developed. Below the basic modifications to a HART device to create a WirelessHART instrument type is illustrated.

The first step is to create a new device with a new description. In this example, we have created a WirelessHART flow transmitter. Please note that if the device will be specified as a wired HART device with a WirelessHART adapter, no new instrument types are necessary.
Nothing needs to change on the general tab. Be sure to leverage that the device is a HART AI or a HART AO so that all of the basic parameters of HART apply. Manage the wiring, or lack of wiring separately. The fact that WirelessHART is based on HART allows leverage these pre-defined variables.

Check the box to include the wiring. If this box is not checked when SPI generates loop drawings, the device cannot be added to loop drawings. This also allows for flexibility for different wiring configurations, to be defined elsewhere. Examples include wiring WirelessHART adapters in series with the loop and line power for WirelessHART devices. This process should be repeated for each unique WirelessHART instrument type.

There are only two instrument types that are unique to WirelessHART and could be considered ancillary - the WirelessHART gateway and the WirelessHART adapter. To create these instrument types, it is recommended to use the symbols YG for a WirelessHART gateway and YO for a WirelessHART adapter.

Once the instrument type is defined, the device panel properties can be modified to include reference symbols. It is recommended to assign symbols for both the Enhanced SmartLoop and the Cable Block Drawing.

Basic symbols can be created in SPI using the editing tools. Below are examples for WirelessHART field devices and a WirelessHART gateway. The zig-zig symbol shown below is defined by ISA. For more documentation, nothing special is required since signaling is typically not well indicated. For auto-generated documents, it may be useful to include the update rate by referencing the User Defined Field, although this is not an absolute requirement. Most importantly, the project management team decides on a symbol convention and remains consistent throughout the project.

WirelessHART Gateway symbol:

WirelessHART Device symbol:
WirelessHART devices can be connected to a WirelessHART gateway using the User Defined Field. This type of drawing does not show the path through the WirelessHART network, but does show the relationship of the WirelessHART device and the WirelessHART gateway: Below is an example from the ISA-5.1 document, page 118.

Shared display, shared control and wireless instrumentation:

\[\text{Figure 8.3e – ISA 5.1 Drawing Example}\]

Please note that inclusion of update rates and the wireless signal symbol are optional. The authors of this document found the practice of including such information supportive of adopting and managing the unique attributes of WirelessHART.

### 8.4 Loop Drawings

Given that WirelessHART field devices do not require signal cabling, the documentation of the equivalent of wireless loop drawing is very simple to create.

The key information is to relate each wireless field device to the respective gateway. It is recommended that a basic wireless loop drawing show the traditional tag information as well as the WirelessHART User Defined Fields. This way, it is very clear to see which wireless devices are associated to which WirelessHART gateway. Currently, Intergraph SPI 2009 does not have the means to implement this in a specific drawing, thus it is recommended to use the Instrumentation Index showing the WirelessHART User Defined Fields. In the image below, a comprehensive list of WirelessHART devices are shown associated to different gateways.

\[\text{Figure 8.4a – Filtered View of WirelessHART Tags}\]

### 8.5 Gateway Cable Block Drawings

A useful drawing to create is a Gateway Cable Block Drawing showing the gateway power and communication connections. All WirelessHART gateways, regardless of vendor, should have uninterruptable power supplies to maximize system reliability.

\[\text{Figure 8.5a – Gateway Cable Block Diagram}\]

An additional drawing to consider, possible with a Cable Block Diagram, would be to show all gateways assigned to an area on the same document for convenience.
8.6 SPI Specification Sheets

Existing specification sheets can be used to indicate WirelessHART devices. Key fields to change are listed in the table below:

<table>
<thead>
<tr>
<th>Specification Field</th>
<th>Typical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Update Rate</td>
<td>4, 8, 16, 32, 64+</td>
</tr>
<tr>
<td>Power Supply</td>
<td>Intrinsically safe, field replaceable battery</td>
</tr>
<tr>
<td>Communication Type</td>
<td>WirelessHART</td>
</tr>
</tbody>
</table>

Since WirelessHART is derived from wired HART, other specification fields should be completed as if it is a wired HART device.

8.7 Drawings in SPL – Smart Plant Layout

WirelessHART devices should be installed as their wired HART counterparts. Therefore, all WirelessHART devices can be indicated in drawings without deviation from the practices used for wired HART devices.

8.8 Documenting Security Information

The WirelessHART security parameters of Network ID and Device Join Key(s) should not be a part of a wireless loop drawing or in the SPI design environment. These are security parameters used to protect the network and should be managed per a local security policy implemented by the Owner/Operator. The Network ID and Device Join Key(s) are not required for the design. The wireless loop drawing associates the WirelessHART device with the WirelessHART gateway tags. Separately, secure documents containing WirelessHART security provisioning including the WirelessHART gateway tag can be used to cross reference the Network ID and Join Key(s). Remember, all Network IDs and common Device Join Keys (if used) should be unique for every gateway and every WirelessHART field network. This type of security management is similar to the management of security information for control systems and servers.
9 Wireless Spectrum Governance

<table>
<thead>
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<td>9.2 Wireless Spectrum Governance</td>
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</tr>
</tbody>
</table>
9. Wireless Spectrum Governance

9.1 Wireless Spectrum Coexistence

Wireless applications have been deployed in the process industry for over 40 years. In any process facility, applications using RF signals including personnel communications, RF ID systems, ad hoc systems, and cell phones exist. The essential ingredients to making wireless automation feasible were solving the problems of power to enable devices to operate on batteries for multiple years; self-mitigating RF obstacles in the process environment so expert wireless knowledge was not a requirement for adoption; and coexisting with other RF systems.

WirelessHART operates in the 2.4 GHz Industrial, Scientific, and Medical (ISM) radio band that typically operates from 2.400-2.4835 GHz. The exact frequency limitations and RF output power levels may be slightly different from country to country. WirelessHART employs limitations that allow for universal operation in almost all countries with exceptions being noted for specific products by device manufacturers. The ISM radio bands are license-free, but products utilizing the ISM band require approval from governmental regulating agencies. These approvals are typically obtained by the WirelessHART vendor. Since vendors for multiple applications can use the same spectrum, WirelessHART must be able to successfully coexist.

WirelessHART uses multiple techniques to ensure coexistence with other wireless applications:

- Network segmentation – allows thousands of WirelessHART devices to exist in the same physical space, provided each network has a unique Network ID.
- Spectrum isolation – wireless applications operating in different portions of the RF spectrum do not “hear” each other and thus do not interfere with each other.
- Low power – WirelessHART field devices are typically very low power relative to handheld personnel communicators, Wi-Fi devices, and RFID readers. This helps prevent WirelessHART interference with these high power applications.
- Spatial diversity – self-organizing mesh networks can hop on different paths that may be exposed to different RF conditions. WirelessHART self-organizes paths through the process environment that mitigate RF obstacles the same way as it does for physical obstacles.
- Channel hopping – WirelessHART devices use 15 RF channels within the 2.4 GHz ISM band. Pseudo-random channel hopping ensures that interference on one or several channels does not preclude reliable communications.
- DSSS coding – allows transmissions to be modulated with unique encoding for the purposes of jamming resistance, channel sharing, and improved signal/noise level. DSSS coding extends radio receiver sensitivity through digital signal processing.
- Time Synchronized Mesh Protocol (TSMP) – provides synchronized time slots and schedules coordinated network communication in order to preserve battery life and reduce interference.
- Low duty cycle – bandwidth utilization by any single device in the network is very low (4mS per transmission max.)

In addition to these inherent coexistence features, it is still beneficial to have some form of wireless governance. WirelessHART devices can be interfered with, but only under severe conditions that likely will disrupt any wireless application operating in the 2.4 GHz ISM band, such as Wi-Fi and Bluetooth.

A key example is broadband interference. Many legacy wireless systems are very high power. As an example, consider a personnel communication system using high power two-way radios operating in the 800 MHz licensed frequency band. Although the system is legal and operating according to specifications, it can emit broadband interference that spans several GHz outside its licensed band. This broadband interference then affects devices in other RF bands by reducing their signal-to-noise ratio. The simple solution is to place a passive band pass filter on all such systems so that they only emit significant RF energy in the spectrum licensed for usage. See the illustrative diagram below showing broadband interference before and after the implementation of a passive band pass filter.
9.2 Wireless Spectrum Governance

Most government agencies make the licensing of high power radios public information since there is the potential to interfere with private and public entities other than the licensee. If a facility has licensed radios, efforts should be made to verify band-pass filters are in place on high powered systems in all RF bands. Most regulations were created before the advent of low-power systems, including Wi-Fi, and future consideration was not given to coexistence of low power with high power systems. Other countries are also likely have a similar type of searchable database.

Installing passive band pass filters is straightforward and typically only requires insertion of the filter in series with existing RF cabling and proper resealing of RF connections. All existing wireless systems will benefit by the installation including Wi-Fi.

Systems employing 802.11n Wi-Fi standard may emit in-band interference if operating a non-802.11n application in the 2.4 GHz ISM radio band. Relative to 802.11b or 802.11g which use a single Wi-Fi channel (typically 1, 6, or 11 in North America), 802.11n devices may aggregate multiple channels to enable increased bandwidth for demanding applications such as bulk data transfer, security cameras, and streaming video. Most 802.11n devices can be operated in either the 2.4 GHz ISM band or the 5.8 GHz ISM band. Operation in the 5.8 GHz band applies the principle of spectrum isolation and comes with the additional advantage that 5.8 GHz RF signals can transfer information much faster than 2.4 GHz RF signals due to much faster modulation rates.

Another RF standard is Wi-Max, which operates in the 2.3 GHz, or 2.5 GHz, or 3.5 GHz radio bands. Although these bands do not overlap the 2.4 GHz ISM band, they can also emit broadband interference and there are no provisions in the Wi-Max standard to adopt or enforce the usage of band pass filters in either clients or Access Points. The high power of Wi-Max has the potential to interfere with all wireless applications specifically designed for operation in the 2.4 GHz ISM band. Deployment of Wi-Max clients should be restricted in or near the process facility. Installing passive band pass filters on each segment of a Wi-Max cell tower will further mitigate potential interference problems.

Aside from managing potential broadband interference sources, wireless governance follows a basic process. Below is a summary of key considerations for wireless governance:

- A local wireless governance policy should serve the purpose of documenting all wireless sources in and near a plant and enforcing best practices for wireless coexistence.
- Enforce proper installation and compliance with regulation for all wireless applications with regards to power levels, spectrum usage, and encryption in accordance with government regulation.
- Provide guidelines for wireless applications spectrum usage.
  - Limit 802.11n applications to 5.8 GHz ISM radio band or restrict channel aggregation in the 2.4 GHz ISM band.
- Use band pass filters on all high-power RF sources nearby.
- Put high speed, high bandwidth wireless applications such as security cameras, in the 5.8 GHz radio band.
- Ensure all RF coaxial cables are properly installed with weather sealant tape or comparable methods to mitigate reduction in performance due to exposure to environmental elements.

• Support proper segmentation of WirelessHART networks.
- Every network in the process facility should have a unique Network ID and Join Keys.
- WirelessHart networks can overlap in the same physical space without causing interference problems with each other. Gateway antennas should be installed at least 1 meter apart.
- GW antenna’s should be installed at least 1m from Wi-Fi access Points.
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<tr>
<td>10.8 Rosemount 3051 DP Flow and DP Level Technologies</td>
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<td>10.9 Rosemount 2051 Wireless Pressure Transmitter</td>
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<td>10.10 Rosemount 2051 DP Flow and DP Level Technologies</td>
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<td>10.12 Rosemount Smart Wireless THUM Adapter</td>
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<td>10.13 Rosemount Pressure Multivariable Transmitter with THUM Adapter</td>
<td>101</td>
</tr>
<tr>
<td>10.14 Rosemount Pressure Multivariable Transmitter with THUM Adapter</td>
<td>102</td>
</tr>
<tr>
<td>10.15 Rosemount 848 Wireless Multi Input Temperature Transmitter</td>
<td>104</td>
</tr>
<tr>
<td>10.16 Rosemount 648 Wireless Temperature Transmitter</td>
<td>105</td>
</tr>
<tr>
<td>10.17 Rosemount 248 Wireless Temperature Transmitter</td>
<td>106</td>
</tr>
<tr>
<td>10.18 Rosemount 2160 Vibrating Fork Liquid Level Switch</td>
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<td>10.19 Rosemount 3308 Wireless Guided Wave Radar</td>
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<td>10.20 Smart Wireless THUM™ Adapter for Rosemount</td>
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<tr>
<td>10.21 Smart Wireless for Rosemount Tank Gauging Applications</td>
<td>117</td>
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</table>

10.1 Smart Wireless Gateway 1420

Gain real-time process information with greater than 99% wireless data reliability

- The Smart Wireless Gateway automatically manages wireless communications in constantly changing environments
- Native integration with DeltaV and Ovation automation systems provides simple and fast commissioning for wireless field networks
- Connect to data historians, legacy host systems, and other applications through Ethernet, Modbus, Serial, OPC, EtherNet/IP, and HART outputs

Guarantee system availability with redundant Smart Wireless Gateways

- Never lose the wireless network with hot standby capability and automatic fault detection
- Smart Wireless Gateways function as a single system, eliminating the need for duplicate host integration
- One click configuration and plug-and-play architecture

<table>
<thead>
<tr>
<th>Model</th>
<th>Product Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1420</td>
<td>Smart Wireless Gateway</td>
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</table>

**Power Input**

<table>
<thead>
<tr>
<th></th>
<th>Standard</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>24 VDC Nominal (10.5-30 VDC)</td>
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</table>

**Ethernet Communications - Physical Connection**

<table>
<thead>
<tr>
<th></th>
<th>Standard</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Ethernet</td>
<td>★</td>
</tr>
<tr>
<td>2</td>
<td>Dual Ethernet</td>
<td>★</td>
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</table>

**Wireless Update Rate, Operating Frequency, and Protocol**

<table>
<thead>
<tr>
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<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>A3</td>
<td>User Configurable Update Rate, 2.4 GHz DSSS, WirelessHART</td>
</tr>
</tbody>
</table>

**Serial Communication**

<table>
<thead>
<tr>
<th></th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>None</td>
</tr>
<tr>
<td>A</td>
<td>Modbus RTU via RS485</td>
</tr>
</tbody>
</table>

**Ethernet Communication - Data Protocols**

<table>
<thead>
<tr>
<th></th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Webserver, Modbus TCP/IP, AMS Ready, HART-IP</td>
</tr>
<tr>
<td>4</td>
<td>Webserver, Modbus TCP/IP, AMS Ready, HART-IP, OPC</td>
</tr>
<tr>
<td>5</td>
<td>DeltaV Ready</td>
</tr>
<tr>
<td>6</td>
<td>Ovation Ready</td>
</tr>
<tr>
<td>8</td>
<td>Webserver, EtherNet/IP, AMS Ready, HART-IP</td>
</tr>
<tr>
<td>9</td>
<td>Webserver, EtherNet/IP, Modbus TCP/IP, AMS Ready, HART-IP</td>
</tr>
</tbody>
</table>

**Antenna Options**

**Approvals**
Options (Include with selected model number)

<table>
<thead>
<tr>
<th>Power Input</th>
<th>Standard</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>N5</td>
<td>FM Division 2, Non-incendive</td>
<td>★</td>
</tr>
<tr>
<td>N6</td>
<td>N6 CSA Division 2, Non-incendive</td>
<td>★</td>
</tr>
<tr>
<td>N1</td>
<td>ATEX Type n</td>
<td>★</td>
</tr>
<tr>
<td>ND</td>
<td>ATEX Dust</td>
<td>★</td>
</tr>
<tr>
<td>N7</td>
<td>IECEx Type n</td>
<td>★</td>
</tr>
<tr>
<td>NF</td>
<td>IECEx Dust</td>
<td>★</td>
</tr>
<tr>
<td>KD</td>
<td>FM &amp; CSA Division 2, Non-incendive and ATEX Type n</td>
<td>★</td>
</tr>
<tr>
<td>N3</td>
<td>China Type n</td>
<td>★</td>
</tr>
<tr>
<td>N4</td>
<td>TIIS Type n</td>
<td>★</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Redundancy Options</th>
<th>Standard</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>RD</td>
<td>Gateway Redundancy</td>
<td>★</td>
</tr>
</tbody>
</table>

Smart Wireless Gateway Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery.

The Expanded offering is subject to additional delivery lead time.

<table>
<thead>
<tr>
<th>Adapters</th>
<th>Standard</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>J1</td>
<td>CM 20 Conduit Adapters</td>
<td>★</td>
</tr>
<tr>
<td>J2</td>
<td>PG 13.5 Conduit Adapters</td>
<td>★</td>
</tr>
<tr>
<td>J3</td>
<td>3/4 NPT Conduit Adapters</td>
<td>★</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Antenna Options</th>
<th>Standard</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>WL2</td>
<td>Remote Antenna Kit, 50 ft. (15.2 m) cable, Lightning Arrestor</td>
<td>★</td>
</tr>
<tr>
<td>WL3</td>
<td>Remote Antenna Kit, 20 ft. (6.1 m) and 30 ft. (9.1 m) cables, Lightning Arrestor</td>
<td>★</td>
</tr>
<tr>
<td>WL4</td>
<td>Remote Antenna Kit, 10 ft. (3.0 m) and 40 ft. (12.2 m) cables, Lightning Arrestor</td>
<td>★</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Expanded</th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>WN2</td>
<td>High-Gain, Remote Antenna Kit, 25 ft. (7.6m) cable, Lightning Arrestor</td>
<td></td>
</tr>
</tbody>
</table>

Typical Model Number: 1420 A2 A3 A2 N5

(1) Single active 10/100 baseT Ethernet port with RJ45 connector.
(2) Additional ports disabled.
(3) Dual active 10/100 baseT Ethernet ports with RJ45 connectors.
(4) Multiple active ports have separate IP addresses, firewall isolation, and no packet forwarding.
(5) Convertible to RS232 via adaptor, not included with Gateway.
(6) Includes Webserver, Modbus TCP, AMS Ready, HART-IP, and OPC.
(7) Requires the selection of Dual Ethernet option code 2.
(8) Not available with DeltaV Ready option code 5.
(9) Not available with EtherNet/IP option codes 8 and 9.
(10) The WL2, WL3, WL4, and WN2 options require minor assembly.
(11) Not available in all countries.
## Smart Wireless Gateway 1410

- Gateway connects wireless self-organizing networks with any host system
- Easy configuration and management of self-organizing networks
- Easy integration into control systems and data applications through serial and Ethernet connections
- Seamless integration into AMS Device Manager and Ovation™ system
- Greater than 99% reliability with industry proven security
- 25 device limit remote applications

<table>
<thead>
<tr>
<th>Model</th>
<th>Product Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1410</td>
<td>Smart Wireless Gateway, 2.4 GHz DSSS, Wireless HART, Webserver, AMS Ready, HART IP</td>
</tr>
</tbody>
</table>

### Wireless Configuration

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>25 Device Network (10.5-30 VDC)</td>
</tr>
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</table>

### Ethernet Communications - Physical Connection

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Single Ethernet Connection</td>
</tr>
<tr>
<td>2</td>
<td>Dual Ethernet Connection</td>
</tr>
</tbody>
</table>

### Serial Communication

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>None</td>
</tr>
<tr>
<td>A</td>
<td>Modbus RTU via RS485</td>
</tr>
</tbody>
</table>

### Ethernet Communication - Data Protocols

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>Modbus TCP/IP</td>
</tr>
<tr>
<td>D2</td>
<td>OPC</td>
</tr>
<tr>
<td>D3</td>
<td>EtherNet/IP</td>
</tr>
<tr>
<td>D4</td>
<td>Modbus TCP/IP, OPC</td>
</tr>
<tr>
<td>D5</td>
<td>EtherNet/IP, Modbus TCP/IP</td>
</tr>
<tr>
<td>D6</td>
<td>EtherNet/IP, OPC</td>
</tr>
<tr>
<td>E2</td>
<td>Ovation Ready</td>
</tr>
<tr>
<td>E3</td>
<td>Webserver Only</td>
</tr>
</tbody>
</table>

### Antenna Options

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>WX2</td>
<td>Basic Antenna</td>
</tr>
<tr>
<td>WL2</td>
<td>SMA-to-N-Type Adapter Cable, and Remote Antenna Kit</td>
</tr>
<tr>
<td>WN2</td>
<td>SMA-to-N-Type Adapter Cable, and High-Gain Remote Antenna Kit</td>
</tr>
</tbody>
</table>

### Product Certifications

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
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</tbody>
</table>

## Model Product Description

- Smart Wireless Gateway, 2.4 GHz DSSS, Wireless HART, Webserver, AMS Ready, HART IP
- Easy configuration and management of self-organizing networks
- Easy integration into control systems and data applications through serial and Ethernet connections
- Seamless integration into AMS Device Manager and Ovation™ system
- Greater than 99% reliability with industry proven security
- 25 device limit remote applications

<table>
<thead>
<tr>
<th>Model</th>
<th>Product Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1410</td>
<td>Smart Wireless Gateway, 2.4 GHz DSSS, Wireless HART, Webserver, AMS Ready, HART IP</td>
</tr>
</tbody>
</table>

### Wireless Configuration

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>25 Device Network (10.5-30 VDC)</td>
</tr>
</tbody>
</table>

### Ethernet Communications - Physical Connection

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Single Ethernet Connection</td>
</tr>
<tr>
<td>2</td>
<td>Dual Ethernet Connection</td>
</tr>
</tbody>
</table>

### Serial Communication

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>None</td>
</tr>
<tr>
<td>A</td>
<td>Modbus RTU via RS485</td>
</tr>
</tbody>
</table>

### Ethernet Communication - Data Protocols

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>Modbus TCP/IP</td>
</tr>
<tr>
<td>D2</td>
<td>OPC</td>
</tr>
<tr>
<td>D3</td>
<td>EtherNet/IP</td>
</tr>
<tr>
<td>D4</td>
<td>Modbus TCP/IP, OPC</td>
</tr>
<tr>
<td>D5</td>
<td>EtherNet/IP, Modbus TCP/IP</td>
</tr>
<tr>
<td>D6</td>
<td>EtherNet/IP, OPC</td>
</tr>
<tr>
<td>E2</td>
<td>Ovation Ready</td>
</tr>
<tr>
<td>E3</td>
<td>Webserver Only</td>
</tr>
</tbody>
</table>

### Antenna Options

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>WX2</td>
<td>Basic Antenna</td>
</tr>
<tr>
<td>WL2</td>
<td>SMA-to-N-Type Adapter Cable, and Remote Antenna Kit</td>
</tr>
<tr>
<td>WN2</td>
<td>SMA-to-N-Type Adapter Cable, and High-Gain Remote Antenna Kit</td>
</tr>
</tbody>
</table>

### Product Certifications

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Antenna Options

<table>
<thead>
<tr>
<th>Standard</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>WX2</td>
<td>Basic Antenna</td>
</tr>
<tr>
<td>WL2</td>
<td>SMA-to-N-Type Adapter Cable, and Remote Antenna Kit</td>
</tr>
<tr>
<td>WN2</td>
<td>SMA-to-N-Type Adapter Cable, and High-Gain Remote Antenna Kit</td>
</tr>
</tbody>
</table>

### Product Certifications

<table>
<thead>
<tr>
<th>Standard</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>NA</td>
<td>No Approvals</td>
</tr>
</tbody>
</table>

### Smart Wireless Gateway Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery.

_____ The Expanded offering is subject to additional delivery lead time.

#### Options (Include with selected model number)

<table>
<thead>
<tr>
<th>Host Integration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
</tr>
<tr>
<td>H6</td>
</tr>
<tr>
<td>H9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Oil and Gas Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
</tr>
<tr>
<td>G</td>
</tr>
</tbody>
</table>

**Typical Model Number: 1410  A  2  A  D5  WX2  NA**

(1) Single active 10/100 baseT Ethernet port with RJ45 connector.
(2) Additional ports disabled.
(3) Dual active 10/100 baseT Ethernet ports with RJ45 connectors.
(4) Multiple active ports have separate IP addresses, firewall isolation, and no packet forwarding.
(5) Convertible to RS232 via adapter, not included with Gateway.
(6) Selection of Dual Ethernet option code 2 is recommended.
(7) Requires (A) Modbus RTU via RS-485 Communication protocol.
(8) The WL2 and WN2 options require minor assembly.
(9) Not available in all countries.
(10) Support documentation included in the package.
10.3 Rosemount 702 Wireless Discrete Transmitter

The Rosemount 702 Wireless Discrete Transmitter takes a variety of non-powered switch types such as pressure, flow and level switches as input. It has single or dual channel capacity which cost-effectively enables access to discrete points that are not connected to the control system due to wiring costs and lack of I/O.

- An installation-ready solution that provides dual channel, discrete input, discrete output, or leak detection input options
- Discrete single or dual switch input with logic for limit contact and opposing contact applications
- Momentary inputs are continuously measured between wireless updates
- Dual channels are each configurable for discrete input or discrete output

<table>
<thead>
<tr>
<th>Specification Overview</th>
<th>702 Wireless Discrete Transmitter</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base Model</strong></td>
<td>702</td>
</tr>
<tr>
<td><strong>Application Type</strong></td>
<td>On/OFF Pump, ON/OFF Valve</td>
</tr>
<tr>
<td></td>
<td>Leak Detection, Safety Shower Monitoring</td>
</tr>
<tr>
<td><strong>Measurement Type</strong></td>
<td>Discrete Dual Input (Dry Contact), Detects Momentary Inputs and Counts</td>
</tr>
<tr>
<td></td>
<td>Discrete Dual Input or Output</td>
</tr>
<tr>
<td></td>
<td>Liquid Hydrocarbon Detection (For use with TraceTek Fast Fuel Sensor or TraceTek sensing cable)</td>
</tr>
<tr>
<td><strong>Transmitter Output</strong></td>
<td>IEC 62591 (WirelessHART)</td>
</tr>
<tr>
<td><strong>Radio Frequency Power Output from Antenna</strong></td>
<td>External (WK option) antenna: Maximum of 10 mW (10 dBm) EIRP</td>
</tr>
<tr>
<td></td>
<td>Extended Range, External (WM option) antenna: Maximum of 18 mW (12.5 dBm) EIRP</td>
</tr>
<tr>
<td></td>
<td>High Gain, Remote (WN option) antenna: Maximum of 40 mW (16 dBm) EIRP</td>
</tr>
<tr>
<td><strong>Mounting</strong></td>
<td>Transmitters may be attached directly to switch, brackets also permit remote mounting.</td>
</tr>
<tr>
<td><strong>Rangedown</strong></td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Power Module Life</strong></td>
<td>10 years at 1 min. update rate</td>
</tr>
<tr>
<td><strong>Update Rate</strong></td>
<td>1 sec. to 60min.</td>
</tr>
<tr>
<td><strong>Housing Style/ Material/ Conduit Entry Size</strong></td>
<td>Housing - Low-copper aluminum, or stainless steel</td>
</tr>
<tr>
<td><strong>Wireless Options Operating Frequency and Protocol</strong></td>
<td>User configuration Update Rate with 2.4GHz DSSS, IEC 62591 (WirelessHART)</td>
</tr>
<tr>
<td><strong>Omnidirectional Wireless Antenna</strong></td>
<td>External Antenna</td>
</tr>
<tr>
<td></td>
<td>Extended Range, External Antenna</td>
</tr>
<tr>
<td></td>
<td>High-Gain, Remote Antenna*</td>
</tr>
<tr>
<td><strong>Expanded:</strong></td>
<td>WN1</td>
</tr>
<tr>
<td><strong>Smart Power</strong></td>
<td>Adapter for Black Power Module</td>
</tr>
<tr>
<td></td>
<td>(I.S. Power Module sold separately)</td>
</tr>
<tr>
<td><strong>Display</strong></td>
<td>The optional integral LCD can display discrete state and diagnostic information. Display updates at each wireless update.</td>
</tr>
</tbody>
</table>

For more information, please refer to the Product data sheet (PDS)
## Specification Overview

<table>
<thead>
<tr>
<th>Specification Overview</th>
<th>702 Wireless Discrete Transmitter</th>
</tr>
</thead>
</table>
| **Product Certification** | I1: ATEX Intrinsic Safety  
I5: FM Intrinsically Safe, Division 2  
I6: CSA Intrinsically Safe  
I7: IECEx Intrinsic Safety  
IU: ATEX Intrinsic Safety for Zone 2  
IY: IECEx Intrinsic Safety for Zone 2  
N5: FM Division 2, Non-Incendive  
N6: CSA Division2, Non-Incendive  
NA: No Approval |
| • I1  
• I5  
• I6  
• I7  
• IU  
• IY  
• N5  
• N6  
• NA |

*For more information, please refer to the Product data sheet (PDS)*
Wireless Float Switch Solution
The advent of wireless communications allows process plant managers to save up to 90% on installation cost compared with wired technologies. More data can be collected at central Without an overfill protection system, potential overflow may occur, which may cause safety and environmental issues. Furthermore, the cost of installing wired instrumentation to all tanks in the tank farm is very high.

Using the Rosemount 702 Wireless Discrete Transmitter signal high and low level alarms tanks on remote tanks.

Wireless Safety Shower and Eyewash Monitoring
Eye wash and safety showers are commonly installed in chemical plants, refineries, factories, and any work areas where there is any risk or eye and/or face damages due to the presence of corrosive or irritating materials. Using the Rosemount 702 Wireless Discrete Transmitter and TopWorx GO Switches monitor your safety shower and eyewash stations remotely.

• Improve Safety and Response Time
• Safety in Remote Locations
• Improve Incident Reporting
• Reduced Installation and Maintenance Cost

Wireless Liquid Hydrocarbon Leak Detection for Tank Farm
Wireless liquid hydrocarbon leak detection is done by integrating Rosemount’s 702 Wireless Discrete Transmitter and Pentair’s TraceTek sensor cable or fast fuel sensors. These two technologies make it easy for operators to quickly and inexpensively add leak detection and monitoring to their operations to comply with government regulations and ensure that valuable hydrocarbons are not wasted. Distant tanks, pipelines and valves can now be monitored without the need to run expensive signal wires back to the control room.

Proven Result References
• Customers Are Solving Real Plant Problems: Lion Oil (p.181)
• Refinery Initiates Tank Overfill Protection and Optimization of Pre-Heaters with Smart Wireless (p.209)

For more proven results:
http://www2.emersonprocess.com/en-US/brands/rosemount/Documentation-and-Drawings/Proven-Results/Pages/index.aspx#metals
10.4 Rosemount 708 Wireless Acoustic Transmitter

The Rosemount 708 Wireless Acoustic Transmitter provides acoustic event detection including steam trap failures and pressure relief valve upsets. The transmitter communicates acoustic noise and temperature measurements as well as device and event status via the WirelessHART network for integration into host systems, data historians or energy management software.

Virtually maintenance-free performance

Deploy the wireless acoustic transmitter to realize a decade of virtually maintenance-free performance.

- 10-year Power Module life
- 10-year stability

<table>
<thead>
<tr>
<th>Specification Overview</th>
<th>708 Wireless Acoustic Transmitter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Model</td>
<td>708</td>
</tr>
<tr>
<td>Application Type</td>
<td>Steam Trap Monitoring</td>
</tr>
<tr>
<td></td>
<td>Pressure Relief / Safety Valve Monitoring</td>
</tr>
<tr>
<td>Measurement Type</td>
<td>Acoustic Noise (Counts)</td>
</tr>
<tr>
<td></td>
<td>Temperature (°F/°C)</td>
</tr>
<tr>
<td>Transmitter Output</td>
<td>IEC 62591 (WirelessHART)</td>
</tr>
<tr>
<td>Acoustic Frequency</td>
<td>35kHz – 45 kHz</td>
</tr>
<tr>
<td>Wave Guide</td>
<td>Machined 316L SST</td>
</tr>
<tr>
<td>Radio Frequency Power Output from</td>
<td>Internal (WP option) antenna:</td>
</tr>
<tr>
<td>Antenna</td>
<td>Maximum of 10 mW (10 dBm) EIRP</td>
</tr>
<tr>
<td>Mounting</td>
<td>Transmitters are directly attached to process piping using two stainless steel mounting bands.</td>
</tr>
<tr>
<td>Rangedown</td>
<td>N/A</td>
</tr>
<tr>
<td>Power Module Life</td>
<td>10 years at 1 min. update rate</td>
</tr>
<tr>
<td>Update Rate</td>
<td>1 sec. to 60 min.</td>
</tr>
<tr>
<td>Process Alerts</td>
<td>High threshold alert</td>
</tr>
<tr>
<td>Housing Style/ Material/ Conduit</td>
<td>P: Engineered Polymer</td>
</tr>
<tr>
<td>Entry Size</td>
<td></td>
</tr>
<tr>
<td>Wireless options/ Operating Frequency and Protocol</td>
<td>WA3: User configuration Update Rate with 2.4GHz</td>
</tr>
<tr>
<td>Omnidirectional Wireless Antenna</td>
<td>WPS: Internal Antenna, Compatible with Green Power Module (I.S. Power Module Sold Separately)</td>
</tr>
<tr>
<td>Product Certification</td>
<td>I1: ATEX Intrinsic Safety</td>
</tr>
<tr>
<td></td>
<td>I5: FM Intrinsically Safe, Division 2</td>
</tr>
<tr>
<td></td>
<td>I6: CSA Intrinsically Safe</td>
</tr>
<tr>
<td></td>
<td>I7: IECEx Intrinsic Safety</td>
</tr>
<tr>
<td>Display Type</td>
<td>N/A</td>
</tr>
</tbody>
</table>

For more information, please refer to the Product data sheet (PDS)
Poorly maintained steam traps can lead to:

**Safety / Equipment Failure**
- Water in piping can result in water (steam) hammer, pressure transients, and erosion corrosion of piping
- Plant personnel and equipment are placed at risk

**Reduced Thermodynamic Efficiency**
- Water on heat transfer surfaces results in decreased thermal performance, product throughput and quality

**Energy / Steam Loss**
- Failed high value steam traps can cost $10k - $25k/yr in lost steam

---

**The Rosemount 708 Wireless Acoustic Transmitter**
- Gives you real-time visibility to all your critical steam traps
- Provides information that enables you to make good decisions
- Is fast and easy to install and maintain
- Is proven technology that’s easy to use

---

When pressure relief valves (PRVs) open, they can release pollutants, causing potentially massive regulatory fines and putting your staff and community at risk.

Visual inspections for PRV releases are time consuming for your staff and don’t tell you exactly when a release occurred.

**Limited visibility to pressure relief valve releases**

“A PRV release can be disruptive and dangerous. I need a better way to monitor for releases so that I can respond quickly and identify the root cause to prevent future releases.”

---

**Ensuring my plant operates in an environmentally responsible way is important**

“Releases of volatile organic chemicals from PRVs can result in steep regulatory fines and is bad PR for our organization. I need to make sure my plant operates in an environmentally-responsible manner and adheres to all regulatory requirements.”

---

Keep your operation running safely and smoothly and reduce your environmental impact by having constant visibility to all your critical PRVs

**The Rosemount 708 Wireless Acoustic Transmitter**
- Gives you real-time visibility to PRV conditions
- Provides time stamped data
- Helps reduce your environmental impact
- Is fast and easy to install and maintain

---

**Proven Result References**
- Productivity Improvement with Wireless Steam Trap Monitoring (p.140)
- Barking Power Lowers Steam Costs, Improves Efficiency with Wireless Acoustic Monitoring (p.188)
- Petrochemical Company in South Africa Saves Energy and Improves Productivity with Emerson’s Smart Wireless Acoustic Solutions (p.203)

For more proven results:
http://www2.emersonprocess.com/en-US/brands/rosemount/Documentation-and-Drawings/Proven-Results/Sort-by-Technology/Pages/index.aspx#wireless
### 10.5 Rosemount 3051S Wireless Series of Instrumentation

Emerson’s Smart Wireless solutions eliminate blind spots that previously were too difficult or expensive to instrument. Promising a decade of maintenance-free operation, the Rosemount 3051S Wireless offering allows you to cost effectively implement wireless with confidence.

#### Virtually Maintenance-Free Performance

Deploy wireless pressure, flow and level solutions with SmartPower™ to realize a decade of virtually maintenance-free performance.

- 10-year Power Module life
- 10-year stability
- 12-year limited warranty

<table>
<thead>
<tr>
<th>Specification Overview</th>
<th>3051S Scalable Pressure Transmitter</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base Model</strong></td>
<td>3051S1 Ultra</td>
</tr>
<tr>
<td><strong>Application Type</strong></td>
<td>P, DP, Flow, Level</td>
</tr>
<tr>
<td><strong>Measurement Type</strong></td>
<td>D, G, A</td>
</tr>
<tr>
<td><strong>Transmitter Output</strong></td>
<td>4-20mA with digital signal based on HART protocol, Foundation Fieldbus protocol, WirelessHART</td>
</tr>
<tr>
<td><strong>Reference Accuracy</strong></td>
<td>±0.025% of span</td>
</tr>
<tr>
<td><strong>Total Performance</strong></td>
<td>±0.1% of span</td>
</tr>
<tr>
<td><strong>Long Term Stability</strong></td>
<td>10 Yrs</td>
</tr>
<tr>
<td><strong>Warranty</strong></td>
<td>12 Yrs</td>
</tr>
<tr>
<td><strong>Rangedown</strong></td>
<td>200:1</td>
</tr>
<tr>
<td><strong>Power Module Life</strong></td>
<td>10 years at 1 min. update rate</td>
</tr>
<tr>
<td><strong>Update Rate</strong></td>
<td>1 sec. to 60min.</td>
</tr>
<tr>
<td><strong>Process Alerts</strong></td>
<td>4 Configurable Alerts</td>
</tr>
<tr>
<td><strong>Housing Style/ Material/ Conduit Entry Size</strong></td>
<td>5A: Wireless PlantWeb Hsg/ Aluminum/1/2-14 NPT 5J: Wireless PlantWeb Hsg/ SST/ 1/2-14 NPT</td>
</tr>
<tr>
<td><strong>Wireless Options/ Operating Frequency and Protocol</strong></td>
<td>WA3: User configuration Update Rate with 2.4GHz DSSS, IEC 62591 (Wireless HART)</td>
</tr>
<tr>
<td><strong>Omnidirectional Wireless Antenna</strong></td>
<td>WK: External Antenna (Std Lead-time) WM: Extended Range: External Antenna (Std Lead-time) WN: High-Gain, Remote Antenna (Expanded Lead-time)</td>
</tr>
<tr>
<td><strong>Smart Power</strong></td>
<td>Adapter for Black Power Module (I.S. Power Module sold separately)</td>
</tr>
<tr>
<td><strong>Product Certification</strong></td>
<td>I1: ATEX Intrinsic Safety I5: FM Intrinsically Safe, Division 2 I6: CSA Intrinsically Safe I7: IECEx Intrinsic Safety</td>
</tr>
<tr>
<td><strong>Display Type</strong></td>
<td>M5 Plant Web LCD Display</td>
</tr>
</tbody>
</table>

For more information, please refer to the Product data sheet (PDS)
### 10.6 Rosemount 3051S DP Flow and DP Level Technologies

#### Innovative, Integrated DP Flowmeters
- Fully assembled & leak-tested for out-of-the-box installation
- Lower installed costs by replacing 10 devices with one integrated flowmeter
- Reduce straight pipe requirements, lower permanent pressure loss, and achieve accurate measurement in small line sizes
- Measure up to 14:1 flow turndown with % of reading performance

#### Proven, Reliable, and innovative DP Level Technologies
- Connect to virtually any process with a comprehensive offering of process connections, fill fluids, direct mount or capillary connections, and materials
- Quantify and optimize total system performance with QZ option
- Achieve success on tall vessels and distillation towers with Electronic Remote Sensor digital architecture
- Optimize level measurement with cost efficient Tuned-System Assemblies

<table>
<thead>
<tr>
<th>Specification Overview</th>
<th>DP Flow</th>
<th>DP Level</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base Model</strong></td>
<td>3051SFA</td>
<td>3051SFC</td>
</tr>
<tr>
<td><strong>Measurement Type</strong></td>
<td>D, G, A, T</td>
<td>D, G, A, T</td>
</tr>
<tr>
<td><strong>Transmitter Output</strong></td>
<td>IEC 62591 (WirelessHART)</td>
<td>IEC 62591 (WirelessHART)</td>
</tr>
<tr>
<td><strong>Reference Accuracy</strong></td>
<td>MV-Ultra: 0.8% &amp; Classic: 1.15%</td>
<td>MV-Ultra: 0.75% &amp; Classic: 1.1%</td>
</tr>
<tr>
<td><strong>Total Performance</strong></td>
<td>For all Beta ratio, refer to PDS</td>
<td>Use toolkit</td>
</tr>
<tr>
<td><strong>Long Term Stability</strong></td>
<td>MV-Ultra: 10Yrs &amp; Classic: 5Yrs</td>
<td>SV-Ultra &amp; Ultra for Flow: 10Yrs, Classic: 5Yrs</td>
</tr>
<tr>
<td><strong>Warranty</strong></td>
<td>MV-Ultra: 12Yrs &amp; Classic: 1Yr</td>
<td>SV-Ultra &amp; Ultra for Flow: 12Yrs, Classic: 1Yr</td>
</tr>
</tbody>
</table>

For more information, please refer to the Product data sheet (PDS)
<table>
<thead>
<tr>
<th>Specification Overview</th>
<th>DP Flow</th>
<th>DP Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Model</td>
<td>3051SFA</td>
<td>3051SFC 3051SFP</td>
</tr>
<tr>
<td>Power Module Life</td>
<td>10 years at 1 min. update rate</td>
<td></td>
</tr>
<tr>
<td>Update Rate</td>
<td>1 sec. to 60 min.</td>
<td></td>
</tr>
<tr>
<td>Process Alerts</td>
<td>4 Configurable Alerts</td>
<td></td>
</tr>
<tr>
<td>Housing Style/ Material/ Conduit Entry Size</td>
<td>5A: Wireless PlantWeb Housing/ Aluminum/ 1/2-14 NPT 5J: Wireless PlantWeb Housing/ SST/ 1/2-14 NPT</td>
<td></td>
</tr>
<tr>
<td>Wireless Options/ Operating Frequency and Protocol</td>
<td>WA3: User configuration Update Rate with 2.4GHz DSSS, IEC 62591 (WirelessHART)</td>
<td></td>
</tr>
<tr>
<td>Omnidirectional Wireless Antenna</td>
<td>WK: External Antenna (Std Lead-time) WM: Extended Range; External Antenna (Std Lead-time)</td>
<td></td>
</tr>
<tr>
<td>Smart Power</td>
<td>Adapter for Black Power Module (I.S. Power Module sold separately)</td>
<td></td>
</tr>
<tr>
<td>Product Certification</td>
<td>I1: ATEX Intrinsical Safety I5: FM Intrinsically Safe, Division 2 I6: CSA Intrinsically Safe I7: IECEx Intrinsical Safety</td>
<td></td>
</tr>
<tr>
<td>Display Type</td>
<td>M5 Plant Web LCD Display</td>
<td></td>
</tr>
</tbody>
</table>

For more information, please refer to the Product data sheet (PDS)
10.7 Rosemount 3051 Wireless Pressure Transmitter

3051 Proven best-in-class performance, reliability and safety
- Meet your toughest environmental conditions with the IP66/67, NEMA 4X lightweight engineered polymer housing
- Address all your application needs with calibrated spans from 3 in H2O to 10,000 PSI (7.5 mbar to 689 mbar)
- Better Monitor your process and assets with 0.04% reference accuracy and 0.15% total performance error
- Extend calibration intervals with 5-year guaranteed stability

Maximize Installation Flexibility with Coplanar Platform
- Improve reliability and performance with integrated DP Flowmeters, DP Level and manifolds
- Reduce installation time and cost with factory assembled and configured pressure, level, and flow solutions.

<table>
<thead>
<tr>
<th>Specification Overview</th>
<th>3051 Pressure Transmitter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application Type</td>
<td>P, DP, Flow, Level</td>
</tr>
<tr>
<td>• Pressure (P)</td>
<td></td>
</tr>
<tr>
<td>• Differential Pressure (DP)</td>
<td></td>
</tr>
<tr>
<td>• DP Flow (Flow) and DP Level (Level)</td>
<td></td>
</tr>
<tr>
<td>Measurement Type</td>
<td>G, A, D (Not available on inline platforms)</td>
</tr>
<tr>
<td>• Differential (D)</td>
<td></td>
</tr>
<tr>
<td>• Gage (G)</td>
<td></td>
</tr>
<tr>
<td>• Absolute (A)</td>
<td></td>
</tr>
<tr>
<td>Transmitter Output</td>
<td>IEC 62591 (WirelessHART)</td>
</tr>
<tr>
<td>Reference Accuracy</td>
<td>±0.04% of span</td>
</tr>
<tr>
<td>Total Performance</td>
<td>±0.12% of span</td>
</tr>
<tr>
<td>Long Term Stability</td>
<td>up to 5 Yrs</td>
</tr>
<tr>
<td>Warranty</td>
<td>12 Months</td>
</tr>
<tr>
<td>Rangedown</td>
<td>150:1</td>
</tr>
<tr>
<td>Power Module Life</td>
<td>10 years at 1 min. update rate</td>
</tr>
<tr>
<td>Update Rate</td>
<td>1 sec. to 60min.</td>
</tr>
<tr>
<td>Process Alerts</td>
<td>4 Configurable Alerts</td>
</tr>
<tr>
<td>Housing Style/Material/Conduit Entry Size</td>
<td>P: Engineered Polymer</td>
</tr>
<tr>
<td>Wireless Transmit Rate, Operating Frequency</td>
<td>WA3: User configuration Update Rate with 2.4GHz</td>
</tr>
<tr>
<td>and Protocol</td>
<td></td>
</tr>
<tr>
<td>Omnidirectional Wireless Antenna</td>
<td>WP5: Internal Antenna, Compatible with Green Power Module</td>
</tr>
<tr>
<td></td>
<td>(I.S. Power Module Sold Separately)</td>
</tr>
<tr>
<td>Product Certification</td>
<td>I1: ATEX Intrinsic Safety</td>
</tr>
<tr>
<td>• I1</td>
<td>I5: FM Intrinsically Safe, Division 2</td>
</tr>
<tr>
<td>• I5</td>
<td>I6: CSA Intrinsically Safe</td>
</tr>
<tr>
<td>• I6</td>
<td>I7: IECEx Intrinsically Safe</td>
</tr>
<tr>
<td>• I7</td>
<td></td>
</tr>
<tr>
<td>Configuration buttons</td>
<td>DZ: Digital Zero Trim</td>
</tr>
<tr>
<td>Display Type</td>
<td>M5 Plant Web LCD Display</td>
</tr>
</tbody>
</table>

For more information, please refer to the Product data sheet (PDS)
10.8 Rosemount 3051 DP Flow and DP Level Technologies

Innovative, Integrated DP Flowmeters
- Fully assembled, configured, and leak tested for out-of-the-box installation
- Reduce straight pipe requirements, lower permanent pressure loss and achieve accurate measurement in small line sizes
- Up to 1.65% volumetric flow accuracy at 8:1 turndown

Proven, Reliable and Innovative DP Level Technologies
- Connect to virtually any process with a comprehensive offering of process connections, fill fluids, direct mount or capillary connections and materials
- Quantify and optimize total system performance with QZ option
- Operate at higher temperature and in vacuum applications
- Optimize level measurement with cost efficient Tuned-System™ Assemblies

<table>
<thead>
<tr>
<th>Specification Overview</th>
<th>DP Flow</th>
<th>DP Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Model</td>
<td>3051CFA</td>
<td>3051CFC</td>
</tr>
<tr>
<td>Application Type</td>
<td>DP, Flow</td>
<td>DP, Level</td>
</tr>
<tr>
<td>Measurement Type</td>
<td>D</td>
<td>D, G</td>
</tr>
<tr>
<td>Transmitter Output</td>
<td>IEC 62591 (WirelessHART)</td>
<td></td>
</tr>
<tr>
<td>Reference Accuracy</td>
<td>±1.60% of Flow Rate at 8:1 flow turndown</td>
<td>±1.75% of Flow Rate at 8:1 flow turndown</td>
</tr>
<tr>
<td>Total Performance</td>
<td>For all Beta ratio, refer to PDS</td>
<td>Use toolkit</td>
</tr>
<tr>
<td>Long Term Stability</td>
<td>±0.125% of URL for 5 years ±50 °F (28 °C) temperature changes, and up to 1000 psi (6.9 MPa) line pressure.</td>
<td>N.A.</td>
</tr>
<tr>
<td>Warranty</td>
<td>12 Months</td>
<td></td>
</tr>
<tr>
<td>Rangedown</td>
<td>Refer Reference Accuracy</td>
<td></td>
</tr>
<tr>
<td>Power Module Life</td>
<td>10 years at 1 min. update rate</td>
<td></td>
</tr>
<tr>
<td>Update Rate</td>
<td>1 sec. to 60min.</td>
<td></td>
</tr>
<tr>
<td>Process Alerts</td>
<td>4 Configurable Alerts</td>
<td></td>
</tr>
<tr>
<td>Housing Style/ Material/Conduit Entry Size</td>
<td>P: Engineered Polymer</td>
<td></td>
</tr>
<tr>
<td>Wireless Transmit Rate, Operating Frequency and Protocol</td>
<td>WA3: User Configurable Transmit Rate, 2.4GHz WirelessHART</td>
<td></td>
</tr>
<tr>
<td>Antenna and SmartPower</td>
<td>WP5: Internal Antenna, Compatible with Green Power Module (I.S. Power Module Sold Separately)</td>
<td></td>
</tr>
<tr>
<td>Product Certification</td>
<td>I1: ATEX Intrinsic Safety I5: FM Intrinsically Safe, Division 2 I6: CSA Intrinsically Safe I7: IECEx Intrinsic Safety</td>
<td></td>
</tr>
<tr>
<td>Configuration buttons</td>
<td>DZ: Digital Zero Trim</td>
<td></td>
</tr>
<tr>
<td>Display Type</td>
<td>M5 Plant Web LCD Display</td>
<td></td>
</tr>
</tbody>
</table>

For more information, please refer to the Product data sheet (PDS)
### 10.9 Rosemount 2051 Wireless Pressure Transmitter

**2051 industry leading capabilities extended to IEC 62591 (WirelessHART)**
- Best in Class performance with up to 0.05% high accuracy option
- Rangeability of 100:1
- Cost effectively implement wireless on the industry’s most proven platform
- Eliminate wiring design and construction complexities to lower costs by 40-60%

**Innovative, Integrated DP Flowmeters**
- Fully assembled and leak tested for out-of-the-box installation
- Reduce straight pipe requirements, lower permanent pressure loss, and achieve accurate measurement in small line sizes
- Up to 2.00% volumetric flow accuracy at 5:1 turndown

<table>
<thead>
<tr>
<th>Specification Overview</th>
<th>2051 Pressure Transmitter</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Application Type</strong></td>
<td>P, DP, Flow, Level</td>
</tr>
<tr>
<td><strong>Measurement Type</strong></td>
<td>G, A, D (Not available on inline platforms)</td>
</tr>
<tr>
<td><strong>Transmitter Output</strong></td>
<td>IEC 62591 (WirelessHART)</td>
</tr>
<tr>
<td><strong>Reference Accuracy</strong></td>
<td>±0.075% of span</td>
</tr>
<tr>
<td><strong>Total Performance</strong></td>
<td>N.A.</td>
</tr>
<tr>
<td><strong>Long Term Stability</strong></td>
<td>2 Yrs</td>
</tr>
<tr>
<td><strong>Warranty</strong></td>
<td>12 Months</td>
</tr>
<tr>
<td><strong>Rangedown</strong></td>
<td>100:1</td>
</tr>
<tr>
<td><strong>Power Module Life</strong></td>
<td>10 years at 1 min. update rate</td>
</tr>
<tr>
<td><strong>Update Rate</strong></td>
<td>1 sec. to 60min.</td>
</tr>
<tr>
<td><strong>Process Alerts</strong></td>
<td>N.A.</td>
</tr>
<tr>
<td><strong>Housing Style/ Material/ Conduit Entry Size</strong></td>
<td>P: Engineered Polymer</td>
</tr>
<tr>
<td><strong>Wireless Transmit Rate, Operating Frequency and Protocol</strong></td>
<td>WA3: User configuration Update Rate with 2.4GHz</td>
</tr>
<tr>
<td><strong>Omnidirectional Wireless Antenna</strong></td>
<td>WP5: Internal Antenna, Compatible with Green Power Module (I.S. Power Module Sold Separately)</td>
</tr>
<tr>
<td><strong>Product Certification</strong></td>
<td>I1: ATEX Intrinsic Safety</td>
</tr>
<tr>
<td></td>
<td>I5: FM Intrinsically Safe, Division 2</td>
</tr>
<tr>
<td></td>
<td>I6: CSA Intrinsically Safe</td>
</tr>
<tr>
<td></td>
<td>I7: IECEx Intrinsically Safety</td>
</tr>
<tr>
<td><strong>Configuration buttons</strong></td>
<td>DZ: Digital Zero Trim</td>
</tr>
<tr>
<td><strong>Display Type</strong></td>
<td>M5 Plant Web LCD Display</td>
</tr>
</tbody>
</table>

*For more information, please refer to the Product data sheet (PDS)*
10.10  Rosemount 2051 DP Flow and DP Level Technologies

Innovative, Integrated DP Flowmeters
- Fully assembled, configured, and leak tested for out-of-the-box installation
- Reduce straight pipe requirements, lower permanent pressure loss and achieve accurate measurement in small line sizes
- Up to 1.65% volumetric flow accuracy at 8:1 turndown

Proven, Reliable and Innovative DP Level Technologies
- Connect to virtually any process with a comprehensive offering of process connections, fill fluids, direct mount or capillary connections and materials
- Quantify and optimize total system performance with QZ option
- Operate at higher temperatures and in vacuum applications
- Optimize level measurement with cost efficient Tuned-System™ assemblies

<table>
<thead>
<tr>
<th>Specification Overview</th>
<th>DP Flow</th>
<th>DP Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Model</td>
<td>2051CFA</td>
<td>2051CFC</td>
</tr>
<tr>
<td>Application Type</td>
<td>• Differential Pressure (DP) • DP Flow (Flow) • DP Level (Level)</td>
<td>DP, Flow</td>
</tr>
<tr>
<td>Measurement Type</td>
<td>• Differential (D) • Gage (G)</td>
<td>D</td>
</tr>
<tr>
<td>Transmitter Output</td>
<td>IEC 62591 (WirelessHART)</td>
<td>±2% of Flow Rate at 5:1 flow turndown</td>
</tr>
<tr>
<td>Reference Accuracy</td>
<td></td>
<td>Total Performance</td>
</tr>
<tr>
<td>Long Term Stability</td>
<td>±0.125% of URL for 5 years</td>
<td>±50 °F (28 °C) temperature changes, and up to 1000 psi (6.9 MPa) line pressure.</td>
</tr>
<tr>
<td>Warranty</td>
<td>12 Months</td>
<td></td>
</tr>
<tr>
<td>Rangedown</td>
<td>Refer Reference Accuracy</td>
<td></td>
</tr>
<tr>
<td>Power Module Life</td>
<td>10 years at 1 min. update rate</td>
<td></td>
</tr>
<tr>
<td>Update Rate</td>
<td>1 sec. to 60min.</td>
<td></td>
</tr>
<tr>
<td>Process Alerts</td>
<td>N.A.</td>
<td></td>
</tr>
<tr>
<td>Housing Style/ Material/ Conduit Entry Size</td>
<td>P: Engineered Polymer</td>
<td></td>
</tr>
<tr>
<td>Wireless Transmit Rate, Operating Frequency and Protocol</td>
<td>WA3: User Configurable Transmit Rate, 2.4GHz WirelessHART</td>
<td></td>
</tr>
<tr>
<td>Antenna and SmartPower</td>
<td>WP5: Internal Antenna, Compatible with Green Power Module (I.S. Power Module Sold Separately)</td>
<td></td>
</tr>
<tr>
<td>Product Certification</td>
<td>• I1 • I5 • I6 • I7</td>
<td>I1: ATEX Intrinsic Safety I5: FM Intrinsically Safe, Division 2 I6: CSA Intrinsically Safe I7: IECEx Intrinsic Safety</td>
</tr>
<tr>
<td>Configuration Buttons</td>
<td>DZ: Digital Zero Trim</td>
<td></td>
</tr>
<tr>
<td>Display Type</td>
<td>M5 Plant Web LCD Display</td>
<td></td>
</tr>
</tbody>
</table>

For more information, please refer to the Product data sheet (PDS)
10.11 Rosemount 1199 Submersible Seal

**New diaphragm uses proven seal technology**
- Based on reliable and easy to use pressure based level technology
- Ideal for smaller top-down tank connections, from 1 1/2 NPT threaded connections to 2-3 inch flanged connections (DN 50 to DN 100)
- Intended for vented and open tank applications

**Self compensates for changes in temperature**
- Fill fluid and process fluid expand and contract at a similar rate

**System construction**
- Flanged or threaded connection
- Capillary up to 30ft (~9m) with SST or PVC coated armor
- Seal and bellows available with SST

**Attaches to any 3051S, 3051 inline transmitter for a simple top-down drop-in level measurement**

<table>
<thead>
<tr>
<th>Transmitter</th>
<th>Attach-to Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>3051S_TG</td>
<td>B11</td>
</tr>
<tr>
<td>3051TG, 2051TG, 2088G</td>
<td>S1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model</th>
<th>Product Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1199</td>
<td>Seal Systems</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Connection Type</th>
<th>Seal System</th>
<th>Seal Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>All In-Line Transmitters (3051S_TG, 3051TG, 2051TG, 2088G)</td>
<td>One Seal System</td>
<td>High Side of Transmitter</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Seal Fill Fluid</th>
<th>Specific Gravity at 77 °F (25 °C)</th>
<th>Temperature Limits (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D Silicone 200</td>
<td>0.93</td>
<td>-49 to 401 °F (-45 to 205 °C)</td>
</tr>
<tr>
<td>G Glycerin and Water</td>
<td>1.13</td>
<td>5 to 203 °F (-15 to 95 °C)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Seal Connection Type / Capillary ID, Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
</tr>
<tr>
<td>B 0.03-in. (0.711 mm) ID</td>
</tr>
<tr>
<td>C 0.04-in. (1.092 mm) ID</td>
</tr>
<tr>
<td>E 0.03-in. (0.711 mm) ID, PVC Coated with Closed End</td>
</tr>
<tr>
<td>F 0.04-in. (1.092 mm) ID, PVC Coated with Closed End</td>
</tr>
</tbody>
</table>
### Measurement Length (2)

<table>
<thead>
<tr>
<th>Standard</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.7 ft (0.5 m)</td>
</tr>
<tr>
<td>51</td>
<td>2.3 ft (0.7 m)</td>
</tr>
<tr>
<td>52</td>
<td>3.9 ft (1.2 m)</td>
</tr>
<tr>
<td>5</td>
<td>5.7 ft (1.7 m)</td>
</tr>
<tr>
<td>54</td>
<td>7.2 ft (2.2 m)</td>
</tr>
<tr>
<td>55</td>
<td>8.9 ft (2.7 m)</td>
</tr>
<tr>
<td>10</td>
<td>10.7 ft (3.2 m)</td>
</tr>
<tr>
<td>57</td>
<td>12.1 ft (3.7 m)</td>
</tr>
<tr>
<td>58</td>
<td>13.8 ft (4.2 m)</td>
</tr>
<tr>
<td>15</td>
<td>15.7 ft (4.7 m)</td>
</tr>
<tr>
<td>59</td>
<td>17 ft (5.2 m)</td>
</tr>
<tr>
<td>60</td>
<td>20.3 ft (6.2 m)</td>
</tr>
<tr>
<td>20</td>
<td>20.7 ft (6.3 m)</td>
</tr>
<tr>
<td>61</td>
<td>23.6 ft (7.2 m)</td>
</tr>
<tr>
<td>25</td>
<td>25.7 ft (7.8 m)</td>
</tr>
<tr>
<td>62</td>
<td>26.9 ft (8.2 m)</td>
</tr>
<tr>
<td>63</td>
<td>30.2 ft (9.2 m)</td>
</tr>
<tr>
<td>30</td>
<td>30.7 ft (9.3 m)</td>
</tr>
</tbody>
</table>

### Industry Standard

<table>
<thead>
<tr>
<th>Standard</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>ASME B16.5/ANSI B1.20.1 (American National Standards Institute/American Society of Mechanical Engineers)</td>
</tr>
<tr>
<td>D</td>
<td>EN 1092-1 (European Standard)</td>
</tr>
<tr>
<td>J</td>
<td>JIS B2238</td>
</tr>
</tbody>
</table>

### Process Connection Style

<table>
<thead>
<tr>
<th>Standard</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSM</td>
<td>Threaded Submersible Seal</td>
</tr>
<tr>
<td></td>
<td>Expanded</td>
</tr>
<tr>
<td>FSM</td>
<td>Flanged Submersible Seal</td>
</tr>
</tbody>
</table>

### Process Connection Size

<table>
<thead>
<tr>
<th>Standard</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Threaded (TSM)</td>
<td>ANSI B1.20.1, ISO 7-1, DIN 2999, BS 21 (BS EN 10226-1), JIS B0203</td>
</tr>
<tr>
<td>4</td>
<td>1 1/2 - 11.5 NPT</td>
</tr>
</tbody>
</table>
## 10 – Product Specification & Application

<table>
<thead>
<tr>
<th>Expanded</th>
<th>Expanded</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flanged (FSM)</strong></td>
<td></td>
</tr>
<tr>
<td>JIS B2238</td>
<td>ASME B16.5 / HG20615</td>
</tr>
<tr>
<td>4</td>
<td>40 A</td>
</tr>
<tr>
<td>G</td>
<td>50 A</td>
</tr>
<tr>
<td>7</td>
<td>80 A</td>
</tr>
<tr>
<td>J</td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td>100 A</td>
</tr>
<tr>
<td>F</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pressure Rating</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Threaded (TSM)</strong></td>
<td></td>
</tr>
<tr>
<td>ANSI B1.20.1</td>
<td>ISO 7-1, DIN 2999, BS 21 (BS EN 10226-1), JIS B0203</td>
</tr>
<tr>
<td>0</td>
<td>60 psi</td>
</tr>
</tbody>
</table>

| Flanged (FSM) | |
| JIS B2238 | ASME B16.5 / HG20615 | EN 1092-1 / GOST 12815-80 / HG20592 |
| 1 | 10K | Class 150 | - |
| 2 | 20K | Class 300 | - |
| 4 | 40K | Class 600 | - |
| G | - | - | PN 40 |
| E | - | - | PN 10 / 16 |

| Diaphragm, Upper Housing, Flange Material | |
| Diaphragm | Upper Housing | Flange |
| Standard | Standard |
| DG00 | 321 SST | 316 SST | 316 SST |

<table>
<thead>
<tr>
<th>Process Filter</th>
<th>Standard</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No Filter</td>
<td>★</td>
</tr>
<tr>
<td>1</td>
<td>1/4 in. NPT Screen Insert</td>
<td>★</td>
</tr>
</tbody>
</table>
Oil and Gas Automation
• Tubing, casing and bradenhead
• Injection flow rates

Automate O&G fields faster and gain insight to remote operations. Reduce maintenance headaches, spend less time on site and reduce the risk of environmental fines while maximizing production output. Ensure wellhead integrity and optimize injection rates.

Pressure Gauge Replacement
• Manual operator rounds
• Asset monitoring

Reduce operator rounds to improve productivity. Improve personnel safety by reducing exposure to hazardous gases and extreme weather. Automate data collection to proactively detect abnormal situations in real time for troublesome assets.

Plant Utility Monitoring
• Steam and Gas
• Compressed Air
• Water

Monitor flow and pressure in compressed air, steam and water systems to benchmark energy usage, identify energy saving opportunities throughout the plant and provide accurate internal billing.

Heat Exchangers
• Inlet and outlet flow rates and pressure to calculate efficiency

Fouling of tubes reduces efficiency and increases energy usage and cost. Early detection of fouling allows for planned, preventative maintenance rather than reactive. Detect and correct heat exchanger fouling to ensure efficient heat transfer and lower energy costs.

Filters for Pumps, Turbines, Compressors
• Measure DP across filters and strainers

Prevent plugged filters, protect rotating equipment from debris, and maintain efficiency.

Environmental Compliance
• Emissions flow
• Tank overspill protection

Monitor and record emissions (SO2, CO2, NOX) to comply with government regulations with automated reporting. Minimize emissions or potential tank overfills.

Rotating Equipment
• Measure lube oil pressure

Measure and maintain lube oil pressure to prevent damage or failure of critical assets such as pumps, compressors, conveyors and other rotating assets.

Tank Inventory
• Measure tank levels

Track and manage inventories levels ensure optimal scheduling of incoming deliveries. Protect against overflow or under fill. Avoid material shortages or unnecessary resupply trips.

Proven Result References
• AkzoNobel Improves Storage Tank Heating Control (p.120)
• FH Tank Storage Meets Latest Safety Requirements (p.128)
• Petrochemical Plant Drives Energy Efficiency (p.130)
• Silicone Manufacturer Improves Energy Costs (p.132)
• Coogee Chemicals Prevents Breakdowns and Lost Production (p.135)
• Sun Chemical Improve Product Quality and Meet Air Permit Requirements (p.136)
• Atlas Pipeline Improves Production Efficiency (p.147)
• Offshore Oil Platform Mitigates Risk (p.152)
• Oil Producer Reduces Production Loss (p.160)
• Oil Production Company Reduces Steam Injection Costs (p.162)
• Pipeline Company Eliminates Risk of Environmental Fines (p.166)
• Pipeline Company Reduces Environmental Risk and Project Costs (p.168)
• PXP Improves Oilfield Operation (p.170)
• RWE Maximizes Gas Storage Capacity and Improves Efficiency and Safety (p.174)
• Timely Compliance to State Regulation Made Possible (p.179)
• San Diego Gas & Electric Improve Operations and Safety (p.186)
• Lime Kiln Throughput Improves (p.197)
• Refinery Improved Product Quality and Throughput (p.199)
• Refinery Improves Availability of Coking Unit (p.205)
• Refinery Improves Environmental Compliance (p.207)
• Refinery Monitors Junction Box Pressure (p.212)
10.12 Rosemount Smart Wireless THUM Adapter

IEC 62591 (WirelessHART™)
- Self-organizing, Adaptive Mesh Routing
- Industry standard radio with Channel hopping
- Standard IEEE 802.15.4 radios
- 2.4Ghz ISM band sliced into 16 radio-channels
- Self-healing Network
- Seamless Integration to existing hosts

Device Specification
- The THUM adapter is connected into a powered 4-20mA loop, powering itself by scavenging power.
- Approvals: FM, CSA, ATEX, IECEx
- Input: Either 2- or 4-wire HART 5.0 device
- Allow any HART Device to be on WirelessHART™ Network
- SmartPower™: Power scavenging technology (no battery required)

<table>
<thead>
<tr>
<th>Base Model</th>
<th>775 Smart Wireless THUM Adaptor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input</strong></td>
<td>Any 2- or 4-wire HART powered device</td>
</tr>
<tr>
<td><strong>Transmitter Output</strong></td>
<td>IEC 62591 (WirelessHART)</td>
</tr>
<tr>
<td><strong>Warranty</strong></td>
<td>18 months from Delivery</td>
</tr>
<tr>
<td><strong>Update Rate</strong></td>
<td>User selectable, 1 sec. to 60min.</td>
</tr>
<tr>
<td><strong>Process Alerts</strong></td>
<td>4 Configurable Alerts</td>
</tr>
</tbody>
</table>
| **Housing Type** | • D: Aluminum (Nema 4X & IP66)  
• E: SST |
| **Mounting Connection** | • 1: 1/2 - 14NPT  
• 2: M20-Conduit Adaptor |
| **Wireless Options/Operating Frequency and Protocol** | User configuration Update Rate with 2.4GHz DSSS, IEC 62591 (WirelessHART) |
| **Omnidirectional Wireless Antenna** | Long range, Integral Antenna, Power Scavenging |
| **Product Certification** | NA: No Approval  
I5: FM Intrinsically Safe, Division 2  
I6: CSA Intrinsically Safe  
I1: ATEX Intrinsically Safe  
N1: ATEX Type N  
I7: IECEx Intrinsically Safe  
N7: IECEx Type n  
I2: INMETRO Intrinsically Safe  
N2: INMETRO Type n  
I3: China Intrinsically Safe  
IP: India (CCOE) Intrinsically Safe  
IW: GOST (Russia) Intrinsically Safe |

For more information, please refer to the Product data sheet (PDS)
10.13 Rosemount Pressure Multivariable Transmitter with THUM Adapter

Easy to Use
Only need access to a Smart Wireless Gateway

Easy to Integrate
All Smart Wireless field network devices integrate directly into existing automation architecture without the need for upfront engineering, site surveys or additional software

Easy Access
Gain access to additional process variables while conserving control system inputs

For more information, please refer to the Product data sheet (PDS)
### Specification Overview

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3051SAM + THUM</td>
<td>3051SAL + THUM</td>
<td>3051SMV + THUM</td>
</tr>
</tbody>
</table>

### Application Type
- Pressure (P)
- Differential Pressure (DP)
- Flow (DP Flow)
- Level (DP Level)
- Temperature (T) for DP Flow

### Measurement Type
- Differential (D)
- Gage (G)
- Temperature (T) for DP Flow

### Transmitter Output
- IEC 62591 (WirelessHART)

### Reference Accuracy
- MV: Multivariable (DP Flow)
- SV: Single variable (DP Flow)

#### (3051S by performance class)
- S1
- S2
- S3

#### Ultra: ±0.025% of span
- Classic: ±0.055% of span

#### Total Performance (3051S by performance class)
- Ultra: ±0.1% of Span
- Classic: ±0.15% of span

### Long Term Stability
- MV: Multivariable
- SV: Single variable (3051S by performance class)

#### (3051S by performance class)
- S1
- S2
- S3

#### 10 Yrs
- 5 Yrs
- N.A.

### Warranty
- MV: Multivariable
- SV: Single variable (3051S by performance class)

#### (3051S by performance class)
- S1
- S2
- S3

#### 12 Yrs
- 1 Yr

### Use toolkit
- Applies to DP Measurement only
- Ultra: ±0.1% of span; Classic & Classic MV: ±0.15% of span
- Ultra for Flow: ±0.15% of span

### S1: ±0.025% of span
- S2: ±0.055% of span
- S3: ±0.04% of span

### S1: ±0.1% of span
- S2: ±0.15% of span
- S3: ±0.15% of span

### S1: 10 Yrs
- S2: 5 Yrs
- S3: 10 Yrs

### S1: 12 Yrs
- S2: 5 Yrs
- S3: 12 Yrs
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base Model</strong></td>
<td>3051SAM + THUM</td>
<td>3051SAL + THUM</td>
<td>3051SMV + THUM</td>
</tr>
<tr>
<td><strong>Rangedown</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MV: Multivariable</td>
<td>200:1</td>
<td>100:1</td>
<td>• MV: Ultra: 200:1 &amp; Classic: 100:1</td>
</tr>
<tr>
<td>SV: Single variable (3051S by performance class)</td>
<td>100:1</td>
<td></td>
<td>• SV: Ultra &amp; Ultra for Flow: 200:1, Classic: 100:1</td>
</tr>
<tr>
<td>S1</td>
<td></td>
<td></td>
<td>• S1 - 200:1</td>
</tr>
<tr>
<td>S2</td>
<td></td>
<td></td>
<td>• S2 - 100:1</td>
</tr>
<tr>
<td>S3</td>
<td></td>
<td></td>
<td>• S3 - 200:1</td>
</tr>
<tr>
<td><strong>Display Type</strong></td>
<td>M5 Plant Web LCD Display</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Update Rate</strong></td>
<td>User selectable, 1 sec. to 60min.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Process Alerts</strong></td>
<td>4 Configurable Alerts</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Housing Style</strong></td>
<td>Housing Style: Material (Conduit Entry Size) 1A/2A/2E: Aluminum (1/2-14 NPT) 1B/2B/2F: Aluminum (M20 X 1.5) 1J/2J/2M: SST (1/2-14 NPT) 1K: SST (M20 X 1.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plantweb Hsg (1A/1B/1J/1K)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction Box Hsg (2A/2B/2J)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction Box Hsg for remote display and interface (2E/2F/2M)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mounting Connection for THUM</strong></td>
<td>• 1: 1/2 - 14NPT</td>
<td>• 2: M20-Conduit Adaptor</td>
<td></td>
</tr>
<tr>
<td><strong>Wireless Options/Operating Frequency and Protocol</strong></td>
<td>User configuration Update Rate with 2.4GHz DSSS, IEC 62591 (Wireless HART)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Product Certification</strong></td>
<td>NA: No Approval</td>
<td>I5: FM Intrinsically Safe, Division 2</td>
<td>I6: CSA Intrinsically Safe</td>
</tr>
<tr>
<td>NA</td>
<td></td>
<td></td>
<td>I1: ATEX Intrinsic Safety</td>
</tr>
<tr>
<td>I5</td>
<td></td>
<td></td>
<td>N1: ATEX Type N</td>
</tr>
<tr>
<td>I6</td>
<td></td>
<td></td>
<td>I7: IECEx Intrinsic Safety</td>
</tr>
<tr>
<td>I1</td>
<td></td>
<td></td>
<td>N7: IECEx Type n</td>
</tr>
<tr>
<td>N1</td>
<td></td>
<td></td>
<td>I2: INMETRO Intrinsic Safety</td>
</tr>
<tr>
<td>I7</td>
<td></td>
<td></td>
<td>N2: INMETRO Type n</td>
</tr>
<tr>
<td>N7</td>
<td></td>
<td></td>
<td>I3: China Intrinsic Safety</td>
</tr>
<tr>
<td>I2</td>
<td></td>
<td></td>
<td>IP: India (CCOE) Intrinsic Safety</td>
</tr>
<tr>
<td>N2</td>
<td></td>
<td></td>
<td>IW: India (CCOE) Intrinsic Safety</td>
</tr>
<tr>
<td>I3</td>
<td></td>
<td></td>
<td>IM: GOST (Russia) Intrinsically Safe</td>
</tr>
</tbody>
</table>

For more information, please refer to the Product data sheet (PDS)
10.15 Rosemount 848 Wireless Multi Input Temperature Transmitter

A Wireless Solution for High Density Temperature Measurement

The 848T Wireless Temperature Transmitter measures up to four independently configurable temperature providing users access to multiple measurement points with a single transmitter. Costs per point are dramatically reduced through the use of smart wireless networks, with the same reliability and security of wired solutions.

- Four independently configurable inputs including RTD, thermocouple, ohm, voltage and 4 - 20 mA signals
- Eight user configurable alerts for advanced measurement monitoring
- Efficient wireless network utilization by sending all four sensor readings in one transmitted message
- Type 4x, IP66 housings allows for installation in harsh process environments
- Ambient temperature compensation reduces measurement error in harsh applications, especially for wide fluctuations of ambient temperature

<table>
<thead>
<tr>
<th>Specification Overview</th>
<th>848 Temperature Transmitter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensor Input Configuration</td>
<td>4 independent measurements configurable to the following input types: Thermocouple, RTD, 0-1000 mV, 0-10 V, ohm, and 4-20 mA</td>
</tr>
<tr>
<td>Transmitter Output</td>
<td>IEC 62591 (WirelessHART)</td>
</tr>
<tr>
<td>Reference Accuracy</td>
<td>±0.30 °C (Pt 100 @ 20°C)</td>
</tr>
<tr>
<td>Long Term Stability</td>
<td>±0.15% of output reading or 0.15 °C (whichever is greater) for 2 years</td>
</tr>
<tr>
<td>Warranty</td>
<td>12 Months</td>
</tr>
<tr>
<td>Power Module Life</td>
<td>10 years at 1 min. update rate</td>
</tr>
<tr>
<td>Update Rate</td>
<td>4 sec. to 60min.</td>
</tr>
<tr>
<td>Process Alerts</td>
<td>8 Configurable Alerts</td>
</tr>
<tr>
<td>Housing Style/ Material/ Conduit Entry Size</td>
<td>D: Aluminum Dual Compartment Housing</td>
</tr>
<tr>
<td>Wireless Transmit Rate, Operating Frequency and Protocol</td>
<td>WA3: User configuration Update Rate with 2.4GHz</td>
</tr>
<tr>
<td>Omnidirectional Wireless Antenna</td>
<td>WK1: External Antenna, WM1: Extended Range External Antenna</td>
</tr>
<tr>
<td>Product Certification</td>
<td>I5: FM Intrinsically Safe, Non-Incendive, and Dust Ignition-proof</td>
</tr>
<tr>
<td></td>
<td>N5: FM Non-Incendive and Dust Ignition-proof</td>
</tr>
<tr>
<td></td>
<td>I6: CSA Intrinsically Safe</td>
</tr>
<tr>
<td></td>
<td>I1: ATEX Intrinsic Safety</td>
</tr>
<tr>
<td></td>
<td>I7: IECEx Intrinsic Safety</td>
</tr>
<tr>
<td></td>
<td>I4: TIIS Intrinsic Safety</td>
</tr>
<tr>
<td></td>
<td>N6: CSA Class I, Division 2</td>
</tr>
<tr>
<td>Display Type</td>
<td>NA</td>
</tr>
<tr>
<td>Sensor Trim</td>
<td>NA</td>
</tr>
</tbody>
</table>

For more information, please refer to the Product data sheet (PDS)
## 10.16  Rosemount 648 Wireless Temperature Transmitter

### A Smart Wireless Solution for Single Point Temperature Measurements

The industry-leading Rosemount 648 Wireless Temperature Transmitter delivers unmatched field reliability and performance as a wireless measurement solution. The 648 Wireless is ideal for high performance applications, helping you achieve optimal efficiency with Best-in-Class product specifications and capabilities.

- Accepts wide variety of sensor inputs for flexibility to meet application requirements
- Transmitter-Sensor Matching improves measurement accuracy by 75%
- 4 user-configurable alerts for increased process insight
- Large, easy to read LCD display
- Long Range and Extended Range Antenna options
- Dual-compartment housing provides high reliability in humid, corrosive and EMI/RFI environments

<table>
<thead>
<tr>
<th>Specification Overview</th>
<th>648 Temperature Transmitter</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sensor Input Configuration</strong></td>
<td>Thermocouple, RTD, millivolt, and ohm</td>
</tr>
<tr>
<td><strong>Transmitter Output</strong></td>
<td>IEC 62591 (WirelessHART)</td>
</tr>
<tr>
<td><strong>Reference Accuracy</strong></td>
<td>±0.225 °C (Pt 100 @ 20°C)</td>
</tr>
<tr>
<td><strong>Long Term Stability</strong></td>
<td>±0.15% of output reading or 0.15 °C (whichever is greater) for 2 years</td>
</tr>
<tr>
<td><strong>Warranty</strong></td>
<td>12 Months</td>
</tr>
<tr>
<td><strong>Power Module Life</strong></td>
<td>10 years at 1 min. update rate</td>
</tr>
<tr>
<td><strong>Update Rate</strong></td>
<td>1 sec. to 60min.</td>
</tr>
<tr>
<td><strong>Process Alerts</strong></td>
<td>4 Configurable Alerts</td>
</tr>
<tr>
<td><strong>Housing Style/ Material/ Conduit Entry Size</strong></td>
<td>D: Aluminum Dual Compartment Housing</td>
</tr>
<tr>
<td></td>
<td>E: SST Dual Compartment Housing</td>
</tr>
<tr>
<td><strong>Wireless Transmit Rate, Operating Frequency and Protocol</strong></td>
<td>WA3: User configuration Update Rate with 2.4GHz</td>
</tr>
<tr>
<td><strong>Omnidirectional Wireless Antenna</strong></td>
<td>WK1: External Antenna</td>
</tr>
<tr>
<td></td>
<td>WM1: Extended Range External Antenna</td>
</tr>
<tr>
<td><strong>Product Certification</strong></td>
<td>I5: FM Intrinsically Safe, Non-Incendive, and Dust Ignition-proof</td>
</tr>
<tr>
<td></td>
<td>N5: FM Non-Incendive and Dust Ignition-proof</td>
</tr>
<tr>
<td></td>
<td>I6: CSA Intrinsically Safe</td>
</tr>
<tr>
<td></td>
<td>I1: ATEX Intrinsic Safety</td>
</tr>
<tr>
<td></td>
<td>I7: IECEx Intrinsically Safe</td>
</tr>
<tr>
<td></td>
<td>I4: TIIS Intrinsically Safe</td>
</tr>
<tr>
<td></td>
<td>I3: China Intrinsically Safe</td>
</tr>
<tr>
<td><strong>Display Type</strong></td>
<td>M5: LCD Display</td>
</tr>
<tr>
<td><strong>Sensor Trim</strong></td>
<td>C2: Transmitter-Sensor Matching</td>
</tr>
</tbody>
</table>

For more information, please refer to the Product data sheet (PDS)
## 10.17 Rosemount 248 Wireless Temperature Transmitter

### A Smart Wireless Solution for Single Point Temperature Measurements

The Rosemount 248 Wireless temperature transmitter offers a cost effective solution for wireless process monitoring. The standard design of the 248 Wireless helps you optimize plant efficiency and increase measurement reliability with industry-proven capabilities and specifications.

- Accepts wide variety of sensor inputs and mounting options for flexibility to meet application requirements
- Dual-compartment housing provides high reliability in humid, corrosive and EMI/RFI environments
- Ambient temperature compensation enhances transmitter performance

### Specification Overview

<table>
<thead>
<tr>
<th>Specification Overview</th>
<th>248 Temperature Transmitter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensor Input Configuration</td>
<td>Thermocouple, RTD, millivolt, and ohm</td>
</tr>
<tr>
<td>Transmitter Output</td>
<td>IEC 62591 (WirelessHART)</td>
</tr>
<tr>
<td>Reference Accuracy</td>
<td>±0.45 °C (Pt 100 @ 20°C)</td>
</tr>
<tr>
<td>Long Term Stability</td>
<td>±0.15% of output reading or 0.15 °C (whichever is greater) for 2 years</td>
</tr>
<tr>
<td>Warranty</td>
<td>12 Months</td>
</tr>
<tr>
<td>Power Module Life</td>
<td>10 years at 1 min. update rate</td>
</tr>
<tr>
<td>Update Rate</td>
<td>1 sec. to 60min.</td>
</tr>
<tr>
<td>Process Alerts</td>
<td>NA</td>
</tr>
<tr>
<td>Housing Style/ Material/ Conduit Entry Size</td>
<td>D: Aluminum Dual Compartment Housing</td>
</tr>
<tr>
<td>Wireless Transmit Rate, Operating Frequency and Protocol</td>
<td>WA3: User configuration Update Rate with 2.4GHz</td>
</tr>
<tr>
<td>Omnidirectional Wireless Antenna</td>
<td>WK1: External Antenna</td>
</tr>
<tr>
<td>Product Certification</td>
<td>i5: FM Intrinsically Safe, Non-Incendive, and Dust Ignition-proof</td>
</tr>
<tr>
<td></td>
<td>N5: FM Non-Incendive and Dust Ignition-proof</td>
</tr>
<tr>
<td></td>
<td>I6: CSA Intrinsically Safe</td>
</tr>
<tr>
<td></td>
<td>I1: ATEX Intrinsically Safe</td>
</tr>
<tr>
<td></td>
<td>I7: IECEx Intrinsically Safe</td>
</tr>
<tr>
<td>Display Type</td>
<td>NA</td>
</tr>
<tr>
<td>Sensor Trim</td>
<td>NA</td>
</tr>
</tbody>
</table>

For more information, please refer to the Product data sheet (PDS)
Monitor Heat Exchanger Temperature Profile
• Measure inlet and outlet temperatures
• Calculate heat exchanger efficiency and adjust to improve energy usage
• Minimize maintenance costs and optimize cleaning schedules to prevent fouling
• Increase production with increased heat exchange

Monitor Motors for Pumps, Fans, Dryers, or Compressors
• Bearing temperature is indicator of potential failure
• Keep motors operating within specifications to extend life
• Minimize maintenance costs and downtime by preventing unexpected failures

Boiler Tube Surface Temperature for Fatigue Management Analysis
• Minimize boiler shutdowns due to tube ruptures
• Reduced boiler operating and maintenance costs
• Profile furnace temperature to improve energy usage
• Reduce operating costs

Tank Monitoring
• Profiles for accurate determination of density, volume and mass

Reactor Temperature Profile
• Identify hot spots & channeling to improve efficiency and prevent catalyst damage

Distillation Column Temperature Profile
• Optimize separation and product quality

Other Potential for Temperature Pipe Clamp + Wireless Applications
• On-shore
  – Pipe Lines
  – Pipe Heating system
  – Well Heads
  – Flow lines
  – Underground pipe lines
• Off-shore
  – Flare control
  – Fire water control
  – Well Heads
  – Flow lines

Proven Result References
• Chemical Manufacturer Improves Safety and Reduces Costs with Smart Wireless Solution (p.126)
• Petrochemical Plant Drives Energy Efficiency with Smart Wireless DP Flowmeters and Temperature Transmitters (p.130)
• Emerson’s Smart Wireless Products Prevent Breakdowns and Lost Production on Rotating Reactor at Coogee Chemicals (p.135)
• Food Manufacturer’s Regular Maintenance Cost and Production Downtime Reduced by Wireless Solution (p.138)
• Temperature Technologies Provide New Insights to Improve Safety, Productivity at American Crystal Sugar (p.142)
• Atlas Pipeline Improves Production Efficiency at Natural Gas Processing Facility (p.147)
• Offshore Oil Platform Mitigates Risk of Reduced Production in Flowing Oil Wells and Pipelines with Timely Process Data (p.152)
• Pipeline Company Eliminates Risk of Environmental Fines with Smart Wireless (p.166)
• RWE Gas Storage Uses Wireless Technology to Maximize Gas Storage Capacity and Improve Efficiency and Safety (p.174)
10.18 Rosemount 2160 Vibrating Fork Liquid Level Switch

Reliable Performance In Demanding Applications

WirelessHART vibrating fork liquid level switch combines Emerson’s wireless expertise with the Rosemount 2100 series vibrating short fork technology. It has all the same features as the wired level switches in the Rosemount 2100 series, but without the complication and cost of wiring. Features include a complete range of process connections, aluminum housing, a choice of wetted parts materials, dry-to-wet and wet-to-dry switching functions, extended fork lengths, and hazardous area approvals. Industry best practice is to fit a level switch with a continuous level transmitter to act as emergency shutdown switch-for example fit a 2160 with a 3308.

The Rosemount 2160 continuously performs instrument health diagnostics of the fork and sensor. These diagnostics can detect external damage to the forks, internal damage to the sensor, excessive corrosion and over-temperature. The 2160 can withstand temperatures from -94 °F (-70 °C) up to 500 °F (260 °C) and pressures to 1450 psig (100 bar g).

<table>
<thead>
<tr>
<th>Specification Overview</th>
<th>2160 Wireless Vibrating Fork</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base Model</strong></td>
<td>2160</td>
</tr>
<tr>
<td><strong>Application Type</strong></td>
<td>Material Frequency Changes</td>
</tr>
<tr>
<td>• Overfill protection</td>
<td></td>
</tr>
<tr>
<td>• High/ Low level alarm</td>
<td></td>
</tr>
<tr>
<td>• Pump control or limit detection</td>
<td></td>
</tr>
<tr>
<td><strong>Switching Point</strong></td>
<td>0.5 in. (13 mm) from fork tip if mounted vertically.</td>
</tr>
<tr>
<td></td>
<td>0.5 in. (13 mm) from the fork edge if mounted horizontally.</td>
</tr>
<tr>
<td><strong>Radio Frequency Power Output from Antenna</strong></td>
<td>Maximum of 10 mW (10 dBm) EIRP</td>
</tr>
<tr>
<td><strong>Mounting Horizontal/ Vertical</strong></td>
<td>Rotatable housing allows correct alignment of both the forks and the omnidirectional antenna for optimal signal and best viewing position of the LCD integral display.</td>
</tr>
<tr>
<td><strong>Minimum Extended Length</strong></td>
<td>Process Connection</td>
</tr>
<tr>
<td>¾-in threaded</td>
<td>3.8 in. (95mm)</td>
</tr>
<tr>
<td>1-in. Threaded</td>
<td>3.7 in. (94 mm)</td>
</tr>
<tr>
<td>Flanged</td>
<td>3.5 in (89 mm)</td>
</tr>
<tr>
<td>Tri-Clamp</td>
<td>4.1 in (105mm)</td>
</tr>
<tr>
<td><strong>Power Module Life</strong></td>
<td>10 years at 1 min. update rate</td>
</tr>
<tr>
<td><strong>Update Rate</strong></td>
<td>1 sec. to 60min.</td>
</tr>
<tr>
<td><strong>Process Alerts</strong></td>
<td>DRY/ WET</td>
</tr>
<tr>
<td><strong>Housing Style/ Material/ Conduit Entry Size</strong></td>
<td>Housing: Low-copper aluminium</td>
</tr>
<tr>
<td></td>
<td>Cover O-Ring: Silicone</td>
</tr>
<tr>
<td><strong>Wireless Options/ Operating Frequency and Protocol</strong></td>
<td>User configuration Update Rate with 2.4GHz DSSS, IEC 62591 (Wireless HART)</td>
</tr>
<tr>
<td><strong>Omnidirectional Wireless Antenna</strong></td>
<td>Internal Antenna</td>
</tr>
<tr>
<td><strong>Smart Power</strong></td>
<td>Adapter for Black Power Module (I.S. Power Module sold separately)</td>
</tr>
</tbody>
</table>
### Specification Overview

<table>
<thead>
<tr>
<th>Specification Overview</th>
<th>2160 Wireless Vibrating Fork</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Adjustable Switching Delay</strong></td>
<td>User configurable 1-3600s for turbulent applications</td>
</tr>
<tr>
<td><strong>Operating Frequency</strong></td>
<td>~1400 Hz</td>
</tr>
<tr>
<td><strong>Minimum Process Media Density</strong></td>
<td>≥ 500 kg/m³</td>
</tr>
<tr>
<td><strong>Viscosity</strong></td>
<td>0.2 to 10000 cP</td>
</tr>
<tr>
<td><strong>Switch Hysteresis</strong></td>
<td>±0.039 in. (± 1 mm)</td>
</tr>
<tr>
<td><strong>Process Pressure Limits</strong></td>
<td>-14.5 to 1450 psi</td>
</tr>
<tr>
<td><strong>Process Temperature Limits</strong></td>
<td>-94 to 500°F</td>
</tr>
<tr>
<td><strong>Ambient Temperature Limits</strong></td>
<td>-40 to 176°F</td>
</tr>
<tr>
<td><strong>Fork Material</strong></td>
<td>316/316L SST; Alloy C, Alloy C-276; hand polished option available (Ra &lt; 0.4 µm)</td>
</tr>
<tr>
<td><strong>Fork Length</strong></td>
<td>3.5 in to 118.1 in (89 to 3000 mm)</td>
</tr>
<tr>
<td><strong>Electronic Switching Output</strong></td>
<td>WirelessHART</td>
</tr>
<tr>
<td><strong>Hazardous Areas Approvals</strong></td>
<td>ATEX IS, FM IS, CSA IS, IECEX IS, NEPSI IS</td>
</tr>
<tr>
<td><strong>Other Approvals</strong></td>
<td>DIBt/WHG overfill protection</td>
</tr>
<tr>
<td><strong>Advanced Diagnostic/self check</strong></td>
<td>Built in diagnostics continually check electronic and mechanical health.</td>
</tr>
<tr>
<td><strong>LCD Display</strong></td>
<td>The optional five-digit integral LCD can indicate a sequence of up to four process variables (dry/wet, electronics temperature, frequency, supply voltage) and diagnostic information</td>
</tr>
<tr>
<td></td>
<td>‘Locate device’ function allows easy visual identification of instrument during commissioning and inspection</td>
</tr>
<tr>
<td><strong>Other Information of Interest</strong></td>
<td>Aiming previously inaccessible environments, where cost or practical constraints with using wired technology prevented 2100 use. Suitable for both monitoring and critical control applications</td>
</tr>
<tr>
<td></td>
<td>Virtually all liquids, including coating and aerated liquids, slurries, hygienic applications and hazardous areas</td>
</tr>
<tr>
<td></td>
<td>Long power module lifetime, even with fast update rates (10 years at 60seconds, over 1 year at 1second)</td>
</tr>
<tr>
<td></td>
<td>Simple installation requires no calibration</td>
</tr>
<tr>
<td></td>
<td>Fast Drip fork design gives quicker response time, especially with viscous liquids. Rapid wet-to-dry time for highly responsive switching</td>
</tr>
</tbody>
</table>

*For more information, please refer to the Product data sheet (PDS)*
**Overfill Protection**
Spillage caused by overfilling can be hazardous to people and the environment, resulting in lost product and potentially high clean up costs.

**Hi-Hi and Lo-Lo Level Detection**
Maximum and minimum level detection in tanks containing different types of liquids are ideal applications. It is common practice to have an independent high level alarm switch as a backup to an installed level device in case of primary failure.

**Pump Protection or Empty Pipe Detection**
With the fork projecting only 2 in. (50 mm) (dependant on connection type), the 2160 can be installed in small diameter pipes. Short forks mean minimum intrusion on the wetside and allow for simple, low cost installation at any angle into tanks or pipes.

**Pump Control (Limit Detection)**
Batch processing tanks often contain stirrers and agitators to ensure mixing and product ‘fluidity’. The standard user-selectable time delay, from 0 to 3600 seconds, virtually eliminates the risk of false switching from splashing.

**Extreme Temperature Applications**
The 2160E is designed for extreme temperatures and is suitable for continuous operation within the temperature range of –94 to 500 °F (–70 to 260 °C).

**Hygienic Applications**
With the highly polished forks option providing a surface finish (Ra) better than 0.4 µm, the 2160 meets the most stringent hygienic requirements used in food and beverage, and pharmaceutical applications. Manufactured in stainless steel, the 2160 is robust enough to easily withstand steam cleaning (CIP) routines.

---

**Proven Result References**
- HPCL Bagru Jaipur Terminal Achieves Pump Protection and Increased Safety with Wireless Level Switch (p.216)
- BP Oil Implements Rosemount 2160 Wireless Switches for Floating Roof Tilt Detection (p.218)

**For more proven results:**
http://www2.emersonprocess.com/en-US/brands/rosemount/Documentation-and-Drawings/Proven-Results/Pages/index.aspx#metals
### 10.19 Rosemount 3308 Wireless Guided Wave Radar

- Accurate, direct level measurement virtually unaffected by process conditions
- Minimized maintenance with no moving parts and no re-calibration required
- Fewer process penetrations and reduced installation costs with a MultiVariable™ level and interface transmitter
- Versatile and easy-to-use transmitter with field proven reliability
- High application flexibility with a wide range of process connections and accessories

<table>
<thead>
<tr>
<th>Specification Overview</th>
<th>3308 Wireless Guided Wave Radar</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base Model</strong></td>
<td>3308</td>
</tr>
<tr>
<td><strong>Application Type</strong></td>
<td>Continuous Level &amp; Interface Level (Time Domain Reflectometry - TDR)</td>
</tr>
<tr>
<td><strong>Transmitter Output</strong></td>
<td>IEC 62591 (WirelessHART)</td>
</tr>
<tr>
<td><strong>Reference Accuracy</strong></td>
<td>±0.25 in. (6 mm)</td>
</tr>
<tr>
<td><strong>Repeatability</strong></td>
<td>±0.08 in. (2 mm)</td>
</tr>
<tr>
<td><strong>Maximum Measuring Range</strong></td>
<td>33 ft (10 m)</td>
</tr>
<tr>
<td><strong>Minimum Dielectric Constant</strong></td>
<td>2.0 up to 33 ft (10 m)</td>
</tr>
<tr>
<td><strong>Min/max Temperature</strong></td>
<td>-40 to 302 F (-40 to 150 C)</td>
</tr>
<tr>
<td><strong>Min/max Pressure</strong></td>
<td>-14 to 580 psig (-1 to 40 bar)</td>
</tr>
<tr>
<td><strong>Power Module Life</strong></td>
<td>9 years at 1 min. update rate</td>
</tr>
<tr>
<td><strong>Update Rate</strong></td>
<td>4 sec. to 60 min.</td>
</tr>
<tr>
<td><strong>Process Alerts</strong></td>
<td>Signal Quality Alert (Enhanced Diagnostics for e.g. coated probes)</td>
</tr>
<tr>
<td></td>
<td>High Level Alerts</td>
</tr>
<tr>
<td></td>
<td>Low Level Alerts</td>
</tr>
<tr>
<td></td>
<td>User-Defined Alert</td>
</tr>
</tbody>
</table>
| **Housing Style/ Material/ Conduit Entry Size** | D1: Wireless Dual Compartment Housing, Aluminum (with plugged ½-14 NPT conduits)  
D1: Wireless Dual Compartment Housing, Stainless steel (with plugged ½-14 NPT conduits)  
E1: Wireless Dual Compartment Housing, Aluminum (with plugged ½-14 NPT conduits)  
E1: Wireless Dual Compartment Housing, Stainless steel (with plugged ½-14 NPT conduits) |
| **Wireless Options/ Operating Frequency and Protocol** | WA3: User configuration Update Rate with 2.4GHz DSSS, IEC 62591 (WirelessHART) |
| **Omnidirectional Wireless Antenna** | WK: External Antenna  
WK: High Gain, Remote Antenna (Not CE Approved) |
| **Smart Power**        | 1: Adapter for Black Power Module (I.S. Power Module sold separately) |
| **Product Certification** | I1: ATEX Intrinsic Safety  
I5: FM Intrinsically Safe, Division 2  
I6: CSA Intrinsically Safe  
I7: IECEx Intrinsic Safety |
| **Display Type**       | M5: Plant Web LCD Display      |

For more information, please refer to the Product data sheet (PDS)
Production Tanks
The Rosemount 3308 Series transmitter is ideal for production tanks that contain oil, gas condensate or water.

Storage and Buffer Tanks
The Rosemount 3308 Series transmitter is ideal for shorter storage or buffer tanks that for example contain oil, condensate, water, or chemicals.

Separator Tanks and Chambers
The Rosemount 3308 Series transmitter can measure both level and interface level in for example chamber and separator applications.

Waste Tanks and Sump Pits
The Rosemount 3308 Series transmitter is a good choice for waste tanks and underground tanks, such as sump pits.

For more proven results:
http://www2.emersonprocess.com/en-US/brands/rosmount/Documentation-and-Drawings/Proven-Results/Pages/index.aspx#metals
10.20 Smart Wireless THUM™ Adapter for Rosemount Process Level Transmitter Applications

Introduction
The Smart Wireless THUM Adapter is used to wirelessly communicate HART® data acquired from a Rosemount Process Level transmitter using a self-organizing WirelessHART™ network.

The THUM Adapter which consists of a radio transmitter, receiver, microprocessor and antenna, allows you to wirelessly transmit HART measurement and diagnostic information.

This document provides information and special considerations for using the THUM Adapter with the following Rosemount Process Level HART Transmitters:
- Rosemount 3100 Series Ultrasonic Level Transmitter
- Rosemount 3300 Series Guided Wave Radar Level and Interface Transmitter
- Rosemount 5300 Series High Performance Guided Wave Radar Level and Interface Transmitter
- Rosemount 5400 Series 2-Wire Radar Level Transmitter
- Rosemount 5600 Series 4-Wire Radar Level Transmitter

Product Certifications and Barrier (Associated Apparatus) Requirements
The THUM Adapter is only for intrinsically safe (IS) approvals, e.g. model codes I1, I5, I6, and I7. As the THUM Adapter and Rosemount Process Level transmitter are ordered separately, the customer must ensure that these are ordered with the same IS approval (model code).

The user must perform an IS investigation and verify that the entity (output) parameters of the Barrier (Associated Apparatus) comply with the entity (input) parameters of the connected THUM Adapter and Rosemount Process Level transmitter. The entity parameters are specified in the respective QIGs as well as on the respective Control (Installation) Drawings. The Control (Installation) Drawings can be found in e.g. the Reference Manuals, see section “Documentation” for document reference numbers. The requirements on the Control (Installation) Drawings must be followed when installing the equipment.
For more information, please refer to the Product data sheet (PDS)
Technical Requirements

During normal operation, or in fault condition, the THUM Adapter will cause a maximum drop of 2.5 volts in the connected loop. It is important to ensure that the power supply can provide at least 2.5 volts more than the minimum input voltage of the transmitter to make sure it works properly with the THUM Adapter installed.

Minimum input voltage (UI) for Rosemount Process Level transmitters with THUM Adapter

<table>
<thead>
<tr>
<th>Transmitter</th>
<th>Minimum input voltage (UI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rosemount 3100</td>
<td>14.5 V dc</td>
</tr>
<tr>
<td>Rosemount 3300</td>
<td>13.5 V dc</td>
</tr>
<tr>
<td>Rosemount 5300</td>
<td>18.5 V dc</td>
</tr>
<tr>
<td>Rosemount 5400</td>
<td>18.5 V dc</td>
</tr>
<tr>
<td>Rosemount 5600</td>
<td>22.5 V dc</td>
</tr>
</tbody>
</table>

The voltage drop caused by the THUM Adapter across the loop is linear from 2.25 volts at 3.5 mA to 1.2 volts at 25 mA, but does not affect the 4–20 mA signal on the loop. Under fault conditions, the maximum voltage drop is 2.5 volts.

In order for the THUM Adapter to function properly there must be at least 250 Ohms resistance in the loop.

See the Reference Manuals and Product Data Sheets for more information about the minimum input voltage for each transmitter. For Document Reference numbers, see section “Documentation”.

Remote Mounting Kit

The THUM Remote Mounting Kit can be used when direct mounting of the THUM Adapter on the transmitter isn’t feasible or advisable. This may be in situations where the wireless communication from the transmitter is obstructed, where direct mounting is physically difficult, or in certain transmitter configurations. Also, for retrofit installations where wireless communication from the transmitter may be obstructed, the remote mounting kit should be considered.

Some applications may have heavy vibrations close to the maximum specification according to the product documentation for the transmitter. This may include vessels with heavy agitation, rapid fluid movement, or in cases where external equipment may induce vibrations. In these cases, the effects of vibration may become excessive for additional items attached to top-mounted devices. If this is likely, remote mounting of the THUM Adapter is recommended. This applies to the following Rosemount Process Level transmitters:

- Rosemount 5400 with Process Seal Antenna
- Rosemount 5400 with SST Transmitter Head Housing
- Rosemount 3100 Series

The THUM Remote Mounting Kit is also recommended for the Rosemount 5600 Series due to the THUM Adapter Radio Frequency performance.

The THUM Remote Mounting Kit part number is 00775-9000-0001.

When choosing an installation location and position for the THUM Adapter, take into account access to the device. If possible, the THUM Adapter should be positioned vertically, either straight up or straight down, and it should be approximately 3 ft. (1 m) from any large structure, building, or conductive surface to allow for clear communication to other devices. If the THUM Adapter is mounted horizontally, wireless communication range may be decreased.
Configuration And Troubleshooting

The THUM Adapter can route any HART command to the Rosemount Process Level transmitters. When using the AMS® Device Manager, this allows for configuration commands to be sent to the transmitter.

For the Rosemount 5300/5400 Series, the echo curve can be read and used for configuration and troubleshooting through AMS(1).

Rosemount 5600 Series 4-Wire

Installation

The Rosemount 5600 Series must be used with the THUM Remote Mounting Kit and it may only be connected to the primary output (model code 5A, 5B, 5C, and 5D). 4-wire wiring diagrams for active or passive device output can be found in the THUM QIG, see section “Documentation” for document reference number.

Transmitter Software Version

The Smart Wireless THUM Adapter has been designed and tested to work with all HART Rev. 5 devices or later which covers a span of about 20 years of installed devices in the field. In particular, the THUM Adapter has been tested and verified using the following software revisions:

<table>
<thead>
<tr>
<th>Transmitter</th>
<th>Recommended software version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rosemount 3100</td>
<td>3.2 or higher</td>
</tr>
<tr>
<td>Rosemount 3300</td>
<td>12 or higher</td>
</tr>
<tr>
<td>Rosemount 5300</td>
<td>1A4 or higher</td>
</tr>
<tr>
<td>Rosemount 5400</td>
<td>1C2 or higher</td>
</tr>
<tr>
<td>Rosemount 5600</td>
<td>3A4 or higher</td>
</tr>
</tbody>
</table>

Proven Result References

- FH Tank Storage Meets Latest Safety Requirements Using Smart Wireless Differential Pressure and Radar Transmitters (p.128)
- Oil & Gas Distributor Improves Inventory Management with Wireless Level Measurement (p.156)

For more proven results:
http://www2.emersonprocess.com/en-US/brands/rosemount/Documentation-and-Drawings/Proven-Results/Pages/index.aspx#metals
10.21 Smart Wireless for Rosemount Tank Gauging Applications

During the operational lifetime of tank storage facilities there are a number of different phases, from expansion and upgrading to general maintenance and repair. With each phase comes change and along with change the need for flexibility. A Smart Wireless tank gauging solution maximizes safety and operational performance. It is suitable for bulk liquid storage plants since:

- Tanks are often built in clusters
- High antenna positions mean you normally have line-of-sight
- It works well for both short and long distances

When is wireless a logical choice?

When distances and topological conditions are challenging:

It enables you to connect to tanks that were previously isolated, divided by water, roads or other infrastructure related objects.

When you want to reduce cost and complexity:

Replacing or maintaining field cables that are outdated or in poor condition can be expensive. The use of wireless instruments means less installation work and wiring as well as fewer junction boxes and conduits. No detailed site surveys are required, and you reduce engineering and drawing work.

When installation or replacement of field wiring is a safety concern:

Risk is reduced by delivering data to the control room without any unnecessary hazardous excavation or cable installation.

When redundant communication is required:

A wireless interface can easily be added to new or installed wired radar level gauges. Combining wired communication, via a Field Communication Unit, and Smart Wireless, via a Gateway, provides a safe and cost-efficient way to meet requirements for full communication redundancy, with two independent data paths to the host/DCS.
The use of Smart Wireless for the tank gauging data means the existing field cabling can be used for other purposes. For example, when you need to get both tank gauging data and a high level alarm signal back to the control room, but only have one single set of wiring available to the tank. The high level SIL relay signal from the Tank Hub is connected to the existing wiring and the complete tank gauging data is sent via a wireless connection.

When existing tank instrumentation needs modernizing:
Existing tank gauging systems using old technology can have their limitations. Emulation technology enables seamless integration of new tank instrumentation in a control room infrastructure from other vendors. Add Smart Wireless and gain full capacity that:
- Works in parallel with the wired emulation protocol
- Gives more measurement data and advanced diagnostics
- Enables remote radar gauge configuration and calibration functionality
- Offers new and modern protocols to host/DCS system

When time is critical:
Expansion, upgrading and maintenance projects take time but Smart Wireless tank gauging is a plug-and-play solution when resources are scarce, deadlines are tight, and you want to minimize downtime and get a quick start-up.

Smart Wireless THUM Adapter in a Tank Gauging System
The Smart Wireless THUM Adapter acts as a wireless data link between the level gauge and a Smart Wireless Gateway in a WirelessHART network. The THUM Adapter is connected to the 2410 Tank Hub or a TankRadar Rex or a TankRadar Pro level gauge.

The THUM adapter is supplied with a mounting kit which allows it to be installed away from the radar gauge, at the best possible tank roof position. The THUM Adapter is assembled to a connection box.

The THUM adapter for Tank Gauging can be configured via:
- TankMaster
- AMS Wireless Configurator
- Field Communicator

Rosemount 2410 Tank Hub
Rosemount 2410 is handling communication between the field devices and the control room, and it is available in two versions, for single or multiple tanks. In a wireless network, it is connected to a Smart Wireless THUM Adapter. It also feeds power to the units on the Tankbus, collects and calculates tank data, such as average temperature, observed density and strapping table based volume.

The Tank Hub has a model code for the wireless option (Model Code W), and together with the THUM adapter it enables the following features:
- Support for up to 10 tanks
- Up to 16 transmitter variables @ 8–16 seconds update rate (update rate configurable between 1–3600 seconds. The typical value is 16 seconds which is suitable for most tank shapes and filling rates. The flexible range enables adjustment to requirements from other WirelessHART devices joining the same network.)
- Supports Wireless in combination with wired emulation or TRL2 interface
- Wireless + SIL 2 or SIL 3 relay output
- Display:
  - 2230 Graphical Field Display
  - 2410 Tank Hub display

Proven Result References
- Wired and Wireless Communication Makes the System More Reliable (p.134)
- Altintel improves safety with Smart Wireless (p.150)
- Tüpraş Refinery improves reliability with Smart Wireless (p.154)
- Akim Tek tank terminal reduced start-up time (p.158)
- IPLOM Refinery Gets Highest Level Accuracy (p.164)
- Swedish refinery expands wireless Tank (p.176)
- Wireless Adds Advanced Diagnostics and Configuration (p.182)
- SIOT Italy Introduces Wireless Radar for Pipe Transportation of Crude (p.183)
## Proven Result

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<th>PAGE</th>
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</thead>
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<tr>
<td>11.2 Food and Beverage</td>
<td>138</td>
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<tr>
<td>11.3 Life Science</td>
<td>145</td>
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<tr>
<td>11.4 Oil and Gas</td>
<td>147</td>
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<tr>
<td>11.5 Power</td>
<td>188</td>
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<tr>
<td>11.6 Pulp and Paper</td>
<td>195</td>
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<tr>
<td>11.7 Refinery</td>
<td>199</td>
</tr>
<tr>
<td>11.8 Steels and Mining</td>
<td>220</td>
</tr>
</tbody>
</table>
11 – Proven Result

11.1 Chemical

AkzoNobel Improves Storage Tank Heating Control and Gas Vent Monitoring Using Smart Wireless technology

RESULTS
• Ensured final product met customer requirements
• Lowered operating costs by significantly reducing steam consumption
• Improved operator efficiency by eliminating need for manual readings
• Saved approximately €180,000 related to cabling and DCS changes
• Reduced cost of implementing future measurement points

APPLICATION
Storage tank heating control, gas venting pipe monitoring

CUSTOMER
AkzoNobel – Ghlin (Mons), Belgium

CHALLENGE
Existing manual measurement and control methods were unsatisfactory for maintaining the temperature of fatty nitriles and amines in the 40 tanks where they were stored before shipment to customers. Too much steam was sometimes used to heat the materials, and a number of customers complained that delivered product was too hot.

In addition, corporate guidelines and new environmental legislation required monitoring and controlling all gas emissions. Existing procedures for detecting potential problems required an operator to make regular trips into the field to take ‘snap-shot’ readings from pressure gauges on the tank farm’s venting conduits. This was time-consuming and failed to provide continuous and immediate information.

Additional thermal measurements were required from within same the venting conduits to help prevent potential fires arising from high temperatures. An important issue was the short timeframe available to install new devices to obtain these additional measurements.

All three applications would benefit from automated measurement or control technology, but a lack of cable infrastructure, shortage of available I/O, and tight budget constraints made traditional wired solutions impractical.

“We were particularly impressed by the number and range of existing implementations of Smart Wireless around the world. Emerson’s experience was far in front of other vendors, and this experience gave us great confidence with our own application.”

Nicolas Delfosse
Process Engineer
Surface Chemistry AkzoNobel

For more information:
www.EmersonProcess.com/QBR
SOLUTION

AkzoNobel met these challenges by installing Emerson’s Smart Wireless technology, which is based on the IEC 62591 (WirelessHART®) standard. This solution removed the need to install new cable infrastructure. No modification of the existing control system was required. Wireless data is fed, via a gateway, directly into the DCS using Modbus communications - without consuming any I/O.

Four Emerson Rosemount® WirelessHART temperature transmitters were installed to control the temperature on a number of tanks. Measurement data is transmitted every minute to the DCS, which controls a simple On/Off steam valve. Temperature can now be maintained using this wireless closed-loop control. Operators simply insert the product type and quantity into the DCS and the appropriate heating and temperature levels are already preconfigured. Automating this process has allowed operators to focus on higher value tasks. Much tighter control has reduced steam consumption, lowering operating costs, while helping to ensure that customers receive product at the right temperature.

Within the gas venting application ten Rosemount WirelessHART pressure transmitters have replaced the manually read gauges. The resulting continuous pressure data has enabled AkzoNobel to meet corporate and government legislation. Blockages can be identified immediately and quickly solved by flushing the vents. Three Rosemount WirelessHART temperature transmitters provide the required thermal data and will raise an alert should levels rise above preset limits. Automating the measurements has further improved operator efficiency.

AkzoNobel estimate overall savings from adopting a wireless solution instead of installing cabling and making changes to the DCS to be approximately €180,000. The wireless network has also created an opportunity for installation savings every time a device is added in the future. AkzoNobel now intends to upgrade the temperature gauges on all 40 storage tanks. The company is also considering using the existing wireless network for tank overspill protection, monitoring condensate levels within a drain switch system and even monitoring valve position to ensure against tank filling errors.

Nicolas Delfosse
Process Engineer Surface Chemistry
AkzoNobel

“Wireless offered the opportunity to add new devices to the network quickly and at little cost compared to wired devices. Adding devices is so simple that I would describe the Emerson Smart Wireless solution as ‘plug and play.’”

Nicolas Delfosse
Process Engineer Surface Chemistry
AkzoNobel
Bitumen Tank Farm Mitigates Risk of Overspill and Increases Plant Safety with Wireless Discrete Transmitters

RESULTS
- Reduced risk of overfill during tank filling
- Mitigated risk on plant personnel safety
- Reduced project cost and difficulty of installation

APPLICATION
Tank overfill level alarm

APPLICATION CHARACTERISTICS
Aging plant without prior automation solution

CUSTOMER
Asphalt plant in China

CHALLENGE
Bitumen is largely used as a construction product. It is supplied and stored as hot liquid at temperatures ranging from 150 °C to 230 °C (302 °F to 446 °F). Care is needed for safe handling of bitumen to avoid accidents. The project manager of this bitumen plant wanted an automated solution for monitoring tank level to ensure plant safety during filling as tank status was not visible to engineers on site or at the control room.

The bitumen plant is aging and has no appropriate solution installed for overfill protection for individual tanks in the tank farm. There are no means to signal high-high and low-low alarms of liquid in bitumen tanks.

Without an overfill protection system, potential overflow may occur, which may cause safety and environmental issues. Furthermore, the cost of installing wired instrumentation to all tanks in the tank farm is very high. Aside from the capital needed, man-hours to complete the project could affect plant operation.

The wireless solution was easy to setup, cost-effective, and provided the much needed alarm automation especially for this bitumen plant, which has many existing cables that are risky to remove and had been operating for years.

A Rosemount 702 Wireless Discrete Transmitter installed on top of a bitumen tank provides overspill protection.
SOLUTION
The plant installed 28 Rosemount 702 Wireless Discrete Transmitters connected to 41 third party RF capacitance switches on the bitumen tanks. This combination provided wireless high-high and low-low alarms, saving on cost of wires, junction boxes, and I/O cards. Since the 702 transmitter has dual channel capacity, many of the tanks had only one device for both high and low level alarms, further saving on installation costs. Connecting the alarm signal to the control room via OPC is a Smart Wireless Gateway. Its web interface allowed engineers in the control room to configure the network by navigating a web browser, while the Gateway’s universal integration provided the HMI operators on-site, tank level information via Modbus RTU. The wireless solution was easy to setup, cost-effective, and provided the much needed alarm automation especially for this bitumen plant, which has many existing cables that are risky to remove and had been operating for years. No wires also meant it required less preparation such as scaffolding and excavation, reducing project cost. Lastly, the risk of overspill and risk on personnel safety was greatly reduced.

RESOURCES
Emerson Process Management Chemical Industry
http://www2.emersonprocess.com/en-US/industries/Chemical/Pages/index.aspx
Rosemount 702 Wireless Discrete Transmitter
Bulk Chemicals Manufacturer Improves Product Quality with Reduced Capital Cost by Using Smart Wireless

RESULTS
• Mitigated product quality risk
• Reduced operating costs
• Lowered installation and material costs

APPLICATION
Cold box temperature monitoring

CUSTOMER
Bulk chemicals manufacturer in the United States

CHALLENGE
This bulk chemicals manufacturer was having problems maintaining temperature of the cold box. The cold box is used as a holding vessel to maintain product temperature before moving to the next process. The temperature of the cold box was being measured with a simple thermocouple that was wired directly back to the DCS thermocouple input card. The direct measurement caused excessive temperature drift, which led to measurement unreliability.

The unreliable cold box temperature measurement presented a significant risk to product quality. Operations personnel did not trust the measurement and were constantly concerned about producing off-spec product and other downstream problems. Special field trips by operators to look at the local cold box temperature readings added to operating costs. The customer could not justify the capital costs needed in material and installation for more reliable temperature monitoring on the cold box.

SOLUTION
This customer's problem was solved with a Rosemount 848T Wireless Temperature Transmitter. This high density temperature transmitter was centrally located, allowing for a reliable and low cost solution for the temperature measurement. The 848T eliminated the measurement drift the customer previously experienced by eliminating the direct wiring practice. The Smart Wireless self-organizing network eliminated the costs associated with new wiring and additional conduit.

The best core technology, implementation practices, and field intelligence built into the Smart Wireless solution provided a positive business impact to this customer.
**BULK CHEMICAL**

The Rosemount 848T Wireless Temperature Transmitter allowed this bulk chemicals manufacturer to mitigate the risk of off spec product and downstream manufacturing problems. By providing reliable and continuous measurement of cold box temperatures, operating costs were reduced because special trips to the field were eliminated. These positive business benefits were realized at a reduced material and installation cost, compared to a wired solution.

**RESOURCES**

**Emerson’s Smart Wireless**
http://www.emersonprocess.com/smartwireless/

**Rosemount Temperature**
## Chemical Manufacturer Improves Safety and Reduces Costs with Smart Wireless Solution

### RESULTS
- $15,000 in reduced operations and maintenance costs
- Increased plant safety
- Early detection of temperature excursions

### APPLICATION
Railcar chemical storage temperature

### CUSTOMER
Croda Inc., Mill Hall, PA

### CHALLENGE
Croda Inc. is a wholly owned subsidiary of Croda International Plc, a U.K.-based manufacturer and worldwide supplier of oleo and industrial chemicals. The Mill Hall plant had a problem monitoring rising temperatures in railcars containing chemicals. Normally, three railcars are remotely located on-site. Since the railcars are frequently moved, hard wiring of temperature sensors was not practical. Employees had to climb to the top of each car once a day to check the temperatures and record each reading. This was a time-consuming procedure that during wet or icy conditions presented a fall potential.

### SOLUTION
Emerson Process Management successfully applied a Smart Wireless solution. No matter where the railcars may be positioned at the Mill Hall plant, a wireless temperature transmitter on each car sends minute-by-minute temperature readings to a central host. Croda uses this information to improve the performance and safety of their facility. In this way, Emerson’s wireless system contributes to overall plant safety, making operators aware of any unexpected temperature rise, while saving the company about $15,000 per year in reduced maintenance.

The wireless temperature transmitters are quickly and easily installed atop a railcar upon its arrival at the site, and they remain there until the car is about to be removed. The wireless communications pass through a Smart Wireless Gateway (receiver) and on to the plant’s DeltaV™ control system.

While the operators watch for rising temperatures, transmitter performance and diagnostics are simultaneously checked by Emerson’s AMS® Suite: Intelligent Device Manager.

“Emerson’s wireless solution not only saves us time and money, since plant personnel no longer have to monitor those railcars daily; it has also greatly enhanced the overall safety of the plant and our personnel.”

Denny Fetters
Instrument and Electrical Designer

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“We are pleased with the performance of the Rosemount transmitters and Emerson’s self-organizing mesh network. No matter where a railcar is positioned on-site, the quality of the transmission is unaffected, and the signals integrate seamlessly into our control system.”

According to Denny Fetters, Instrument and Electrical Designer for Croda, “Emerson’s wireless solution not only saves us time and money, since plant personnel no longer have to monitor those railcars daily; it has also greatly enhanced the overall safety of the plant and our personnel. We are pleased with the performance of the Rosemount transmitters and Emerson’s self-organizing mesh network. No matter where a railcar is positioned on-site, the quality of the transmission is unaffected, and the signals integrate seamlessly into our control system.”
FH Tank Storage Meets Latest Safety Requirements Using Smart Wireless Differential Pressure and Radar Transmitters

RESULTS
- Met latest environmental and safety requirements
- Estimated installation savings of €50,000 - €100,000
- Reduced delivery uncertainty
- Increased personnel safety

APPLICATION
Overspill protection of tanks at petrochemical storage terminal

CUSTOMER
FH Tank Storage AB - Kalmar, South-East Sweden

CHALLENGE
To meet the latest environmental and safety requirements, overspill protection was required on existing tanks storing solvents, petrol, and a range of chemicals. Previously there was no instrumentation in place. Level measurements were performed manually, with operators climbing on tanks roofs. There was a risk of potential injury, especially during winter when temperatures fall to -20 °C (-4 °F). FH Tank Storage wanted to automate these measurements and remove any potential human error when recording, calculating, and listing tank levels on a white board. Some tanks are over 200m from the main control room and new cable infrastructure was required. This would have involved extensive groundwork at a cost of between €50,000 - €100,000. While these works were being completed, fuel tanker traffic around the site would have been seriously disrupted. The storage tanks varied in size and a number of the larger tanks have floating roofs. Minimizing the number of types of level devices was preferred to enable easier maintenance and reduced inventory.

SOLUTION
Emerson’s PlantWeb digital architecture, with a plant wide Smart Wireless network based on the IEC 62591 (WirelessHART®) standard, DeltaV™ automation system, and Rosemount® level and pressure transmitters has been installed and provides both the automated tank storage level monitoring and overspill protection. Fourteen Rosemount 3051S wireless differential pressure transmitters have been deployed on smaller size tanks and 15 Rosemount 5402 non-contacting radars on larger tanks. Smart Wireless THUM™ Adapters are connected to each of the radars to transmit the data via the wireless network. The Rosemount 5402 devices are able to cope with very large tanks and floating roofs. A Rosemount 848T wireless temperature transmitter with four inputs connecting four temperature sensors has also been installed to provide continuous temperature information for four tanks.

“Emerson’s wireless solution not only saves us time and money, since plant personnel no longer have to monitor those railcars daily; it has also greatly enhanced the overall safety of the plant and our personnel.”
Denny Fetters
Instrument and Electrical Designer

Wireless 3051S differential pressure transmitters automate 14 of the solvents, petrol, and chemical tanks. Both level technologies eliminate manual entry errors and improve safety.
Measurement data is transmitted back to Emerson’s DeltaV digital automation system in the main control room. A large screen provides operators with visualisation of all the tanks, tank levels and any high level alarms or instrumentation failures. Emerson’s AMS Suite predictive maintenance software is used to monitor the health of both the wireless network and the individual wireless transmitters. This improves the efficiency of maintenance staff by identifying faults and reducing the number of trips into the field.

FH Tank Storage has ordered 15 Rosemount radars and THUM Adapters to automate 15 more tanks. Rosemount radar devices and THUMs are also expected to provide the level measurements and overspill protection for five tanks currently under construction.

“Emerson’s Rosemount level, pressure and temperature transmitters, and Smart Wireless network have enabled us to implement a cost effective automated measurement system,” concluded Lars Ferm, Site Manager, FH Tank Storage.

RESOURCES

Emerson Process Management Oil and Gas Industry

Rosemount Wireless Products

Rosemount Non-Contacting Radar 5400 Series

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Rosemount 5402 non-contacting radar measurement devices with Smart Wireless THUM’s were placed on large tanks and over floating roofs to automate tank level measurements and overspill protection.
Petrochemical Plant Drives Energy Efficiency with Smart Wireless DP Flowmeters and Temperature Transmitters

RESULTS
- Higher efficiency
- Lower operations costs
- Lower capital costs
- Fast, easy installation

APPLICATION
Natural gas flow to a gas metering grid

CUSTOMER
Petrochemical plant in India producing Linear Alkali Benzene (LAB)

CHALLENGE
Energy efficiency is an important operations consideration in the process industries. Reducing energy cost is an imperative in today’s environment. Operations personnel wanted to measure the plant’s consumption of natural gas and have tighter control over the gas metering grid to drive efficiency and reduce operating cost.

To achieve this target, gas flow needed to be measured at the steam source and temperature measured at the gas metering grid respectively. The plant’s layout resulted in some challenging physical limitations. For instance at the heater and boiler system, a traditional orifice plate could not be installed due to limited straight run availability. At the gas metering grid, it was not economical to layout cables to wire the temperature transmitter to the central control room. Furthermore, there were no available empty slots for additional analog input (AI) cards at the Distributed Control System or DCS, preventing additional data integration into the DCS without a capital expenditure.

Without means to measure process parameters, engineers were unable to have tighter control of the process. They could not tell if the boiler and heater were consuming too much gas, resulting in an inefficient process and increased energy cost. Installing traditional measurement devices would incur high project cost and could affect the production schedule due to the need for pipe preparation and wire trenching.

The wireless solution brought critical operations data such as flow rate, gage pressure and process temperature, to the control room enabling engineers to tighten and improve process efficiency.

Wireless gas flow measurement with Rosemount 3051SFC and THUM was easily integrated into the plant DCS.

For more information:
www.rosemount.com

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PETROCHEMICALS

SOLUTION
The plant called on Emerson Smart Wireless capabilities to address the project limitations. Six Rosemount 3051SFC Conditioning Orifice Flowmeters with THUM adapters were installed to measure gas flow into the boiler and heater systems. The 3051SFC requires a shorter straight pipe run with its Conditioning Orifice Technology. It also has fewer leak points as it eliminates impulse lines, and is leak tested at the factory to ensure fast and easy installation between existing flanges. For the gas metering grid, two Rosemount 648 Wireless Temperature Transmitters were installed. This provided immediate temperature measurement without worrying about wiring costs. These field devices were wirelessly integrated to the existing DCS through a Smart Wireless Gateway.

The wireless solution brought data such as flow rate, gage pressure and process temperature to the control room which is critical to operations. This made gas consumption visible to the process engineers enabling them to make adjustments and make the process more efficient. The ease of installation also made the project easier to execute. And lastly, with the wireless network in place, the plant now has more flexibility to explore other measurement points.

RESOURCES
Emerson Process Management Chemical Industry
http://www2.emersonprocess.com/en-US/industries/Chemical/Pages/index.aspx

Emerson Smart Wireless

Rosemount Conditioning Orifice Flowmeters

Rosemount Temperature

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Silicone Manufacturer Improves Energy Costs with Wireless Flowmeters

RESULTS
- Improves energy cost management
- Reduced operation and maintenance costs
- Increased the safety of plant personnel

APPLICATION
365 °F (185 °C) saturated steam flow measurement at -20 °F (-29 °C) ambient temperature

CUSTOMER
A large silicone manufacturer in the North Eastern US

CHALLENGE
This silicone manufacturer had challenges trying to keep their process units accountable for the steam usage within the plant. The company needed to better understand their steam usage to know if there were leaks or other waste in their system.

The silicone manufacturer needed to make six flow measurements on steam distribution lines that were located throughout their facility. Unreliable insertion vortex and turbine meters were not providing reliable steam flow measurement and constantly required maintenance. These meters would frequently fail and needed to be replaced. The measurement points are located outside in a cold environment, requiring the manufacturer to consider the use of heat tracing or other measures to safeguard the measurement instrument from freezing. Not having reliable steam flow measurement constrained their ability to effectively manage their energy costs by process unit. Furthermore, the unreliable measurement instruments increased maintenance problems that required frequent replacement of flowmeters at high installation costs. Replacing these flowmeters required maintenance personnel to climb scaffolding to reach the installations in icy and dangerous locations.

SOLUTION
The silicone manufacturer purchased four 3051SFC Compact Orifice Wireless Flowmeters and two 3051SFA Annubar Wireless Flowmeters. The wireless technology enabled them to install the flowmeters without the need for wiring. They utilized new top mounting installation recommendations for DP Flowmeters in steam service. By direct mounting the transmitter above the pipe, the installation eliminated impulse lines and utilized the heat of the process to safeguard the installation from freezing. This eliminated the need for costly heat tracing.

For more information: www.rosemount.com

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Utilizing reliable wireless flowmeter technology enabled the plastics manufacturer to understand their steam usage in the plant. In addition, they saved $40K in wiring costs by using wireless technology and eliminated the frequent maintenance and replacement of the unreliable flowmeters. They were also able to achieve a safer work environment for their maintenance personnel as they were not required to frequently troubleshoot failures in hazardous conditions.

RESOURCES

Emerson Process Management Chemical Industry
http://www.emersonprocess.com/solutions/chemical/

Emerson Smart Wireless

Rosemount Annubar Flowmeters
http://www.rosemount.com/Flow/DP-Flow-Products/Annubar-Flowmeters/Pages/index.aspx

Rosemount Compact Orifice Flowmeters

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Wired and Wireless Communication Makes the System More Reliable

RESULTS
- Saved project cost and time
- Increased tank operational availability
- Reduced safety and environmental risks
- Lowered operating and maintenance cost

APPLICATION
Tank Gauging

CUSTOMER
A Singapore-based world-class manufacturer develops and markets quality additives that improve the performance of fuels and lubricants, with its products sold to more than 15 countries in Asia and distributed to worldwide markets.

CHALLENGE
Existing old “float and tape” mechanical tank gauging system requires more frequently maintenance, upgrading to radar technology with existing aging cable may face an intermittent communication, laying new cabling increases project cost and causes long project schedule due to construction work.

SOLUTION
A Rosemount Raptor 2-IN-1 radar with one mechanical opening saves cost on tank modification but delivers redundant level measurement.

- Wired and wireless communication makes the system more reliable, and increase the safety and maximize the throughput.
- Wireless communication provides another access for servicing of tank gauging system, minimizing the interference to operation.

For more information: www.rosemount.com

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Emerson’s Smart Wireless Products Prevent Breakdowns and Lost Production on Rotating Reactor at Coogee Chemicals

**BENEFITS**
- Smart Wireless transmitters replaced wired instruments on plant’s rotating chemical reactor that failed frequently
- Control of the process and product quality are greatly improved
- Productivity has increased substantially

**CHALLENGE**
Coogee Chemicals in Australia produces a wide range of industrial, agricultural and mineral processing chemicals. Obtaining accurate pressure and temperature data from inside the plant’s rotating reactor is very important to maintaining process control, but wired instruments were not dependable in this environment. The failure of seals on the slip-rings connecting wires to the rotating equipment allowed the entry of moisture into the instruments. Unreliable temperature and pressure measurements resulted in poor control of the reactor, which had to be shut down two or three times a week.

**SOLUTION**
The installation at Coogee Chemicals consists of two wireless instruments mounted on one end of a rotating chemical reactor and transmitting pressure and temperature data continuously to a nearby Smart Wireless Gateway. The data is passed from the gateway via Modbus communications to the programmable logic controller (PLC) controlling the process. More reliable inputs enable the PLC to improve both process control and product quality.

**RESULTS**
Emerson Process Management’s Smart Wireless instruments mounted on a rotating reactor are credited with delivering reliable pressure and temperature measurements to prevent frequent reactor breakdowns and lost production time. Control of the process and product quality are greatly improved as a result, and productivity has increased substantially since the wireless instruments were installed in late 2007.

“**The Smart Wireless solution provides a means of obtaining accurate pressure and temperature measurements from the moving vessel without having to connect wires to the measurement devices. Wireless delivers reliability where it wasn’t available before.**”

Noel Shrubsall
Electrical Project Officer

For more information:
CHALLENGE
Sun Chemical, the world’s largest producer of printing inks and pigments, needed a way to improve ink quality and collect additional data in compliance with its air permit classification at its Kankakee, Ill., facility.

SOLUTION
Sun Chemical is using Emerson’s Rosemount® wireless DP transmitters and a Smart Wireless Gateway to deliver reliable, continuous process data from two applications to its PLC.

In the first application, the devices measure differential pressure on filter housings used in ink production. The pressure changes as the filters become clogged with particles. Alarms sent to operators signal when filters should be changed. Periodic staff rounds to check gauges on the filter housing and record the data manually are no longer necessary.

The second application enabled Sun Chemical to be compliant with a modified air permit classification by quickly establishing a cost-effective monitoring network to measure vapor stream from solvent vent condensers at multiple locations on roofs across the facility. Running conduit for a wired network would have been physically difficult and more expensive.

RESULTS
• Smart Wireless enables easy compliance with environmental regulations
• Robust network of Rosemount® DP wireless transmitters reduces product rejects
• Smart Wireless was easily installed and integrated with the company’s PLC

“With these points spanning the entire site, the multiple roof elevations, and special electrical classifications, a wired solution would have been a challenge. Emerson’s ‘peer to peer’ communication between the wireless instruments gave us a robust solution.”

John Dwyer
Process Engineer, Sun Chemical

For more information:
SMART WIRELESS APPLICATIONS

RESULTS
Smart Wireless helps Sun Chemicals prevent over-pressurizing the filter housing, which enables them to provide better quality ink to customers, and save thousands of dollars in eliminating material rejects.

With points spanning the entire site, the multiple roof elevations, and special electrical classifications, a wired solution would have been a challenge. But, Emerson’s ‘peer to peer’ communication between the wireless instruments gave Sun Chemical a robust solution, and the network becomes more secure and reliable as more instruments are added.

Sun Chemical easily installed the Smart Wireless technology and Emerson helped to integrate the network with the company’s PLC. The self-organizing network has been operating without problem since commissioning. Now that the network is established and more monitoring points are available, the plant can easily fulfill its desire to pick up more process monitoring data.
11.2   Food and Beverages

Food Manufacturer’s Regular Maintenance Cost and Production Downtime Reduced by Wireless Solution

**RESULTS**
- Increased roaster availability
- Faster roaster startup
- Higher production throughput
- Improved quality
- 10,000 USD saved in maintenance costs

**APPLICATION**
Temperature measurement of product inside a rotating roaster

**APPLICATION CHARACTERISTICS**
Roaster rotating at 30 to 35 rpm

**CUSTOMER**
Food Manufacturing Company in Asia

**CHALLENGE**
Accurate and reliable temperature measurement is important in maintaining quality of roasted products. The Instrumentation Engineer of this food manufacturing plant wanted to eliminate regular maintenance of the slip ring assembly used to measure product temperature inside a rotating roaster. Reducing downtime due to maintenance would mean increased roaster availability and thus increased production throughput.

Two thermocouples wired into a slip ring assembly were used to measure the surface temperature of the rotating roaster. The slip ring converts the temperature reading into resistance and sends it to a Distributed Control System or DCS. Due to high temperature and high humidity of the roasting process, the slip ring contacts began to oxidize sending out erratic readings.

Without accurate temperature measurement, the product would get over-roasted and affect quality. In addition, a fire could potentially occur due to unchecked high process temperature once the slip ring assembly oxidizes. To mitigate this risk, the roaster needed to be turned off so a replacement assembly could be installed. Since it takes about four production days to finish surveying the roaster and mold a new slip ring assembly, frequent oxidation of the slip rings not only increased maintenance cost, but lost four days of production as well.

For more information: www.rosemount.com

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**FOOD & BEVERAGE**

**SOLUTION**
The Instrumentation Engineer replaced the slip ring assembly with a Rosemount 648 Wireless Temperature Transmitter. This eliminated the need to use a slip ring assembly which was prone to oxidation. The existing thermocouples were connected to the wireless transmitter, which transmits surface temperature measurements to a Smart Wireless Gateway. The wireless network is then integrated into a DCS with OPC to allow data tracking to maintain product quality. The Rosemount 648’s Transmitter-Sensor Matching feature eliminates sensor interchangeability error, improving accuracy of measurement for better quality control.

By replacing the slip ring assembly with a Rosemount 648 wireless solution, the plant was able to save an estimated 10,000 USD on maintenance cost. They were also able to improve production throughput as the roaster downtime due to maintenance of the slip ring assembly was eliminated. And with a robust and accurate temperature measurement integrated into a DCS, product quality can be easily monitored and maintained.

**RESOURCES**

*Emerson Food and Beverage Industry*
http://www.emersonprocess.com/foodandbeverage/

*Emerson 648 Wireless Temperature Transmitter*
http://www2.emersonprocess.com/en-US/brands/rosemount/

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For more information:
www.rosemount.com
Productivity Improvement with Wireless Steam Trap Monitoring

**RESULTS**
- Reduced energy use by minimizing steam blow-through and/or blocked flow
- Improved productivity by eliminating preventative maintenance (PM) activities on steam traps
- Reduced mechanical/asset failures by minimizing water-hammering

**APPLICATION**
Steam trap wireless monitoring

**CUSTOMER**
Major Food Manufacturer in the Southeast United States

**CHALLENGE**
A major food manufacturer in the United States drives innovation in all areas of their business, while maintaining the highest quality in their products, services, and relationships. For the food product’s plant in the southeast, innovation extends to process instrumentation and control. “We are always looking to improve energy use,” said the Project Engineer who provides project and maintenance services in the utility area of this plant. “This is a large plant with multiple product lines which are run as individual business units from a cost perspective. We want to know the energy use for each business unit over time, and compare them. In that way, we can make continuous improvements to the areas that need it the most.”

Steam traps were identified as one culprit of energy loss. When a steam trap fails open, steam is not completely consumed and is blown directly into the condensate return system, where it may be lost to the atmosphere in an “open system.” It also can raise the pressure in the condensate system, inhibiting the discharge of other traps, causing system-wide inefficiencies. If it fails closed, the system will flood, causing a loss of heat transfer and subsequent loss of production. Steam trap failures also increase the potential for water-hammer that may lead to equipment damage and downtime.

In an effort to prevent steam trap failures, a preventative maintenance schedule was developed. With close to 100 traps in the plant, PM could only be performed once per year. It takes the maintenance crew at least one hour per unit to check the steam traps, when done properly, so maintenance labor on the traps was 100 hours annually.

“When I heard about the acoustic transmitter from Emerson, I wanted to try it out,” the customer said. “We were looking for automatic, on-line monitoring of steam trap performance and real-time alerts to minimize preventative maintenance (PM) requirements and minimize energy losses. This new innovation from Emerson seemed like a good fit, and we were glad to test it.”

“We found 22% of our traps needed to be replaced during our last PM check. By installing wireless acoustic transmitters, the plant will prevent steam loss with early detection of steam trap failure. Not only will this minimize energy loss, but it will free up maintenance to focus their time and attention on things that need to be fixed, to further improve our productivity.”

Project Engineer
Major Food Manufacturer in the U.S.
SOLUTION
A self-organizing, wireless network with wireless 3051S DP flowmeters had already been installed to monitor compressed air flow to the various business units in the plant, to understand the electrical energy use. Adding the non-intrusive wireless acoustic measurement device was easy, and saved a lot of money in installation cost. “Wireless greatly reduces installation cost,” said the customer, “and we use those savings to purchase more instrumentation to extend utility monitoring in our plant.” For steam trap monitoring, nine 708 Rosemount Wireless Acoustic Transmitters (with integrated sensors that mount externally) were installed on steam lines throughout the plant and integrated into the existing Smart Wireless Gateway, which communicates to a plant host. The steam traps range from thermostatic (TT) to float and thermostatic (FT) to simple bucket traps, and the acoustic transmitters work equally well on all of them. One application is even a steam driven pump, where the acoustics of the pump are being monitored to give early indication of problems. The network was easy to expand, and the new transmitters just strengthened the mesh. They have a lot of concrete between the transmitters and the gateway, and high EMF, but the wireless communications are strong and reliable.

The 708 transmitter, with an industry-leading combination of temperature measurement and acoustic “listening,” gives unparalleled visibility into steam trap states. “Manual monitoring of temperature did not give us enough information to conclusively target a steam trap for replacement when we saw water-hammering,” the project engineer continued. “But when we installed the wireless acoustic transmitter, we could tell immediately which steam trap was stuck.” It was quickly fixed, and a trend of the new trap showed normal acoustics and temperature.

Now the plant has real time alerts for each of the nine steam traps with wireless acoustic transmitters. Some are in "wash down" areas, and one is in a high humidity environment. All are communicating reliably. Because of the design of this device, the customer can "set and forget" each of the acoustic transmitters, and eliminate manual PM activities.

“We found 22% of our traps needed to be replaced during our last PM check. By installing wireless acoustic transmitters, the plant will prevent steam loss with early detection of steam trap failure. Not only will this minimize energy loss, but it will free up maintenance to focus their time and attention on things that need to be fixed, to further improve our productivity,” concluded the customer.

RESOURCES
Emerson Process Management Food and Beverage Industry
http://www.emersonprocess.com/foodandbeverage/
Rosemount 708 Wireless Acoustic Transmitter
Pages/index.aspx

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Temperature Technologies Provide New Insights to Improve Safety, Productivity at American Crystal Sugar

RESULTS
• Improved plant safety
• Greater visibility in hazardous areas
• 2.5% reduction in operations time for higher operator productivity
• Improved pond management
• Ready for new upcoming EPA reporting requirements

APPLICATION
Monitor bearing temperature and motor current in Weibull Bins (sugar silos) and conveyor system to prevent ignition point; remote monitoring of settling ponds.

CUSTOMER
American Crystal Sugar (ACS), East Grand Forks, MN

CHALLENGE
Sugar dust in safety equipment caused a small explosion at a sugar refinery near Savannah, GA. Just eleven days earlier, a similar but bigger blast killed nine workers at a Port Wentworth, GA plant according to a federal investigator. Alerted to the potential danger of sugar dust, American Crystal Sugar (ACS) proactively searched for ways to prevent a similar accident in its plants. The company looked to measure abnormal situations where field equipment could become potential ignition points in hazardous areas, including hazardous dust in the Class II Div 1 & 2 Group G.

“We first identified equipment and devices that were potential ignition points,” said Gary Phelps, Electronic Control Technician for ACS. “We were looking for devices that were not ignition sources under normal conditions, but had the potential to become ignition sources under abnormal situations.” Bearings and motors in the sugar silos where sugar dust was in the greatest concentration were the first to be identified, as were misaligned conveyors that delivered the sugar from the silos to the sugar handling area.

“We identified the bearings on the sugar conveyor system as well as the misaligned conveyors, as both could heat up and potentially introduce an ignition point,” said Jay Sorum, also an Electronic Control Technician for ACS. “Even sealed bearings can fail, and create an ignition point.

Rub blocks provide an indication when the conveyor is even slightly out of alignment. A conveyor out of alignment can be a potential ignition source.

Sugar silos at ACS in EGF have a rotating bridge that made wired instrumentation impossible to implement.

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Conveyor belts, too, have the potential if they become even slightly misaligned.” The challenge was installing an instrument network that had high reliability and performance with a low installed cost. In the sugar silos, an additional challenge was introduced. “The sugar silos are about 75 feet high and 100 feet across,” said Phelps. “A rotating bridge spans the top, and a tube down the center holds the motor where some of the bearing temperature and motor amp measurements needed to be made. There are also two screws on the floor of the silo with motors that require temperature measurements. Conventional instrumentation proposed a huge challenge in this area.” It was also a challenge for wireless, as the silos are made of a heavy gauge stainless steel with an additional metal skin for insulation.

**SOLUTION**

“We evaluated three technologies to determine the best course to improve safety at our plant,” said Sorum. “The first was a conventional (4-20 mA) wired system, but it was too expensive to wire each instrument point to point.” It also was not an option for the Weibull Bins because of the rotating bridge. The second solution was a wired bus. A bus solution would minimize home run wiring and lower the installed cost of the instruments while providing high performance and reliability. The third technology was a wireless network. This was considered mainly for the silos because of the rotating bridge.

**Conveyor System**

“We determined that FOUNDATION™ fieldbus provided the highest performance and reliability at the lowest installed cost,” said Phelps. “Since one 848T FOUNDATION fieldbus Temperature Transmitter could handle all eight measurement points on a conveyor, we were able to handle 72 temperature points with only 9 transmitters.” One 848T was installed for each of the nine conveyor belts, with each transmitter reading four bearing temperatures and four “rub block” temperatures. These points were integrated via fieldbus into the DeltaV control system to provide automatic detection, trending, and alarming of temperature, rate of change, and temperature delta for the operators. Integrating logic for the rub block temperature alarms was easy with the DeltaV tools. A function block template was used to design the complex logic and copied for all ignition points. Troubleshooting the logic was simple, as making a change to the template changed the function blocks for all ignition points.

**Sugar Silos**

Since the three Weibull Bins (sugar silos) had rotating equipment, a mixed solution of both WirelessHART® and wired instrumentation was installed. Each of the three silos had one Smart Wireless Gateway with four 648 (single point) Wireless Temperature Transmitters installed; two measuring bearing temperatures on motors and two measuring motor amps. Since the output of the motors is milliamperes and the 648 transmitters read millivolts, it was a simple solution to put a 5ohm resistor in the loop to get a millivolt output from each of the motors that the transmitters could read. Within each silo the four instruments formed a “communication mesh” that communicated with the Gateway. Since the outside of each silo was made of a heavy gauge stainless steel (with a thin metal skin and insulation), a remote antenna was placed inside the silo on the central rotating tube. This antenna was wired through the tube to the Gateway located on the outside of each silo. Each of the three gateways was hard wired back with ethernet to the DeltaV control system, where it was seamlessly integrated as “native I/O,” and information was made available for trending and alarming. Installation time was minimized and commissioning was easy with the AMS Device Manager. “The AMS Device Manager was invaluable during installation and commissioning of the wireless and fieldbus instruments. Having one location to manage the devices saved a lot of time, as the instruments are spread all over the plant.”

**FOOD & BEVERAGE**

Each of the nine conveyor belts had four bearing temperature measurements and four rub block temperature measurements that were handled by one 848T FOUNDATION™ Fieldbus High Density Temperature Transmitter.

One 848T Wireless Temperature Transmitter can handle up to 4 inputs including 4-20mA, mV, Thermocouple, RTD, or ohm. The field hardened enclosures and intrinsically safe Power Module makes it ideal for this hazardous environment.

Four 648 (single point) Smart Wireless Temperature Transmitters were placed inside the silos to measure bearing temperatures and motor currents.
Pond Management

ACS extended the use of Emerson’s Smart Wireless technology to integrate non-critical points into the control room as well. Remote pond measurements were collected regularly to manually record pond levels, pH, ORP, dissolved oxygen, temperature and discharge flow rate. These conventionally wired devices were too expensive to bring back to the control room since the ponds were three quarters of a mile away or more. ACS realized the 848T had a wireless option as well as fieldbus, and could accept four inputs from any combination of RTD, thermocouple, ohm, millivolt and 4-20 mA signals. The analytical devices, ultrasonic flow devices, magmeters, and all other measurements from each of the 9 ponds were locally wired to the Wireless 848T Temperature transmitter and sent back to a Gateway and integrated into the control room environment where they could be automatically recorded, trended and reported. Two 702 discrete transmitters, acting as range extenders, were installed on 15 foot poles 0.54 miles from the furthest pond. The intent was to place the second device in series closer to the instrument mesh, but the network was able to communicate reliably at that distance. The second instrument therefore acts as a backup range extender to further improve communication reliability.

Now wireless data is automatically collected at one minute intervals instead of twice weekly by operators. This rich information has helped ACS manage their ponds more closely, to make final treatment more efficient. It has also set the stage for new upcoming EPA reporting requirements, like proving the plant is meeting the new dissolved oxygen standard. Overall, the combination of Wireless HART and FOUNDATION fieldbus provided the most cost-effective solution for both critical and non-critical applications. The additional instruments widened the operator view into both hazardous and remote areas of the plant, and enabled engineering to improve plant safety. Operators spend their time more productively with fewer trips out to remote areas, and the plant is set up for new EPA reporting requirements. The Emerson solution has proven to be so valuable that ACS has installed it in all five sugar plants in the region.

RESOURCES

Emerson Process Management Food & Beverage Industry

Rosemount 848T Temperature Solutions

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00830-0400-4848, Rev AB
11.3 Life Science

Emerson’s Smart Wireless Technology Monitors Water Usage at GlaxoSmithKline

RESULTS
• Able to clearly identify water usage for different areas of the plant
• Significant cost of new power and data cables avoided
• Easy and inexpensive to add additional measurement devices without the need for new cabling

APPLICATION
Monitoring mains and potable (drinking) water usage

CUSTOMER
GlaxoSmithKline – Cork, Ireland

CHALLENGE
The Cork site is a strategic manufacturing plant that produces a range of bulk active ingredients for use in the formulation of prescription drugs. The existing water storage facility was too small and had no measurement instrumentation in place. Two new storage tanks were installed along with a new pipework infrastructure. The tanks are located around 300 metres from the main control room and there was no existing cabling in place. A wired installation would have required new power and data cables to be buried in trenches. By adopting a wireless solution, these significant costs could be avoided. However there was no line of sight between the location of the transmitters and the ideal position for a gateway.

SOLUTION
GlaxoSmithKline selected Emerson’s Smart Wireless self-organising technology, which does not require line of sight. If there is an obstruction, transmissions are simply re-routed along the mesh network until a clear path to the Smart Wireless Gateway is found. Ten Smart Wireless devices were installed including six Rosemount pressure transmitters, two Rosemount flow transmitters and two Rosemount level transmitters. The Smart Wireless technology integrates seamlessly with the existing automation equipment.

“Whenever we look to improve the plant with new equipment, we are always looking to minimise capital expenditure and Smart Wireless can help achieve lower costs”
Emmett Martin
Site Services & Automation Manager
GlaxoSmithKline

For more information:
www.EmersonProcess.com/QBR
**PHARMACEUTICAL**

Flow data is transmitted every 30 seconds and pressure and level data every 300 seconds to a Smart Wireless Gateway strategically positioned on the control room roof. This is connected using a serial connection to the existing DeltaV™ system that controls the plant utilities. From here the flow and pressure measurements are sent to a data historian and are available to plant operators for regular monitoring and reporting.

The new data obtained has enabled GlaxoSmithKline to clearly identify water usage for different areas of the plant, providing a far better understanding of the costs. GlaxoSmithKline is now in a position to identify changes and which processes they relate to.

The new wireless infrastructure makes it very easy and cost effective to add additional measurement devices without the need for new cabling. GlaxoSmithKline are already looking at installing a wireless level device that will be added to the existing network.

“We are more than satisfied with the solution, which is proving to be reliable with no signal loss. Based on a successful implementation, at some point in the future we are perhaps, looking towards a plant with no wires.”

Emmett Martin
Site Services & Automation Manager
GlaxoSmithKline
Atlas Pipeline Improves Production Efficiency at Natural Gas Processing Facility

RESULTS
- Improved gas production efficiency
- Minimized process upsets and plant shutdowns
- 42% reduction in operator time
- Saved $725K on installation costs

CUSTOMER
Atlas Pipeline Partners L.P. is a full service midstream company providing reliable gas gathering, compression, processing and treating services to its customers.

CHALLENGE
In west Texas, Atlas Pipeline Partners built a new gas processing plant adjacent to an old plant to keep safety and production efficiency as high as possible, as the old plant was too old to refurbish. However, the capital investment was minimized by utilizing viable tanks, compressors, stabilizers and cooling towers in the old plant and integrating them with processing equipment in the new plant. A problem arose in bringing measurement and control points into the new control room, because the old vessels were now hundreds of yards away.

A wired solution was expensive. The assets are hundreds of yards from the control room, and trenching was not an option because accurate piping diagrams were not available due to the age of the plant. The operators were making rounds and manually reading stabilizer pressures and temperatures, compressor status, and cooling tower levels as well as inlet vessel and tank levels. It took two hours to read and record all 75 gauges, and this had to be done four to five times a day to give operators the best chance of finding a problem before it upset the process. Not only was this time consuming, the high frequency of operator rounds still did not provide adequate warning for operators to take corrective action. Problems like compressor failures and poor inlet vessel level control were causing process upsets and impacting production, with some issues causing shutdowns.

“The application gave us a centralized location to view our total plant process. Our operators do not have to make rounds to learn about potential problems. They can more efficiently operate the plant by seeing changes and problems when they occur.

Wayne Wauson
I&E and Field Supervisor

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SOLUTION

Atlas quickly realized that assets from the old plant had to be integrated into the control room, as manual monitoring was not providing the efficiency and productivity needed. To avoid the cost of wires and cable trays, a Smart Wireless network from Emerson was installed with 75 measurement points and three Smart Wireless gateways. “Wireless was our only way to do this project,” said Wayne Wauson, I&E and Field Supervisor at Atlas. “Without it we would have spent three times as much, and the project would have been dragged out for months.” The instruments included 55 wireless Rosemount 3051S pressure and DP level transmitters, 5 wireless Rosemount 648 temperature transmitters, 2 Emerson THUMS connected to Radar gauges and 18 discrete transmitters connected to compressors to report status, as well as other various devices.

The first gateway communicates to about 34 instruments. The second gateway communicates with 24 devices. The third gateway, communicates up to 1200 feet away with the remainder of the instruments.

Startup took only a day. “Most of the instruments were installed and communicating in a matter of minutes,” said Wauson. “There were a few issues that took a little longer, but overall it was easy and seamless and took about a day to have them all communicating and showing up on DeltaV™.” DeltaV is the digital automation system that monitors and controls critical plant processes. Operators are able to view process information from wireless devices in the same way as any of the wired field instruments. Maintaining the wireless instruments also has the same look and feel. AMSTM Suite: Intelligent Device Manager predictive maintenance software was integrated into the control network, so the plant can proactively maintain both wireless and wired field devices from both plants in the control room, including the Fisher® valves.

Now operators only go to the old plant in response to alarms from DeltaV, and even then they know exactly which vessel or asset needs maintenance. The wireless network has eliminated 8-10 hours of operator rounds per day, giving operators 42% more time to accomplish more productive tasks. “The application gave us a centralized location to view our total plant process,” said Wauson. “Our operators no longer have to make rounds to learn about potential problems. They can more efficiently operate the plant by seeing changes and problems when they occur, and by taking immediate action."

Real-time information from the wireless network has improved operator response time, resulting in higher gas production efficiency. Operators are spending their time more productively and process upsets have been minimized. “The Emerson Wireless solution works as advertised,” concluded Wauson. “We installed a device and could see it on the DeltaV in a matter of minutes. We are only using one-fifth of the capacity of the wireless gateways, so we can add instruments to the network with minimal cost and effort. The Emerson solution is truly plug and play, not plug and pray.”
NATURAL GAS DISTRIBUTION

RESOURCES
Emerson Process Management Oil and Gas Industry

Emerson's Smart Wireless THUM™ Adapter

Rosemount 3051 Pressure Transmitters
http://www2.emersonprocess.com/en-US/brands/rosemount/Pressure/Pressure-Transmitters/3051-Pressure-Transmitters/Pages/index.aspx

Rosemount 648 Wireless Temperature Transmitter

Rosemount 3051S Wireless Solutions

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00830-0700-4802, Rev AA
Altintel Improves Safety with Smart Wireless

**RESULTS**
- Improved safety
- Minimized cost for cabling
- Quick installation and commissioning
- Easy to expand

**APPLICATION**
Wireless tank gauging system for storage terminals.

**CUSTOMER**
Altintel, is strategically located in the Izmit area, close to Istanbul. This seaport terminal is one of the largest for liquid chemical and petroleum storage in Turkey, with 51 storage tanks, 60,000 m³ in total. Examples of stored products are pharmaceutical liquids, paints, plastics, and also hydrocarbons such as 95/98 gasoline, asphalt, diesel, and naphtha. The tank gauging system at Altintel is used for inventory control and when filling the tanks.

**CHALLENGE**
When 9 more tanks were taken into operation in January 2011, there were a number of things to consider:

The stored products are extremely hazardous liquid chemicals. Any installed cable is a risk factor. Hydrocarbons need air to be flammable, but handling hydrocarbon oxides like certain solvents, ketones, alcohols, glycols, esthers and monomers, which already contain oxygen, are even more hazardous since a static electricity discharge is enough to cause a flame. The cable infrastructure documentation for the plant is also missing, so it would have been extremely hard to dig. Every time a road machine has been used at Altintel, wires have been damaged. Another challenge is energy power fluctuation. Although the terminal uses a UPS (Uninterruptable Power Supply) system, they experience frequent energy cut-downs.

**“Safety is a must! That is why we spend money on state-of-the-art tank gauging.”**
İbrahim Ünlü
Terminal Manager, Altintel

Mr. İbrahim Ünlü, stresses the importance of having a strong company safety culture, with Health, Safety, Security and Environment (HSSE) in focus.
When using automatic tank gauging there is no need for anyone to go on top of the tank. The risk is high, especially during a transfer, when the static electricity in the tank can be as much as 35,000 V. It is a great advantage to watch from a distance.

Liquids are landed by tankers at the Altintel jetty, and further pumped into the storage tanks. 50-70 trucks are loaded daily, to provide Altintel's 2200 customers with their product blend.

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Offshore Oil Platform Mitigates Risk of Reduced Production in Flowing Oil Wells and Pipelines with Timely Process Data

RESULTS
- Mitigated risk of reduced production in flowing wells and flowing pipelines
- Increased workers safety
- Decreased operations and maintenance costs of offshore facility

APPLICATION
Remote monitoring of flowing oil wells and flowing pipelines

APPLICATION CHARACTERISTICS
Unmanned offshore platform without electric power supply

CUSTOMER
An offshore platform in the Gulf of Mexico

CHALLENGE
This petroleum company needed to remotely monitor well performance and platform operating conditions in one of its unmanned offshore installations. Well performance monitoring is very important in order to maintain production targets and to improve the decision making process for reservoir exploitation. It is ideal to have the process data delivered cost-effectively and in real time.

There are several challenges present in the project. First is infrastructure limitation such as power availability. Without an electric power supply, process conditions can only be monitored through chart recorders. Second is thermowell preparation in the flowing pipelines. Pipeline temperature measurement is used to monitor presence of paraffin build-up which may impact production and flow. There are ten flowing pipelines with one temperature and pressure measurement point each. These pipelines have no existing thermowell insertion points and drilling one will incur cost and delay the production. Third is process data timeliness and availability. Each day they are sending workers to the platform via helicopter to manually gather process data from the chart recorders. The platform is about 100 km (62 miles) from the onshore control center. It takes an approximate 4-6 hours before process data can reach the management team in the onshore operation center.

With process information delayed, decision making was affected. This risked reduced oil production in the flowing well and flowing pipelines as proper adjustment to efficiently operate oil exploitation was not timely. This delay may also increase maintenance cost as they cannot immediately adjust unstable process and platform conditions that may lead to damages in infrastructure. Add also the cost of transporting workers daily to the platform to gather data which increases operating cost and the risk of an accident during personnel transport.

The innovative solution provided the petroleum company valuable process data, giving way to a deeper visibility on production processes, enhancing operation decision.

RESULTS
- Mitigated risk of reduced production in flowing wells and flowing pipelines
- Increased workers safety
- Decreased operations and maintenance costs of offshore facility

OIL & GAS ROSEMOUNT SMART WIRELESS

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SOLUTION

The petroleum company tapped on Emerson Process Management’s Smart Wireless solution to solve the inherent challenges of the project. The non-intrusive Rosemount Pipe Clamp RTD Sensor measures pipe surface temperature in the flowing lines. Pipe intrusion was not needed anymore, saving on installation time and cost, while the Rosemount 3051S Wireless Pressure Transmitter was used to wirelessly measure flowing pipeline pressure. These field devices send the data to a Smart Wireless Gateway which is then connected to a WiMax base station. This solar-powered base station connects the SCADA system in the onshore operation center and the field devices in the offshore platform. Emerson Process Management provided all means to integrate information from the two facilities.

This innovative solution provided the petroleum company valuable process data. It gave way to a deeper visibility on production processes and enhanced operation decision making, mitigating the risk of reduced oil production. In addition, their personnel do not need to fly to the offshore platform to manually gather process data, reducing risk of accidents during transport. Finally, the timely adjustment, brought about by real time process data, enabled maintenance and operating cost savings.

RESOURCES

Emerson Process Management Oil and Gas Industry

Rosemount Pipe Clamp RTD Sensor

Rosemount 3051S Wireless

The non-intrusive Rosemount Pipe Clamp RTD Sensor measures pipe surface temperature in the flowing lines.

The Rosemount 3051S Wireless Pressure Transmitter used to wirelessly measure flowing pipeline pressure.
Tüpraş Refinery Improves Reliability with Smart Wireless

RESULTS
• Improved tank gauging system for critical oil movement tanks
• Minimized cost for cabling, conduits, and cable trays.
  Quick installation and commissioning
• No risk of operational disturbances due to excavation work
• Future proof – easy to add instrumentation
• Data from other instrumentation can also be sent via the wireless network

APPLICATION
Wireless tank gauging system including a batch calculation function for product transfers.

CUSTOMER
Tüpraş Izmir, a leading petroleum refinery company in Turkey.

CHALLENGE
Tüpraş sometimes experienced communication problems and incorrect readings from some of their storage tanks, equipped with non-Emerson instrumentation, because of damage to cables during excavation in the field. It was not always easy to get support personnel coming to the site in reasonable time. A decision was made to initiate an upgrade project. The cable infrastructure and junction box situation were old and not up to standard, so Tüpraş considered laying new cables. However, excavation work can be problematic and risky. If a cable is cut, it may result in an operation disruption for several tanks. In addition, it is hard to dig in the area. The tank farm infrastructure, with piping and roads, is complex and the geological conditions are tough.

SOLUTION
Tüpraş tested the wireless tank gauging system on 21 tanks. After the evaluation period, the refinery decided to go for an extended Smart Wireless tank gauging system from Emerson to minimize installation costs, including cabling, cable trenches, conduits, cable trays and man hours. This order comprised 85 more tanks, including radar gauges to be used for level measurements in the critical oil movement tanks. Within the refinery there is also a lubeoil facility. All 44 tanks have wired TankRadar Rex parabolic antenna gauges in successful operation since 2007. This wired tank gauging system from Emerson was a strong reference when the decision was made to upgrade the other tanks in the plant, since the system has proven to be very reliable, and accurate.

“By using the Emerson Smart Wireless solution we can minimize costs for cabling, cable trenches, conduits, and cable trays.”
Ali Erener
Project Chief Engineer

More than 100 tanks at the Tüpraş refinery will be equipped with Smart Wireless devices from Emerson. Each radar level gauge is connected with a wireless THUM Adapter, which transmits wireless data within the network.
The refinery first considered using the emulation feature within the TankRadar Rex level gauge, but when taking practical and installation considerations into the upgrade budget, Tüpra decided to try a wireless alternative.

The wireless solution has the same benefits as a wired system, but has practical advantages, and is easy to set up.

Going wireless also gives the flexibility to add more devices in the future – not only for level and temperature measurements, but also for tank water control and nitrogen pressure control at tanks which are far from the control room, as well as other applications. Flow, and valve position data can also be distributed within the wireless system.

In the wireless field network each tank is a node. At Tüpra, it includes a TankRadar Rex radar level gauge installed together with an antenna unit, the THUM Adapter, and a multiple spot temperature sensor.

Temperature and level data is sent via the wireless network to the Smart Wireless Gateway, which is the network manager. The gateway provides an interface between field devices and the TankMaster inventory management software or host / DCS systems.

TankMaster is used for net volume calculations, reporting, alarm handling etc. During the test period, the TankMaster software was upgraded to include batch calculation for product transfers.

**Emerson Smart Wireless Solution**

Emerson’s Smart Wireless solution is based on IEC 62591 (WirelessHART), the industry standard for wireless field networks.

A WirelessHART device can transmit its own data as well as relay information from other devices in the network. The self-organizing mesh network automatically finds the best way around any fixed or temporary obstacle. Nodes can identify a network, join it, and self-organize into dynamic communication paths. Reliability actually increases when the network expands – the more devices, the more communication paths!

**RESOURCES**

- Rosemount TankRadar Rex Technical Description, 703010En
- Smart Wireless Tank Gauging from Emerson Brochure, 201026En
- [www.rosemount-tg.com](http://www.rosemount-tg.com)

Technical details are subject to change without prior notice.
Oil & Gas Distributor Improves Inventory Management with Wireless Level Measurement

RESULTS
• Increased visibility of tank level measurement
• Lowered risk of tank overfill
• Reduced safety risk to plant personnel

APPLICATION
Volumetric measurement of ethanol storage tanks

CUSTOMER
Oil and gas distributor in the United States

CHALLENGE
Site personnel had to manually approximate the ethanol level in storage tanks with a stick. The company needed to better monitor ethanol levels to reduce the risk of spills.

The oil and gas distributor had no automated way to measure ethanol level in their storage tanks. In addition, the distributor had no capabilities to integrate a level signal into a control system at this site.

The manual gauging process was unreliable leading to a risk of spills. The manual measurement method also exposed personnel to the fuel twice per day. In addition, climbing the tank to take the measurement was dangerous in winter months. Manual measurements took approximately a half hour per point, which in turn took at least two hours per day.

SOLUTION
Two Smart Wireless THUM™ Adapters were coupled with Rosemount 3300 Level Transmitters to wirelessly transmit volumetric measurement. Since there was not a control system to easily view the information, the measurement information was sent directly to a computer through the Smart Wireless Gateway. The distributor now has visibility to read the volumetric measurement of the ethanol storage tanks more frequently and more accurately than before. This was accomplished without the need to run new signal wires.

Rosemount THUM wireless adapter increases visibility to feedstock levels.

For more information:
www.rosemount.com

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The customer can now prevent overfilling the tank, thus eliminating the risk of spills. Site personnel are more efficient due to elimination of manual measurements. Project costs were minimized by eliminating the need to run new wires. Finally, safety is improved due to elimination of slips and falls during manual measurement, and reduced exposure to ethanol.

RESOURCES

**Emerson Process Management Oil & Gas Industry**
http://www.emersonprocess.com/rosemount/industry/oil_gas/index.html

**Emerson Smart Wireless**
http://www.emersonprocess.com/rosemount/smartwireless/index.html

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# Akim Tek Tank Terminal Reduced Start-Up Time with a Smart Wireless Tank Gauging System

## RESULTS
- Safe and reliable communication
- Minimized installation cost, including major cable savings
- No excavation or digging
- Engineering and commissioning time savings

## APPLICATION
Wireless tank gauging for terminal storage tanks.

## CUSTOMER
Akim Tek Güvercinlik in Turkey, is a privately owned tank terminal, and a subcontractor of BP. This terminal has a strategic geographical location, close to main roads and the railway. It is the only terminal in Ankara, and the oldest in Turkey being built in 1946. It stores mainly gas and diesel.

An average of 700-750 m³ of oil products comes every day by train from the Atas Refinery in Mersin – 7 days per week. There are three product line connections from the train unloading to the main terminal. Stored products are then loaded onto trucks to supply gas stations all over central Turkey.

## CHALLENGE
The terminal had been inactive for nearly 15 years, when the decision was taken to resume operation. The field cabling from the storage tanks to the control room was obsolete.

Digging in the area where the terminal is situated is difficult since it is very rocky. The fact that the terminal is divided into two parts, with separating walls, adds complexity to any infrastructure work. The sole cost for new cabling would have been approximately $ 30,000.

There were also project requirements for an early start-up, in the middle of winter, when the weather conditions, with rain, snow and frost, would have been harsh for installation work.

## SOLUTION
When it was time to update the system, Smart Wireless radar technology from Emerson was selected.

Mr. Haydar Cömert, terminal manager at Akim Tek, had previous experience of the wired Rosemount Tank Radar system. Compared to mechanical systems he finds that radar enables the terminal to confidently fill the tanks to a higher level.

"If you are going to use radar, use Rosemount Tank Gauging. Accuracy is very high, and there are no special maintenance requirements. Products are excellent, and the technical support capability is great”

Mr. Haydar Cömert
Terminal Manager Akim Tek

Mr. Cömert with the THUM Adapter antenna unit which sends data within the wireless field network.
The Akim Tek management preferred the Smart Wireless Solution due to both economical and practical reasons.

The main reason was time savings and to have a system up and running quickly. However, the savings Akim Tek had with the wireless installation was $20,000, which is close to 70% compared to a wired system.

Each of the 15 tanks is equipped with a TankRadar Rex level gauge with a Smart Wireless THUM Adapter, and a multiple spot temperature sensor. Field network data is sent to the control room via the Smart Wireless Gateway.

TankMaster and TankMaster.net provide an operator interface for tank inventory management.

Akim Tek also uses flow rate data calculated by TankMaster to control the critical pump functions.

### Emerson Smart Wireless Solution

Emerson’s Smart Wireless solution is based on IEC 62591 (WirelessHART), the industry standard for wireless field networks.

A WirelessHART device can transmit its own data as well as relay information from other devices in the network. The self-organizing mesh network automatically finds the best way around any fixed or temporary obstacle. Nodes can identify a network, join it, and self-organize into dynamic communication paths. Reliability actually increases when the network expands – the more devices, the more communication paths!

### RESOURCES

- **Rosemount TankRadar Rex Technical Description, 703010En**
- **Smart Wireless Tank Gauging from Emerson Brochure, 201026En**
- [www.rosemount-tg.com](http://www.rosemount-tg.com)

Technical details are subject to change without prior notice.

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Oil Producer Reduces Production Loss with Smart Wireless Technology

RESULTS
- Reduced production loss through increased visibility of well production
- Reduced operations and maintenance costs
- Decreased health, safety, and environmental risks

APPLICATION
Gross oil production flow monitoring

CUSTOMER
Independent oil and gas producer

CHALLENGE
Being able to measure the gross oil production at a site is extremely important to understanding the performance of a given well. This customer used portable meter skids to measure well performance on a monthly or semi-annual basis. When the skid was not onsite, the last tested measurement was assumed until the portable meter skid returned to the site. Because the flow measurement was assumed, the company was guessing that the well was performing at the same level during the duration the skid was not on location.

Other than the routine portable skid measurement, no measurement was made at these sites because of the costs associated with installing measurement points. Labor and infrastructure costs including RTU's, cabling, batteries, and radios made it cost prohibitive to replace the portable skids system.

By not having measurement on the well site, this company could not quickly identify where production problems were arising. This resulted in reactive operations, lower well production, and increased safety risks.

SOLUTION
The customer installed a Smart Wireless self-organizing network from Emerson Process Management. The Rosemount 3051S Wireless Pressure Transmitter and Rosemount 648 Wireless Temperature Transmitter were installed for gross oil monitoring. Smart Wireless allowed the client to keep track of individual well production at all times.

The self-organizing network provided greater than 99% data reliability so that well problems could be identified near real-time. Extended range communication of up to a half mile provided a stronger network with many devices communicating into a gateway from multiple wells.

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For more information: www.rosemount.com
 Communication reliability is only as strong as the reliability of the devices and the quality of data they provide. The Rosemount 3051S Wireless Pressure Transmitter and Rosemount 648 Wireless Temperature Transmitter lead the industry in both reliability and performance, making them ideal for this remote oilfield application.

By using the Smart Wireless solution, gross production levels could now be monitored near real-time for well production management to prevent production loss. Skid rental costs were eliminated, as were the safety and environmental risks associated with skid relocation such as driving, spills, lifting, and working with high pressure lines.

Capital costs to install the Smart Wireless network were also much less than if the customer chose the traditional architecture with RTUs, batteries, and radios. For this application, a Smart Wireless architecture eliminated all the infrastructure and wiring normally associated with oilfield automation.

RESOURCES
Emerson Smart Wireless
http://www.emersonprocess.com/rosemount/smartwireless/index.html
## Challenge

An oil and gas company was manually monitoring 147 steam injection wells in an oil field in the western United States. Steam usage needed to be monitored in order to avoid oversteaming, which could cause producing well damage, or understeaming, which could result in reduced production.

Steam injection was monitored using chart recorders. This approach had a number of disadvantages. First, operations personnel needed to visit each of the 147 injection wells every day and manually take steam readings. Accuracy of the readings was suspect as the chart recorders were difficult to accurately read, and data entry errors could occur. In addition, the chart recorder at each injection well needed to be calibrated every 3 months. Finally, only one reading per day was made to each injection well. If oversteaming or understeaming occurred the problem could go undetected for almost a full day.

Operations and maintenance costs were high due to the need to drive to and read steam usage at 147 wells a day, and perform almost 600 chart recorder calibrations each year. Next the customer experienced excess steam costs due to oversteaming. Steam costs can represent up to 75% of a producer’s cost. In addition, oversteaming can damage producing wells leading to hundreds of thousands of dollars in needed repair costs. Finally, understeaming can result in reduced production from individual wells and the field.

### Results
- Reduced operations and maintenance cost
- Reduced steam cost
- Increased production

**For more information:**
[www.rosemount.com](http://www.rosemount.com)

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SOLUTION
The customer replaced the chart recorders on each injection well with Rosemount 3051S WirelessHART™ Pressure Transmitters. At each injection well, one transmitter was placed upstream of a calibrated choke, and one downstream. Almost 300 transmitters were installed on the 147 injection wells. Installation was fast and easy. Existing pressure gages were removed, and the pressure transmitter threaded onto the gage connection. The use of wireless communications also eliminated the need to attach signal wires to the devices. Four Emerson Smart Wireless Gateways were connected to industrial broadband radios to transmit the steam injection readings to the control room about 1 mile from the field. This solution gave the company personnel access to steamflow readings continuously instead of only once per day. In addition, deviation limits for steamflow were set. Now if a deviation occurs operators are notified immediately.

Operations and maintenance costs were immediately reduced by eliminating trips to each of the 147 injection wells each day. In addition, maintenance costs were reduced by changing the calibration schedule from 4 times per year for every chart recorder to once every 5 years for each wireless transmitter. Operators are notified immediately if steam injection deviates from desired levels, so oversteaming and understeaming can be detected and corrected quickly. Also, when a well is “done”, or saturated with steam, operators will know immediately and can redirect steam to other wells. These capabilities will reduce steam cost and increase production.

The customer expects savings and higher production to pay for the entire project in just a few months.

RESOURCES
Emerson Process Management Oil & Gas Industry
http://www.emersonprocess.com/rosemount/industry/oil_gas/index.html

Emerson Smart Wireless
http://www.emersonprocess.com/rosemount/smartwireless/index.html

Rosemount 3051S Transmitters
I believed in wireless transmission, and the technology has been proven in our most strategic measurement system

Mr. Cristiano Cicardi  
Instrument and Maintenance Coordinator IPLOM Refinery

The wireless system has proved very reliable despite long distances and obstacles like towers and distillation columns in the Lineof-Sight view.

IPLOM Refinery Gets Highest Level Accuracy Using Emerson’s Wireless Tank Gauging System

RESULTS
• Improved accuracy using hybrid system instead of HTG
• Increased flexibility for future modifications – easy to expand refinery network and include remotely located tanks
• Reduced maintenance
• Quick installation and commissioning
• Easy to send data from other instrumentation over the wireless network

APPLICATION
The refinery produces and stores premium quality petroleum products, such as diesel, virgin naptha, fuel oil, crude and bitumen. IPLOM originally used an HTG system for fiscal purposes, and to utilize tank storage to its maximum capacity.

CUSTOMER
IPLOM is a privately owned Italian refinery, relying on their main competitive strength – flexible production. It is located in Busalla, 18 km from their additional tank storage facility at the harbor of Genova. The refinery has a strategic location, right by the A7 highway, near several big cities in Northern Italy, and also close the Swiss border. It is in direct connection with the port, where oil arrives by tanker ships. This oil is either sent to the Fegino depot or straight to the refinery. One pipe in each direction transports products between the two locations. IPLOM produces 7000 tons of products per day – 50% is delivered to domestic and international end customers via road/rail, the rest is distributed via the dense Italian pipeline system. The total storage capacity is approximately 240,000 m3, 50 tanks in Busalla, and 12 in Fegino. There is a mixture of floating roof tanks and fixed roof tanks.

CHALLENGE
The refinery had an old HTG system, accurate for mass but not equally good for volume, which is the fiscal trade unit of today. This system was not supported anymore. In addition, it required periodical checking, heat tracing and insulation. The level value required for volume calculations was indirectly received via two pressure transmitters. The accuracy and stability of the level value was not satisfactory due to temperature drift. Except the need for improved level measurement performance, another challenge was to access signals from the whole storage area.

If IPLOM could get better level and volume measurements, the company would be able to control and operate their tanks more efficiently. With an increased Low to High level range, they would also gain more space for product blends.
SOLUTION
In 2011, IPLOM looked for an alternative to ensure high precision level measurements, and decided to try the Emerson’s Smart Wireless Solution. Nine tanks were equipped with TankRadar Rex, one 3920 horn antenna gauge or one 3930 parabolic antenna gauge per tank, depending on nozzle availability.

Each gauge is connected to a Smart Wireless THUM Adapter which transmits data over the wireless network to a Smart Wireless Gateway, which communicates with their Yokogawa DCS system via Modbus TCP/IP.

Wiring and access to power were already in place, so the main reasons for going wireless was a quick and easy installation procedure, and the future flexibility to add tanks and measurement data from other devices, such as flow and temperature transmitters.

The experience so far has been very good. IPLOM receives virtually maintenance free, accurate and reliable level measurements. Eight more tanks are now in the process for the next upgrade phase.

Emerson Smart Wireless Solution
Emerson’s Smart Wireless solution is based on IEC 62591 (WirelessHART), the industry standard for wireless field networks.

A WirelessHART device can transmit its own data as well as relay information from other devices in the network. The self-organizing mesh network automatically finds the best way around any fixed or temporary obstacle. Nodes can identify a network, join it, and self-organize into dynamic communication paths. Reliability actually increases when the network expands – the more devices, the more communication paths!

RESOURCES
Rosemount TankRadar Rex Technical Description, 703010En
Smart Wireless Tank Gauging from Emerson Brochure, 201026En
www.rosemount-tg.com/wireless

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Pipeline Company Eliminates Risk of Environmental Fines with Smart Wireless

RESULTS
- Eliminated risk of environmental fines
- Avoided risk of shutdown
- Minimized capital costs

APPLICATION
Engine Exhaust Temperature and Pressure Monitoring

APPLICATION CHARACTERISTICS
800-1000 °F (430 – 540 °C)

CUSTOMER
Gas transmission customer in the United States

CHALLENGE
This customer was not compliant with local state environmental emission regulations for some of their existing natural gas compressors. These regulations were set in place to control the amount of carbon dioxide and nitrogen oxide released into the atmosphere from natural gas fired reciprocating internal combustion engines (RICE).

The customer did not have the necessary measurements to be compliant with the state regulation. The customer was required to record the exhaust temperature and the differential pressure across the exhaust catalyst to ensure it remained within the operating limits. Signal wiring between the compressor station and the control room was not available. Conduit would need to be run 500 ft. (152 m) and trenching would need to be done under a road to connect the compressor stations to the control room. Lastly, there was a shortage of qualified electricians in the area to implement a wired solution.

This customer faced several negative business impacts by not having the necessary measurements. These included fines and ultimately a risk of compressors being shut down if they did not demonstrate compliance with the regulation. To become compliant, their automation staff faced high capital costs associated with instrument installation such as trenching, conduit, cable trays, and labor.

Smart Wireless transmitters eliminated long wire runs back to the control room and enabled the customer to quickly comply with regulations.

Figure 1. Rosemount 848T Wireless High Density Temperature Transmitter

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**SOLUTION**

This customer’s challenge of being non-compliant with local environmental regulations was solved with Rosemount 848T Wireless High Density Temperature Transmitter and the Rosemount 3051S Wireless Pressure Transmitter. The 848T measured exhaust temperatures from multiple compressors and the 3051S measured the differential pressure of the catalyst. The Smart Wireless transmitters and a single Smart Wireless Gateway communicated between three gas treating and compression facilities separated by 500 ft. (152 m). Wireless communication eliminated trenching under a road and wiring conduit back to a centrally located control room. IEC 62591 (Wireless HART® Protocol) self-organizing network enabled easy and seamless integration for quick regulatory compliance.

This customer experienced several positive business results by implementing Smart Wireless instruments at their gas treating and compression station. They eliminated the risk of environmental fines by complying with local RICE regulations. Operations personnel avoided the risk of shutting down natural gas compressors and not meeting projected gas transmission volumes. Finally, capital costs were greatly reduced by eliminating the trenching, conduit, cable trays, and labor associated with wired instruments.

**RESOURCES**

- **Emerson Process Management Oil & Gas Industry**
  

- **Rosemount 848T Wireless Temperature Transmitter**
  

- **Rosemount 3051S Wireless Series of Instrumentation**
  
Pipeline Company Reduces Environmental Risk and Saves on Project Cost with Smart Wireless Technology

**RESULTS**
- Reduced environmental risk from oil leak
- Reduced project capital cost
- Reduced project schedule

**APPLICATION**
Pipeline leak detection

**CHARACTERISTICS**
The pipeline is located under a river

**CUSTOMER**
A pipeline company in the US

**CHALLENGE**
This pipeline company has two terminals, one on each side of a major river system. These terminals were set up to receive liquids from natural gas wells and transfer liquids via pipelines that extended under the river. Maintaining the river’s water quality is very important. The pipeline company needed a cost effective solution to eliminate the risk of undetected catastrophic pipeline leaks.

To detect a catastrophic leak, the line pressure on both sides of the river needed to be measured and compared. If the measured pressures deviate from an expected value, there is evidence of a pipeline leak and the operators can immediately shut down the pipeline. The river is 1 ½ miles wide at this point making wired solutions very expensive.

The leak detection system was vital to the terminal operation due to the risk of liquids leaking into the river. A leak could lead to various negative impacts such as fines, clean up costs, product lost and others. Moreover, wiring the pressure readings would increase the cost of the project and lead to implementation delays.

An estimated 30,000 USD in project cost was saved and in addition, with two gateways already installed the company is well positioned to add wireless measurement devices at a low incremental cost.

For more information: www.rosemount.com

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**SOLUTION**

A total of four Rosemount 3051S Wireless Pressure Transmitters were needed to create the leak detection system for the user. The application consisted of two pipelines that each had a pump located on both sides of the river. Wireless Pressure Transmitters were installed to measure the pressure on both sides of the river for each pipeline. The measurement was then transmitted wirelessly to two wireless gateways located on each side of the river. This made the pressure readings accessible to both terminals. Shutdown systems were configured to stop the pumps if a user defined deviation in pressure was detected.

The system is currently online and operating as expected. No oil leaks have occurred to date. Emerson’s wireless solution eliminated the need to run communication lines to the transmitter resulting in significant cost savings over traditional installation practices. Finally, the system was implemented several weeks ahead of schedule, bringing timely environmental protection to a major river system.

**RESOURCES**

Emerson Process Management Oil and Gas Industry  
http://www.emersonprocess.com/solutions/oilgas/

Rosemount 3051S Series of Instrumentation  

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00830-3600-4801, Rev AA
PXP Improves Oilfield Operation by Optimizing Steam Injection with Emerson Smart Wireless

**APPLICATION**
Oilfield surveillance of remote production and injection wells

**CUSTOMER**
Plains Exploration & Production Company (PXP) is an independent oil and gas company.

**CHALLENGE**
Thermal energy is commonly used in oil extraction to stimulate production. Thermal energy is also the greatest cost of oil production for many tertiary recovery projects. The heat injected in the form of steam commonly accounts for 40 to 65 percent of a producer’s costs and is responsible for much of the revenue derived from production of a well. On the Hopkins lease property 35 miles north east of Bakersfield in California, there are close to 171 producing wells. The wells are concentrated in a one square mile area, producing approximately 3,200 barrels of oil per day. This field also has 120 steam injection wells, each of which heat and push oil toward a pattern of producing wells. In order to meet the production goal and optimize SOR (steam to oil ratio), it is critical to measure injected steam rate, total injected steam, and water and oil production to optimize the effect of thermal stimulation on production.

Because there was no power or communications in the vicinity of the wells, the field was monitored by mechanical chart recorders and operator trips to as many wells as possible in a day. The daily readings by operators were summarized once a day. The data was then sent to the office in Bakersfield where it was used to make business decisions.

“This technology has opened up new possibilities for us. We plan to continue utilizing wireless technology to improve our oil production, improve our cost position, and make our people more productive.”

Michael Fischback
Facilities Engineer

**RESULTS**
- Increased production
- Optimized steam-to-oil ratios
- Reduced cut liners at a cost of $90k to $500K each
- Reduced instrumentation maintenance and calibration
- Higher operator productivity and better response times to field problems
- Improved reservoir modeling

"Cut liners from over-injection of steam is one of the hazards of poor steam injection control"
Manual monitoring methods were not the most effective method to prevent over-injection of steam that caused breakthrough and cut liners in producing wells. Cut liners would take a well out of production for months at a time, losing an average of around 20 barrels per day. If a new liner could be installed, the cost of repairing the damage was roughly $90,000. If there was a dogleg in the well, however, it would have to be idled and a new well would have to be drilled, for a total cost as high as $500,000. The company was averaging 10 cut liners per year. Furthermore, for each month each well was not producing because of a cut liner, an average of 600 barrels of production was foregone.

Manual monitoring methods also led to under-injection, which meant foregone production. Part of the problem was lack of timely information. With 120 wells to visit the operators could, at most, get one data point per well per day. The data then had to be manually entered into a database quickly and accurately. Even if the data was accurately gathered and entered, the data collection rate of once per day led to lag time in responding to issues that impacted costs and production.

Another part of the problem was the technology itself. The accuracy of metering with an orifice and a chart recorder was a concern. For one thing, PXP was dependent on a contractor to provide the proper coefficient for the orifice plate to get an accurate flow reading. For another, they had to be sure the orifice was installed properly and remained intact. Finally, the charts had to be read accurately, with the chart recorder properly calibrated (a task done every three months) with no plugged tubing.

**SOLUTION**

**Steam Injection Wells**

PXP looked at wireless technology to provide real-time information to optimize steam injection rate. The mesh technology from Emerson combined with ProSoft Ethernet radios provided a robust, reliable solution across the one square mile property. PXP chose the Emerson wireless solution because of the security built into the network and the reliability of the robust, self-organizing mesh that is easy to install and expand. The solution from Emerson opened a new pathway to capture real-time, accurate, and nearly maintenance-free well test data.

“When weighted against what was to be gained from this project, the $750K total project cost, including installation services and customized user interface software, seemed quite reasonable given the project’s payback”, said Michael Fischback, Project Facilities Engineer, PXP.

The solution began with a pilot project to test the technology on four injection wells. Ten 3051S WirelessHART™ pressure transmitters were purchased and installed; one on the upstream side of a fixed bean choke to calculate flow rate (upstream pressure and bore size from the fixed bean choke determine the flow rate) and another on the downstream side to help with troubleshooting. Two wells were dual-stream, utilizing a single upstream transmitter.

A Smart Wireless Gateway, where process variables as well as process and instrument diagnostics are converted to Modbus TCP/IP data, was installed as well. A ProSoft Technology 802.11 industrial broadband radio provided a backhaul network, or a robust wireless network for long distances, to connect the gateway to an industrial PC in the office a mile away.
Once communications were established and tested, the first step was complete. However, the company still had to find a convenient way to make the real-time wellhead data accessible company-wide so that it could be stored, trended and analyzed to solve problems before production could be impacted. The customer also wanted to test the performance of the instruments. A 3rd party was brought in to test the true steam injection levels and compare them with the chart recorders and the new high performance 3051S wireless pressure transmitters.

“We found the steam measurements using the pressure transmitters from Emerson to be ten times more accurate, on average, than the chart recorders,” said Fischback. “It is even more accurate when we know the steam quality”. Other advantages to using the (3051S) wireless transmitters were further explained, “They come factory calibrated and only need to be recalibrated every 10 years instead of 3 months (as with the chart recorders), they give early notification of downhole issues, we eliminated human error in entering data, we increased the efficiency of our operation concerning trips to the field, we have increased efficiency of our data management, and better accuracy has led to better modeling of our operation.” That means PXP is not over-injecting wells, which leads to cut liners, and are not losing production from under-injection of steam into the viscous oil.

Once Emerson wireless technology proved it could handle the sparse distribution of transmitters on the large area that incorporated the four wells (spaced 150 feet apart and located 0.25 miles from the nearest gateway), PXP rolled out the bulk of the project, implementing a total of 249 WirelessHART transmitters and 4 WirelessHART gateways on 120 wells across an area of one square mile. Three industrial radios provide the backhaul to reliably communicate data to the office a mile away. Deployment of the wireless technology was made easy with Emerson’s AMS Suite. Emerson’s highly engineered tools take the complexity of configuration, installation, and startup out of the user’s hands. “Users can set up instrument mesh networks quickly. Out of a project cost of $750,000, only $10,000 was spent on installation,” said Fischback.

Oil Production Wells
The project paid for itself in months. With this success, PXP continued to invest in wireless by adding twenty seven 8800 MultiVariable™ Vortex meters with WirelessHART THUMS to the network to measure the mixture of oil and water out of the producing wells. These low-maintenance devices update production data for operators every minute on every well instead of once a day only on those wells that are in test. Therefore, they are no longer blind to what the majority of the wells which are not in test are doing. Now operators get flow rate, flow total, and temperature for each of the wells. The temperature is used to determine how hot the production is emerging to indicate not only that steam is reaching the well, but to provide further field intelligence on whether the pattern injection wells are being over- or under-injected. For diagnostics, the shuddering frequency is also monitored. This provides intelligence to the operators if any process disruptions are affecting the meter, so maintenance can remedy the problem and minimize the impact on production.
When weighted against what was to be gained from this project, the $750K total project cost, including installation services and customized user interface software, seemed quite reasonable given the project’s payback.

Michael Fischback
Project Facilities Engineer, PXP

Customer Impact
Operators can now monitor wellhead status, respond to alarms immediately if parameters deviate from pre-determined limits, and problem solve by analyzing data on historical trends. Overall, operations have improved their productivity with better response times and smarter decision-making. This has led to improved productivity of the field, since operators can prioritize wells that need attention and visually monitor the others simply by driving by and looking for steam or oil leaks. This has translated to improved SOR or steam-to-oil ratios. The number of cut liners has been reduced, which has further increased profitability.

The results for Field Operations are reduced maintenance and calibration, elimination of manual data collection and manual entry, more effective use of vehicles, quicker response times to field problems and better prioritization of daily activities. Production Engineering experienced fewer lost wells to steam cutting, and live data at their fingertips leads to better decisions. Operators have additional time to “pump” the wells (on-site testing) to make them more productive. Reservoir Engineering has a more accurate reservoir model, target steam rates are being achieved, and they are no longer reliant on the field for data. The Corporate Data System Management group has data fed automatically from the field now with no interface to a data clerk. This has increased accuracy by eliminating human error. It has also enriched the information being sent from the field as more data can now be gathered by the field instruments.

“This technology has opened up new possibilities for us,” concluded Fischback. “We plan to continue utilizing wireless technology to improve our oil production, improve our cost position, and make our people more productive.”

RESOURCES
Emerson Process Management Oil and Gas Industry
http://www.emersonprocess.com/solutions/oilgas/

Rosemount Smart Wireless

Rosemount 3051S

Rosemount Vortex Flowmeters

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RWE Gas Storage Uses Wireless Technology to Maximize Gas Storage Capacity and Improve Efficiency and Safety

RESULTS

- Running closer to capacity
- No downtime, saving $250,000/day in lost revenue
- Installation costs reduced by 20% compared with a wired solution
- Maintenance costs reduced by 10%

APPLICATION

Upgrading instrumentation for managing underground natural gas storage

CUSTOMER

RWE Gas Storage, Dolní Dunajovice, is part of the RWE Group and is the biggest underground gas storage operator in the Czech Republic, operating six facilities with a total capacity of almost 3 billion cubic meters.

CHALLENGE

RWE Gas Storage was looking to maximize the capacity of its Dolní Dunajovice underground gas storage facility in the Czech Republic. To achieve this, existing measurements needed to be automated to give operators greater visibility into the process and to increase personnel efficiency by reducing manual rounds. New online pressure, temperature and level measurements were required, as well as access to diagnostic data from existing control valves.

“We needed to upgrade our existing instrumentation and add additional measurements, but with just two short windows of opportunity each year and no available existing cabling infrastructure, it was impossible to complete the work within the scheduled two-week downtime,” said Pavel Šilinger, Energy Manager, RWE Gas Storage s.r.o. “Extending the downtime would cost RWE an estimated $250,000 a day in lost income.”

RWE needed a solution that did not require installation of new cabling and allowed a longer period for the upgrade to be completed.

SOLUTION

RWE selected Emerson’s Smart Wireless technology, which is well-proven, reliable, and both quick and easy to install and commission. Unlike a wired solution, Smart Wireless didn’t require RWE to install new I/O cards in the control host. Smart Wireless Gateways were simply added to the existing Modbus network to make data from the wireless transmitters available within the existing control system. This meant that the plant could continue to operate while new instruments were being installed, removing the need for the upgrade to be completed within the allotted two-week downtime.

“Emerson’s wireless solution takes only a quarter of the time to install, and saves around 20% of the cost of a cabled installation.”

Pavel Šilinger
Energy Manager
RWE Gas Storage s.r.o.

Emerson Smart Wireless networks were installed to span the entire 50,000-square-meter facility.

ROSEMOUNT

For more information:
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Five separate Smart Wireless networks were installed to span the entire 50,000-squaremeter facility. More than 100 new wireless transmitters were installed, predominantly Emerson’s Rosemount® wireless pressure and temperature transmitters. A number of Rosemount Guided Wave Radar level transmitters and Fisher® control valves were also connected using Emerson’s THUM™ Adapters. RWE also uses Emerson’s AMS Suite predictive maintenance software to monitor wireless network performance and provide device diagnostics.

“Emerson’s wireless solution takes only a quarter of the time to install, and saves around 20% of the cost of a cabled installation,” continued Šilinger. “The availability of HART® data, including diagnostics from new and existing devices, was another significant reason for selecting Smart Wireless and is helping us to improve plant maintenance procedures."

In fact, remote online access to diagnostic information has reduced maintenance costs by 10% per year, and enables operators to identify potential instrument problems earlier and correct them before poor measurements affect the process. Access to online data has also reduced the number of trips into the field, helping to reduce operator rounds and improve the safety of equipment and workers.

On-line measurements have increased visibility into the process, enabling the plant to improve control and run closer to capacity. Wireless technology saved RWE around 20% on the cost of installation and commissioning compared to a wired alternative. The total saving is much higher when the potential lost income of $250,000/day for extended downtime is taken into account.

Based on the successful implementation of wireless technology at the Dolní Dunajovice site, RWE plans to implement Emerson’s Smart Wireless at all of its underground storage facilities in the Czech Republic.

RESOURCES
Emerson Process Management Oil and Gas Industries
http://www2.emersonprocess.com/EN-US/INDUSTRIES/OIL-GAS/Pages/OilandGas.aspx

Rosemount 3051S Wireless Series of Instrumentation

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**Swedish Refinery Expands Wireless Tank Gauging System by Installing Pervasive Field Network**

**RESULTS**
- Fast and reliable communication
- Minimized engineering time and installation cost
- Quick and easy installation
- Direct remote access to wireless field network

**APPLICATION**
St1 uses Rosemount Tank Gauging equipment from Emerson for inventory measurements in liquid storage tanks. The plant has a mixture of wired and wireless equipment for level and temperature measurements. Their wireless tank gauging system is complemented with a wireless link between the field network and the control room.

**CUSTOMER**
St1, a Swedish petroleum refinery, located in the Gothenburg harbor area.

**CHALLENGE**
Initially, there was no direct access from the control room to the Smart Wireless Gateway, which collects tank data from the wireless field network.

To be able to monitor the wireless network status, and configure the devices, instrument technicians had to go into field and investigate. Work permits, and keys were required for entering the locked facility, where the PC connected to the gateway is situated.

**SOLUTION**
To improve access to the wireless network, St1 added a wireless connection from the control room to the gateway via the Wi-Fi based Pervasive Field Network (PFN) solution from Emerson.

St1 chose the wireless alternative for cost reasons, and because installation of both the field network and PFN is quick and easy.

The PFN link at St1 includes three industrial Hotspot Units, all of which are installed indoors. Each of these is connected to a remotely installed outdoor panel antenna.

It is also possible to install a Hotspot Unit outdoors.

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**“It is like walking around in the tank farm, doing it from your office! All measurement points are centralized – Gas/oil leakage, level, and tank temperature.”**

Curt Åkesson
Instrument Engineer, St1

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Rosemount Tank Gauging

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**OIL & GAS**

**WIRELESS TANKRADAR REX**

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**EMERSON**

Process Management
1. One Hotspot Unit is connected to the gateway, and a remotely installed directional panel antenna.

2. Another Hotspot Unit serves as a repeater to achieve line-of-sight. It is connected to two remotely installed panel antennas, one receiving and one transmitting, to be able to relay data.

3. The third Hotspot Unit is installed in the control room area. It is also connected to a remotely installed panel antenna. In addition, it is equipped with an integrated antenna to create a Wi-Fi zone. This enables the operator to access the wireless network from any place in the control room, via a laptop, equipped with AMS Wireless Configurator, AMS Wireless SNAP-ON, and/or TankMaster.

**Emerson Smart Wireless Solution**

Emerson’s Smart Wireless solution is based on IEC 62591 (WirelessHART), the emerging industry standard for wireless field networks.

A WirelessHART device can transmit its own data as well as relay information from other devices in the network. The self-organizing mesh network automatically finds the best way around any fixed or temporary obstacle. Nodes can identify a network, join it, and self-organize into dynamic communication paths. Reliability actually increases when the network expands – the more devices, the more communication paths!
Data from the Rex gauge is sent to the control room via PFN.

AMS Wireless SNAP-ON gives you a graphical overview of the tank farm, the devices in the network, and their status.

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Timely Compliance to State Regulation Made Possible By Smart Wireless Solution

RESULTS
• Achieved state regulatory compliance on time
• Minimized environmental impact
• Lowered installation costs
• Reduced project time

APPLICATION
Remote monitoring of outlet gas pressures from four district regulators at a company property

APPLICATION CHARACTERISTICS
• Devices are 150 ft. (46 m) from the communication’s building
• SCADA System is about 60 miles (97 km) from the site

CUSTOMER
Unitil Corporation / Northern Utilities

CHALLENGE
The site required a quick installation solution to comply with state regulatory standards. The outlet pressures of the four district regulator stations at this site needed to be monitored by the SCADA System. The existing RTU and communications were in the DAC building which was 150 feet away from the 4 regulator stations. The DAC building was also separated from the four stations by a busy driveway, which was shared with an LPGA trucking Company.

Digging was a complicated and expensive option and overhead wires could not be used. In order to comply with a state regulatory mandate, the additional pressure data from this site was necessary. A monitoring solution had to be implemented quickly. Installation of conduit and cabling would have required trenching in hazmat soil, which would have been difficult to implement in the winter months. In addition to a potentially difficult installation, this project needed to be completed prior to the end of the calendar year to be in compliance.

The Smart Wireless Solution enabled the natural gas LDC to meet regulatory requirements on time in an extreme environment.

For more information:
www.rosemount.com

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SOLUTION
A Smart Wireless solution was put in place quickly and without the need to hard wire the additional measurement points which eliminated the need for trenching. Rosemount 2051 Pressure Transmitters with Smart Wireless THUM adapters attached were installed along with a Smart Wireless Gateway in one day’s time, and the pressure data was sent wirelessly to the Smart Wireless Gateway. After the Gateway was configured, it was connected directly to the existing frame relay communications line existing in the DAC building. From there, the data was easily integrated into the existing SCADA Host System. The entire System was tested and tuned in three days. Now all of the required data is consistently received by the SCADA System, displayed on control screens, and logged into a historical database.

The equipment was installed by Unitil’s regulator group and Dan Joubert of SCADA Network Services performed activation of the Emerson Smart wireless system and integration of the data into the SCADA System.

The wireless solution reduced project cost and time, and overcame the logistical challenge of trenching in hazmat soil and winter construction costs. The customer now has pressure data for these four regulator stations in their SCADA System and no longer relies on paper chart recorders at this site.

This important information, now in the SCADA System, allows Unitil’s Gas Controllers the ability to perform quicker troubleshooting of the equipment on site and provide faster response to their customers with changing system conditions. The data is also captured in the SCADA historian, where it provides a permanent record and helps the Engineering group plan and develop for future system needs. Another important advantage is growth, as Unitil now has the ability to transmit additional data from other areas on this site using the existing Smart Wireless Gateway System.

RESOURCES
Emerson Process Management Oil and Gas Industry
http://www.emersonprocess.com/solutions/oilgas/
Emerson’s Smart Wireless THUM™ Adapter
Rosemount 2051 Pressure Transmitters
http://www2.emersonprocess.com/en-US/brands/rosemount/Pressure/Pressure-Transmitters/2051-Pressure-Transmitters/Pages/index.aspx

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Customers Are Solving Real Plant Problems: Lion Oil

RESULTS
• $60K installed cost savings over wired solution
• $20K in operational cost savings
• Data sent to company’s DeltaV control system
• Operators alerted when safety showers used

APPLICATION
Safety Shower Monitoring

CUSTOMER
A Lion Oil markets a wide range of petroleum products that range from multiple grades of gasoline and ethanol blended gasolines, to ultra-low sulfur diesel, solvents, propanes, and asphalt products.

CHALLENGE
The customer requires to monitor safety shower use in areas over 1,600 feet from the control room at its El Dorado, Ark., facility. Wired Solution is not considered because of it’s long distance.

SOLUTION
The company installed three wireless Rosemount® 702 discrete switches on safety showers in three remote areas. The switches alert operators when a shower has been turned on so they can send help. Another wireless discrete switch was installed on the UPS (uninterruptible power supply) for the radio tower because of the great distance from the control room. Due to the large distances involved in all the measurements, two additional wireless Rosemount® temperature transmitters were installed as signal repeaters. All fourteen devices form a self-organizing field network and transmit their signals to a Smart Wireless Gateway. The gateway sends the reliable data to the facility’s DeltaV™ digital automation control system.
Wireless Adds Advanced Diagnostics and Configuration

RESULTS
- Lowered operating and maintenance cost
- Reduced safety and environmental risk
- Increased tank utilization
- Reduced unscheduled tank shutdown.

APPLICATION
Tank Gauging

CUSTOMER
A local GAS company S.E.Asia, manufacturing and distributing of industrial and medical gases and liquefied petroleum gas (LPG), operates 16 LPG storage plants in the country and supplies cooking gas to households.

CHALLENGE
Some of old plants are operating with other brand tank gauging system and servo type of level gauges, requiring more maintenance work and high inventory of spares. Customer plans to upgrade the servo to radar level gauge, but radar gauge must be integrated to existing tank gauging system and concerns of limited data information.

SOLUTION
A radar gauge with emulation and wireless is proposed to solve the customer pain.

A radar gauge with emulation is to replace an old servo type of level gauge, which can be seamlessly integrated to existing tank gauging system through wired connection and provides level measurement and average temperature with multi-spot temperature sensor.

A radar gauge wireless communication with wireless gateway provides additional communication channel to access all diagnosis data for servicing and troubleshooting of radar gauge, making maintenance personal much easier to carry out the service.
SIOT Italy Introduces Wireless Radar from Emerson for Pipe Transportation of Crude for the Heart of Europe

RESULTS
• Improved custody transfer efficiency for critical oil movement business
• Increased flexibility for future modifications – easy to add instrumentation
• Minimized cost for cabling, conduits, and cable trays
• Quick installation and commissioning, with no risk of operational disturbances due to excavation work
• Easier access to data from other instrumentation

APPLICATION
Custody transfer crude oil pipeline transportation using level and temperature measurements for volume calculations. These readings are used to calculate official values for fiscal transfers. Online blending operations are facilitated via level rate measurements from the same system.

CUSTOMER
SIOT (Società Italiana per l’Oleodotto Transalpino S.p.A.) is the Italian branch of TAL (Transalpine Pipeline), strategically located close to the Adriatic harbor of Trieste and several Mid-European countries. It comprises a tank storage terminal and port facilities.

CHALLENGE
Every year more than 400 vessels bring an average of 35 million tons of crude oil—worth approximately 13-14 billion Euros—to the SIOT Marine Terminal mostly from Africa, the Middle East, Russia and Venezuela. The 100 different grades of crude oil are stored in 32 floating-roof tanks and then pumped pure or in-line blended to be transported through a 753 km pipeline to any of eight refineries in Germany, Austria, and the Czech Republic.

SIOT had a good experience with its existing Saab (now Emerson) radar-based tank gauging system installed in 1993. The problem was that it was getting old and replacement parts were not easily available.

Furthermore, the existing cabling to the tanks dated back to the 1960s and was not suitable for modern data communication. At the time the cabling was installed, there were no regulations regarding installation within cable trays, so the cabling’s shielding was worn out. Additionally, the location of the cabling created a risk of communication cross-talk.

The cost of new signal cabling, however, was estimated at about 1 million Euro.

Accurate tank level measurement is critical for custody transfer pipe transportation, so the customer looked to Emerson for a reliable, cost-effective alternative.
**SOLUTION**

Since SIOT was satisfied with the reliability of its old radar system over the past two decades, Emerson suggested the company stay with the technology, but with a modern upgrade—wireless capabilities.

The high cost for investing in new signal cabling made Emerson’s Smart Wireless technology economically attractive, and, thanks to the robust, simple and elegant one-layer network architecture that surpassed other options on the market, SIOT eventually selected the Emerson Smart Wireless technology.

For each tank, the existing level gauge was replaced by a wireless Rosemount TankRadar Rex gauge equipped with a 12-in. still-pipe array antenna positioned on the same nozzle.

The Rex gauge uses a Smart Wireless THUM Adapter which, in turn, sends tank level and temperature data over the wireless network to a pair of redundant Smart Wireless Gateways located indoors in the control center.

“We wanted the highest reliability out of the entire system, so we added redundant gateways to the wireless network”, said Mr. Diminich.

The Gateway antennas were installed at the control center roof via a 15 m cable. Communication between Gateways and the DCS system is handled via the Modbus protocol.

Four tanks were included in a pilot test network installed in October 2011. Before putting the system into full operation, the company wanted to make sure the new wireless system would be as accurate, fast and reliable as the legacy wired system. SIOT also wanted to analyze the network with the following considerations:

- Extreme weather conditions in the area, with strong bora winds and heavy rain
- Tank sizes range between 20-80 m in diameter, and distances between tanks can reach up to 300 m
- SIOT had a bad experience with a previous non-Emerson wireless system at their marine terminal

The test went well, so SIOT is now confident about Smart Wireless and Emerson as a supplier, and will expand the network to the other 28 tanks.

Diminich said SIOT appreciates the flexibility of the open WirelessHART-based system. The network can easily be expanded to other tanks by adding new equipment. Additionally, the wireless system enabled each tank to be connected to a fire alarm system that utilizes the wireless network. With Smart Wireless, data from nearby equipment—such as gas detectors and switches, which are powered but have no signal lines—can be seamlessly integrated into the network, opening up numerous possibilities for future modifications.

*The TankRadar Rex gauge from Emerson is connected to a Smart Wireless THUM Adapter antenna unit (mounted on the vertical pipe above the tank).*
Installation was quick and easy,” said Massimo Diminich, Technical Assets Manager, SIOT Italy. “The test turned out as fantastic as expected despite the worst bora in years stressing the system during commissioning.”
**Emerson’s Smart Wireless Helps San Diego Gas & Electric Improve Operations and Safety as Well as Extend Asset Life**

**RESULTS**
- Integrates with the plant’s Ovation® expert control system providing additional insight to field information
- Protects against pump damage valued at $20,000 per pump
- Lengthens motor life, saving $15,000-$20,000 per motor every 5 years
- Eliminated wire and cable costs, saving $5,000-$8,000 per device
- Installed each device in 1 hour versus an estimated 2 weeks to run cable for a single wired monitor

**CHALLENGE**
San Diego Gas and Electric (SDG&E) is a regulated public utility that provides energy service to 3.4 million consumers throughout San Diego and South Orange County.
SDG&E wanted to implement a wireless architecture throughout the Palomar combined cycle plant in order to access data that was previously unattainable through traditional wired solutions. The wireless data would be used in various efficiency calculations at the plant. Project goals included:
- Straightforward project implementation by plant personnel
- Achieve cost savings versus traditional wired applications
- Improve Operational efficiencies
- Enhance plant safety and asset protection

**SOLUTION**
Five applications of Emerson’s WirelessHART™ network at the Palomar Energy Center use Rosemount® wireless transmitters communicating with a single Smart Wireless Gateway to collect new, continuous data for SDG&E.
The wireless network is integrated into Emerson’s Ovation expert control system, providing access to additional plant and process data for control and asset optimization, which translates into operational efficiencies and performance improvements.

“Emerson Smart Wireless is very easy, very reliable. We used wireless for the ease of installation; we did not have to run any power or instrument wiring resulting in cost savings. Another great benefit was the fact that we could install the devices ourselves instead of hiring contractors. The ability to do it ourselves in a fraction of the time delivered big savings.”

Steve Lyons
Instrument Technician
San Diego Gas & Electric, Palomar Energy Center

For more information:
OIL AND GAS

RESULTS
SDG&E has increased its cooling water throughput with the help of real-time cooling riser data delivered by Rosemount wireless temperature transmitters. This data is used in efficiency calculations to verify that cooling fans are running at correct speeds. Confirmation of properly operating cooling fans eliminates the need to over-compensate, which gives the plant better thermal efficiency.

In a second application, turbine compartment temperatures are checked continuously by wireless temperature transmitters to detect cooling air leaks. The new data has allowed SDG&E to cut preventative maintenance on the turbines in half.

A third Smart Wireless application of Rosemount wireless pressure transmitters detect air leaks from two forced draft fans as each alternately sit idle while the other runs to cool turbines. Wireless pressure data helped find leaks in a more expeditious manner. SDG&E is now able to lower the fans’ amps, which has lengthened their lifetime, saving at least one fan motor every five years, providing an estimated savings of $15,000 to $20,000.

In a fourth application, Rosemount wireless DP transmitters check inlet air filters that protect turbine blades in an area subjected to construction dust which severely reduces efficiency. After installing wireless DP, turbine efficiency has improved and megawatt usage was reduced. Better DP information across the filters enables plant personnel to clean them at the proper time.

In a fifth Smart Wireless application,a Rosemount wireless temperature transmitter monitors pipes on the facility’s fire safety system. Pipe temperatures can rise to 160°F if pumps are accidently left on after weekly tests. Use of wireless helps to protect against pump damage, which could cost the plant $20,000 per pump, and protect plant personnel from burns.

Because wireless is flexible and scalable, power producers can adopt this approach wherever it makes sense for their plant. By picking even one small application, users can achieve improvements that would not be possible in a traditional plant configuration.

“The new data provided by the Smart Wireless network allows us to perform maintenance when needed, and less on a scheduled basis. As a result, we have cut our preventive maintenance on the turbines in half. Additionally, after installing wireless DP transmitters, we have improved turbine efficiency and reduced our megawatt usage.”

Steve Lyons
Instrument Technician
San Diego Gas & Electric, Palomar Energy Center

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**11.5 Power**

**Barking Power Lowers Steam Costs, Improves Efficiency with Wireless Acoustic Monitoring**

**RESULTS**
- 1400/day steam loss minimized through early leak detection on high pressure superheater
- Eliminated steam loss, estimated at 4 tonnes per hour, from multiple slow leaks lasting for weeks
- Improved ability to get power to the grid more quickly, more consistently
- Improved overall plant efficiency
- Reduced unscheduled downtime through early fault detection on critical assets

**APPLICATION**
Wireless steam monitoring and management

**CUSTOMER**
Barking Power Station owned by Barking Power Limited and operated by Thames Power Services, is one of the largest independently owned generating plants in the UK. The Combined Cycle Gas Turbine (CCGT) is capable of generating 1,000 MW of electricity - about 2% of the peak electricity demand in England and Wales.

**CHALLENGE**
Deregulation of the power generation market in the U.K. has increased the need for power plants to reduce overall unit generating costs. Originally built for base load generation, Barking Power now competes in the peaking power market. To be competitive, they must continually strive to lower cost and increase flexibility to meet short-term contract windows.

“We are constantly looking to get the highest heat rate,” said Tony Turp, Senior Control Engineer. “We have performance models and are continually striving to improve our heat rate even one hundredth of a percent.” The problem, of course, was time and money. “Our main area of concentration is our steam lines,” Turp continued. “We need to minimize steam loss on any steam lines that go to drains, or any steam traps, anything that vents to atmosphere, start-up vents, blow-down lines... anything that will increase our effluent waste or cause us to generate more water to replenish any losses.”

“Overall, we have improved plant efficiency, reduced steam losses, and improved the safety and productivity of our people.”

Tony Turp
Senior Control Engineer
Barking Power Station, London

Acoustic technology combined with WirelessHart enables on-line monitoring of steam traps, vent valves and PRV’s across the plant, including remote areas.
To minimize losses, operators performed frequent rounds to identify leaks from vents, poorly seating pressure relief valves (PRV’s) and malfunctioning steam traps during normal operations. Large, single leaks were easy to detect (most of the time) but smaller leaks could go unidentified for 2-3 weeks. Although lower volumes were lost during these episodes, multiple leaks lasting for 2-3 weeks when combined, lost as much as four metric tons of steam per hour before detection through deterioration in plant performance. Ideally, Barking wanted to identify failed steam traps and leaks caused by malfunctioning valves before they impacted the plant.

A few vent valves were also known to stick during startups and shutdowns, and had to be monitored manually. Manual monitoring was not only time consuming, but also failed to indicate when or why a release occurred, increasing the chances of a safety, regulatory, or environmental incident in the case of PRV’s.

**SOLUTION**

Sophisticated WirelessHART® acoustic “listening” technology combined with an integrated temperature measurement was deployed across the plant to monitor steam traps, PRV’s and vent valves. This innovative combination of technologies offered a reliable and cost effective solution for identifying the problems that lead to unscheduled downtime, poor turbine efficiency and energy loss. A total of 100 Rosemount™ 708 Wireless Acoustic Transmitters were non-intrusively installed on critical vent valves, steam traps and PRV’s.

Barking had previous experience with a WirelessHART network in the plant. Despite the vast distance covered by the network and the tough environment introduced by the power plant, the wireless network proved to be very reliable. This gave Barking confidence to use Emerson’s Smart Wireless technology for this new application.

**Steam Traps**

The plant is split into two areas consisting of a 400MW unit with two boilers and a 600MW unit with three boilers. To cover both areas the customer installed two new wireless field networks, each with a Smart Wireless Gateway that will support up to 100 devices. The first acoustic transmitters were targeted for problematic steam traps, where the software will “listen” to pick up a change in noise level from the expected footprint. Any deviation from normal state alarms the operators to take corrective action. This reduces the risk of significant leaks taking place during periods of production to minimize energy loss.

Within the first week of operation, the new technology identified a leak from a highpressure superheater steam trap. The cost of that leak was estimated to be over €1400 for every 24 hours of operation, not including the loss of pressure when the operation moved to hot standby mode, lost nitrogen if the plant moved to cold standby, increased discharge waste, and increased water and chemical use.

**Steam Vent Valves and Pressure Relief Valves**

After deploying 35 acoustic transmitters to identify failing steam traps, Barking instantly saw the potential of these devices and installed 15 additional wireless acoustic transmitters to monitor PRV’s and steam vent valves. “Steam loss isn’t restricted to steam traps,” said Turp. “Vent valves can stick during start-up, or fail to seat properly. We normally have an operator viewing problematic valves during this time, but by installing wireless acoustic transmitters we can now monitor these devices from the control room, removing the need for field observations.”

Some of these valves are located 25m high on top of the boilers and are difficult to check visually by operators. Remote monitoring significantly improved operator safety and improved reporting of releases. While lack of visibility increased the chances of a safety, regulatory, or environmental incident, the Rosemount devices enable very precise reporting of a release, alerting operators within a second of when a relief valve had opened. The time stamped alerts can be compared against process conditions or environmental reporting to help identify the root cause of a release.

For more information: www.rosemount.com

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Conclusion

With three wireless networks now in place, additional devices can be added anywhere in the plant at a much lower cost than adding wired devices.

The devices have proven effective at reducing steam loss and downtime and have freed up valuable time for operators. “We no longer have to send one of our operators to watch this valve during start-up,” said Turp. “It is prone to failure from debris in the seawater. The acoustic transmitter alerts operators when the vent is stuck, and only then does an operator need to go out to the device”.

The devices have been installed for over a year, and have proven very robust. Recently, a leak from a vent valve bathed one of the acoustic transmitters in high temperature steam for over a day before it was discovered, with no effect to the performance of the device.

“These devices give us a better picture of what is happening,” said Turp. “Someone made a comment that they are like a baby monitor; you know everything’s okay until they alert you that there’s a problem.”

He also noted that Barking can now better plan their maintenance resources to avoid losses that impact efficiency. They don’t have to pay a premium to third party contractors when repairs can be planned in advance, “Overall, we have improved plant efficiency, reduced steam losses, and improved the safety and productivity of our people.”

RESOURCES

Emerson Process Management Power Generation Industry
http://www2.emersonprocess.com/en-US/divisions/power-water/Pages/powerwater.aspx

Emerson’s Smart Wireless

Rosemount 708 Wireless Acoustic Transmitter

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Energy Company Complies to New Mercury Removal Emission Regulations Without Compromising Project Cost by Using Smart Wireless

RESULTS
- Compliance with Federal and State Regulations
- Reduced project cost
- Minimized environmental risk
- Reduced safety and health risk of nearby communities

APPLICATION
Temperature measurements of boiler boxes

CUSTOMER
Energy company located in Western, USA

CHALLENGE
All coal fired plants are being required to reduce mercury emissions under federal regulatory rules by November 2010. This energy company planned to comply with the law by implementing a system which would reduce their mercury emissions without incurring high project cost.

One way to reduce mercury emissions is to introduce chemicals that will help mercury in coal to be water soluble. The first step is to spray calcium bromide onto the coal which will react with mercury to form mercury bromide. Then, inject activated carbon upstream of the air pre-heater to grab mercury bromide and allow a flue gas desulfurization (FGD) scrubber to remove it. This process needs accurate and reliable temperature measurements at the back of the boiler box since mercury conversion works better at specific temperatures.

Uncontrolled mercury emissions have many adverse effects; one is raising the risk of polluting the environment. Another is risking the health and safety of nearby communities. Furthermore, if found not complying with the law, this energy company risks penalties and damages to their reputation.

SOLUTION
Efficient mercury removal requires that the temperature across the entire back of the boiler box be within a specific temperature range. A complete temperature profile across the back of the boiler box is needed. Several multi-point Rosemount 848T wireless temperature transmitters were installed at the same level on each boiler box. These were then wirelessly connected to a single DCS to provide the desired temperature profile monitoring. This installation proved cost effective as it eliminated the cost of running conduit and wires to each sensor.

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Rosemount 848T Wireless Temperature Transmitter enabled this energy company to meet the new mercury emission removal regulation, avoiding fines and penalties while saving an approximate 40,000 USD in project cost by going wireless. Most importantly, the 848T played a key role in a control system with which they were able to lower mercury levels in their flue gas, reducing risk to the environment and the health and safety of nearby communities.

**RESOURCES**

- Emerson Process Management Power Industry
- Rosemount Temperature
- Emerson Smart Wireless
WE Energies Automates Dewatering Bin Sludge Level Measurement and Monitors the Result Without Wires

RESULTS
• Improved personnel safety
• Reduced operations and maintenance cost
• Reduced project implementation cost

APPLICATION
Ash level measurement in the bottom of an Ash Dewatering Bin

CHARACTERISTICS
Very cold temperatures during the winter months; murky water

CUSTOMER
WE Energies, Upper Pensinsula of Michigan, USA

CHALLENGE
Ash from the bottom of a boiler must be removed. This ash is mixed with water to form slurry which is carried to dewatering bins where the ash is concentrated for disposal. When the ash in the bottom of the bin reaches a predetermined level it is pumped out. WE Energies’ power plant needed to reliably measure the level of ash in the bottom of a dewatering bin.

Customer had been using a “yo-yo” system to monitor the sludge. A weight on a string is dropped into the bin until it hits the sludge. As the weight is reeled back, a servo motor determines the length of string and sludge level is calculated. Maintenance personnel needed to manually read and record the level measurement. During the winter months, the wet string caused the device to freeze up even though it has a heat blanket. The result is a lost level measurement, and the need for maintenance to repair the frozen device.

WE Energies experienced several negative business consequences as a result of the unreliable ash level measurement. In winter, snow, ice, and cold presented safety risk to maintenance personnel needing to climb to the top of the dewatering bin. The need to maintain the frozen “yo-yo” measurement device increased maintenance costs. Finally, due to the loss of the ash level measurement, ash was sometimes pumped from the dewatering bin before reaching the desired level. This increased operations cost.

Mobrey MSL600 Sludge Blanket Level Monitor and Rosemount 648 Wireless Temperature Transmitter
SOLUTION

WE Energies installed a Mobrey MSL600 Sludge Blanket Level Monitor to measure the ash level. The monitor uses sonar technology to make a continuous measurement. The sensor is mounted below the water level and has no moving parts that can freeze. The output from the MSL600 was sent to a Rosemount 648 Wireless Temperature Transmitter. The 648 wirelessly sent the level reading to the control room. The system has operated successfully through the harshest winter months without requiring any maintenance and had no downtime. In addition, plant personnel no longer need to climb to the top of the bin to read and record the sludge level.

WE Energies experienced several positive business results by automating the sludge level measurement with the Mobrey MSL600 and Rosemount 648. First, personnel safety has been improved by eliminating the need to climb to the top of the bin to manually take the level measurement. Second, unscheduled maintenance on the bin level measurement has been eliminated, reducing maintenance cost. Third, ash pumping cost was reduced due to elimination of unnecessary ash pumping. Finally, by wirelessly communicating the level measurement to the control room, the cost of installing wires was eliminated reducing implementation cost. The installation has been so successful that additional Ash Dewatering Bins on site are being upgraded with this solution.

RESOURCES

Emerson Process Management Power Industry

Mobrey MSL600 Sludge Blanket Level Monitor
http://www2.emersonprocess.com/en-US/brands/mobrey/Level-Products/Ultrasonic/MSL600/Pages/index.aspx

Rosemount 648 Wireless Temperature Transmitter
11.6 Pulp and Paper

Korsnäs Gävle Meets Environmental Requirements Using Smart Wireless Technology

RESULTS
- Compliance with environment monitoring legislation
- Reduced installation costs
- Fast implementation of additional measurement points

APPLICATION
Leak detection

CUSTOMER
Korsnäs Gävle – board and paper manufacturer, Sweden

CHALLENGE
Environmental legislation required that water from heat exchangers must be carefully monitored for contamination before it is returned to the sea. Failure to comply could require production to be stopped at the plant. Monitoring electrical conductivity is a standard detection method for leaks of acids, bases, or salts since any leak is easily detected using a conductivity sensor, but the existing I/O supporting these devices was to be removed in a renovation project. An alternative way to transmit the required measurements to the main control room was needed.

A second application required Korsnäs Gävle to establish continuous monitoring of effluent in aerated basins and ponds. New sensors measuring pH, dissolved oxygen, and water temperatures had to be installed and connected to the central monitoring system, but there were no available cable runs and the closest available wired connection point was more than 500 metres away. Installing new cabling would present a considerable challenge and cost roughly €200/metre.

SOLUTION
Korsnäs Gävle implemented Emerson’s Smart Wireless technology, which is based on the IEC 62591 (WirelessHART™) standard. A Rosemount Analytical 6081C wireless transmitter connected to a conductivity probe monitors the water from the heat exchanger and transmits the measurement data via a Smart Wireless Gateway to the existing control and data acquisition systems. This new solution ensures compliance with the environmental monitoring legislation.

“Less than two months after ordering the Smart Wireless devices, the whole system was fully operational. That is very fast for implementing 30 new measurement points. Now that the network is in place, we also have found that adding additional devices becomes very simple.”

Peter Hallenberg
Project Leader Process Automation
Korsnäs Gävle

For more information:
www.EmersonProcess.com
www.raihome.com
Six Rosemount 848T wireless transmitters were installed to relay data from 22 analytical sensors monitoring the aerated basins and ponds. These new transmitters provide the necessary data to meet the environmental requirements.

With the Smart Wireless network established, Korsnäs Gävle was also able to install seven Rosemount 648 wireless temperature transmitters to monitor temperatures in the water pits supplying water to aerated basins and ponds. A further eight Rosemount 3051S wireless pressure transmitters are to be implemented to identify plugged filters of two wood chip digesters within the main processing section of the plant.
Lime Kiln Throughput Improves with Smart Wireless Solution

RESULTS
- 5% throughput improvement in lime kiln
- Minute-by-minute mid-zone temperature trending
- Self-powered transmitters were sending temperature updates within 24 hours of delivery
- Communication of devices on opposite sides of a rotating kiln to one Gateway

APPLICATION
Lime Kiln Mid-Zone Temperature

APPLICATION CHARACTERISTIC
Rotating kiln, high temperature, radiant heat, dusty ambient environment

CUSTOMER
Pulp and Paper Mill in North America

CHALLENGE
A Pulp and Paper Mill in North America struggled to properly control calcining in the lime kiln. In fact, the kiln was operating so poorly that it had become a choke point. The mill bought a new burner system and adjusted the flame profile to improve heat transfer at the mid-zone, where calcining of the lime mud takes place. The burner system is fired at the hot end (2000 °F [1093 °C]) of this long, cylindrical, rotating kiln and a draft is induced at the feed end (400 - 500 °F [204 – 260°C]). The flame is adjusted through the draft to provide the optimum shape and achieve the right mid-zone temperature. For this mill, however, the mid-zone temperatures could not be measured reliably and were inferred through the firing and feed end temperatures.

Unfortunately, the new burner system did not solve the problem. The mill suspected a new chain system was needed on the inside of the kiln to break up the lime mud and promote heat transfer. The Pulp Mill Leader did not want to invest the money, however, until the mid-zone temperatures for the center of the kiln (the air temperature) and the inside wall (where lime mud tumbled around chains) could be measured and actual heat transfer could be confirmed. The temperature measurement that had accompanied the purchase of the kiln, which relied on a brush system, had never worked and had not been maintained. A wired solution could not handle the rotating equipment, so the customer approached their instrument partner - Emerson Process Management - for a solution.

“...four days after the order was placed, we could see minute-by-minute mid-zone temperatures trending on the control system.”
Pulp Mill E&I Leader
**SOLUTION**

Emerson Process Management’s new Smart Wireless solution was proposed, and the customer asked for shipment as soon as possible. Two Rosemount 648 Wireless Temperature Transmitters with thermocouples and a 1420 Gateway arrived at the plant three days later. The sensors were installed on opposite sides of the kiln’s mid-zone, 180° apart, without thermowells to provide the fastest possible response time. One was positioned toward the center of the kiln to pick up the air temperature, and the other was positioned at the outer extremity to pick up radiant heat from the brick, indicating lime mud temperature. The self-powered transmitters were mounted on a pipe that extends away from the kiln and were sending temperature updates to the control room through the 1420 Gateway within 24 hours of delivery. “We had a Modbus® address available, so it was easy to add the Gateway as a slave to the control system,” said E&I Leader for the Pulp Mill and Lime Kiln. “In fact, four days after the order was placed, we could see minute-by-minute mid-zone temperatures trending on the control system.”

Immediately the mill recognized the inferred temperatures were off by 350 °F (177 °C), and confirmed that a new chain system was required to break up the lime mud. “Since the wireless system has been installed, we can tell if there’s build-up of lime in the mid-zone area,” said the Pulp Mill Team Leader, “You can see fluctuation in the temperature, which is an indication of build-up. Overall, we have improved operation of the lime kiln, and increased throughput by 5%.” The Pulp Mill Team Leader concluded by saying, “I think it’s a pretty good achievement to have two different devices communicating with one Gateway, when they are on opposite sides of a rotating kiln.

**RESOURCES**

http://www.emersonprocess.com/smartwireless
Refinery Improved Product Quality and Throughput with Smart Wireless

**APPLICATION**
Steam pressure measurements at compressor

**CUSTOMER**
Leading oil refinery in Southeast Asia

**CHALLENGE**
This refinery was having problems with process upsets at the Crude Distillation Unit (CDU) resulting in offspec product due to steam supply pressure fluctuations, and at times steam supply failure.

The problem was caused by pressure dial gauges on steam lines at the compressor, which did not provide any real time pressure monitoring. Additionally, being an old and congested refinery, it was difficult and costly to install new wiring due to space limitations in the marshalling cabinets, junction boxes, and I/O limitations in the legacy control system.

Absence of online steam pressure monitoring on the compressor had negative business impacts to the customer, which resulted in poor product quality and lower plant throughput. Also, the capital costs (CAPEX) for installing additional wired inputs to the legacy control system were high and acted as a barrier to solving the problem.

**SOLUTION**
Three pressure dial gauges on the compressor were replaced with Rosemount 3051S Wireless Pressure Transmitters, part of Emerson's Smart Wireless Solutions. This allowed automatic monitoring of steam pressure.

A Smart Wireless Gateway was also installed to complete the wireless network. Emerson's Smart Wireless Field Network installation effectively solved all the problems related to space congestion for new wiring, and eliminated higher CAPEX costs associated with a wired solution.

Improved field intelligence, facilitated by wireless online measurement of steam pressures on the compressor resulted in better control of the compressor operation. This stabilized the steam supply pressure to the crude unit product side streams, which resulted in improved product quality and increased plant throughput.

**RESULTS**
- Improved product quality
- Minimized capital expenditure
- Increased plant throughput

For more information: www.rosemount.com

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Emerson’s Smart Wireless Solutions allowed this customer to implement wireless steam pressure measurement points at minimal additional CAPEX in congested areas with wiring limitations.

RESOURCES
Emerson’s Smart Wireless
http://www.EmersonSmartWireless.com

Smart Wireless Gateway
Refinery Improved Throughput with Wireless Differential Pressure Flowmeters

RESULTS
• Improved refinery product inventory monitoring
• Minimized capital expenditure
• Improved throughput

APPLICATION
Production rate measurements for diesel and kerosene jumper lines

CUSTOMER
Leading oil refinery in Southeast Asia

CHALLENGE
This refinery did not have real time production flow rate measurements on newly constructed diesel and kerosene jumper lines.

Being an old and very congested refinery, it was difficult and costly to install flow measurement points for the newly constructed diesel and kerosene jumper lines. Due to space limitations in the marshalling cabinets, junction boxes, and I/O limitations in the legacy control system, this installation appeared cost prohibitive.

Lack of production rate information for new diesel and kerosene products was causing inventory monitoring problems. This led to significant financial implications in terms of both expected revenue and profitability from these new products. However, the capital cost for installing additional wired inputs to the existing control system was quite high. Space constraints also prevented installation of traditional orifice plates for the flow measurements points due to the required upstream and downstream straight pipe run lengths.

SOLUTION
Two Rosemount 3051S Wireless DP Flowmeters, part of Emerson’s Smart Wireless Solutions, were installed on the new diesel and kerosene product lines at minimal additional capital cost. The self-organizing technology eliminated the need to wire new measurement points. This solved the problems related to the existing control system expansion and capital constraints associated with this difficult installation.

In addition, a Rosemount Compact Conditioning Orifice Plate was installed as the primary element on the diesel jumper line. The Compact Conditioning Orifice Plate only required 2 diameters straight pipe run both upstream and downstream, resulting in no additional changes to the current pipe.

The Rosemount 3051S Wireless DP Flowmeters with Compact Conditioning Orifice Plate technology allowed production tracking of two new distillate products at minimal additional capital cost.
The Rosemount 3051S Wireless DP Flowmeters allowed this refinery to significantly improve inventory monitoring of new products, diesel and kerosene, at minimal additional capital cost. This improved revenue and profitability estimation for these new products.

Also, the real time production tracking and operational adjustments of the new products led to improved throughput. Finally, the combination of Emerson’s Smart Wireless and Rosemount Conditioning Orifice Plate technology minimized the capital cost needed to have real time production flow rate measurements.

RESOURCES

Emerson’s Smart Wireless
http://www.EmersonSmartWireless.com

Rosemount Compact Conditioning Orifice Plate
http://www.emersonprocess.com/rosemount/products/flow/m405p.html
Petrochemical Company in South Africa Saves Energy and Improves Productivity with Emerson’s Smart Wireless Acoustic Solutions

RESULTS
- Payback period of 3 months
- Saved over $42,000 annually in steam costs
- Saved $11,390 in installation costs
- Annual maintenance savings of $15,627
- Reduced downtime

APPLICATION
Steam trap monitoring on a range of high-value product streams, including liquid fuels, chemicals and low-carbon electricity

CHALLENGE
Petrochemical Customer in South Africa has a dedicated research and development team of more than 600 people, with over 200 people holding PhD’s or Masters in Engineering and Science. In this semi-commercial pilot plant environment that develops innovative solutions for chemical, refining, gas, petrochemical and other technologies, reducing energy costs is an important goal.

One focus of the Instrumentation and Control group was to minimize energy losses from the large number of steam traps. More specifically, the group investigated methods to minimize steam loss when traps failed, as steam is a high cost utility and undetected trap failure was a significant cost. “With the current system we have a maintenance team that do weekly manual inspections on a certain number of steam traps, as determined by a specific inspection schedule,” said Control Systems and Instrumentation Manager. “The purpose of the inspection was to ensure the traps are fully functional. By following this manual process, it can take up to 3 to 4 weeks before a faulty steam trap can be detected.”

“The Emerson wireless acoustic devices were very easy to install and provide valuable insight into steam traps which were cumbersome to monitor manually. Significant energy savings have been achieved with the added benefit of reduced downtime and maintenance savings.”

Team Leader Petrochemical Company, South Africa

“Rosemount 708 Wireless Acoustic Transmitters provide nonintrusive, continuous on-line steam trap monitoring.”

For more information:
www.rosemount.com

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The Research and Development team’s control systems group looked at smart wireless acoustic transmitters to assist the mechanical group to do more effective maintenance on the failing steam traps. With knowledge and documentation obtained from Emerson’s Global Users Conference in the USA and Germany, Customer partnered with Emerson to trial twenty (20) acoustic transmitters to monitor critical traps.

The transmitters and software were easily configured and setup. Fourteen transmitters were installed on critical steam traps throughout the semi-commercial plant and six on critical traps in the steam utilities area.

The wireless transmitters with acoustic sensing technology successfully detected failing steam traps. “With on-line acoustic monitoring, the facility now has early warning when steam traps fail,” said Customer’s Control Systems and Instrumentation Manager, referencing the 20 traps with the new wireless acoustic transmitters. “The Mechanical Department gets on-line alerts and can respond more quickly, reducing steam loss through the failed traps. We computed the lost steam costs was in the region of $42 195.00 per annum at the current exchange rate of R9.12 if we look at an average of 20 steam traps that failed for an average period of 3 weeks.”

Inspections (on those traps) are now reduced to a few manual inspections per year, saving $15,627 in maintenance costs. Process downtime, which could result from some critical steam trap failures, was also reduced. “Overall, the smart acoustic transmitters paid for themselves in under 3 months,” he concluded.

The Petrochemical Company plans to scale up the use of on-line wireless acoustic monitoring to production facilities all over the world.

RESOURCES
Emerson Process Management Chemical Industry
http://www2.emersonprocess.com/en-US/industries/Chemical/Pages/index.aspx
Rosemount 708 Wireless Acoustic Transmitter & Steam Trap Monitor

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00830-0200-4708, Rev AA
Refinery Improves Availability of Coking Unit with Wireless Monitoring

RESULTS
- Improved availability of coking operation by reducing unplanned failure of expensive equipment
- Operator time freed up for higher value activities
- Up to 90 percent reduction in installed cost over traditional wireless network

APPLICATION
Calcining Unit for a Coking Operation

CUSTOMER
Refinery in North America

CHALLENGE
A refinery in North America wanted to automate non-production areas of their plant to free up labor resources for higher-value activities that improve plant productivity. Unfortunately, the high installed cost of traditional wired instrument networks was prohibitive, and they were forced to manually log most of their monitored points. Operators were visiting the calcining unit for the coker once a month and manually logging motor bearing temperatures, pump casing temperatures, differential pressure across water filters, and in-line pressures on chemical injection lines to detect plugging.

For the motor bearing and pump casing temperatures they had to manually take the readings for each of the three hearths with an infrared gun, then write them in a log and key the data into a data historian. This was in addition to any action that would be taken in case maintenance was needed. Because of limited resources, the refinery was seeking a cost-effective way to automate this area of the coker and free the operators from this time-consuming process. They also wanted to eliminate human error in logging each measurement and keying it into the historian. Finally, they wanted to improve resolution to the process and receive readings every hour instead of the current rate of once per month. They hoped to move from preventative maintenance techniques, which could result in unnecessary maintenance or unplanned failure of expensive equipment, to a proactive environment with predictable turnarounds. They needed an affordable, reliable measurement system that could handle the high humidity, high vibration, high EMF/RF environment as well as the extreme temperatures of -40°C to 85°C.

SOLUTION
The refinery installed a Smart Wireless self-organizing network from Emerson to monitor 14 points across a 1200 foot area of the coker and support units. Customers have estimated the cost of installing a traditional wired point is

Unplanned shutdowns are minimized because of more frequent and accurate bearing temperature monitoring.
Very little training was required because Rosemount wireless devices can be installed exactly the same way as their wired counterparts.

For more information:
www.rosemount.com

RESOURCES
http://www.emersonprocess.com/rosemount/smartwireless/

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For more information:
www.rosemount.com
Refinery Improves Environmental Compliance and Reduces Costs with Wireless Instruments

RESULTS
- Eliminated false Volatile Organic Compound (VOC) emission reports
- Reduced VOC emissions through timely operator intervention
- Minimized fines for VOC emissions through more accurate reporting
- Eliminated manual logs for compliance reporting

APPLICATION
Coking Unit in a Refinery

CUSTOMER
Refinery in North America

CHALLENGE
A refining customer in North America needed better monitoring of their pressure relief valves (PRVs) to track any release of VOCs more closely. Pressure relief valves allow a release only when line pressure builds up to a critical level, to prevent a more catastrophic failure due to overpressure. The Environmental Protection Agency (EPA) requires plants to report any VOC release, and assumes a worst-case scenario. That means the plant must assume the release happened immediately after the last logged entry, and that it lasted the full complement of time until the next logged entry. The plant is then fined accordingly. For this refining customer, that time was a 12 hour period. The plant did not have resources to automatically monitor the pressure relief valves on the coking unit, so they put rubber “socks” on the stacks to indicate a VOC release. If a sock was off, a 12 hour emission at the maximum rate was assumed and reported. Unfortunately, VOC release wasn’t the only culprit for a “sock-off” scenario. High winds sometimes blew the socks off, resulting in fines up to $350,000 for zero emissions. The plant did not have labor resources to manually monitor their PRVs more frequently than once a shift, and did not have $300,000 to engineer, design and install a traditional instrument network. They needed a more cost-effective solution to eliminate false emission reports, accurately report the length of time and rate for a true VOC release, and maintain a log to prove zero emissions.

SOLUTION
The refinery found a solution that was 90 percent below the cost of a traditional wired network. This reliable and economical solution came from Emerson Process Management’s Smart Wireless self-organizing network. The plant placed twenty-seven Rosemount 3051S wireless pressure transmitters on stacks in the coking unit to automatically monitor the high side of the pressure relief valves. This network provided coverage to an area spanning 1500 feet horizontally and 150 feet vertically.

For more information:
www.rosemount.com

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The new technology has been openly embraced by IT, process operators, instrument technicians, contractors, and engineers.

The existing OSIsoft® PI System™ is used for trending and compliance reporting.

The customer hired their standard contractor to engineer the instrument locations and install the network of devices. The contractor treated the devices as if they were wired, following their standard installation practices. There was no complicated site survey required to ensure wireless connectivity. They were placed on top of towers, at ground level, beneath the coking infrastructure, and between tanks. When the electrical sub-contractor installed the first 14 devices, they had perfect connectivity across the entire process unit. The self-organizing network allowed any device to talk to any other device on the network, so they had built-in communication redundancy at multiple levels. The network was strengthened when the remaining 13 devices were added according to the same standard installation practices.

The instrument readings were seamlessly integrated into the existing OSIsoft® PI System™ through the 1420 Wireless Gateway for trending, analysis, calculation of VOC release rates, and automatic reporting of events. They provided high resolution data to prove environmental compliance; in fact, the rate of one point every fifteen seconds is four times the resolution required by the EPA for electronic equipment. The plant now has 2,880 data points per shift instead of one. They also have an actual pressure reading instead of a “sock on” reading. That pressure reading provides valuable trend history to generate alerts, and operators can take proactive steps to prevent an emission. Furthermore, instead of the “sock off” reading the customer now has the time of release within 15 seconds, as well as the actual rate of emission, so maximum pressure is no longer assumed. Finally, there are no more false positives from socks being blown off by high winds. The socks are still there, but only provide redundancy.

The result has been a significant drop in fines by eliminating false emission reports, prevention of VOC emissions through timely operator intervention, and true time and rate calculations for brief emissions that previously were assumed to be 12 hours at maximum pressure. A significant cost to the plant was also reduced with automated compliance reporting. Proving compliance is often more costly than compliance itself, and the plant was able to utilize their existing plant host to trend, analyze, report and prove zero emissions. The new technology has been openly embraced by IT, process operators, instrument technicians, contractors and engineers, and the customer plans to eventually install wireless devices on all 600 pressure relief valves in the refinery, both for stacks and drain pipes. Emerson Process Management’s Smart Wireless technology enables any refining facility to cost-effectively meet new, stricter regulations.

RESOURCES
http://www.emersonprocess.com/rosemount/smartwireless/

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0830-0100-4420, Rev AA
Refinery Initiates Tank Overfill Protection and Optimization of Pre-Heaters with Smart Wireless

RESULTS
- Saved upwards of $1 million by eliminating tank spills/remediation during ship off-loading
- Initiated cost effective overfill protection on over 60 crude and product tanks
- Improved safety with heater firebox draft monitoring
- Increased energy efficiency with heat exchanger temperature monitoring

APPLICATION
Tank overfill protection, heat exchanger energy efficiency monitoring, heater firebox draft monitoring

CUSTOMER
A Major Oil and Gas Company in the United States

CHALLENGE
A large refinery in the United States accepts crude oil from ships and stores it in crude oil storage tanks in the tank farm on the south side of the refinery. To reduce expenses, these ships are off-loaded as quickly and efficiently as possible. This means large volumes of oil being moved with measurements and controls that are critical to moving it safely and efficiently.

The crude oil storage tanks had a primary level measurement system that would sometimes fail. The loss of crude oil was minor compared to the cost of cleanup. Remediation from a single tank spill cost the company $1 million. A redundant system was too expensive to wire, as the tank farm is spread out over several square miles. When the tank gauging system failed a second time, the Plant Manager insisted that an independent secondary system be installed immediately. He did not want an overfill situation to happen again.

Other challenges for the plant included heat exchanger energy efficiency calculations and heater firebox draft monitoring. Since the refinery is an older structure with dense piping as well as tanks, vessels, and other obstructions in the area of the pre-heaters, wiring is very expensive and difficult at some locations. The customer was looking to optimize efficiency of the pre-heaters and minimize energy consumption, and could not do it effectively with spot checks from an infrared gun. They also wanted to install a safety precaution by measuring pressure in the heater firebox, and ensure noxious gases were not escaping.

“Overall the refinery has eliminated tank spills from level measurement errors on the crude tanks, provided overfill protection on all crude, intermediate and product storage tanks, improved safety by measuring pressure on heater fireboxes, and improved energy efficiency of the heat exchangers.”

Senior Instrument Engineer
Large U.S. Refinery
Given the large geographical location of the tank farms, wiring was cost prohibitive. Given the complexity of the infrastructure near the pre-heaters, wiring would have been difficult and expensive. The only alternative for the customer was regular trips to the field for manual measurement. To improve safety and optimize efficiency, the plant was looking to automate.

**SOLUTION**
A Senior Instrument Engineer at the refinery started to look at wireless technology to provide fast, cost effective overfill protection on the tanks. At the time, wireless was just emerging on the market. One technology required line-of-sight, and had difficulty in dense infrastructures. The other technology, a self-organizing mesh, promised three dimensional application of the technology.

After carefully evaluating both systems, the customer purchased the Smart Wireless self-organizing network from Emerson. A high level displacer switch was placed on each of the floating roof crude tanks, and connected to a Rosemount 702 Wireless Discrete Transmitter. Each of the wireless transmitters communicates to a Smart Wireless gateway in the east side of the south field, where the crude tanks are located. The wireless points were easily integrated into an existing Modbus port on a 1980’s distributed control system, so it did not require extra I/O from the vintage control system. “A wired solution would have been very expensive, and required additional I/O on our control system” said the Senior Instrument Engineer. “We took a chance on the wireless mesh from Emerson, and it has worked great.”

In fact, the plant has not had an overfill condition since the wireless network and level switches were installed. With one minute updates from the wireless measurements, the operators have early warning if the primary level measurement fails and a high level is reached. That gives operators enough time to either stop the tank fill or divert it to another storage tank. “We monitor the level measurements from the control room” said the customer, “as well as battery life on the wireless transmitters. We know when we have a couple of weeks to change the batteries.”

With the successful installation of secondary level measurements on the crude tanks, it was decided to add all 30 product tanks in the East field to the gateway as well. “Once you have the gateway, it is easy to add additional measurements” the engineer commented. “We installed 30 more displacer switches and wireless 702 discrete transmitters and joined them to the existing network. The interface to our vintage DCS was already in place.” Although the customer had not had problems with overfill on product tanks, they wanted to take preventative action to ensure it would never happen. This was partly in anticipation of legislation changes concerning tank overfill protection, which has already been passed in some states like California. Given the relatively low cost of installation for wireless points, it was an easy decision to make.

Once the East field was finished, second and third networks were installed in two other fields. Twenty five product tanks in the first field and three in the second, both of which are even further from the control room, were given the same independent secondary (wireless) level measurement system as insurance against overfill. Each field had its own gateway installed. One was integrated into a Modbus port on the vintage DCS and the other was integrated via Modbus into the next generation DCS from the same vendor.
With the success of wireless in the tank farms, the refinery looked to secondary draft monitoring on two heater fireboxes to further improve safety. To ensure the heaters were operated within specified operating limits, two Rosemount 3051S wireless pressure transmitters (with 4 second update rates) were placed in the heater draft system to give early indication of any loss of pressure. These transmitters connect to a fourth gateway in that area of the refinery, and were easily integrated into another vendor’s DCS through existing Modbus I/O. With open standards, the Emerson wireless network is easily integrated into multiple host systems.

The most recent project was the installation of a fifth gateway in the crude oil pre-heating area. The refinery was plagued with poor temperature measurements on the heat exchangers from degradation of thermocouple and RTD wiring. Because of the dense infrastructure, line-of-sight wireless technologies would not work. Operators had to take spot measurements with an infrared gun once a month, and manually enter the readings so heat exchanger efficiencies could be calculated and cleaning schedules developed. Unfortunately, this caused loss of efficiency as the differential temperatures would often fall far below optimal before readings were taken.

Ten Rosemount 648 Wireless Temperature Transmitter were installed on the inlet and outlet of several heat exchangers with one minute update rates. The installation points were hidden behind dense piping, vessels, and tanks, but the mesh remains strong with high signal reliability. Now process engineering has live, accurate, information at one minute intervals instead of once a month. Richer information, 43,200 automatically measured and recorded points per month compared to one manually measured and recorded point, gives engineering the tools to optimize energy efficiency. Timely alerts are issued to operators to clean the exchangers and optimize thermal efficiency for each unit. The improvements in energy use have led process engineering to ask for three more wireless temperature transmitters to be added.

“Overall the refinery has eliminated tank spills from level measurement errors on the crude tanks, provided overfill protection on all crude, intermediate and product storage tanks, improved safety by measuring negative pressure on heater fireboxes, and improved energy efficiency of the heat exchangers,” the customer concluded. The plant continues to expand the wireless mesh networks, and sister companies are following suit.

RESOURCES
Emerson Process Management Refining Industry

Emerson Smart Wireless
http://www.emersonprocess.com/rosemount/smartwireless/index.html

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Refrery Wirelessly Monitors Junction Box Pressure, Eliminating Manual Checks, Improving Monitoring Coverage, and Preserving Wiring Infrastructure

RESULTS
• Reduced Operations Cost
• Reduced Safety Risk
• Reduced Project Cost
• Reduced Infrastructure Used

APPLICATION
Monitor positive air pressure in Z-Purge Junction Boxes

CUSTOMER
Refining Company

CHALLENGE
The refining company needed to continuously monitor the pressure in Z-Purge junction boxes around the refinery. These junction boxes are maintained at a low positive pressure to prevent process gasses from entering the junction boxes. These junction boxes are widely distributed throughout the plant. Previously these junction boxes were manually monitored by operators on periodic rounds in the refinery.

No instruments currently existed to monitor the junction box pressure. Limited wiring existed to instrument the junction boxes to add new instruments. In addition, wiring available was not always analog. Sometimes only digital inputs were available.

Lack of continuous monitoring meant refinery was not meeting their safety standards. Having operators take manual readings increased operations cost and exposed operators to hazardous areas in the plant. Using a wired solution would have used much of the available spare wiring infrastructure in the plant increasing cost and reducing spares available for future plant needs. Finally, the lack of consistent input type available at the different junction boxes would increase project cost as different types of solutions would have been needed.

The Rosemount 3051S Wireless Pressure Transmitter provided a solution that could be used everywhere without consuming limited spare wiring capacity.
**SOLUTION**
The problem was solved by monitoring the Z-Purge junction boxes with Rosemount 3051S wireless pressure transmitters. Each Z-Purge junction box was monitored for proper pressure on a continuous basis. The wireless solution eliminated the need to use existing spare wire capacity to monitor the junction boxes. Finally, since no wires were needed, engineering didn’t need to design multiple solutions to accommodate different wiring types, and operations and maintenance didn’t need to run additional wires to areas with no spare wire capacity.

Operations costs were reduced and operator safety was improved by eliminating operator rounds to check junction box pressure. In addition, plant safety goals were met. Next, project costs were reduced since the 3051S wireless pressure transmitters could be used in every location, eliminating the cost of designing multiple solutions. Project costs were further reduced by eliminating the need to engineer the wiring connections associated with wired solutions. In addition, spare plant wiring infrastructure was preserved as no wires were needed to implement the solution. Finally, adding future wireless devices will save an estimated $5,000 per device compared to wired solutions.

Emerson’s Smart Wireless Solutions allowed this customer to implement wireless junction box pressure measurement points at minimal additional CAPEX in congested areas with wiring limitations.

**RESOURCES**
Emerson Process Management Refining Industry

Emerson’s Smart Wireless
http://www.EmersonSmartWireless.com

Rosemount 3051S Wireless Pressure Transmitter

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www.rosemount.com
Smart Wireless Minimizes Capital Costs for Online Monitoring of Plant and Instrument Air

RESULTS
- 73% savings in CAPEX costs
- Reduced plant downtime with live trending of compressor data
- Saved over $50,000 per year in operations costs

APPLICATION
Wireless air compressor monitoring

CUSTOMER
A major refinery in North America

CHALLENGE
This refinery installed two new compressors to maintain the reliability of plant and instrument air. Unfortunately, the buildings that house the compressors and control room are very old. The only way to wire was to pull cable under the road between the buildings. Access above ground was unavailable due to the dense infrastructure of equipment. “We only have nine measurements, but wiring was a logistical nightmare”, said the Systems Engineer in charge of the project. “A wired option would have cost over $135,000. It just was not an option.”

The refinery needed a cost effective solution to continuously monitor pressure, temperature, and flow of compressed air going to both the plant air system and the instrument air supply system. Online measurement would ensure timely intervention if air flow was interrupted, and also would provide information necessary to monitor the efficiency of the compressors.

SOLUTION
This customer purchased nine Smart Wireless instruments. The wireless instruments included Rosemount pressure and temperature transmitters, and DP flowmeters to monitor the new compressors. Due to the dense infrastructure of both buildings, a remote antenna for the Smart Wireless Gateway was placed on top of the building that housed the control room to optimize reliability of communications. Emerson’s Wireless Field Network was integrated into the legacy host via Modbus™ over ethernet protocol. Now operators can continuously monitor the health of the compressors from a remote location, and will automatically get an alarm if the efficiency of the compressors begins to decrease, or if there is a loss of pressure or flow.

“We only have nine measurements, but wiring was a logistical nightmare. A wired option would have cost over $135,000. It just was not an option.”

Systems Engineer
Major North American Refinery

For more information:
www.rosemount.com

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Loss of compressed air can have a significant impact on the plant, and early detection will prevent process downtime and compressor failure. Not only does wireless provide early warning, but it provides a historical trend of pressure, temperature and flow.

Instead of three manual readings per day, each Smart Wireless instrument updates the control host every minute for a historical trend of nearly 1500 points per day. That means operators can spend their time doing more productive tasks instead of travelling to the compressors every shift. Also, the high resolution of data makes troubleshooting compressor problems much easier.

This customer received the AMS® Wireless Configurator and purchased the AMS Wireless SNAP-ON™ to enhance monitoring of the wireless network. The AMS Suite predictive maintenance application provides real-time access to wireless data from any engineering console. This gives system engineers full access to the Smart Wireless instrument data, and also shows them the communication paths of each instrument. “The AMS Wireless SNAP-ON allows us to monitor and verify path stability of each instrument through the entire mesh network,” said the Project Engineer. “In fact, when an obstruction interrupted the network I watched live as the mesh network groomed itself and automatically reorganized, without interruption to any of the nine instrument signals.”

The wireless solution represented a 73% savings over the wired option, and enabled live trending of compressor data, which decreased plant downtime. Since the wired solution was cost prohibitive, the only alternative was manual readings once a shift. If operator time is valued at $50/hr., the plant saved over $50,000 per year in labor costs. This does not include the value of live trending and alarming to prevent process downtime. Overall, the Smart Wireless Network has improved reliability of the plant and instrument air supply, and enabled operators and systems engineers to work more productively.

RESOURCES

Emerson’s Smart Wireless
http://www.EmersonSmartWireless.com
HPCL Bagru Jaipur Terminal Achieves Pump Protection and Increased Safety with Wireless Level Switch

RESULTS
- Reduced unplanned shutdown and maintenance cost with pump protection
- Improved safety of equipment for longer life
- Increased equipment availability
- Saved on Operations and Maintenance costs

APPLICATION
Pump Protection

APPLICATION CHARACTERISTICS
A variety of petroleum products.

CUSTOMER
HPCL Bagru Jaipur Terminal - India’s major integrated oil refining and marketing company.

CHALLENGE
This oil refining and marketing company uses multiple pipe line division pumps which continually pump fluids from the refinery to the terminals for sale and must be kept running constantly in order to maintain production. Any mechanical damage to the equipment will result in an emergency breakdown at the pumping station. To protect the pumps, each one has a supply of lubrication oil that passes through the bearing housing and returns back to the lube oil reservoir. To monitor this, a sight glass on the flow line provides visual indication of the fluid levels. However the fluid level would vary depending on whether the circulation was on or off. Trying to keep track of the lube oil supply at each pump was a very manual process in both reading the levels at the right time and keeping records of the supply. It was proving to be an impossible task for the customer. All they really needed to

The Rosemount 2160 wireless switch replaced the gauge and provided low level alarms to a central location via the Emerson 1420 gateway.
**SOLUTION**

Rosemount 2160 Wireless Point Level Switches were installed on each of the reservoirs. The 2160’s were all connected wirelessly to the Emerson 1420 Wireless Gateway. The Gateway provided a Modbus connection to the host system. This combination allowed the Rosemount 2160’s to monitor the reservoir levels and to alarm when critical low points were reached. Reservoirs needing additional supply of lube oil can now be immediately identified.

Instead of relying on manual checks of the sight glasses, the Rosemount wireless switch and Emerson gateway system provides real time data to the operators. Since the process information is now available over the network and visible in the control room, manual collection of data is eliminated and the status of the reservoirs is known without going into the plant. This resulted in a reduction in operating costs while increasing protection of the pumps from mechanical breakdown. This in turn created an increased availability of the pumps to run the pipelines.

**RESOURCES**

Emerson Process Management Petroleum Refining Industry

Rosemount 2160 Wireless Level Switch

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**REFINING**
BP Oil Implements Rosemount 2160 Wireless Switches for Floating Roof Tilt Detection

APPLICATION
Floating roof tilt detection

APPLICATION CHARACTERISTICS
Provide safe, efficient storage of volatile products with minimum vapor loss to the environment.

CUSTOMER
BP - one of the world's leading international oil and gas companies.

CHALLENGE
With the advent of new European Union safety and environmental directives, floating roof tanks must be made safer to avoid the risk of overfill. Overfills can be detrimental from an environmental perspective as well as to human safety. An overfill can be expensive in terms of both penalty fines and public relations.

One common problem with floating roofs is that they can tilt. This allows vapors and gases to escape from the gap on the un-covered side and create a fire hazard. Once a roof starts to tilt, the lower part can begin to take on liquids on the top side. Sometimes the liquid is the hydrocarbon fluid that starts to gradually leak onto the lower portion of the roof. Other times, the liquid may be melting snow or rain water that runs down to a low point.

Subsequently, users are looking for ways to monitor floating roofs to determine that they are truly floating on the surface. Mechanical devices have been used in the past but some incidents have caused them to be prohibited. At some sites, only manual and visual inspections are used to determine the state of the roof. If fluid is present, it would be good to know if it is oil or water. A way to detect this without a trip to the top of the tank is highly desirable. In addition, EU regulations require automation of this application.

RESULTS
- EU environmental regulations for floating roof safety met
- Increased personnel safety by eliminating manual inspections
- Implemented automation for better floating roof management

The use of a repeater ensures that the wireless signal from the Rosemount 2160 is transmitted to the Gateway when the roof is at a low level.
SOLUTION
A solution to determine both the tilt of the roof and the type of fluid present was found in the Rosemount 2160 vibrating fork switch. Three of these wireless switches were installed at 120° of each other. Since they were wireless, the installation was a simple mounting connection off a support beam. To ensure that the signal would be available when the tank level was low, a repeater was installed near the top rim of the vessel. The one second updates of the switches were sent to a central engineering station by way of a Rosemount Gateway and a PLC to their control room. The visualization for each tank showed the three measurements with frequency displayed. If a switch went from a dry to a wet state, this would inform the operators that liquid was present at that location. To take it one step further, the frequency supervision function of the switch in the wet state allowed it to differentiate between oil and water as each fluid had a distinct frequency. Built-in self diagnostics of the 2160 provided additional assurance that the switch was operating properly and the power supply was good.

With the installation of the wireless 2160 switches, BP was able to make their floating roof tanks safer and meet the European Union safety and environmental directives. They automated a system that previously entailed a trip to top the tank for a visual inspection. The system was easy and economical to implement since there were no wiring costs. Built in diagnostics of the 2160 further ensured proper operation and minimized the need for validation.

RESOURCES
Emerson Process Management Petroleum Refining Industry

Rosemount 2160 Wireless Level Switch

Use of wireless vibrating level switch for floating roof monitoring.
Steel Mill Decreases Operating Costs and Reduces Environmental and Safety Risks with Smart Wireless

RESULTS
- Decreased operations and maintenance costs
- Reduced environmental and safety risks
- Improved coke quality

APPLICATION
Coke oven temperature

CUSTOMER
Steel mill in North America

CHALLENGE
This steel mill was having problems controlling the temperature in their coke ovens. It is crucial to stay within the coke oven operating limits. Low temperatures risk oven collapse and capital damage. High temperatures waste heat and increase utility costs.

Because of high wiring cost this steel mill initially had no measurement on their coke ovens and required measurement rounds twice every shift. The customer tried implementing a wireless technology in this application, but the technology was unreliable due to battery life and moving larry cars. The long communication distance increased the power consumption and therefore decreased the battery life to a couple of months. Also, the wireless technology was point-to-point and the larry cars regularly blocked the signal path, causing communication to be unreliable.

Not having a reliable coke oven temperature measurement negatively impacted this customer’s business. Routine measurement rounds increased operations and maintenance costs. It also made an environmental impact and increased the safety risks of personnel.

When the lids to the coke ovens were opened to make manual measurements, coke oven emissions were released into the atmosphere. The carcinogens and the high oven temperatures increased the safety risks of its operators. Lastly, the quality of coke exiting the oven was diminished when it did not operate at the correct temperatures.
REFINING

SOLUTION
The Rosemount 848T Wireless High Density Temperature transmitter solved the challenges this customer faced. The 848T wireless transmitter utilizes SmartPower™ technology, which provided a longer battery life for this application. It improved battery life from months to years. Also, the self-organizing network provided greater than 99% data reliability and was not affected by the lorry cars.

This customer utilized the best core technology, implementation practices, and field intelligence within the Rosemount 848T Wireless High Density Temperature Transmitter to positively impact their business. The customer decreased operation and maintenance costs because they no longer had to perform measurement rounds twice every shift. Environmental and safety risks were also reduced because the coke oven doors never had to be physically opened by an operator, exposing them to the emissions or intense heat. Lastly, the customer experienced an improvement in coke quality because it could reliably control the coke oven temperatures.

RESOURCES
Smart Wireless
http://www.emersonprocess.com/smartwireless/

Rosemount Temperature
Steel Mill Reduces Downtime, Improves Productivity Through Wireless Monitoring of Secondary Systems

RESULTS
• 5% productivity improvement, downtime reduced
• Eliminated coiling temperature rejects due to insufficient water flow
• Reduced downtime due to grease system failures
• Eliminated damage to roughing mill work rolls due to insufficient work roll coolant water
• eliminated downtime due to back-up roll bearing failures

APPLICATION
• Run-out table cooling water flow
• Grease system pressure
• Work roll coolant pressure
• Back-up roll bearing lubrication temperature

CUSTOMER
Wheeling-Pittsburgh Steel Corporation, Mingo Junction, OH

CHALLENGE
Wheeling-Pittsburgh Steel Corporation is a progressive manufacturer and fabricator of selected metal products. When the Mingo Junction mill increased the product mix with a heavier and wider material, it required more run-out table cooling water to maintain the proper grain structure throughout the strip. Unfortunately, as the new product was being rolled, the target coiling temperature could not be achieved. Manual valves used to scale the curtain flow to the proper setting for each product could not be confirmed with flow meters, since they were too expensive and difficult to install in this congested environment.

SOLUTION
When the run-out table was down, the customer installed four Rosemount 3051S Wireless Flowmeters, with Annubar® Primary Elements and one Smart Wireless Gateway. The measurements were easily integrated into the plant OSIsoft® PI System™ with a Modbus® interface through the gateway, where trending and reporting are done. “It only took two hours at the end of one day for a person to drill four holes and install the flow meters,” said Gary Borham, Operations Manager, 80-inch Hot Strip Mill. “The next day, we installed the gateway, and had the whole system working. I got the flow numbers I needed within 24 hours of installing the devices. Wireless is fantastic.” The flow information obtained from the wireless transmitters enabled Wheeling-Pittsburgh Steel to fine tune the sprays. Since then, coiling temperature rejects have been almost entirely eliminated.
The ease of installation and cost of installing a wireless device compared to its wired counterpart has convinced Wheeling-Pittsburgh Steel to use wireless on many other monitoring applications. On the same run-out table a rash of roll failures prompted the customer to look at the grease system. The rolls which deliver the strip to the coilers can overheat, and any lack of lubrication can stop the roll which will cause strip surface defects. It was discovered that the grease system was malfunctioning and not adequately lubricating the roll bearings, creating downtime and impacting productivity. A Rosemount 3051S Wireless Pressure Transmitter was installed on the system and raises an alarm if the pressure drops or cannot be maintained, so preventative measures can be taken. This has eliminated downtime from rolls freezing up.

The mill was also experiencing work roll damage and subsequent downtime in the roughing mill due to coolant flow problems. The roll failure investigation uncovered a problem with a manual valve that was closing and dropping pressure and flow to rolls. Wireless pressure transmitters were installed on each roughing stand to insure a practice of maintaining constant flow and pressure of coolant to the work rolls. Since the adjustment and practices were put in place roll failures have disappeared.

The latest secondary system to benefit from wireless technology was the back-up roll bearings. Back-up roll bearing failures cause major downtime. The customer installed Rosemount 648 temperature transmitters in the drains to determine any increase in the inlet and outlet temperatures. If an increase is detected a small delay will occur to allow time to repair the problem. In the past bearing lock-ups would cause a lengthy delay in production while the back-up rolls were changed. Lengthy, unscheduled downtime has been replaced with short repair times, and costs due to equipment damage of the back-up rolls has been eliminated.

Borham concluded that wireless technology has allowed Wheeling-Pittsburgh Steel to gain process data almost effortlessly in areas where wiring would have been too costly. “We are building an infrastructure that opens up opportunities for more applications. The result is better information from difficult-to-reach areas of the mill, and this is helping our personnel prevent unscheduled downtime, meet customers’ quality requirements, and optimize productivity.”

“The result is better information from difficult-to-reach areas of the mill, and this is helping our personnel prevent unscheduled downtime, meet customers’ quality requirements, and optimize productivity.”
Gary Borham
Operations Manager
80” Hot Strip Finishing Mill
Titanium Dioxide Pigment Manufacturer Increases Plant Availability with SmartPower™

RESULTS
- Increased plant availability
- Lowered maintenance and energy costs
- Reduced risk of low product quality

APPLICATION
Rotating calciner temperature measurement and control

CUSTOMER
Large chemical manufacturer in Southeast Asia

CHALLENGE
This titanium dioxide manufacturer had difficulty controlling a constant material temperature within their rotating calciner. The rotating calciner, which is about 40 m (131 ft.) long, has five temperature measurement points. The midpoint of these temperature measurements is used for burner control of the calciner.

The wireless temperature transmitters previously installed were purchased from a non-Emerson vendor. The devices on the calciner required frequent maintenance due to low battery life. Due to the rotation and vibration of the calciner, batteries often became misaligned. This caused intermittent measurement and resulted in soldering the battery connections. The batteries needed to be changed every one to two months because of low battery life.

The low battery life led to frequent shutdowns. These frequent shutdowns increased energy use and other operating costs. Maintenance costs were high, due to frequent battery replacement and damage to the kiln refractory liner. Inaccurate temperature measurements caused poor burner operation, which led to higher fuel consumption and higher emissions. Poor burner operation also risked low product quality.

The Rosemount 648 Wireless Temperature Transmitters allowed this pigment manufacturer to significantly improve availability of their rotating calciner and reduce unscheduled shutdowns.
SOLUTION
This customer’s problem was solved with five new Rosemount 648 Wireless Temperature Transmitters. The Rosemount 648 utilizes Emerson’s SmartPower™ technology, which significantly reduced the amount of time spent replacing the batteries. Intervals between battery replacement were increased by more than a factor of 10. The keyed connection feature eliminated alignment concerns and soldering requirements during battery replacement. Also, the self-organizing field network, provided exceptional data reliability and easy installation. The SmartPower technology also features an intrinsically safe power module that allowed field replacements without removing the transmitter from the process.

The Rosemount 648 Wireless Temperature Transmitters allowed this pigment manufacturer to significantly improve the availability of their plant and reduce unscheduled shutdowns for battery replacement. Also, maintenance costs decreased due to a reduction in trips to replace batteries and the kiln refractory liner. Energy costs decreased because the plant continued to operate at peak performance levels. In addition, having a reliable temperature control of the calciner resulted in reduced risk of low product quality, lowered fuel consumption, and decreased emissions.

RESOURCES
Emerson Smart Wireless
http://www.EmersonSmartWireless.com

Rosemount 648 Transmitter

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12. Appendix

12.1 Choosing the Wireless Standard

Wireless Meeting Your Needs

Two or more wireless infrastructures of gateways around the plant would be costly and hard to support. Corporate engineering standards for two or more wireless technologies would increase burden. A plant needs to select a single standard for wireless field network. There has been much confusing claims with respect to what wireless field network standards can and cannot do, and which differences matter, making the choice a challenge. This white paper will, with the NAMUR NE124 user requirement specification for wireless field networks as a basis, examine why IEC 62591 (WirelessHART) is the most suitable wireless plant standard for meeting practical requirements like ease of deployment and maintenance.

The wrong wireless standard could lead to limited device selection, manual data mapping, point rebuild on device replacement, new unfamiliar tools (each vendor different), site surveys, complicated communication settings, need for close liaison with IT, risk of security left off, the need to wire backbone infrastructure throughout the plant, as well as multiple ways to commission, setup, calibrate, and troubleshoot wireless transmitters.

The solution is to adopt a single corporate wireless standard, with a single common application protocol, already in use by wired devices in the plant, supporting full multi-hop mesh networking, with security always on, and designed specifically for process applications.

As a result, a single right standard ensures best practices can be leveraged company-wide. It provides broad device selection from multiple vendors, native integration, uses existing familiar tools, eliminates site surveys and complicated configuration, requires no IT liaison, and reduces risk of damaging the existing installation. Commissioning, setup, calibration, and troubleshooting are consistent.

Application Classes

NAMUR is an organization comprised of many automation end-users who jointly develop recommendations and best practices for process applications used in plants the world over. Recommendation NE124 covers user requirements for wireless in process applications including communication requirements for availability, coexistence and interoperability, security, power, integration into systems, forward and backward compatibility, network management, diagnostics, configuration and commissioning, device replacement, and certification. WirelessHART addresses these requirements.

![Figure 12.1a – NAMUR NE124 recommendation for wireless in process applications](image)

The NAMUR NE124 recommendation identifies three classes of applications. Wireless is predominantly used in class C applications (indication and monitoring), but also in class B applications (process control).
### Table 12.1b – NAMUR NE124 application classes

<table>
<thead>
<tr>
<th>Application Class</th>
<th>Description</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Functional safety</td>
<td>Time-critical applications governed by the requirements of functional safety standards.</td>
</tr>
<tr>
<td>B</td>
<td>Process control</td>
<td>Time-critical, deterministic applications requiring high availability and reliability.</td>
</tr>
<tr>
<td>C</td>
<td>Indication and monitoring</td>
<td>Applications which are not time-critical.</td>
</tr>
</tbody>
</table>

**Availability and Reliability**

A plant is a challenging environment for wireless since Radio Frequency (RF) waves do not propagate through metal such as vessels, piping, and structural steel. Below the pipe racks the range can be 50 m or less. Furthermore, daily plant activity such as moving vehicles, motors starting and stopping, rising of scaffolding, and welding constantly changes the RF environment. Disruption of the wireless communication would mean the plant falls back to its productivity level before wireless was introduced. Therefore, sites must use a wireless technology with high reliability and availability.

*WirelessHART* is a self-organizing mesh network, supporting a full multi-hop, multi-path topology. For instance, the process variable from a remote transmitter is relayed from one transmitter to the next, in up to seven hops or more, around impenetrable obstacles or RF obstructions, until it reaches the gateway. Multiple paths are maintained such that when a new obstacle appears blocking the path, an alternate path is used for the process variable to reach the gateway. All transmitters, regardless of manufacturer, participate in the mesh topology to ensure reliability needs are met. Redundant *WirelessHART* gateways are available if required. Thanks to the full multi-hop, multi-path mesh topology, a high level of productivity can be sustained.

Other topologies such as ‘star’/‘backbone’ cannot achieve the same result because each wireless transmitter in a star topology communicates directly with only one backbone router through a single path, or optionally through dual paths through two backbone routers (provided that lots of backbone routers have been installed to ensure every wireless transmitter is within range of two backbone routers). If the path is block in a single path architecture, due to changes in the RF environment by a metal object such as a forklift or tanker truck etc., communication is lost completely. If one out of two paths is blocked in the dual architecture, reliability will be reduced as updates will intermittently be lost as an alternate path is not available. See separate which paper on wireless network topology.

**Real-time Performance**

Some applications require faster updates and lower latency than others. If the update period is configured too slow, alarms may not trigger in time, and the resolution of historical trending may not be sufficient for diagnosing process problems. If update periods are configured faster than required, technicians will have to replace batteries unnecessarily often. Therefore, use a wireless technology where the update period can be configured per measurement. Automatic retries of communication to increase the reliability should occur within the specified update period. Use a gateway that keeps track of latency for each wireless transmitter such that it can be verified from wireless network management software.

Although the application for 4-20 mA/HART was device configuration and diagnostics, not process monitoring and control, *WirelessHART*...
is time synchronized and scheduled ensuring reliable communication of process variables in real-time. **WirelessHART** transmitters timestamp measurements from the original point of measurement allowing latency to be tracked and have a selectable update period adjustable from 1 second to 1 hour. It is recommended to set update period according to application requirements, but not faster, in order to conserve battery life since every time a measurement is done, the sensor draws power.

**Security**

Wireless signals reach beyond the plant boundary. Outsiders must not be able to join the network, eavesdrop, modify, delay, or send data, etc. If security was breached, production and inventory data could be revealed, or safety compromised. Therefore wireless communication in any application requires encryption, authentication, and other security measures. A remote site that deploys a Wi-Fi backhaul network should also consider the security of the backhaul network.

**WirelessHART** security measures include encryption, authentication, verification, key rotation, and sequence numbers. Most importantly, security cannot be turned off; it is always on. Commissioning a wireless transmitter includes assigning a secret join key (password) which should not be done wirelessly. All **WirelessHART** transmitters have a wired HART maintenance terminal where the handheld field communicator or laptop interface that all plants already have can be connected to securely commission the transmitters before any wireless communication commences. **WirelessHART** does not use IP addressing in devices. Thus **WirelessHART** makes it easier to maintain security.

Wireless transmitters based on other technologies cannot provide a comparable result because security can be turned off, and they use wireless or non-standard interfaces instead of the standard HART maintenance terminal.

**Coexistence**

The wireless field network has to operate at the same time as many other wireless network technologies in the same 2.4 GHz band such as Wi-Fi, Bluetooth, and ZigBee etc. Therefore, use a wireless technology which supports coexistence with other wireless technologies.

**WirelessHART** uses the IEEE 802.15.4 standard radio which uses Direct Sequence Spread Spectrum (DSSS) modulation enabling coexistence with other wireless networks. Additionally, **WirelessHART** uses channel hopping as well as channel black listing, further improving its ability to coexist with other radios. A common application is to use **WirelessHART** for the transmitters in a remote application such as a tank farm or wellhead, together with Wi-Fi for the backhaul of the data gathered, to a central location.

**Interoperability and Interchangeability**

Process applications require many types of measurements such as flow, level, valve position, pH, conductivity, vibration, temperature, pressure, and acoustic as well as on/off contact input and level switches. These measurements may come from different transmitter manufacturers. If communication with a broad range of transmitter types is not available, applications cannot be solved, and plant productivity could not be improved. Therefore, use an open wireless standard enabling a single common wireless infrastructure, without different types of gateways, device drivers, and configuration software for each type of wireless transmitter. The wireless standard must also include common security measures. If a remote mounted antenna is required for the application, use a gateway with a standard coax connector.

**WirelessHART** (IEC 62591) is the only international standard for wireless communication in process applications for which products are available. Most importantly, **WirelessHART** is based on a single common application protocol which all **WirelessHART** devices use. Thus all **WirelessHART** transmitters of many different types from many manufacturers...
integrate into the system the exact same way using
the same application protocol, through the same
gateway, without the need for multiple drivers, using
a common way of configuration. This makes it easy to
solve diverse application needs using WirelessHART.

Wireless solutions based on other technologies
relying on “tunneling” many application protocols
will result in wireless transmitters around the plant
using different protocols and therefore the system
need gateways and drivers for all these different
tunneled protocols. The system has to have data
mapped differently for each tag as required by the
tunneled protocol making it difficult to engineer
as well as maintain and troubleshoot in the long
run, and it does not make devices using different
protocols work together. While “tunneling”
theoretically appears to be a good protocol-
independent solution, the reality is that mixing
application protocols adds complexity.

Transparent System Integration
Plants already have digital devices using hardwiring
and bus integrated in intelligent device management
software, predominantly using Device Description
/DD) or the newer enhanced Electronic Device
Description Language (EDDL) device integration
technology. Using another technology and
establishing new practices would increase the cost of
adoption. Therefore, use a wireless technology that
supports the EDDL standard (IEC 61804-3)
such that a single common system software
application supports configuration and diagnostics
for wireless transmitters from multiple vendors
as well as the wired system in place today. New
control systems should have native integration of
the wireless gateway such that process variables
appear automatically without manual database
configuration for mapping parameters via
intermediate data registers.

WirelessHART supports EDDL (www.eddl.org),
enabling WirelessHART transmitter integration in
existing intelligent device management software,
regardless of manufacturer. When the EDDL file for
the WirelessHART transmitter is loaded, the system
automatically picks the correct EDDL file for the
transmitter, without manual association.

Native integration also means that overview
faceplate, configuration/setup, and device
diagnostics can be accessed directly from the control
system in a few simple clicks.
Wireless network planning software can be used to ensure the network is reliable before the first device is deployed, as well as providing real-time network diagnostics once network is live. Mesh topology network planning software is available for validation of WirelessHART network design criteria before installation.

Most importantly, mesh topology makes network design and installation easy by eliminating the need for backbone routers and associated wiring for power and backbone network. Thus engineering and integrating a WirelessHART system is easy.

Other device integration technologies require manual association (configuration) between the driver software and the device. A star/backbone topology requires meticulous planning and design to ensure sufficient backbone routers are installed within reach of devices in every nook and cranny of the plant.

**Version and Lifecycle Management**

A control system has an expected lifespan of 15 years or more. Over its lifecycle, new types and versions of wireless transmitters will come into the plant. The control system must be kept up to date with these to avoid obsolescence. Therefore, use a device integration technology which has no dependency on Microsoft Windows version thus ensuring backwards and forwards compatibility between system and wireless transmitters.

The EDDL technology is a text-based standard (IEC 61804-3) totally independent of Microsoft Windows. DD files for WirelessHART transmitters can be downloaded from the Internet and loaded onto the control system. Thus new versions of WirelessHART transmitters can be deployed and all the setup/configuration and diagnostics be accessed, without having to upgrade the Windows version on the control system. See separate white papers on the EDDL site: www.eddl.org

Other device integration technologies based on Microsoft Windows technologies such as COM, ActiveX, and .NET are dependent on Windows version and .NET version, requiring frequent upgrades of the many drivers, resulting in undue burden on the system administrator.

**Battery**

A preferred wireless technology enables battery life of several years. Replacing batteries requires manpower, and inserting old and new battery cells together in a transmitter, or using a battery which has been dropped, could result in a hazard. Battery cells which are permanently encapsulated into modules prevent mixing discharged cells with good cells. Use battery modules which are intrinsically safe to enable replacement in hazardous areas, such that the transmitter does not need to be moved to a safe area for battery replacement. Make sure to use transmitters where the configuration is not lost while the battery is replaced.
WirelessHART uses the extremely low-power IEEE 802.15.4 radio signal. Sensors are turned off between measurements. Thus WirelessHART transmitters in a mesh topology enable a battery life of up to ten years depending on sensor type and update period.

**Wireless Network Management**

Preventing network disruptions and effective troubleshooting are key for an easy to manage network. Therefore, use a wireless technology which provides standard communication status such as signal strength and number of neighbors from all transmitters in the network, regardless of manufacturer. Use a gateway that tracks communication statistics such as missed updates, discarded updates, reliability, path stability, signal strength, latency, number of re-joins, and timestamp for last join, as well as maintains a “live list” with node state, and if service is denied due to network load. Also use network management software which continuously monitors network health and battery status, and displays it graphically for an easy overview of problem locations.

The WirelessHART standard provides communication status for all transmitters.

**Products and Software**

Some applications can’t be solved using equipment from only a single vendor. To cover transmitters for all measurements, gateways, and interfaces as well as software for configuration, troubleshooting and historians, it’s probable that multiple vendors will be required. Therefore, use a wireless technology with broad support from many manufacturers. This should include a gateway with OPC, Modbus, and Ethernet connectivity into any third-party control system; to get process variable into the DCS. Full transmitter setup and diagnostics information from the intelligent device management software must also be supported. Wireless adapters for 4-20 mA/HART devices shall also be available in order to transmit smart device information into intelligent device management systems for legacy DCS that do not support digital HART communication. 4-20 mA and on/off signal input converters, should also be available. Use rugged, industrial grade, field mounted components, suitable for hazardous areas.

The WirelessHART standard has broad support from more than a dozen renowned manufacturers of process instrumentation providing a wide selection of WirelessHART transmitters, adapters, and gateways. The HART-IP protocol over Ethernet from the gateway ensures full access to WirelessHART transmitter configuration and diagnostics. Thus complete and robust applications can easily be achieved using WirelessHART.

WirelessHART can be integrated to any system. That is, WirelessHART does not limit system selection, and does limit device selection.
Other wireless technologies tunneling a mix of multiple protocols make the setup of a homogenous system a real challenge.

**Device Configuration and Commissioning**

If it is difficult to commission wireless transmitters, this could cause startup delays. Therefore, use a wireless technology where the same handheld field communicator and EDDL-based laptop software which the technicians are already familiar with can also be used to commission the wireless transmitters. For simplicity, use transmitters for which the manufacturer provides an intelligent device management user interface with guidance in the form of wizards, help text, and illustrations.

All WirelessHART transmitters can be commissioned using the same handheld field communicator as the wired 4-20 mA/HART and FOUNDATION fieldbus devices which plants already have. The WirelessHART protocol has been optimized for process applications, eliminating the need to adjust complicated communication settings in transmitters in order to make them work. Thus commissioning WirelessHART transmitters is easy for technicians to learn.

Wireless transmitters based on other technologies are not as easy to commission because they do not have standard maintenance terminals for HART handhelds, they use IP addressing which may require the IT department to get involved, and they require configuration of slot time, arbitration method, hopping sequence and other advanced communication settings.

**Device Diagnostics and Replacement**

Over time, due to the harsh operating conditions, transmitters will eventually fail. If replacement is difficult and takes too long, the plant falls back to its productivity level before wireless was introduced. Therefore, use a wireless technology where a replaced transmitter can integrate with the system automatically without reconfiguring the system. For simplicity, use transmitters with rich self-diagnostics and for which the manufacturer provides a user interface with troubleshooting tips. Use a control system which includes intelligent device management software. Make sure wireless transmitters have a maintenance terminal for handheld field communicator for diagnostics in the field.

The WirelessHART standard includes universal commands to monitor the process variable, common for all WirelessHART transmitters. Therefore a WirelessHART transmitter can be replaced with another without reconfiguring the system. Universal commands and specific commands allow access to all diagnostics in the transmitter, making WirelessHART transmitters easy to troubleshoot.

Wireless transmitters based on other technologies are not as easy to replace because transmitters tunnel different application protocols, such that a transmitter replacement requires a complete point rebuild in the system by a system engineer.

**Certification**

If wireless transmitters are unable to join the network, the plant commissioning and startup would be delayed. Therefore, use a wireless technology where interoperability and standard conformance is tested by an independent third-party.

WirelessHART transmitters are interoperability tested by the HART Communication Foundation providing trouble free commissioning in the field.

![Figure 12.1m – HART Communication Foundation certificate](image)

**Implementation Strategy**

Unique features of WirelessHART includes a full multi-hop, multi-path mesh topology, an application protocol common for all WirelessHART devices, the ability to use the same handheld field communicators and software as 4-20 mA/HART and FOUNDATION fieldbus devices, secure commissioning, security
which is always on, and commissioning without advanced communication settings or IP addressing. By selecting the WirelessHART standard just like thousands of other plants have done, users can ensure they can build a wireless network that meets their current and future needs.

<table>
<thead>
<tr>
<th>NAMUR NE124 Clause</th>
<th>Description</th>
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<td>3.2</td>
<td>Availability and reliability</td>
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<td>3.3</td>
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<td>3.7</td>
<td>Transparent integration in DCS</td>
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<td>3.8</td>
<td>Version and lifecycle management</td>
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<td>3.9</td>
<td>Long battery life</td>
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<td>5.2</td>
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</table>

References
“Wireless Meeting Your Needs”, Industrial Automation Asia, Feb/Mar 2012, p40
12.2 Wireless Network Topologies

It should be possible to deploy wireless in an existing plant without installing lots of network infrastructure in the midst of the plant and running an inordinate amount of cables. This can only be achieved with a full mesh topology, and it reduces the risk of damage to the existing plant.

Most, if not all, wireless network literature illustrate star and mesh topologies with almost indistinguishable similarity. The huge difference between these two topologies and the importance for reliability and ease of deployment, and the huge implications for plant operation, is therefore not well understood. This white paper will make the difference and their significance clearer.

**Network Topologies**

Typically star topology and mesh topology illustrations are greatly simplified with only a few transmitters, each network having a gateway. This makes the two topologies look almost the same, and may inadvertently give the impression they have comparable characteristics.

However, once the application goes beyond more than a few clustered transmitters, the difference becomes clear. Star topology requires multiple backbone routers, a backbone network, plus a gateway, while mesh topology requires only a gateway.

**Star Topology with Backbone**

Star topology is used in home/office wireless networks. In a star topology, such as for some wireless sensor networks, each transmitter communicates with a backbone router in a point-to-point fashion. A transmitter does not route process variables from other transmitters. That is, transmitters do not communicate with other transmitters.
In a plant environment, star topology requires multiple backbone routers which have to be networked together using a backbone network to route the data to the gateway on to the system. For this reason the term “backbone router” is used instead of “access point”. That is, the star-backbone topology uses both backbone routers and a gateway. The backbone network is either wired copper, fiber optic Ethernet, or wireless Wi-Fi. Either option requires installation work, and installing the backbone network in an existing plant would be very disruptive and carries risk as field junction boxes and cable trays have to be opened and modified.

**Backbone router power**

Power must be provided for each backbone router. Power supply must come from redundant sources to avoid a single point of failure. Hazardous area requirements have to be observed for both Ethernet and power wiring. Running wiring to the many backbone routers is counter to the concept of wireless.

**Copper wire backbone**

For indoor plants it is possible to use copper wire Ethernet. A wired Ethernet backbone requires copper LAN cable to be laid from the gateway to each backbone router. Wired Ethernet distance is limited to 100 m. Due to the short distance and ground potential differences, application of copper Ethernet is usually limited to indoor plants. Laying this cable comes at a high cost, and in an existing plant poses a risk of damaging the existing installation as cable trays and junction boxes throughout the plant have to be opened and modified to accommodate Ethernet switches. Additional field junction boxes will likely be required. Rugged industrial Ethernet switches supporting the Rapid Spanning Tree Protocol (RSTP) and IEEE 1588 v2 Precision Time Protocol (PTP) have to be used.

**Fiber-optic backbone**

Outdoor applications require the use of fiber optic Ethernet media for the backbone network to achieving longer distance and avoid issues with ground potential differences. This requires fiber optic media converters to be installed. Power is required for both media converters and backbone routers.
Wi-Fi backbone

Wireless LAN to the IEEE 802.11-series of Wi-Fi standards is a third option for the backbone network. That is, a second wireless network to support the first. This option requires industrially hardened Wi-Fi access points in an outdoor enclosure to be installed throughout the plant. Even with a Wi-Fi backbone network, power cables still has to be run out to each and every backbone router; a considerable planning and installation effort for an existing plant. Redundant power has to be run to each Wi-Fi access point in the plant.

![Figure 12.2i – Outdoor Wi-Fi access point (Courtesy: Cisco)]

Each backbone router has to be within line of sight of the Wi-Fi access points. Wi-Fi in an industrial environment requires mesh topology where multiple Wi-Fi access points are within line-of-sight of each other. This requires additional design effort. At site, validation and additional backbone routers to ensure a robust mesh backbone.

Hardware exists that combine wireless sensor network backbone router and Wi-Fi access point in the same enclosure. Due consideration should be given before choosing hardware integrating wireless sensor network and Wi-Fi in the same enclosure. The radios in the enclosure and their antennas are different. Antennas should be kept 1 m apart, which means separate external antennas should be used. Another point to consider is that Wi-Fi standards used in office and consumer products evolve much faster than wireless sensor network standards, Wi-Fi seeing a new version released every few years. It may be a good idea to keep separation between the wireless sensor network and the Wi-Fi backbone network such that they can be upgraded independently if need be.

**Star Topology without Backbone**

In a star topology without backbone a single integrated gateway is used. This architecture is only capable of very small deployments because all wireless transmitters have to be with two hops of the integrated gateway.

Mesh Topology

Mesh topology is used in industrial wireless networks to circumvent impenetrable steel objects. In a mesh topology, as used by WirelessHART, transmitters are able to talk with the gateway and with other transmitters. That is, a transmitter is able to route process variables from other transmitters enabling process variables to travel from transmitter to transmitter until it reaches the gateway. That is, WirelessHART use routing function built into the transmitters themselves instead of having to install backbone routers. This topology without any backbone routers is referred to as a full mesh topology. That is, a full mesh topology eliminates the need for backbone network and backbone routers, thus minimizing the risk of installation damage to the existing plant.

In mesh topology, only a single, optionally redundant, gateway is required for up to 100 transmitters. Thus the control/plant network from this single the gateway to the system becomes very simple. The single, optionally redundant, gateway can be installed at the edge of the plant area such as Local Equipment Room (LER), Field Auxiliary Room (FAR), or Process Interface Building (PIB), so that wires need not be run to the middle of the plant unit. Laying this cable is therefore low cost, and in an existing plant poses less risk of damaging the existing installation.

![Figure 12.2j – Full mesh topology only requires gateway since routing is done by the transmitters](image)

**WirelessHART transmitters are time synchronized and scheduled ensuring that each process variable is communicated in its dedicated timeslot ensuring multiple process variables are not colliding in a “traffic jam”.”**
Coverage

Wireless has been used successfully in long-distance outdoor SCADA applications for many years, using tall masts to clear obstructions such as hills or earth curvature. However, applications inside plants are very much more demanding.

All wireless sensor networks such as IEC 62591 (WirelessHART), ISA100.11a, and ZigBee, use the same radio standard: IEEE 802.15.4. The range for all these protocols is therefore the same. In an unobstructed “line of sight” (LOS) outdoor application such as an open field, dessert, or over waters the maximum transmission range could be as far as 250 m, 600 m, or even more depending on the antenna used (antenna gain) etc. However, inside a plant these maximum transmission ranges become irrelevant because metal obstacles in the plant such as pipe racks, vessels, and structural steel are impenetrable to radio waves and can reduce the maximum range to 100 m, 50 m, or even less depending on density of these obstructions. The short range inside the plant has been a challenge for wireless coverage inside plants, until now.

Dueling Range Claims

In a plant environment, a line-of-sight range of hundreds of meters or even kilometers does not matter because in the plant the obstructions are very much closer.

Star Topology Coverage

Because in a star topology, transmitters do not talk to other transmitters, when deployed in a plant environment, a star topology will require lots of backbone routers throughout the site so that every transmitter, in every nook and cranny of the plant, will be within range of a backbone router. The large number of backbone routers will come at a high cost. A pure star topology would not be practical in a plant environment. Therefore, some transmitters will inevitably need the routing function to be turned on. This may be called a “mixed topology”.

However, mixed topology protocols only support device-routing in four hops. This is not sufficient for process variables to work their way around all obstacles in some plant environments. Therefore, in spite of four-hop device-routing, a very large number of backbone routers are required for coverage, which is very costly.

Mesh Topology Coverage

Mesh topology is a better solution. Because in a mesh topology, a process variable is relayed from transmitter to transmitter for long distance and around multiple obstacles until it reaches the gateway. With WirelessHART, process variables can be relayed seven or more times between transmitters to circumvent obstacles and sources of noise. That is, all transmitters do not have to be within the range of the gateway. A transmitter just has to be within range of a few other transmitters. For this reason, a full multi-hop mesh topology is more important than maximum range of the transmitter. A mesh topology only requires a single gateway. This single gateway is low cost.

Radio blind-spots are hard to predict. Backbone routers are hard to add. Meshing repeaters are very easy to add. That is, it is much easier to fortify a mesh network than a star topology network.

Availability and Reliability

The plant radio frequency (RF) environment is very dynamic. From time to time tanker trucks or railcars, forklifts, compressors, gen-sets, or scaffolding, or other impenetrable metal objects may temporarily obstruct radio signals which can normally pass. For this reason traditional RF “site surveys” do not work inside plants, because from time to time the RF environment will be very different from what it was during the site survey. This ever-changing nature of the plant environment has been a challenge for wireless reliability inside plants, until now. To achieve greater reliability for the wireless communication, redundant communication paths have to be established from the wireless transmitters such that paths can dynamically adapt to changes in the RF environment.
Reliability of Star Topology with Backbone

Redundant path communication from the transmitters in a star topology is referred to as duocast. This requires pairing of backbone routers. That is, redundant pairs of backbone routers are used instead of singly backbone routers. The cost of the backbone routers and backbone network may be high. Each pair of redundant backbone routers must be installed such that each wireless transmitter is within line-of-sight of a pair of backbone routers. Ensuring that every wireless transmitter in the plant is within line-of-sight of a pair of backbone routers, and not obstructed by metal vessels, pipes, and structural steel will require careful planning of the backbone router location. Each pair of redundant backbone routers forms an IP-subnet. A different channel hopping pattern shall be configured for each subnet to enable coexistence. Redundant power and backbone networking is required for the backbone routers.

The radio frequency (RF) environment in the plant is constantly changing, such as obstructions, sources of noise, or other radios. If one of the two duocast paths stop working, it is necessary to make changes to the wireless infrastructure installation to ensure the second duocast path is reestablished since redundancy should never be operating in degraded singly mode for too long. This can be a challenge in an operating plant.

Reliability of Star Topology without Backbone

The low reliability of star topology is the main reason why wireless transmitters were not used inside plants the past.

Reliability of Mesh Topology

Mesh topology is a better solution. Transmitters in a mesh topology establish multiple redundant communication paths with neighboring transmitters, typically three or more, ensuring there is no one single point of failure. That is, if one path is obstructed, the process variable will instantly switch to one of the other paths. The more transmitters there are in the network, the more paths become possible. WirelessHART supports self-organizing mesh topology, meaning that all transmitters report back communication health which is used to optimize the communication paths. When an obstruction occurs, the rerouting of the path is instantaneously and totally automatic, requiring no manual reconfiguration. When new transmitters join or leave the network, the network is dynamically re-optimized without human intervention. The system also makes sure that all process variables are not routed through the same “pinch point”.

Once mesh topology was introduced, wireless transmitters have been adopted very quickly.

The WirelessHART gateway keeps communication statistics making it possible to tell the health of the network. This includes number of neighbors, missed updates, discarded updates, reliability / path stability or packet error rate (PER), signal strength, number of joins, and join time.
Interoperability

Interoperability is achieved by standards.

Interoperability of Star Topology with Backbone

There is no standard for the backbone protocol used between backbone routers in a star-backbone topology. That is, the backbone network uses standard media such as copper Ethernet or Wi-Fi, but the backbone application protocol is not standardized. The drawbacks of proprietary networks are well understood. All backbone routers in a plant have to come from the same manufacturer. This makes the plant highly dependent on a single vendor for the backbone infrastructure. For example, if the network has to be expanded with additional backbone routers in the future, they must be purchased from the same manufacturer as the existing backbone routers. This dependency often results in higher prices. Similarly, if a backbone router fails, a spare must be purchased from the same manufacturer at high cost. That is, backbone routers from different manufactures, both using Ethernet and both using TCP/IP, will not work together, even if the wireless sensor network protocol is the same, because the backbone protocol is not the same.

Interoperability of Mesh Topology

Since a full mesh topology does not require backbone routers, no such dependency on a single vendor exists.

Mesh Topology Battery Life

A wireless transmitter consists of a sensor, measurement electronics, local display, and radio with antenna. WirelessHART transmitters are time synchronized and scheduled and have automatic power management that allows them to go into deep sleep most of the time, and then wake up at the right time to measure, and send their own process variables as well as relay process variables from neighboring transmitters. This deep sleep minimizes power consumption thereby maximizing battery life. Long battery life means low maintenance.

For instance, when the update period is set to one minute, the transmitter will be in deep sleep for just under a minute, then wake up, turn on its sensor, perform the measurement, then turn on the radio to communicate the measured value just in time, and then go back to sleep again. The radio transmission has a 10 ms timeslot, but the actual transmission time is about 4 ms. That is, the transmitter is not ‘on’ all the time. The radio “air time” is minimal.

It’s the Update Period

Sensors consume more power than the radio, therefore battery life is mainly determined by measurement update period, not network topology.

In a mesh topology the radio is also turned on to relay process variables from neighboring transmitters. However, the sensor and measurement electronics are the part of the transmitter which consumes the most power. The radio consumes much less power. Therefore, relaying values from other wireless transmitters which only takes 4 ms of radio time requires extremely little power because the relaying transmitters do not have to turn on their sensor, measurement electronics, or display to relay other process variables. Therefore, data traffic for mesh routing does not have a major impact on overall battery life.

The routing function in each transmitter is dynamically turned on or off as required depending on if process variables from neighboring transmitters have to be routed or not. The network management function (usually in the gateway) routes communication through separately powered devices such as wireless adapters when possible.
The main determining factor for battery life is not routing or non-routing (mesh or star topology), but the type of sensor and update period. For example, a vibration transmitter accelerometer consumes more power than a pressure sensor, which consumes more power than a temperature element. WirelessHART transmitters with multiple update periods coexist in the same WirelessHART network such as 1 second, 1 minute, or 1 hour making it possible to optimize update time and battery life according to application requirements of each measuring point. For instance, in the same WirelessHART network, DP flow transmitters can update at 4 seconds, pressure transmitters at 16 seconds, temperature transmitters at 1 minute, DP level transmitters at 2 minutes, and vibration transmitters every 30 minutes and so on.

**Mesh Topology Latency**

Each hop in a WirelessHART mesh topology only takes 10 ms. Therefore, even for a path along seven hops, the total transmission time is small. In comparison to typical update periods, latency is not significant.

**Star-backbone Topology**

1. One transmitter is located on the same side of an obstruction as the gateway (star topology proprietary backbone LAN in red).

2. Another transmitter is located on the other side of the obstruction

3. To reach the transmitter behind the obstruction, a star topology has to add another backbone router which requires power supply cabling and proprietary backbone networking. However, the mesh topology only has to add another transmitter, which requires no power or networking. Moreover, the transmitter can perform a useful measurement.

**Example**

The power of device-routing can perhaps best be explained through an example: if a transmitter is located on the other side of an obstruction, to reach this transmitter, a star topology has to add another backbone router on the other side of the obstruction. This backbone router in turn requires power supply cabling and proprietary backbone networking. However, the mesh topology only has to add another transmitter, which requires no power or networking. Moreover, this transmitter can perform a useful measurement. A transmitter is lower cost and far easier to install, and with less risk, than a backbone router. This is the reason why mesh topology does not require multiple gateways.

**Large Scale Networks**

For plants that have many WirelessHART transmitters or are sprawled out across multiple areas, best practice is to install one WirelessHART gateway in each area, distributing the transmitters, keeping each wireless sensor network small (“don’t put all...
eggs into one basket”). Multiple wireless sensor networks are integrated between plant units over the wireless (Wi-Fi) or wired (Ethernet) control or plant network using the standard HART-IP protocol providing architecture with plant-wide converge. Each plant area typically has its own DCS controller, so it makes sense to have a wireless sensor network and gateway per DCS controller. This ties in nicely with the instrumentation responsibilities for the plant areas – i.e. the gateway and the DCS for the plant area only connect with the wireless transmitters in that plant area, not with wireless transmitters all over the site. The gateway has built-in firewall for cyber security. Standard HART-IP is an integral part of the HART protocol, enabling native integration of WirelessHART gateways into control systems. The gateway is line powered, and Ethernet/Wi-Fi backhaul is high data rate.

**Commissioning Acceptance Criteria**

At the time of wireless network commissioning, a checkout procedure confirms the wireless network is robust and will operate reliably. Audit metrics include:

- Signal strength (RSSI) for all transmitters shall be $>-75$ dBm
- Reliability $>99\%$ for all transmitters
- All transmitters to have at least two wireless paths (redundancy), enabling the network to tolerate changes

**Conclusion**

Mesh topology as used by WirelessHART provides a lower cost solution, with greater coverage, greater reliability, and can be installed with less risk. Limitations of star topology is one of the main reasons wireless transmitters were not used inside plants the past. Once mesh topology was introduced, wireless transmitters have been adopted very quickly.

**References**

3. “Wireless meeting your needs”, Industrial Automation Asia, February 2012
4. “Hart-IP: Large Scale System Integration”, Control Engineering Asia, April 2013

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1. The IEC 62591 technology supports many more than 100 transmitters per network, but 100 transmitters is the recommended maximum loading.
2. The range depends on transmit power and antenna gain which is limited by national regulations and is the same for all protocols. Range also depends on radio chip receiver sensitivity, and since all protocols can use the same radio chip the range for all protocols using IEEE 802.15.4 are the same. Any difference in range is product specific, not protocol specific.
12.3 Same Familiar Tools for Wireless

Just like 4-20 mA/HART and FOUNDATION fieldbus transmitters, Wireless transmitters need setup/configuration, calibration, and troubleshooting/diagnostics etc. Wireless transmitters also require “provisioning” to prepare it for joining the wireless network. That is, the tasks performed on a wireless transmitter are largely the same as for 4-20 mA/HART or FOUNDATION fieldbus transmitters. It therefore makes sense to use the same tools for wireless devices as for 4-20 mA/HART and FOUNDATION fieldbus devices.

Maintenance Port

Wireless devices need to be configured with a network ID and a secret join key before they can join the wireless network, a process known as “provisioning”. Because it has to be secret for security reasons, provisioning cannot be done wirelessly. Only after provisioning has been done, does the device have the necessary security credentials to commence secure wireless communication. For this reason, provisioning has to be done over wires or other secure means such as infrared.

Other wireless network technologies do not specify a standard maintenance port. This means that every manufacturer has a different interface port on their transmitter for provisioning and other maintenance purposes. Some manufacturers of wireless devices using other wireless network technologies have opted to use infrared communication. Other manufacturers may opt for other interfaces. Since the handheld field communicators and laptops which are used in plants for commissioning, configuration/setup, calibration, and diagnostics/troubleshooting of 4-20 mA/HART and FOUNDATION fieldbus devices today support this port, WirelessHART enables plants to use the same familiar tools also to handle the wireless transmitters.

Common Tools

That is, no special tools are required to provision WirelessHART devices. All plants already have a handheld field communicator for their 4-20 mA and FOUNDATIONHART devices, sometimes also a laptop with configuration software in their workshop for their 4-20 mA and FOUNDATION fieldbus devices, and maybe even a documenting calibrator for their 4-20 mA and FOUNDATION fieldbus devices. The people around the plant are already familiar with these tools.
Figure 12.3c – Configuration software for 4-20 mA/HART and FOUNDATION fieldbus also work for WirelessHART

Figure 12.3d – Documenting calibrator for 4-20 mA/HART and FOUNDATION fieldbus also work for WirelessHART (courtesy of Beamex)

Provisioning
For WirelessHART, the join key can be automatically generated by the system, so that the user need not do it manually, and it doesn’t get seen. The join key can be the same (shared) by all devices on the network, or each device can have a unique network ID, known as an Access Control List (ACL). Once the WirelessHART device joins the network, the system will automatically detect the device based on its HART tag. There is no hassle of transferring any “provisioning files” to the gateway. If the network ID is changed in the WirelessHART gateway, the gateway will automatically update all the devices in the network. There is no need to provision the devices again.

Other wireless network solutions require devices to be commissioned again if the network ID is changed for the network. Other wireless network solutions require a “provisioning information file” to be generated from the provisioning tool, transferred to the network management software on a separate computer, and then downloaded to the gateway. The provisioning information files have to be managed (stored) carefully.

Same Procedures
Another benefit of using the same tools and application protocol for WirelessHART transmitters is that WirelessHART transmitters are setup/configured, calibrated, and diagnosed the same way using the same tool as 4-20 mA/HART and FOUNDATION fieldbus devices. That is, plant technicians already have the tools, and are already familiar with the procedures to use them. 4-20 mA/HART, FOUNDATION fieldbus, and WirelessHART all use the Electronic Device Description Language (EDDL). Thanks to EDDL (www.eddl.org), 4-20 mA/HART, FOUNDATION fieldbus, and WirelessHART have user interfaces which are very similar. This makes it easy to manage a mix of different devices.

Figure 12.3e – 4-20 mA/HART, FOUNDATION fieldbus, and WirelessHART devices “look & feel” the same way making them easy to use
References
1. “Smart Transmitters: Standardisation In Operation”, Industrial Automation Asia, April 2011
4. “Wireless meeting your needs”, Industrial Automation Asia, February 2012
12.4 Cisco Emerson Coexistence Paper

Coexistence of wireless technologies in an open, standards-based architecture for in-plant applications

Some process operations may have been hesitant to adopt in-plant wireless applications because of concerns that radio frequency interference between wireless solutions could affect the reliability of essential communications. An open, standards-based wireless architecture from Emerson Process Management and Cisco Systems addresses these concerns by using mesh network technology and other methods to provide high levels of communication reliability at both the field-network and plant-network levels. Coexistence tests of real-world applications using this architecture demonstrated no noticeable impact on network reliability.

Introduction

New in-plant wireless technologies are gaining market acceptance in the process industries because they offer lower installed cost and faster deployment than traditional wired solutions. Example applications include monitoring process and equipment conditions, giving workers easy access to information from anywhere in the plant, and tracking mobile assets and personnel.

However, some operations may have hesitated to adopt these and other new applications because of concerns that radio frequency (RF) interference between various wireless technologies – such as radios using the IEEE 802.11b/g and IEEE 802.15.4 [1] protocols -- might affect the reliability of essential communications.

Because 802.11 and 802.15.4 radios use the same Industrial, Scientific and Medical (ISM) 2.4GHz non-licensed frequency band, questions have been raised about how these technologies would work together. However, much of the prior research on this issue has focused on static channel operation of both radio types. Information has not been available on real-world coexistence of devices using more recent advancements such as channel hopping and mesh network technology.

Coexistence Basics

Coexistence is defined as “The ability of one system to perform a task in a given shared environment where other systems have an ability to perform their tasks and may or may not be using the same set of rules” [2]. It is measured by end-to-end message delivery success rate.

Coexistence problems can occur when two or more transmitted packets with sufficient interference energy “collide” or overlap in time and frequency – unless the network is designed to avoid or mitigate the effects of those collisions. Mechanisms used to combat coexistence issues may include:

- Frequency diversity – Channel hopping
- Time diversity – Time Division Multiplexing and Clear Channel Assessment
- Power diversity – Low power output (<= 10dBm)
- Space diversity – Mesh technology that allows for space coverage through multiple hops instead of using just output power.
- Coding diversity – Use of advanced Direct Sequence Spread Spectrum

An open, standards-based wireless architecture from Emerson Process Management and Cisco Systems uses several of these advancements to provide high levels of communication reliability at both the field-network and plant-network levels. Extensive testing of multiple applications within this architecture has shown that these technologies can and do coexist very well even under the most difficult circumstances.

There are other aspects of network design that need to be considered when deploying a comprehensive wireless network implementation. These other aspects include security and network management. This paper is focused on addressing RF compatibility and how that is achievable today with Emerson / Cisco joint implementations. Cisco and Emerson have solutions to address these other areas (such as security and network management), and both companies are committed to continue testing and publishing best practices for wireless network implementations in the process industries.

The authors gratefully acknowledge the assistance of Kris Pister of Dust Networks, who contributed data and background information for this paper.
The diagram below shows areas of potential interference between transmissions using IEEE 802.11b/g (Wi-Fi) and IEEE 802.15.4 radios.

For overlapping channels, 802.11b/g radiated power is 10-100 times indoors than that of 802.15.4, and up to 4000 times for outdoor 802.11b/g mesh.

For non-overlapping channels, 802.11b/g side-slopes will impact 802.15.4 channels falling in the guard band between 802.11b/g channels (in purple in the preceding figure), though to a lesser degree. These channels are 15, 20, 25 and 26 in North America and 15, 16, 21 and 22 in Europe.

Although previous research and testing in this area has shown an impact by 802.11b/g on 802.15.4, it is important to note that none of this testing involved radios that used the techniques mentioned above, which are combined in a method called Time Synchronized Meshed Protocol [3] -- an approach which would be expected to reduce the effect of interference.

The effect of extremely low-power 802.15.4 radios on 802.11b/g should also be minimal.

**Wireless Architecture**

Emerson and Cisco together offer an open, standards-based in-plant wireless architecture that benefits from Emerson’s industry-leading technology in process automation and from Cisco’s leading technology in Internet-protocol (IP) infrastructure.

Because both companies are familiar with users’ concerns about coexistence, the wireless networks at both the field and plant levels of this architecture were designed specifically to provide robust, reliable communications under in-plant conditions.

**Wireless Field Network**

Emerson’s Smart Wireless field network solutions take advantage of self-organizing mesh network technology using IEEE 802.15.4 radios. This is the same technology that is the basis for the WirelessHART standard [4].

The mesh capability provides redundant communication paths (path diversity) for better reliability than solutions that require direct, line-of-sight communication between each device and its gateway. Whenever there’s a change in the network or environmental conditions that affect communications, the devices and gateways work together to find a path that optimizes data reliability while minimizing power consumption.

Other features also enhance communication reliability. Pseudo-random channel hopping provides frequency diversity. Time Division Multiple Access (TDMA) provides time diversity by ensuring only one device is talking on the channel at a time. Low-power devices provide power diversity. And Direct Sequence Spread Spectrum (DSSS) provides about +8dB of coding gain/diversity.

These capabilities help avoid problems not only with RF interference from other radios, but also with electromagnetic noise from motors, lights, and other sources that are much more common in plant environments. Emerson’s wireless devices with these features have been proven in use at many process control plants, demonstrating greater than 99.9% data reliability.
Wireless Plant Network

The Cisco Wireless Mesh Networking Solution is based on the Cisco Aironet® 1500 Series, an outdoor Wi-Fi mesh access point using Cisco’s patent-pending Adaptive Wireless Path Protocol (AWPP), which forms the basis of the emerging IEEE 802.11s standard. The Cisco Aironet 1500 Series provides route optimization, self-healing for interference or outages, resiliency, and dynamic re-optimization when new sectors are added.

To address the needs of complex and hazardous industrial plant environments, Cisco has designed the Aironet 1520 Series specifically for such plant operations. It supports zero-touch configuration deployment to easily and securely join the mesh network. Flexible, high-powered, high-sensitivity radio options, along with a selection of high-gain antennas, allow coverage to be scaled as capacity needs increase. Cisco Aironet 1520 is managed and monitored by Cisco wireless LAN controllers and the Cisco Wireless Control System (WCS).

Using AWPP, Cisco 1500 access points discover each other automatically and select the best path for maximizing system capacity and minimizing latency by using intelligent wireless routing based on the AWPP. If a link is degraded, the access point will determine whether a better path exists, and will route traffic through a more optimal node.

<table>
<thead>
<tr>
<th>Cisco – IEEE 802.11b/g</th>
<th>Emerson – IEEE 802.15.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Physical layer</td>
<td>• Physical layer</td>
</tr>
<tr>
<td>- 14 channels,</td>
<td>- 16 channels,</td>
</tr>
<tr>
<td>5 MHz channel spacing,</td>
<td>5 MHz channel</td>
</tr>
<tr>
<td>22 MHz channel width</td>
<td>2 MHz channel width</td>
</tr>
<tr>
<td>- 54 Mbps max data rate</td>
<td>- 250 kbps data rate</td>
</tr>
<tr>
<td>• Only 3 non-overlapping channels</td>
<td>• Physical channel usage</td>
</tr>
<tr>
<td>- 1, 6 and 11 in North America</td>
<td>- Channel hopping</td>
</tr>
<tr>
<td>- 1, 7 and 13 in Europe</td>
<td>(frequency hopping)</td>
</tr>
<tr>
<td>• Radio Power output</td>
<td>- Coordinated channel (TDMA) use permitted</td>
</tr>
<tr>
<td>- 100mW max indoors</td>
<td>• Emerson (and WirelessHART) use channel hopping and coordination</td>
</tr>
<tr>
<td>- Up to 4W outdoors (Mesh)</td>
<td>- 15 channels used</td>
</tr>
</tbody>
</table>

The Standards Advantage

Using technologies based on IEEE 802 standards at both levels of the architecture (802.15.4 for field networks and 802.11 for plant networks) provides a significant advantage in managing coexistence. The IEEE coordinates all its 802 wireless activities, and its coexistence technical advisory group (802.19) provides a framework for coexistence among existing standards as well as those under development.

Coexistence Testing

Tests were conducted to determine the real-world impact of deploying a Cisco IEEE 802.11b/g plant-level network and associated applications in the same process facility as an Emerson Smart Wireless field network using mesh and IEEE 802.15.4 technology from Dust Networks.

Test Description

The test was conducted in a factory floor environment at an Emerson production facility. The environment consisted of two Cisco 1510 outdoor mesh access points, an Emerson 1420 wireless gateway attached to a Cisco 1510 mesh access point, and a mixture of eight Emerson Smart Wireless field devices. In addition, several Emerson facility Wi-Fi access points were near the test network.
Network performance-analysis tools (an Iperf client and server) were connected to the test access points to provide a load on the Wi-Fi network. To provide voice over Internet protocol (VoIP) traffic, a Cisco 7921 IP phone and an Intermec CK60 mobile worker platform with a voice application were used.

Network statistics were monitored on the 802.15.4 network while Iperf was used to generate traffic on the 802.11b/g network. The Iperf client was connected using 802.11g. The data throughput of Iperf was monitored periodically to determine the overall impact on available bandwidth in the 802.11b/g network.

The selected channel for the 802.11b/g network was varied between 1, 6, and 11 during the test. The 802.15.4 network was running with field device data update rates set to 15 seconds (a typical configuration).

The 802.11b/g mesh access point was approximately 1 meter from the 802.15.4 gateway and anywhere from 30 cm to 1 meter from most of the 802.15.4 devices under test. This was again to create as close to worst-case test environment as possible given known RF characteristics.

**Test Results**

**Impact of 802.11b/g on 802.15.4.** Overall data reliability of the 802.15.4 field network remained at 100% throughout the testing. Although 802.11b/g interference caused a small amount of packet loss on some of the 802.15.4 devices, the Emerson field network includes several features (such as retries and path diversity) to counter this effect, and the net packet loss was not significant enough to affect overall data reliability.

Impact of 802.15.4 on 802.11b/g. Throughput on the 802.11b/g network (monitored using Iperf) varied from 4 Mbits/sec to 8 Mbits/sec during baseline testing with no 802.15.4 traffic. In the presence of 802.15.4 traffic, the throughput varied in the same range throughout the testing.

Based on the test results and known RF interactions (overlapping channels, output power), it is more likely that the other 802.11b/g access points that were in the surrounding environment but not part of the test caused most of the variation in the data throughput of the test 802.11b/g network.

Voice over IP testing was also conducted using the Intermec CK60 handheld computer with an IP voice application and the Cisco 7921 IP phone. In the test environment, no impact could be detected in the voice quality when 802.15.4 traffic was introduced into the environment over the test period.

**Implications for Wireless Deployments**

**Impact of 802.11b/g on 802.15.4.** Any 802.15.4 devices within range of but greater than 1 meter from an 802.11b/g mesh access point will have a path stability impact that is dependent on distance and bandwidth utilization. The impact on packet error rate is

\[
\text{Packet Error Rate} = \text{BWU} \times 20\% 
\]

where BWU is the bandwidth utilization of the 802.11b/g mesh access point and the 20% factor comes from empirical data gathered.

For example, if the 802.11b/g average bandwidth utilization is 20% (which is high for a typical Wi-Fi network), then there will be a 4% impact on individual path stability. This level of packet error rate is not large enough to impact the overall 802.15.4 network data reliability. This is because the network protocol has automatic retries built in, allowing some packet loss while continuing to maintain very high data reliability. Also, path diversity and channel hopping help to make the impact of this interference non-existent.

Prior research and testing has showed that static-channel 802.15.4 devices within 10 cm of an 802.11b/g mesh access point are significantly impacted. This is mostly a result of the high power output of the 802.11b/g radio. However, this issue is not seen with the Emerson Smart Wireless solution because it uses channel hopping to move around the interference. A technique not used in this test, “blacklisting” overlapping channels so the devices don’t use them, also provides a way to mitigate the problem.

Impact of 802.15.4 on 802.11b/g. The 802.15.4 network will have an impact on the 802.11b/g network in proportion to its channel usage. Channel usage is a function of the total bandwidth utilization in the network and the channel dwell time. This can range from nearly 0% for typical networks to 100% for very large networks of line-powered devices.
For each device present in the range of an 802.11b/g access point, the maximum possible impact on the throughput will be

$$802.11\text{b/g bandwidth decrease} = 25\% \times \text{BWU} \times \frac{4}{15}$$

The 25% factor comes from empirical data; the 4/15 comes from the number of 802.15.4 channels that are occupied by one 802.11b/g channel. The bandwidth utilization near an 802.15.4 gateway can approach 41% for large-scale networks. The 41% factor comes from the data rate of the 2.4 GHz 802.15.4 network producing maximum size packets (128 bytes) in 10 ms time slots.

The worst-case impact, assuming the 802.11b/g device is near an 802.15.4/WirelessHART gateway, is therefore 25% * 41% * 4/15 = 2.73%, or a reduction from 20 Mbps (typical throughput) to 19.45 Mbps. A reduction of this magnitude is negligible even in the most extreme time-sensitive applications like VoIP communication, which was tested to prove that no degradation occurs.

This testing was intended to represent near worst-case conditions users will encounter in deploying IEEE 802.11b/g devices alongside IEEE 802.15.4 devices. It is unlikely that a practical installation will ever reach greater than 40% bandwidth utilization on either type of network. Even in this extreme deployment, there was no noticeable impact on either network. And since most traffic into the gateways are communicated at a lower power level (power diversity), it has been shown to not impact the network in practical implementations.

Summary

Advancements in wireless technology have overcome previous concerns about using wireless applications in process operations. In particular, features of the Emerson and Cisco wireless architecture such as channel hopping and mesh networks can reduce or avoid potential coexistence problems between 802.11 and 802.15.4 technologies.

Our tests of this architecture under real-world conditions demonstrate that coexistence issues are in fact minimal, even in an extreme deployment scenario. From these findings we conclude that process industry users can move forward with confidence that these technologies can be used together successfully. In fact, there are probably many reasons to begin planning new wireless implementations.

While this paper addresses RF compatibility, other issues such as security and network management are aspects of network design that also require consideration. Cisco and Emerson offer a range of solutions to address these areas based on individual project requirements. Look for future white papers from Cisco and Emerson documenting best practices for process industry users who are implementing wireless networks in the plant environment. Additional information is also available from www.EmersonProcess.com/SmartWireless or by contacting an Emerson or Cisco salesperson.

References

1. IEEE std 802.15.4-2006, Part 15.4: Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low-Rate Wireless Personal Area Networks (WPANs)
4. *WirelessHART™ Specifications*
12.5 WirelessHART Third-Party System Integration

IEC 62591 (WirelessHART) is the international standard for wireless in process applications. WirelessHART is improving maintenance planning, reducing energy consumption, minimizing operator rounds, and getting timely data from remote sites through integration with the control system. Some large-scale plants & fields are quickly approaching 1,000 wireless transmitters. Therefore it should also be possible to manage the wireless transmitters plant-wide from intelligent device management (IDM) software located centrally part of the asset management system. Many plant owners with third-party systems without native support for WirelessHART desire to use WirelessHART transmitters to modernize and sustain their plant. Modbus/RTU, Modbus/TCP, OPC, and the new HART-IP protocol are the technologies that enable integration of process variables as well as setup and diagnostics information from WirelessHART transmitters into any system.

Process Variable Integration

Process variables from WirelessHART transmitters can be used in control systems like a DCS, PLC, or RTU as well as directly in software such as an HMI or for asset monitoring, machinery health monitoring, or a historian etc. There are many ways to get process variable data from the WirelessHART gateway: Modbus/RTU, Modbus/TCP, EtherNet/IP, or OPC-DA. All of these communication protocols are already in use on every imaginable control system, new, old, and very old. No system is too old to accept WirelessHART.

Modbus/RTU

The WirelessHART gateway has an RS485 communication port for use with host systems having a serial interface card and supports the Modbus/RTU protocol. Multiple gateways can be connected to the same RS485 network for plant-wide applications. This is the most common way on older control systems.

RS485 Communication Settings

The RS485 port on the WirelessHART gateway can be configured with Modbus node address, baud rate, parity, stop bits, response delay, data type, byte swap, scaling and error handling etc. to match system requirements.

Modbus Data Selection

The parameters such as process variable value, process variable status, and battery status etc. desired from each WirelessHART transmitter is selected in the WirelessHART gateway and freely assigned to a Modbus register number. Overall network health information can also be selected from the gateway. Import and export function enables faster bulk edit. In the host system, the gateway Modbus registers are in turn mapped to system tags.

Modbus/TCP

The WirelessHART gateway has two Ethernet ports supporting multiple protocols in parallel on the same port for use with host systems having an Ethernet interface card. Multiple gateways can be connected to the same Ethernet for plant-wide applications. For instance, they can interface to systems supporting the Modbus/TCP protocol. This is the most common way on modern control systems. The gateway has an internal firewall for security and offers the option of SSL security for the Ethernet communication.

The Ethernet ports are configured with IP address. The parameter selection for Modbus/TCP is the same as for Modbus/RTU.

EtherNet/IP

The Ethernet ports on the WirelessHART gateway can also be used to interface to systems supporting the EtherNet/IP protocol. This is common on RTUs.

CIP Data Selection

Similar to Modbus, the parameters such as process variable value, process variable status, and battery status etc. desired from each WirelessHART transmitter is selected in the WirelessHART gateway and freely assigned to a CIP Instance and Member. Overall network health information can also be selected from the gateway. Import and export function enables faster bulk edit. In the host system, the gateway CIP members are in turn mapped to system tags.

OPC-DA

OPC-DA is a third protocol option, tunneled through the WirelessHART gateway’s Ethernet ports. As OPC is a protocol between software applications; OPC proxy software on a workstation communicates with the gateway and makes data available to any OPC-
DA clients such as HMI software, asset monitoring software, machinery health management software, or a system database etc.

**Data Selection**

Similar to Modbus and CIP, the parameters such as process variable value, process variable status, and battery status etc. desired from each WirelessHART transmitter is selected in the WirelessHART gateway. For OPC there is no need to assign Register, Instance, or Member. Overall network health information can also be selected from the gateway. Import and export function enables faster bulk edit. In the OPC client, the desired parameters can simply be picked by pointing and clicking.

**Intelligent Device Management Integration**

WirelessHART transmitters are intelligent devices that have to have the correct configuration, will eventually need calibration trim, will detect sensor failures etc. just like wired transmitters. WirelessHART transmitters run on battery which will one day run low.

Use of Intelligent Device Management (IDM) software for daily maintenance and turnaround planning for instrumentation and valves is becoming increasingly common. Wireless transmitters should be no exception.

The same handheld field communicator used for 4-20 mA/HART and FOUNDATION fieldbus devices can be used to configure and check the health of WirelessHART transmitters but for installations with lots of transmitters, centralized monitoring is more practical. Modbus, EtherNet/IP, and OPC-DA are ideal for process variables, but don’t support intelligent device management software.

**HART-IP**

The new HART-IP protocol provides the ability to access all the configuration and diagnostics information in the WirelessHART transmitters, beyond the process variable, from intelligent device management (IDM) software on third-party systems. The HART-IP protocol is communicated on the same Ethernet cable as Modbus/TCP, EtherNet/IP, and OPC-DA. HART-IP uses the same standard commands as 4-20 mA/HART and WirelessHART and therefore requires no data mapping in the gateway or in the software. This makes it easy to manage the vast amount of configuration settings even for huge numbers of transmitters. There are two ways to display device setup and diagnostics data into the IDM software: EDDL and FDT/DTM. Both of these device integration technologies are already in use for WirelessHART transmitter configuration, sensor calibration trim, and diagnostics for troubleshooting.

**EDDL**

For intelligent device management software (IDM) based on the EDDL device integration technology, the EDDL file for each device type is simply loaded, thus enabling the IDM software to access all the information in the WirelessHART transmitters through the WirelessHART gateway over HART-IP.

**FDT/DTM**

For intelligent device management software (IDM) based on FDT/DTM device integration technology, a commDTM and gatewayDTM can be installed for the WirelessHART gateway as well as a deviceDTM for each device type, thus enabling the IDM software to access all the information in the WirelessHART transmitters through the WirelessHART gateway over HART-IP.

**Yokogawa**

WirelessHART gateways and transmitters can be integrated in the Yokogawa Centum DCS and PRM intelligent device management software. Various options can be utilized.
Centum
The connection of the WirelessHART gateways into the Centum DCS using Modbus is not different from that of any other Modbus device.

RS485
Modbus/RTU from the WirelessHART gateway connects to the ALR121 serial communication module on the Yokogawa Centum system.

Modbus Registers
The mapping of the WirelessHART transmitter process variables through the gateways into the Centum DCS using Modbus is not different from that of any other Modbus device.

Ethernet
Modbus/TCP from the WirelessHART gateway connects to the ALE111 Ethernet communication module on the Yokogawa Centum system.
The integration of the WirelessHART gateway and WirelessHART transmitters into the PRM IDM software using HART-IP and FDT/DTM is not different from any other devices. A commDTM and gatewayDTM has to be installed for the WirelessHART gateway as well as a deviceDTM for each device type, thus enabling the PRM software to access all the information in the WirelessHART transmitters through the WirelessHART gateway over HART-IP.

**Honeywell**

WirelessHART gateways and transmitters can be integrated in the Honeywell TDC2000, TDC3000, PlantScape, and Experion PKS DCS as well as the Field Device Manager (FDM) intelligent device management software.

The FDM software supports EDDL and is based on the SDC625 software from the HART Communication Foundation (HCF).

**Deployment**

As a result, systems without native support for WirelessHART are benefitting from improved maintenance planning, reduced energy consumption, reduced operator rounds, and get timely data from remote sites enabled by WirelessHART transmitters. The result is lower maintenance cost and increased production.
1 The Modbus/TCP protocol is sometimes referred to as Modbus TCP/IP, but this is incorrect.

2 Two Ethernet ports for redundancy or connection to independent systems such as one port for DCS, HMI, or historian and the other port for IDM etc.

3 The Ethernet ports can in turn be connected to a Wi-Fi access point or fiber optic media converter etc. as well as various options for long distance backhaul network if required by the application.

4 A Device Diagnostics Deployment and Adoption Guide is available as assistance in deployment and institutionalization of Intelligent Device Management (IDM) software and associated work practices.

5 Experion PKS Field Device Manager Specifications EP03-480-400 Release 400 V0.12, Feb, 2010
12.6 Site Modernization User Guide

Modernize & Sustain Beyond P&ID

Foreword

Many operation and maintenance problems around the plant can be solved by deploying WirelessHART transmitters beyond the P&ID together with asset management system1 and other software to obtain asset health information and other plant data. However, plant procedures must be written so as to make full use of this new information. With the hardware, software, and updated operating procedures in place, central “desktop maintenance” planning, energy conservation measures, and HS&E improvement can become a reality. That is, the new plant information must be institutionalized in daily work processes to be effective.

This is a guide to modernizing and sustaining existing plants, but also to ensure new plants are not built the old fashioned way, and institutionalizing asset health alarms, energy conservation information, and HS&E information in daily work processes. This guide can also be applied to rejuvenation of well head automation.

Glossary

Essential asset monitoring, energy conservation measures, and HS&E have their own set of terminology and acronyms

Terminology

<table>
<thead>
<tr>
<th>Turnaround</th>
<th>Scheduled plant shutdown when a plant is stopped for an extended period for major overhaul. A.k.a. outage or planned shutdown.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ticket</td>
<td>Electronic work order for a job to be carried out.</td>
</tr>
</tbody>
</table>

In this document the terms “work order” (usually on paper) and “ticket” (electronic) are used interchangeably.

The term “remote” refers to the field or plant floor, while the term “central” refers to the control room as opposed to the field or plant floor.

Introduction

Plant-wide modernization is a project requiring wireless transmitters beyond the P&ID feeding raw data into an asset management system. Deployment will have associated engineering hours and cost. The basic deployment phases are illustrated in figure 12.6a and explained in table 12.6b.

<table>
<thead>
<tr>
<th>EAM</th>
<th>Essential Asset Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECM</td>
<td>Energy Conservation Measures</td>
</tr>
<tr>
<td>FAT</td>
<td>Factory Acceptance Test</td>
</tr>
<tr>
<td>FEED</td>
<td>Front-End Engineering &amp; Design</td>
</tr>
<tr>
<td>HMI</td>
<td>Human-Machine Interface</td>
</tr>
<tr>
<td>HS&amp;E</td>
<td>Health, Safety, and Environment</td>
</tr>
<tr>
<td>MHM</td>
<td>Machinery Health Management</td>
</tr>
<tr>
<td>P&amp;ID</td>
<td>Piping and Instrumentation Diagram</td>
</tr>
<tr>
<td>PAM</td>
<td>Plant Asset Management</td>
</tr>
</tbody>
</table>

Figure 12.6a – Basics steps in site modernization with EAM, ECM, and HS&E packages
There will be minor differences depending on if the project is for modernizing an existing plant or to make sure a new plant being constructed is not built the old fashioned way. This deployment process can also be applied to rejuvenation of well head automation.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Justify</td>
</tr>
<tr>
<td>2</td>
<td>Audit</td>
</tr>
<tr>
<td>3</td>
<td>Define</td>
</tr>
<tr>
<td>4</td>
<td>Assign</td>
</tr>
<tr>
<td>5</td>
<td>Plan</td>
</tr>
<tr>
<td>6</td>
<td>Detail Design</td>
</tr>
<tr>
<td>7</td>
<td>Implementation</td>
</tr>
<tr>
<td>8</td>
<td>FAT</td>
</tr>
<tr>
<td>9</td>
<td>Installation</td>
</tr>
<tr>
<td>10</td>
<td>Commissioning</td>
</tr>
<tr>
<td>11</td>
<td>Site Integration</td>
</tr>
<tr>
<td>12</td>
<td>Develop Procedures</td>
</tr>
<tr>
<td>13</td>
<td>Training</td>
</tr>
</tbody>
</table>

Table 12.6b – Basic work process for deploying EAM, ECM, and HS&E packages
Justification
The initial step is to get buy-in from the plant management that will approve the project. For an existing plant, there is a need to justify modernization with wireless. For a new plant, expanding the scope beyond P&ID to include EAM, ECM, and HS&E packages as part of the project must be justified. Explain to the plant management, maintenance manager, reliability engineer, HS&E officer, and project/turnaround manager the opportunity to improve maintenance, energy consumption, and HS&E by modernizing and the value of plant-wide modernization. Investment in wireless transmitters and centralized asset management system can be justified on the basis of reduced downtime, lower cost of maintenance, lower energy consumption, and improved HS&E etc. provided the new information is institutionalized in the daily work processes and the plant culture.

The modernization has to be accompanied by a culture shift, especially for EAM. Maintenance technicians will be able to tell if assets need to be maintained urgently, if it can wait until the next turnaround, or if they need no maintenance at all. This not only enables turnarounds to be shortened, but reduces the costs of crane and crane operator, and the need for hoist, scaffolding, fitters, riggers, instrument technician, electricians, pipe fitters, as well as insulation and other material. Incorporation of EAM in daily maintenance practices must be a management directive, with follow-up to ensure new work processes and EAM tools get adopted, and continues to be used to derive value from the asset health information. Asset maintenance will be an information-driven decision rather than based on a hunch or emotion. EAM allows Maintenance on assets that actually need work, only when they need work. EAM can give detailed information on problems before a field visit. EAM can also reduce impact on operations by advance warning of failure. Note that the number of work orders go up because more asset problems are detected but the maintenance cost go down. EAM enables daily maintenance and turnaround activities to be prioritized. EAM also enables investigative work to determine root cause of asset failures and process upsets.

A consultant can help develop the justification. Make sure to include services as part of the project budget. Make sure to include services as part of the project budget.

Opportunity
Plants face a number of operational and maintenance challenges. The challenges and opportunities for asset management can broadly be classified in three categories:

These challenges and the capabilities required to tackle those problems as well as the expected result are summarized in Table 12.6d.

### Essential Asset Monitoring (EAM)
Essential Asset Monitoring (EAM) provides a capability to see the health of assets, and use this information to more effectively plan the work scope for turnarounds, to make the turnaround shorter and make sure the assets in greatest need of maintenance are attended to, while time and resources are not spent unnecessarily on assets that need no maintenance. EAM provides process equipment diagnostics, a new level of diagnostics, over and above device diagnostics; type 4 in table 12.6e.

<table>
<thead>
<tr>
<th>Essential Asset Monitoring (EAM)</th>
<th>Energy Conservation Measures (ECM)</th>
<th>Health, Safety, and Environmental (HS&amp;E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Heat exchanger</td>
<td>1. Steam trap failure</td>
<td>1. Safety shower and eye wash station</td>
</tr>
<tr>
<td>5. Centrifugal compressor</td>
<td>5. Filter &amp; strainer blocking</td>
<td>5. Grab sampling</td>
</tr>
<tr>
<td>7. Pipes &amp; vessels</td>
<td></td>
<td>7. Stranded diagnostics etc.</td>
</tr>
<tr>
<td>8. Filters &amp; strainers etc.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Table 12.6c – Three broad categories of modernization opportunities*
Type 1 bus diagnostics is performed by the system interface card and includes statistics for communication errors. Type 2 device diagnostics is performed by the device itself (i.e. self-diagnostics) and detects electronics failure (e.g. memory etc.) as well as problem with internal mechanical parts (e.g. spool) as well as supply (electric or pneumatic etc.). Type 3 process connection diagnostics is also performed by the device and detects problems with valve, actuator, and impulse line etc. EAM falls under type 4 process equipment diagnostics and is performed by expert diagnostic algorithms based on multiple PV inputs and is used to monitor heat exchangers, pumps, blowers, and fin fan cooler etc.

<table>
<thead>
<tr>
<th>Type</th>
<th>Diagnostics</th>
<th>Example</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Process equipment diagnostics</td>
<td>• Heat exchanger</td>
<td>By expert diagnostic algorithm based on multiple PV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Pump</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Blower</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Fin fan cooler</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Process connection diagnostics</td>
<td>• Valve</td>
<td>By the device</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Actuator</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Impulse line</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Device diagnostics</td>
<td>• Electronics (memory etc.)</td>
<td>By device itself (self-diagnostics)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Internal mechanical parts</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Supply</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Bus diagnostics</td>
<td>• Communication Errors</td>
<td>By system interface card</td>
</tr>
</tbody>
</table>

Table 12.6d – Types of diagnostics

<table>
<thead>
<tr>
<th>Plant Challenge</th>
<th>EAM Capability</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat exchangers foul and plug but maintenance technicians don’t know how bad it is. Hydro-blasting is done too late by which time the heat exchanger has to be sent offline for decoking. Other times cleaning is done unnecessarily early, wasting resources and causing downtime.</td>
<td>Ability to detect heat exchanger fouling and plugging early, to schedule maintenance when, and only when, required.</td>
<td>Lower maintenance cost by reducing unnecessary cleaning. Higher plant availability by reducing unnecessary downtime.</td>
</tr>
<tr>
<td>Pumps suffer cavitation, vibration and bearing overheating problems, strainer plugging, as well as seal fluid and product leaks which go undetected for long periods leading to failures and spills causing downtime and fire hazard.</td>
<td>Ability to detect cavitation, even pre-cavitation, vibration, strainer plugging, and high bearing temperature, seal fluid and product leaks for essential pumps to change operation or schedule maintenance as required.</td>
<td>Reduced downtime and maintenance costs by avoiding premature pump failure and repair, as well as reducing spills.</td>
</tr>
<tr>
<td>Plant Challenge</td>
<td>EAM Capability</td>
<td>Result</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Blowers suffer resonance problem, filter blocking, bearing overheating and louver defects causing downtime or even premature failure.</td>
<td>Ability to detect high bearing temperature, suction filter blocking, louver defects, and resonance for blowers to change operation or schedule maintenance as required.</td>
<td>Reduced downtime and maintenance costs by avoiding premature blower failure and repair.</td>
</tr>
<tr>
<td>Fin fan coolers suffer vibration and resonance, bearing overheating, louver and actuator defects, fouling, and in some parts of the world cause excessive cooling causing downtime and even premature failure, or simply inefficiencies.</td>
<td>Ability to detect high vibration and resonance, high bearing temperature, louver and actuator defects, fouling, and excessive cooling for fin fan coolers to change operation or schedule maintenance as required.</td>
<td>Reduced downtime and maintenance costs by avoiding premature fin fan cooler failure and repair, and in some locations reduced energy cost.</td>
</tr>
<tr>
<td>Centrifugal compressors suffer instability, vibration and resonance, bearing fault, and plugged intake filter etc. causing downtime and even premature failure.</td>
<td>Ability to detect instability, vibration and resonance, bearing fault, and intake filter plugging for the simple yet essential compressors not fitted with online machinery protection system, to schedule maintenance as required.</td>
<td>Reduced downtime and maintenance costs by avoiding premature compressor failure and repair.</td>
</tr>
<tr>
<td>Cooling tower suffer fan and water circulation pump vibration and resonance, bearing overheating and faults, strainer plugging, fouling and corrosion, as well as windage (water loss).</td>
<td>Ability to detect fan and pump vibration and resonance, high bearing temperature and faults, strainer plugging, fouling and corrosion, as well as windage in cooling towers to schedule maintenance as required. And to compute tower efficiency, saturation index, and cycles of concentration as well as recommend fan power optimization, blowdown and makeup flow.</td>
<td>Reduced downtime and maintenance costs by avoiding premature cooling tower failure and repair, as well as reduced energy cost.</td>
</tr>
<tr>
<td>Pipes and vessels suffer corrosion, extreme temperature and pressure cycles and excursions posing a hazard.</td>
<td>Ability to detect corrosion as well as temperature and pressure cycles and excursions in pipes and vessels, to schedule inspection as required.</td>
<td>Reduced risk of pipe or vessel failure.</td>
</tr>
<tr>
<td>Filters and strainers suffer blocking and plugging reducing throughput and increasing energy consumption.</td>
<td>Ability to detect if filters and strainers are blocked or plugged, to schedule replacement or maintenance accordingly.</td>
<td>Improved throughput and reduced energy cost.</td>
</tr>
</tbody>
</table>

Table 12.6f – EAM opportunities
Modernization shall not be a onetime event every 15 years; it shall be continuous for the plant to be kept abreast of changing needs. For detail justification see separate white paper on applications beyond P&ID.

**Energy Conservation Measures (ECM)**

Energy Conservation Measures (ECM) provides a capability to monitor steam distribution and loss, and using this information to more effectively plan steam trap replacement, heat exchanger cleaning, account and manage energy usage per process unit, and track energy consumption reduction initiatives such as maximizing equipment efficiency, maximizing use of most efficient equipment, reduced hot-standby, and reduced steam venting.

**Health, Safety, and Environment (HS&E)**

Health, Safety, and Environment (HS&E) monitoring provides a capability to reduce the number of people walking the plant, to assist persons in distress sooner, and reduce mistakes.

<table>
<thead>
<tr>
<th>Plant Challenge</th>
<th>ECM Capability</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Steam traps fail open blowing steam, wasting energy. Or they fail closed blocking condensate, possibly causing equipment damage. Manual inspection is too infrequent and time consuming. Failures go undetected for long periods of time.</td>
<td>Ability to automatically monitor health of steam traps to detect passing or blocking, to schedule replacement or maintenance accordingly.</td>
<td>Reduced energy cost, and reduced downtime and maintenance costs by avoiding equipment failure and repair due to condensate backup.</td>
</tr>
<tr>
<td>2 Heat exchangers foul and become inefficient requiring fired heaters to provide make-up heat, increasing fuel cost.</td>
<td>Ability to detect heat exchanger fouling early, to schedule cleaning when required.</td>
<td>Lower energy cost as less make-up heat is required.</td>
</tr>
<tr>
<td>3 There is no visibility which plant units are responsible for high steam consumption.</td>
<td>Ability to monitor steam consumption with finer granularity. Use cost accounting to drive energy efficiency measures at a plant unit level.</td>
<td>Lower energy cost as less steam is consumed.</td>
</tr>
<tr>
<td>4 There is no visibility which plant units are responsible for high chilled water consumption.</td>
<td>Ability to monitor chilled water consumption with finer granularity. Use cost accounting to drive energy efficiency measures at a plant unit level.</td>
<td>Lower energy cost as less chilled water is consumed.</td>
</tr>
<tr>
<td>5 Filter and strainer blocking goes unnoticed requiring pumps to work harder to overcome pressure drop, increasing power consumption.</td>
<td>Ability to monitor filter and strainer condition to detect clogging to better plan filter replacement and cleaning, thus reducing pressure drop.</td>
<td>Lower energy cost as less power is required to overcome a lower filter pressure drop.</td>
</tr>
<tr>
<td>6 Cooling tower fans running when not required, wasting energy.</td>
<td>Ability to optimize fan power when not cooling-limited by shutting down the fixed speed fans if possible and balancing the load across the variable speed fans.</td>
<td>Reduced power consumption.</td>
</tr>
</tbody>
</table>

*Table 12.6g – ECM opportunities*
Wireless transmitters in conjunction with central asset management systems can provide these capabilities when institutionalized in daily work processes.

**F1 Pit-Stop**
An analogy can be made between EAM and Formula 1. An F1 car has sensors and a wireless telemetry system to detect and report its health back to the pit crew. This information is used to decide if the car needs to make a pit-stop for servicing or can continue until the end of the race without downtime improving the chances to win. The data also tells the pit crew what service the car needs and what it does not need so the pit crew can prepare all the parts and crew to tend to the problem in the shortest possible time, not wasting time on non-issues, minimizing downtime, as well as preventing a breakdown before the finish line can be crossed.

Similarly, an ideal plant has sensors and wireless networking to report the health back to the operators and technicians. This information is used to decide if the unit needs to be shutdown to service an asset or can continue production until the next scheduled turnaround without downtime maintaining production. The information also tells the maintenance planner what service the asset needs and what it does not need so the maintenance planner can prepare all the parts and manpower to tend to the problem in the shortest possible time, not wasting time on non-issues, minimizing downtime, as well as preventing a breakdown before the scheduled turnaround.

**Audit Existing Plant**
For an existing plant to deploy EAM, ECM, and HS&E packages as part of a brownfield modernization project, it is necessary to audit the entire plant’s assets, processing equipment, machinery, and valves, to identify shortcomings in measurements beyond the P&ID which need to be filled before work practices based on asset health and automatic data collection can be adopted. The audit is an opportunity to rate the plant’s asset management readiness. Usually only the most critical compressors and turbines are monitored. The assessment should also include a look at the current work processes and procedures for operation and maintenance, as well as the maintenance regime, culture, and the skills of the plant staff. That which is missing in the existing plant architecture to support essential asset monitoring, energy conservation measures, and HS&E becomes the input for the FEED stage of the modernization project. A consultant can help facilitate the plant audit. Make sure to include services as part of the project budget.

### Essential Asset Monitoring (EAM)
List all the process equipment by type. If a master equipment list is not available, make the equipment lists by studying P&ID and plot plans etc.

<table>
<thead>
<tr>
<th>Asset</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 List of heat exchangers</td>
<td></td>
</tr>
<tr>
<td>2 List of pumps</td>
<td></td>
</tr>
<tr>
<td>3 List of blowers</td>
<td></td>
</tr>
<tr>
<td>4 List of fin fan coolers</td>
<td></td>
</tr>
<tr>
<td>5 List of centrifugal compressors</td>
<td></td>
</tr>
<tr>
<td>6 List of cooling towers</td>
<td></td>
</tr>
<tr>
<td>7 List of pipes &amp; vessels</td>
<td></td>
</tr>
<tr>
<td>8 List of filters &amp; strainers</td>
<td></td>
</tr>
</tbody>
</table>

### Energy Conservation Measures (ECM)
List all the consumers of steam and chilled water, as well as potential points of energy loss. Ask the piping department for help.

<table>
<thead>
<tr>
<th>Point</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 List of critical (large pipes, high pressure) steam traps</td>
<td>Ask the piping department</td>
</tr>
<tr>
<td>2 List of all heat exchangers</td>
<td>Equipment lists, P&amp;ID, and plot plans</td>
</tr>
<tr>
<td>3 List of all plant units consuming steam</td>
<td>Ask the piping department</td>
</tr>
<tr>
<td>4 List of all plant units consuming chilled water</td>
<td>Ask the piping department</td>
</tr>
</tbody>
</table>
# 12 – Appendix

<table>
<thead>
<tr>
<th>Point</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>List of all large filters and strainers which don’t already have pressure drop monitoring. Ask the piping department.</td>
</tr>
<tr>
<td>6</td>
<td>List of all cooling towers. Equipment lists, P&amp;ID, and plot plans.</td>
</tr>
</tbody>
</table>

### Health, Safety, and Environment (HS&E)

List all the points that should be monitored to eliminate blind spots and to reduce operators visits to the field.

<table>
<thead>
<tr>
<th>Points</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>List of all safety showers and eyewash stations. If these lists are not available, ask the plant safety officer.</td>
</tr>
<tr>
<td>2</td>
<td>List of all manual valves part of regular operations. If these lists are not available, make such a list by studying the existing work practices.</td>
</tr>
<tr>
<td>3</td>
<td>List of all relief valves. If these lists are not available, make such a list by studying P&amp;ID.</td>
</tr>
<tr>
<td>4</td>
<td>List of gauges (pressure and temperature), level sight glasses, and variable area flowmeters, etc. part of regular operations. Include tanks where level gauging is done using dipstick. If these lists are not available, make such a list by studying the existing work practices and log sheets.</td>
</tr>
<tr>
<td>5</td>
<td>List tapping points where product grab samples are taken and brought back to the lab for analysis, and take note of what parameters are analyzed (such as pH and conductivity etc.). If these lists are not available, make such a list by studying the existing work practices and lab reports.</td>
</tr>
</tbody>
</table>

### Define Scope

The asset management system for the EAM, ECM, and HS&E packages can be a stand-alone or can be integrated with the DCS. The plant-wide asset health information will mostly be used by the maintenance department for daily maintenance scheduling and turnaround planning, but operations can also benefit from being aware of assets which have failed or are degraded as the plant can be operated differently to work around the limitations. Conversely, the EAM diagnostic algorithms in the asset management system often use process measurement already available by connecting to the DCS.

WirelessHART and OPC are the enabling technologies that permit easy deployment of automation beyond the P&ID in an existing plant. An OPC server should be added to the DCS in case OPC is not already supported.

The scope has to be defined early on in the modernization project involving the project/t turnaround team, the DCS team, instrumentation team, asset management system supplier, and the maintenance group. It should be documented in a form of basis of design, a functional design specification including system architecture, network protocols to be used for DCS integration, hardware and software, as well as associated services. For an existing plant the system architecture requirements are based on the plant audit and gap analysis.
Modernization is a project, and deployment of EAM, ECM, and HS&E packages is an engineered solution. Make sure to include cost of engineering man-hours in project scope of work and in the budget.

No essential asset should be left stranded without EAM.

A remote site may not have personnel with the necessary skills required for analysis of asset health information. For such locations, remote access infrastructure such as wired or wireless backhaul network between site and centralized location by shared expert resources in the company or by outside vendors should be considered.

The FEED study should provide sufficient detail to put together a bid package with requirement specification and package count etc. During this FEED stage the number of EAM, ECM, and HS&E packages is determined such that the asset management system vendor can prepare a budgetary proposal.

A consultant can help facilitate the process of selecting assets to monitor and develop the requirement specifications. Make sure to include services as part of the project budget.

**New Plant FEED**

New plants being built should make provisions for essential asset monitoring, energy conservation measures, and HS&E because the process licensor’s design includes instrumentation for efficient operation meeting the performance guarantee for the first thirty days or so, but not for efficient maintenance and long-term operation. Do not build new plants the old fashioned way, with blind spots and operator rounds. The missing measurements should be included. Using wireless, the additional measurement points do not affect DCS I/O count and are beyond the P&ID, cable layout, or junction boxes, etc. and has a minimal impact on the project schedule.

For a new plant, the EAM, ECM, and HS&E package transmitters, gateways, networking, and asset management system etc. will usually be engineered and installed by the main EPC. By defining the scope of work associated with the packages, the EPC contactor and asset management system supplier can better estimate the amount of hardware, software, and number of engineering hours required.

**Existing Plant**

Based on gap analysis from the site audit of the plant assets, processing equipment, machinery, and valves etc., identify the number of EAM, ECM, and HS&E packages required to modernize the plant.

For an existing plant, the EAM, ECM, and HS&E package transmitters, gateways, and networking, along with hookup drawings and other documentation will usually be engineered and installed by a local contractor. By defining the scope of work associated with the packages, the contactor and asset management system supplier can better estimate the amount of hardware, software, and number of engineering hours required.

**Wireless Technology**

IEC 62591 (WirelessHART) is the de-facto standard for wireless in process applications.

**Caveat Emptor: Proprietary Protocols**

Wireless transmitters are also available with a multitude of proprietary protocols. For instance, remote input and output modules for 4-20 mA and discrete signals often use proprietary protocols. Proprietary protocols have many downsides and should therefore be avoided:

- Single vendor lock-in
- Each brand requires its own dedicated wireless gateway or multiple gateways
- No second source replacement transmitters
- Requires special training and test tools

Even though drivers and proprietary software can be used to access data in a proprietary transmitter and through proprietary adapters, interface hardware still becomes a lock-in since other transmitters cannot share the same bus. Therefore standard protocols shall always be the first choice. If the plant is using wireless transmitters with proprietary protocols, replace those transmitters with transmitters using WirelessHART.

**Wireless Transmitters**

WirelessHART integration can be achieved either by using “native” WirelessHART transmitter with built-in radio, antenna, and battery power, or a conventional 4-20 mA/HART transmitter can be fitted with a WirelessHART adapter. WirelessHART adapters can either be loop powered or battery powered.
A battery powered *Wireless*HART adapter does not require any local DC power. However, a conventional 4-20 mA/HART transmitter with a battery powered *Wireless*HART adapter has a much shorter battery life than a native *Wireless*HART transmitter. Therefore, native *Wireless*HART transmitters are always the first choice. However, certain transmitter types are not yet available in a *Wireless*HART version, at the time of writing this includes for example Coriolis massflow, vortex flow, magflow, radar level, and various liquid analyzers. For these measurements, a regular 4-20 mA/HART transmitter with a *Wireless*HART adapter has to be used.

**Software**

The raw measurement data from *Wireless*HART transmitters is brought into the asset management system where it is aggregated into information and knowledge on which decisions can be based.

**Selecting Essential Asset Monitoring Software**

*Wireless*HART gateways support OPC proxy/server and therefore most HMI software is capable of accessing and displaying data from *Wireless*HART transmitters. However, EAM requires diagnostic algorithms, heuristics based on expert know-how, baseline capture and comparison etc. customized for the myriad of combinations available for assets like heat exchangers and pumps, which are not trivial to develop and which take years to perfect. Therefore use an asset management system with field-proven built-for-purpose EAM diagnostic algorithms. The asset management system shall be setup with displays graphically representing assets as well as providing asset health alarm management including prioritization, alarm log, alarm summary, and reporting to facilitate planning.

**Selecting Steam Trap Monitoring Software**

Steam trap monitoring software shall support HART-IP communication with *Wireless*HART gateways. Steam trap monitoring software uses noise and temperature reading from acoustic transmitters to deduce if the steam trap is functioning normally, passing steam, or blocking condensate. The software shall provide steam trap alarm management including prioritization, log, and reporting.

**Wireless Gateway**

*Wireless*HART gateway shall support Modbus/RTU over RS-485 and Modbus/TCP over Ethernet as well as OPC proxy/server for DCS and asset management system integration as well as HART-IP for integration with steam trap monitoring software and other applications.

**Budgetary Scope**

Not all assets may need an EAM package, not all steam traps require monitoring. Work with the maintenance team, piping department, and HS&E officer etc. to select where monitoring is required. Plant personnel can identify the worst cases of bad actors from the top of their head. This shortlist of assets, HS&E equipment, and other measurement points becomes the basis on which the EAM, ECM, and HS&E package vendor can work out a budgetary proposal.

**Essential Asset Monitoring (EAM)**

Select which of the assets require an EAM package. This will create a short list of essential assets to be monitored. Work with plant maintenance personnel to identify the bad-actors and equipment essential to the operation of the plant. Highest priority is those with a history of fouling or failures.

<table>
<thead>
<tr>
<th>Asset</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Shortlist essential heat exchangers</td>
</tr>
<tr>
<td>2</td>
<td>Shortlist essential pumps</td>
</tr>
<tr>
<td>3</td>
<td>Shortlist essential blowers</td>
</tr>
<tr>
<td>4</td>
<td>Shortlist essential fin fan coolers</td>
</tr>
<tr>
<td>5</td>
<td>Shortlist essential centrifugal compressors</td>
</tr>
<tr>
<td>6</td>
<td>Shortlist essential cooling towers</td>
</tr>
<tr>
<td>7</td>
<td>Shortlist essential pipes &amp; vessels</td>
</tr>
<tr>
<td>8</td>
<td>Shortlist essential filters &amp; strainers</td>
</tr>
</tbody>
</table>
### Energy Conservation Measures (ECM)
Select which points require an ECM package. This will create a short list of points to be monitored. Work with the piping department to identify where monitoring is required. Highest priority are those with a history of fouling or failures.

<table>
<thead>
<tr>
<th>Point</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Shortlist which steam traps should be monitored</td>
</tr>
<tr>
<td></td>
<td>Highest priority is given to high pressure steam (150 psig and above), usually those closest to the boiler, then medium (30 to 150 psig), and lastly low pressure steam (below 30 psig). Those steam traps most critical to the process (cause downtime or destroyed product etc.) or greatest (costliest) steam loss may represent 5-20% of steam traps. Also consider those steam traps on the site which tend to fail more often, causing more problems.</td>
</tr>
<tr>
<td>2</td>
<td>Shortlist which heat exchangers should be monitored</td>
</tr>
<tr>
<td>3</td>
<td>Shortlist which plant units require steam consumption tracking</td>
</tr>
<tr>
<td>4</td>
<td>Shortlist which plant units require chilled water consumption tracking</td>
</tr>
<tr>
<td>5</td>
<td>Shortlist which filters and strainers require pressure drop monitoring</td>
</tr>
<tr>
<td>6</td>
<td>Shortlist which cooling tower fans should be optimized</td>
</tr>
</tbody>
</table>

### Health, Safety, and Environment (HS&E)
Select which points require an ECM package. This will create a short list of points to be monitored. Work with the piping department to identify where monitoring is required.

<table>
<thead>
<tr>
<th>Point</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Shortlist which safety showers and eyewash stations require monitoring</td>
</tr>
<tr>
<td></td>
<td>Highest priority are those in areas of the plant where chemicals are handled</td>
</tr>
<tr>
<td>2</td>
<td>Shortlist which manual valves require position feedback</td>
</tr>
<tr>
<td></td>
<td>Highest priority are those part of regular activities</td>
</tr>
<tr>
<td>3</td>
<td>Shortlist which relief valves require monitoring</td>
</tr>
<tr>
<td>4</td>
<td>Shortlist which gauges (pressure and temperature), level sight glasses, variable area flowmeters, and dipstick, etc. should be replaced by wireless transmitters</td>
</tr>
<tr>
<td></td>
<td>Highest priority are those included in the field operator clipboard round log sheets</td>
</tr>
<tr>
<td>5</td>
<td>Shortlist tapping points where grab sampling should be replaced by wireless transmitters</td>
</tr>
<tr>
<td>6</td>
<td>Shortlist assets checked by portable testers such as for vibration, acoustics, and temperature to be automated</td>
</tr>
<tr>
<td>7</td>
<td>Shortlist which 4-20 mA/HART instruments that need to be digitally integrated with the intelligent device management software</td>
</tr>
<tr>
<td></td>
<td>Highest priority is critical valves and flowmeters</td>
</tr>
</tbody>
</table>
Assign Responsibilities

A number of persons are involved in the initial deployment of EAM, ECM, and HS&E package instrumentation and sustaining the asset management system and associated work processes for the long-term. The person that is responsible for roll-out of new practices for maintenance should be on the modernization team, and is best suited as a lead for the team. The plant management is instrumental to lead the cultural change required to institutionalize EAM, ECM, and HS&E packages in daily plant activities. A senior member of the management should be the executive sponsor to drive the change. This includes providing required resources for the deployment of the asset management system, and the continued running of the system for the long-haul. The turnaround manager or project manager needs to be on the modernization team to manage the work and resources required to deploy the asset management system. Identify the persons responsible for work processes associated with the asset management system. Establish a cross-functional modernization team of instrumentation, control system, and maintenance specialists to also be experts on essential asset monitoring, energy conservation measures, and HS&E to support the asset management system for the long-term. Identify the person for the long-term role of analyzing the asset health reports from the asset management system to schedule maintenance. Develop an organization chart for the team with roles and responsibilities. Define who is responsible for delivering what. A consultant can help with the assignment of roles and responsibilities. Make sure to include services as part of the project budget.

Plan Deployment

The modernization team leader should develop and document a plant-wide and site-specific plan for how the asset management system will be deployed at the specific site. This should include a schedule for when each phase of the modernization project will take place and resources required; when people will take on their new roles, as well as detail plans for training of people in different roles. A consultant can help in this planning process. Make sure to include services as part of the project budget.

Detail Design

Based on the short-listed assets and the types of asset health diagnostics required for each asset, the number of WirelessHART transmitters can be determined. Next, the number of gateways and supporting networking equipment can be determined. Lastly, assets need to be prioritized and their health alarms classified in a rationalization process to ensure effective plant-wide alarm management.

Consultants can help in the detail design work. Make sure to include services as part of the project budget.

Prioritize Assets

Rank the criticality of the monitored assets to the production, to indicate the urgency based on the consequence and impact on product quality, process throughput, maintenance cost, and operational cost etc. Once the asset management system is operational, this will drive how maintenance prioritizes their work. The prioritization should be defined or reviewed by experienced operations and process engineers. This process can leverage work already done as part of RCM and other assessments. The chosen priority will be configured in the system in the implementation phase. This process requires a list of all assets in the plant. The desired priorities shall be documented.

A problem with a critical asset would prompt the operator to issue an emergency work order because of the importance of the asset to production. A lower priority essential asset will result in a work order that will be scheduled another day, while an even lower priority asset will be scheduled for the next turnaround period or other convenient time.

Figure 12.6h – Essential assets are the second tier below critical assets like turbine and compressors

Assets with very low criticality do not have monitoring and are allowed to run to failure because the limited maintenance resources must be spent on the critical and essential assets.

Plan Deployment

The modernization team leader should develop and document a plant-wide and site-specific plan for how the asset management system will be deployed at the specific site. This should include a schedule for when each phase of the modernization project will take place and resources required; when people will take on their new roles, as well as detail plans for training of people in different roles.

A consultant can help in this planning process. Make sure to include services as part of the project budget.
For each type of asset, many kinds of health diagnostics are possible, each kind of diagnostic requiring additional measurements. For non-essential assets no diagnostic measurement may be specified. An essential asset may be instrumented to detect the most common problems associated with its particular service. Full diagnostics should be specified for assets in high criticality service, to be able to detect as many problems as possible as early as possible. The criticality ranking is therefore also helpful in the detail specification process for assets.

**Detail Scope**

During detail design the standard EAM packages have to be customized for each specific asset and service because there are many kinds of heat exchanger designs, many pump and seal configurations, and various fin fan cooler types etc., and which operate in services with different severity. That is, the exact number of WirelessHART transmitters of each type for each asset is determined. An “Asset Configuration Sheet” for each type of asset simplifies the data collection.

**Essential Asset Monitoring (EAM)**

Identify the installation details and equipment properties of each monitored asset to enable the instrumentation to be customized accordingly, and to facilitate the instrument selection and software configuration:

<table>
<thead>
<tr>
<th></th>
<th>Asset</th>
<th>Example of Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Heat exchanger</td>
<td>Clean heat transfer coefficient, heat capacities, area, temperature sensor thermowell connections etc., much of this data comes from vendor documents</td>
</tr>
<tr>
<td>2</td>
<td>Pump</td>
<td>Seal type, fixer/variable speed, pressure connections, pressure ranges etc.</td>
</tr>
<tr>
<td>3</td>
<td>Blower</td>
<td>Temperature sensor thermowell connection, pressure connection, pressure ranges, etc.</td>
</tr>
<tr>
<td>4</td>
<td>Fin fan cooler</td>
<td>Temperature sensor thermowell connection, etc.</td>
</tr>
<tr>
<td>5</td>
<td>Centrifugal compressor</td>
<td>Pressure connection, pressure ranges, temperature sensor thermowell connection, etc.</td>
</tr>
<tr>
<td>6</td>
<td>Cooling tower</td>
<td>Temperature sensor thermowell connection, pH sensor connection, conductivity sensor connection, level sensor connection, etc.</td>
</tr>
<tr>
<td>7</td>
<td>Pipes &amp; vessels</td>
<td>Corrosion sensor connection etc.</td>
</tr>
<tr>
<td>8</td>
<td>Filters &amp; strainers</td>
<td>Pressure connection etc.</td>
</tr>
</tbody>
</table>

Based on the information, specify the instrumentation accordingly.

**Energy Conservation Measures (ECM)**

Identify the installation details and equipment properties of each monitored asset to enable the instrumentation to be customized accordingly, and to facilitate the instrument selection and software configuration:

<table>
<thead>
<tr>
<th></th>
<th>Point</th>
<th>Example of Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Steam trap</td>
<td>Type, operating conditions, line size</td>
</tr>
<tr>
<td>2</td>
<td>Heat exchanger</td>
<td>Clean heat transfer coefficient, heat capacities, area, temperature sensor thermowell connections etc., much of this data comes from vendor documents</td>
</tr>
<tr>
<td>3</td>
<td>Steam supply line</td>
<td>Line size, pressure, temperature etc.</td>
</tr>
<tr>
<td>4</td>
<td>Chiller water supply line</td>
<td>Line size, pressure, temperature etc.</td>
</tr>
<tr>
<td>5</td>
<td>Filter &amp; strainer</td>
<td>Normal and abnormal pressure drop, process connection, process fluid, operating temperature range etc.</td>
</tr>
</tbody>
</table>
Based on the information, specify the instrumentation accordingly. Access to setup/configuration information and diagnostics in 4-20 mA/HART devices requires WirelessHART adapters to be purchased for these devices.

**Health, Safety, and Environment (HS&E)**

Identify the installation details and equipment properties of each monitored asset to enable the instrumentation to be customized accordingly, and to facilitate the instrument selection and software configuration:

<table>
<thead>
<tr>
<th>Points</th>
<th>Example of Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Safety shower and eye wash station</td>
</tr>
<tr>
<td>2</td>
<td>Manual valve</td>
</tr>
<tr>
<td>3</td>
<td>Relief valve</td>
</tr>
<tr>
<td>4</td>
<td>Pressure gauge</td>
</tr>
<tr>
<td></td>
<td>Temperature gauge</td>
</tr>
<tr>
<td></td>
<td>Level sight glass</td>
</tr>
<tr>
<td></td>
<td>Variable area flowmeter</td>
</tr>
<tr>
<td></td>
<td>Dipstick</td>
</tr>
<tr>
<td>5</td>
<td>Grab sampling</td>
</tr>
<tr>
<td>6</td>
<td>Temperature gun</td>
</tr>
<tr>
<td>7</td>
<td>Vibration tester</td>
</tr>
<tr>
<td></td>
<td>Ultrasonic tester</td>
</tr>
<tr>
<td>4-20 mA/HART instruments</td>
<td>List brand, model, and revision for every HART device type that shall be integrated into the IDM software</td>
</tr>
</tbody>
</table>

**Update Period**

The update period for the WirelessHART transmitters has to be selected. These are all monitoring applications beyond the P&ID; therefore 1 second update period is not required. The WirelessHART transmitters are monitoring points that previously were checked once a month, once a week, or once per day, once per shift, or not at all. An update period of 1 minute, and in some cases even 1 hour, is sufficient for most transmitters in these applications; once a minute is an improvement of several hundred times over once a day. This ensures that the WirelessHART devices enjoy a long battery life, minimizing battery replacement logistics. Faster update shall be used for transmitters used to compute standard deviation, such as for pump discharge pressure to detect pre-cavitation, as well as for flow and pressure to detect compressor instability.

Although the WirelessHART transmitters for EAM, ECM, and H&SE do not appear on the P&ID, they should still be given a tag in accordance to established plant tagging convention. Make sure to specify the update period along with device tag, network ID, and join key in the purchase order to ensure these are preconfigured by the device supplier. This minimizes site work and speeds up commissioning.

**Wireless Network Design**

Based on the number of plant areas, number of WirelessHART transmitters in each plant area, and desired update period, size the number of WirelessHART gateways for the plant areas. Import the plot plans into a WirelessHART network planning
tool and determine if repeaters are required to form a strong network. Refer to separate engineering guideline for wireless networks. A site survey may be required.

**OPC Planning**

Develop a list of parameters to be linked between the asset management system and the DCS. This includes overall asset health index to the DCS for display to operators, as well as process variables from the DCS for use by the EAM diagnostic algorithms. Since maintenance is handled by a different group from plant operation, not all of the information needs to be displayed in the DCS. For instance, automatic vibration and temperature measurements taking the place of manual checks with vibration testers and temperature guns may be displayed on separate HMI software for maintenance technicians. Similarly, steam trap failure alarms could be integrated in the DCS, but it is not of interest to the operators, but could be an option if a separate maintenance alarm system is not desired. Steam and chilled water consumption could be integrated into the DCS to facilitate their inclusion as line items in the plant’s standard reports. Safety shower and eye wash station activation alarms should be integrated in the DCS such that operators can act on them. Manual valve and relief valve feedback, as well as pressure, temperature, flow, and level measurements taking the place of gauges, sight glass, variable areas flowmeter, and dipstick shall be integrated into the DCS along with pH and conductivity measurements taking the place of grab sampling, such that these readings are logged in the historian and can be incorporated in reports etc. An OPC bridge/mirror application may be required to integrate the two systems.

The resulting tag list speeds up the work in the site integration phase. The tag count is the basis for estimating the cost of integrating the asset health information and alarms into the DCS.

**Asset Health Alarm Management**

Turning all asset health alarms off would result in the plant falling back to reactive maintenance. Sending all asset health alarms to everyone would result in alarm flooding. A formal process should be adopted to rationalize asset health alarms, similar to process alarms. Engineering the asset health alarm management, is about making sure the criteria for a “good” asset health alarm are met. This includes prioritizing assets and classifying health alarms to enable the systems to route these alarms to the relevant person who know what actions to take well before any production impact. Only the asset health alarms needed for safe process operation should go to the operators at the DCS console, as soon as possible. That is, operators don’t see all asset health alarms, only the most critical ones. Information to the maintenance technician at the asset management system shall be as detailed as possible and include proposals to change the operation or how to service.

The criticality of a particular asset is plant specific. And who should receive asset health alarms is dependent on the plant philosophy. Therefore these options have to be engineered and configured for each modernization project. Asset health alarm rationalization is a new engineering discipline. Make sure to specify it for tender bid documents. Be prepared to pay for engineering hours. Typically the asset management system supplier provides these engineering services.

**Categorize Asset Health Alarms**

An array of health diagnostics is possible for each type of asset, to detect many kinds of problems specific to the asset type. The asset health alarms are based on deviation from an established baseline. Not every asset problem detected is equally serious. The asset health alarms for each asset type shall be categorized, such that it can be filtered and routed to the relevant person; operator or maintenance. Asset health alarms that require process intervention should go to both operators and maintenance. Only a small percentage of asset health alarms affect the process and therefore need to be routed to operators to take action. Note that operators do not maintain the asset, but need to see asset health alarms for problems that affect the process so that they to change the operation. Asset health alarms that do not require action to be taken on the process shall only go to maintenance. Most asset health alarms require no operator action. By categorizing the asset health alarms, the asset management system can handle these alarms correctly, routing them to the relevant person. An important part of asset health alarm rationalization is to map each asset health alarm to a desired category. The desired mapping shall be documented.
Asset Health Alarm Routing

Asset health alarms shall be configured and directed to the right personnel who can interpret them and decide on actions well before any production impact. Operations should only receive information they can act upon for running the plant. Maintenance needs to receive all kinds of information that can help with planning corrective activities.

The DCS alarm handling system routes the filtered asset health alarms to the operators. Asset health alarms with high priority from critical assets are routed to both operators and maintenance. Other asset health alarms are only routed to maintenance. That is, all asset health alarms are logged in the asset management system. The number of asset health alarms routed to operators is usually minimized, typically less than 10%, to ensure operators are not flooded with alarms. The alarm filtering in the DCS is configured for which categories and priorities of asset health alarms shall be routed to the DCS operator workstation for annunciation. For instance, a failure in an asset which is essential to the process will be annunciated to the operator, but if the asset has low criticality the failure need not be annunciated in the operator workstations, only logged for maintenance. The priority and category for filtering and routing should be defined by experienced operations and process engineers.

The DCS routes asset health alarms to operator workstation or maintenance workstation based on its priority. That is, by configuring the priority of the device diagnostic alarm, it gets routed to the person it is intended for.

System Implementation

The system implementation is done by the asset management system supplier.

System Database

At the implementation stage the asset management system software database is built including graphics, historian, alarm management, and report formats configured based on input from the detail design.

Essential Asset Monitoring (EAM)

The essential asset monitoring software graphics structure asset tags according to plant areas and asset categories.

Energy Conservation Measures (ECM)

The steam trap monitoring software database is built with structured plant areas, steam trap types, and other information collected in the design phase.

The EAM diagnostic algorithm constants and limits are customized for each asset based on the data in the “Asset Configuration Sheet” collected in the design phase, often originating from process equipment vendor documents.

Displays include representative asset illustrations and asset health alarms color coded to severity for easy at a glance overview.
The asset monitoring and sub-metering software graphics is structured according to plant areas and plant units, and diagnostic algorithm constants are customized based on the data in the “Asset Configuration Sheet” collected in the design phase.

**Health, Safety, and Environment (HS&E)**

Automatic pressure, temperature, flow, level, pH, and conductivity etc. measurements as well as safety shower and eye wash station status, position feedback from manual valves and relief valves, along with automatic vibration, temperature, leak testing can be routed to the existing DCS or a dedicated HMI software. The DCS and HMI shall be configured to display the data, as well as for detecting and logging alarms, historical trending, and reporting etc.

Access to setup/configuration information and diagnostics in 4-20 mA/HART devices requires the EDDL file for each device type to be obtained and loaded on the Intelligent Device Management (IDM) software (refer to separate white paper on device revision management on the www.eddl.org website). An inventory list of device types, and versions developed in the detail design phase will reduce omissions when loading EDDL files.

**FAT**

Factory Acceptance Test (FAT) is done at the asset management system supplier’s staging area, witnessed by the buyer. The EAM and steam trap monitoring software is staged in the system supplier’s factory. A FAT test plan shall be agreed on, and forms the basis for the FAT test procedures to verify the graphics, asset health alarm management, and reports etc.

For the IDM software, verify all versions of all device types from all manufacturers are integrated, that is, their EDDL files are loaded. This involves the IDM supplier, plant instrument specialist, and plant system engineer.

**Installation**

In an existing plant a local contractor installs the wireless transmitters, as well as the wireless gateways with network infrastructure and power. In a new plant the EPC does this work.

The modernization package vendor can help supervise the installation of wireless transmitters and gateways if the correct make and model of manual valves, relief valves, safety showers, and eye wash stations etc. have been identified in the design phase and the correct mounting kits have been specified, the wireless transmitter installation will be smooth.

The wireless transmitter supplier can help supervise the installation. Make sure to include services as part of the project budget.

**Commissioning**

The wireless transmitters and the software have to be commissioned.

**Gateway and Device Commissioning**

A local contractor commissions the wireless transmitters and wireless gateways. This includes setting network ID and join key as well as device tag and update period in case this was not preconfigured by device supplier in the factory (not specified in the purchase order). The site instrument technicians should take the opportunity to participate in the wireless device commissioning in order to familiarize themselves with the WirelessHART technology in order to best support the plant once it is running.

Verify from the wireless gateway web interface that each device joins the network and meet the established requirements for number of neighbors, signal strength, and reliability. Verify that each transmitter measures correctly. Since wireless is digital and does not use 4-20 mA, this can be a simple plausibility check, making sure the present reading is reasonable (single point instead of five). For instance does the position feedback match the actual valve position (i.e. is the feedback mechanism aligned correctly), are measured pressures and temperatures correct at their present value and so on.

The wireless transmitter supplier can help supervise the device commissioning. Make sure to include services as part of the project budget.

**System Commissioning**

The asset management system supplier commissions the asset management software. Missing EAM diagnostic algorithm data not input at implementation (such as constants for heat exchangers etc.) are configured in the commissioning phase. The baselines against which actual values will be compared are captured, either automatically or
manually. EAM diagnostic algorithm weightings are tuned. Make sure to include system commissioning services as part of the project budget.

Site Integration
The asset management system supplier works with the DCS supplier to establish communication between the two systems; for operators to receive asset health information and alarms, and for the EAM diagnostic algorithm to receive process variables already measured by wired transmitters. Site integration starts by establishing the bidirectional OPC link between the plant DCS and the asset management system.

The list of parameters to be linked between the systems developed in the detail design phase speeds up the integration work in the two systems.

Note that for EAM only computed information like one overall asset health index for each asset is passed to the DCS, not all of the dozens of raw data points like vibration and temperature for every asset. This way the DCS tag count is kept low, and the integration is simple.

Process variables already measured by wired devices connected to the DCS come from DCS through OPC into the asset management system. At sites where the asset management system gets process variables like heat exchanger flows or variable pump speed from the DCS through OPC, the site integration and commissioning may happen in parallel.

Make sure to include integration services from both DCS supplier and asset management system supplier as part of the project budget.

Develop Procedures
Write procedures and work processes making use of the new plant-wide information. Development of these procedures can start early in the project and does not need to wait for detail design to be completed. A consultant can help in the development of the procedures and work processes for maintenance, energy conservation, and HS&E. Make sure to include services as part of the project budget.

Maintenance Procedures
Write the maintenance procedures and work processes which maintenance planners and technicians can follow, making use of the asset health information and asset health alarms to screen and prioritize maintenance work. That is, to check the software first, before maintenance is planned and carried out. This involves the maintenance lead and the process engineer.

Note that maintenance technicians and planners are not constantly looking at the asset management software. Rather, daily maintenance planning is driven by asset health alarms, and turnaround planning is driven by reviewing asset health index to screen which assets require maintenance and which ones don’t. That is, as maintenance is planned each morning and before a 5-year turnaround, the asset health alarm summary and health indexes are reviewed to schedule the activities and reduce the scope to minimize the plant downtime. It may even be found that it is possible to extend the turnaround period to 7 years.

ECM
Rework plant report formats used by plant areas for daily, weekly, and monthly reports to include steam and chiller water consumption as one of the line items along with production results and inventory etc. report to be generated by each plant area. The energy consumption is used for cost accounting and tracking progress of ECM initiatives.

Rewrite the maintenance procedures and work processes for steam trap replacement, to make use of the steam trap monitoring software to prioritize steam trap replacement work. This involves the piping department. Pipe fitters need not be constantly looking at the steam trap monitoring software. Rather, replacement planning is driven by steam trap failure alarms. That is, as replacement is planned each day and before a turnaround, the steam trap alarm summary is reviewed to schedule the activities. That is, checking the software first, before going to the field.

Operations HS&E Procedures
Write the procedures which operators can follow, making use of the safety shower and eye wash station as well as relief valve alarms to direct help to persons in distress and respond to environmental releases. This involves the HS&E officer.

See separate guide on incorporating device diagnostics in daily maintenance and turnaround planning (www.eddl.org).
Training for Competency

Use of an asset management system requires new skills. Therefore training is required for all those involved to get the necessary competency in asset management. With asset management, work is centered around computers. Therefore, computer skills are a prerequisite for maintenance work in a modern plant. Asset management training has to be customized to cover the competencies required for the tasks which each role has to carry out. Training has to be carried out not at the end of the modernization project, but throughout the duration of the project before the next phase of the project starts. Once the plant is operational, new employee training and refresher courses should be conducted periodically.

The asset management software supplier should be able to assist with training material and conducting these classes. Training cost should be included as part of the project budget. Training shall not be generic, but must be task-based and site-specific, using the same asset management software as the site. Handouts and manuals must be provided.

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<table>
<thead>
<tr>
<th>Role</th>
<th>Tasks</th>
<th>Competencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant management</td>
<td>• Justification</td>
<td>• Understand EAM and predictive maintenance regimes</td>
</tr>
<tr>
<td>Project/turnaround manager</td>
<td>• Planning</td>
<td></td>
</tr>
<tr>
<td>Maintenance lead</td>
<td>• Audit</td>
<td>• Understand modernization requirements</td>
</tr>
<tr>
<td>Control system lead</td>
<td>• FEED</td>
<td>• Understand wireless system architecture</td>
</tr>
<tr>
<td>Maintenance manager</td>
<td>• Detail design</td>
<td>• Understand EAM</td>
</tr>
<tr>
<td>Process engineers</td>
<td>• Rewrite procedures</td>
<td>• Understand wireless integration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Understand the asset health alarm categorization and prioritization</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• How to write maintenance procedures based on asset health alarms</td>
</tr>
<tr>
<td>System engineers</td>
<td>• FAT</td>
<td>• How to commission (provision) a WirelessHART device</td>
</tr>
<tr>
<td></td>
<td>• Site integration</td>
<td>• WirelessHART troubleshooting</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Device revision/version lifecycle management</td>
</tr>
<tr>
<td>Instrument technicians</td>
<td>• Device commissioning</td>
<td>• Navigate the EAM pages in the asset management system</td>
</tr>
<tr>
<td>Instrument fitters</td>
<td></td>
<td>• How to set baselines</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• How to extract and print daily reports</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• How to acknowledge alarms</td>
</tr>
<tr>
<td>Maintenance technicians</td>
<td>• Process equipment maintenance</td>
<td>• How to export logged data</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operator</td>
<td>• Operations</td>
<td>• How to respond to alarm from personnel in distress</td>
</tr>
</tbody>
</table>

Figure 12.6h – Essential Assets Monitoring (EAM) is part of Plant Asset Management (PAM)
Machinery Health Management Software
Machinery health management software monitors vibration in rotating equipment such as turbines, compressors, and critical pumps to predict failures. Data collected using online machinery health monitors is recorded and can be replayed for root-cause-analysis and troubleshooting. Data from vibration transmitters and offline vibration testers can also be analyzed.

Intelligent Device Management Software
Intelligent device management software monitors field instrumentation such as transmitters, analyzers, control valves, on/off valves, motor drives, and gas chromatographs etc. It enables device configuration and configuration management, device calibration and calibration management, as well as device diagnostics and device diagnostic alarm management.

Refer to separate guideline for deployment process for intelligent device management software and device diagnostic alarm rationalization on www.eddl.org
13

Frequently Asked Questions
## 13. Frequently Asked Questions

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<th>Category</th>
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<tr>
<td>AMS</td>
<td>Can you do normal AMS actions such as “Zero a transmitter” or “Stroke a valve” over a wireless AMS network?</td>
<td>Everything you can do on AMS for wired devices you can do with the wireless devices as well. It is just another device in AMS using a different communication protocol.</td>
</tr>
<tr>
<td>Antenna</td>
<td>Can AMS device alerts be passed to DeltaV to provide alarms for operators when there is a problem with a device? Does someone have to log into AMS to see problems, or can I get alarms?</td>
<td>Yes, you should be able to get all AMS parameters into DeltaV as well. Make it a maintenance alarm if you want.</td>
</tr>
<tr>
<td>Antenna</td>
<td>I’ve heard there are “extended range” antennas for some devices. Are these extended range antennas available for all devices?</td>
<td>Not all devices, no; 3051S, 648 and 702 have extended range antenna options.</td>
</tr>
<tr>
<td>Commercial</td>
<td>What is the typical added cost per device vs. a standard wired device?</td>
<td>With such a large portfolio of WirelessHART devices available, it is difficult to give a typical added cost per device, other than to say that WirelessHART devices do cost more than their wired counterparts. However, there are considerable savings overall with wireless when you consider installation costs of wired devices.</td>
</tr>
<tr>
<td>Commercial</td>
<td>Do you have cost comparison figures available for wired vs wireless solutions?</td>
<td>Yes we do. We have an online Wireless Calculator tool that produces a report, on a per installation basis, based on a specific customer requirement. A comparison of the cost and time required for a wired installation against that of a wireless solution is calculated. Typically we see savings range from 8% to 15% in Cost and up to 70% in time.</td>
</tr>
<tr>
<td>Competition</td>
<td>Can this network system incorporate other brand (E+H) devices that are wireless as well?</td>
<td>Yes, it can, as long as it complies with the WirelessHART spec. (E+H wireless devices will talk WirelessHART).</td>
</tr>
<tr>
<td>Control</td>
<td>What is your opinion about using wireless for control, instead of using it for monitoring only?</td>
<td>Wireless is being used for non-critical closed loop control. For more information, go to: <a href="http://www2.emersonprocess.com/en-US/news/pr/Pages/909-Wireless-Redundancy.aspx">http://www2.emersonprocess.com/en-US/news/pr/Pages/909-Wireless-Redundancy.aspx</a></td>
</tr>
<tr>
<td>Control</td>
<td>Can the discrete and analog input/outputs communicated over wireless networks be interfaced with existing third party SCADA/DCS systems that the plants already use (such as Foxboro or Honeywell)?</td>
<td>Yes, WirelessHART can be integrated into any 3rd party host that will handle Modbus or OPC. A native connection option between the Gateway and DeltaV is available.</td>
</tr>
<tr>
<td>Diagnostics</td>
<td>Is there a warning sent to the control system or some kind of notification when the power module is running low on power?</td>
<td>Yes, there is a low battery alert available.</td>
</tr>
<tr>
<td>Diagnostics</td>
<td>If transmitters are asleep and there is a measurement alert e.g. 9420 Vibration Transmitter asleep and Vibration levels went up would the transmitter detect this and send a signal?</td>
<td>The sensor will only be read at the configured update period.</td>
</tr>
<tr>
<td>Environment</td>
<td>How do you enable location tracking services within high metallic density plant environments?</td>
<td>With reference to RFID, this is answered in detail in Emerson’s Service Data Sheet for wireless location tracking. This document is available online: <a href="http://www2.emersonprocess.com/siteadmincenter/PM%20Central%20Web%20Documents/WPN%20Service%20DS%20Location%20Tracking.pdf">http://www2.emersonprocess.com/siteadmincenter/PM%20Central%20Web%20Documents/WPN%20Service%20DS%20Location%20Tracking.pdf</a>.</td>
</tr>
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<tr>
<td>Frequency</td>
<td>Are there any regulatory requirements for operating at 2.4 GHz in an industrial facility in North America and how does one guard against Radio interference/ radio jamming (for example offshore in International waters on a Rig)?</td>
<td>The 2.4 GHz band is a free usable band. Each WirelessHART device has to be submitted for approvals on a country by country basis. All Emerson WirelessHART devices available in North America will have gone through and approvals and certification process. WirelessHART communications is very robust and resilient to jamming and interference by the very nature of its design. (WirelessHART uses ‘channel hopping’ to avoid sending data over channels with interference and Direct Sequence Spread Sequence (DSSS)). There are WirelessHART installations running on offshore platforms and in international waters without any problem. For more detailed information please consult your local Emerson Process Management contact.</td>
</tr>
<tr>
<td>Gateway</td>
<td>Why isn’t the gateway redundant?</td>
<td>No, not really. WirelessHART is designed to co-exist with other wireless devices. We have a whitepaper available at the following link: <a href="http://www2.emersonprocess.com/siteadmincenter/PM%20Central%20Web%20Documents/cisco_emerson_coexistence-paper_070914.pdf">http://www2.emersonprocess.com/siteadmincenter/PM%20Central%20Web%20Documents/cisco_emerson_coexistence-paper_070914.pdf</a></td>
</tr>
<tr>
<td>Gateway</td>
<td>Can the WirelessHART gateway connect to a Honeywell DCS?</td>
<td>Yes, we have integrated our WirelessHART gateway into Honeywell DCS (and many other vendor hosts)!</td>
</tr>
<tr>
<td>Max. Qty</td>
<td>What is the maximum number of wireless devices that can communicate with a gateway?</td>
<td>The Smart Wireless Gateway can communicate with up to 100 devices.</td>
</tr>
<tr>
<td>Max. Qty</td>
<td>Is data throughput a function of number of devices on the gateway and if so what are typical users using for the maximum number of devices for a typical update time of 1 second how long would the battery last for a Pressure transmitter under these conditions?</td>
<td>Data throughput is not a function of the number of devices. We use TSMP (Time synchronised mesh protocol). Each device on the network has defined timeslots.</td>
</tr>
<tr>
<td>Network</td>
<td>What is your opinion about the influence of the number of hops of mesh networks at the performance and reliability?</td>
<td>Each ‘hop’ will add a certain amount of latency to the data, but this would not affect data reliability!</td>
</tr>
<tr>
<td>Network</td>
<td>If you have a large area to cover different units, I expect you need more than one gateway. How do you set up different areas so the devices communicate only to the right gateway? (You said they automatically add themselves to the network.)</td>
<td>Each Gateway has a unique ‘Network ID’ with a value between 0 &amp; 50000. Devices will be configured with the ‘Network ID’ of the corresponding Gateway.</td>
</tr>
<tr>
<td>Power</td>
<td>What is the typical battery life in cold climates?</td>
<td>In cold climates (-30°C / -22°F) the typical ‘battery’ life is about 5% less than that at ambient temperature (25°C / 77°F).</td>
</tr>
<tr>
<td>Power</td>
<td>Doesn’t the module require recharging? I don’t expect the battery will last 10 years of service without some kind of charging.</td>
<td>The batteries used in the ‘Power Module’ are not rechargeable. Depending on ambient temperature, device type, update rate and number of descendants, the ‘batteries’ can last up to 10 years in operation. (10 years is also the ‘shelf life’ of the batteries!)</td>
</tr>
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</tr>
<tr>
<td>Protocol</td>
<td>Is wireless the replacement and killer for Foundation Fieldbus or other field buses?</td>
<td>No, Wireless will complement FF and other buses (and vice versa). All technologies have their place on a plant.</td>
</tr>
<tr>
<td></td>
<td>If the use/uptake of predictive maintenance has not improved with the FF and wired HART why is Wireless going to be the ‘savior”?</td>
<td>By using wireless you will be saving a lot of cost in installation as the examples Chris Hamlin mentioned! Now the data is in your maintenance system, but you also have to do something with it!</td>
</tr>
<tr>
<td></td>
<td>Are there any plans to make communication with gateway to PC wireless instead of ethernet?</td>
<td>There are no plans in the short term for this, although if you take an ‘off the shelf’ ethernet to wifi adapter, you could achieve this! (There is a ‘fibre optic’ version of the gateway available).</td>
</tr>
<tr>
<td></td>
<td>Where can I get information in regards to Mobile Worker?</td>
<td>Please see Service Data Sheet for more information:<a href="http://www2.emersonprocess.com/siteadmincenter/PM%20Central%20Web%20Documents/WPN%20Service%20DS%20Mobile%20Worker.pdf">http://www2.emersonprocess.com/siteadmincenter/PM%20Central%20Web%20Documents/WPN%20Service%20DS%20Mobile%20Worker.pdf</a></td>
</tr>
<tr>
<td>Range</td>
<td>What is the range of the wireless transmitters, and what are the distance limits between transmitter and receiver?</td>
<td>The overall communications range may be influenced by the density of the environment. Using the standard ‘long range’ antenna devices, the max range is typically ~228 metres / ~748 feet. With ‘extended range’ antenna devices, the range increases to ~800 metres / ~2625 feet. (Each device can also act as a repeater, hence increasing the overall range)</td>
</tr>
<tr>
<td></td>
<td>What is the distance for the THUM adapter?</td>
<td>Depending on the density of the environment, typically up to ~228 meters / ~748 feet.</td>
</tr>
<tr>
<td>Repeater</td>
<td>Is there repeaters available? Not repeater/transmitter but repeater only that could be used to extend the range of wireless network.</td>
<td>There is currently the 775 ‘THUM’ that can be used as a ‘repeater only’ device. A standalone WirelessHART repeater will be available shortly.</td>
</tr>
<tr>
<td>SIL</td>
<td>Can wireless networks be used for safety related applications to SIL 1 or higher</td>
<td>No, WirelessHART devices do not currently have a SIL rating. (It may be a possibility in the future though!)</td>
</tr>
<tr>
<td></td>
<td>Are the wireless instruments also available with a SIL certificate (SIL 1 capability)?</td>
<td>SIL rating of WirelessHART devices is not an option at the moment.</td>
</tr>
<tr>
<td>Survey</td>
<td>What type of site survey is required prior to installation?</td>
<td>A site survey is not required for Smart Wireless field applications because they use self-organizing WirelessHART technology, making wireless signals immune to possible obstacles or barriers. However, a professional site assessment is critical to the successful implementation of wireless plant solutions such as video monitoring, mobile tools, and people/asset tracking.</td>
</tr>
<tr>
<td></td>
<td>What can be used for plot plans as part of “Snap-On”? Photos? Autocad equipment plans?</td>
<td>Use a bitmap or jpeg image for your Snap On planning tool. I always use a image of Google maps!</td>
</tr>
<tr>
<td>Temp</td>
<td>Are there any restrictions as to the ambient temperature in which the wireless instruments can be applied?</td>
<td>No different to the ones that are applicable to traditional wired instruments.</td>
</tr>
<tr>
<td>THUMS</td>
<td>What types of devices are available to use the THUM device?</td>
<td>Every HART 5 and higher devices, even non-Emerson devices, can be connected to the THUM. For more information and documentation, please visit: <a href="http://www2.emersonprocess.com/en-US/plantweb/wireless/products/Pages/SmartWirelessTHUMAdapter.aspx">http://www2.emersonprocess.com/en-US/plantweb/wireless/products/Pages/SmartWirelessTHUMAdapter.aspx</a></td>
</tr>
<tr>
<td></td>
<td>How is the THUM powered?</td>
<td>The THUM scavenges its power from the 4-20mA loop that it is connected to.</td>
</tr>
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</tr>
<tr>
<td>THUMS</td>
<td>What information will the THUM Adapter transmit to the Smart Wireless Gateway?</td>
<td>As a default the THUM Adapter will transmit HART command 3 and 48 for the wired device and command 178 for the THUM Adapter. The THUM Adapter passes any process variable – that can be mapped into these commands – to the Smart Wireless Gateway.</td>
</tr>
<tr>
<td></td>
<td>How do I configure the THUM Adapter to transmit the information I want?</td>
<td>Use AMS Device Manager or a Field Communicator to configure the Wireless THUM Adapter.</td>
</tr>
<tr>
<td></td>
<td>What is the communication distance of the Smart Wireless THUM Adapter?</td>
<td>The THUM Adapter performs just like any other Smart Wireless device in high and medium density environments. We recommend using the AMS Wireless SNAP-ON application to effectively plan a self organizing network that meets best practices for distances and number of neighbors.</td>
</tr>
<tr>
<td></td>
<td>What hazardous approvals does the Smart Wireless THUM Adapter have?</td>
<td>The THUM Adapter is certified intrinsically safe (IS) suitable for Class 1 Div. 1 areas.</td>
</tr>
<tr>
<td>708</td>
<td>Where’s the antenna?</td>
<td>The antenna is located on the circuit board of the device.</td>
</tr>
<tr>
<td></td>
<td>What’s the range of the device?</td>
<td>The 708 has the same range as other wireless devices – 750 ft (250 m) line of sight. Extended range is not available for the acoustic transmitter.</td>
</tr>
<tr>
<td></td>
<td>What is the frequency band of the acoustic transmitter?</td>
<td>The device is sensitive to acoustic noise between 20 and 60 kHz.</td>
</tr>
<tr>
<td></td>
<td>What is a count?</td>
<td>A relative measure of noise in the system.</td>
</tr>
<tr>
<td>Update Rate</td>
<td>How does scan rate affect battery life?</td>
<td>There are guidelines to avoid this type of scenario. Also, because WirelessHART is self-organising, it would attempt to 'spread the load' between devices. We have an application 'snap on' (AMS Wireless SNAP-ON) which will review a network and warn if there are pinch points.</td>
</tr>
<tr>
<td></td>
<td>What limitations have been seen as far as putting too much info through a particular device (acting as a repeater) and slowing that device down?</td>
<td>WirelessHART was designed for control applications. Smart Wireless has already been installed in low speed control applications. We have customers who have deployed self-organizing WirelessHART networks in tank level and temperature control applications. We expect to see greater adoption of wireless in control applications as more customers use wireless technology and become comfortable with it.</td>
</tr>
<tr>
<td>Wireless in Control</td>
<td>In what kinds of control applications do you see wireless first being used?</td>
<td>WirelessHART allows exception reporting for network efficiency; devices only communicate a measurement value if it has changed significantly since the last communication or if the time since the last communication has exceeded a required reporting time, optimizing battery life.</td>
</tr>
<tr>
<td></td>
<td>Can you give a bit more information on the optimized PID algorithms that support using wireless in control applications?</td>
<td>The optimized PID algorithms allow the user to customize the loop for exception reporting, i.e. the device transmits the process variable only when it fall outside a user-defined range.</td>
</tr>
<tr>
<td></td>
<td>Your wireless control demo shows devices with 1 second update rates. What impact does that have on battery life for the device?</td>
<td>The 708 has the same range as other wireless devices – 750 ft (250 m) line of sight. Extended range is not available for the acoustic transmitter.</td>
</tr>
</tbody>
</table>

Do you wish to learn more, log on to, http://intra.emersonprocess.com/wireless/Advertising.htm
Recommended retail price $35.99

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