WIRELESS REMOTE MONITORING OF CATHODIC PROTECTION SYSTEMS

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INTRODUCTION

- Cathodic Protection is an electrochemical technique which has been used for many years to prevent the corrosion of buried and/or immersed metallic surfaces.
- It utilizes the application of small amounts of electrical current (d.c.) to the protected surface to counteract the natural corrosion currents existing at the metal surface.
- The whole of the structure under protection is forced to act as the cathode of an electrochemical cell, hence the term CATHODIC PROTECTION (CP).
- The types of structures which may be protected using CP are wide ranging and include:

- Cross-country pipelines (Oil, Gas, Water etc)

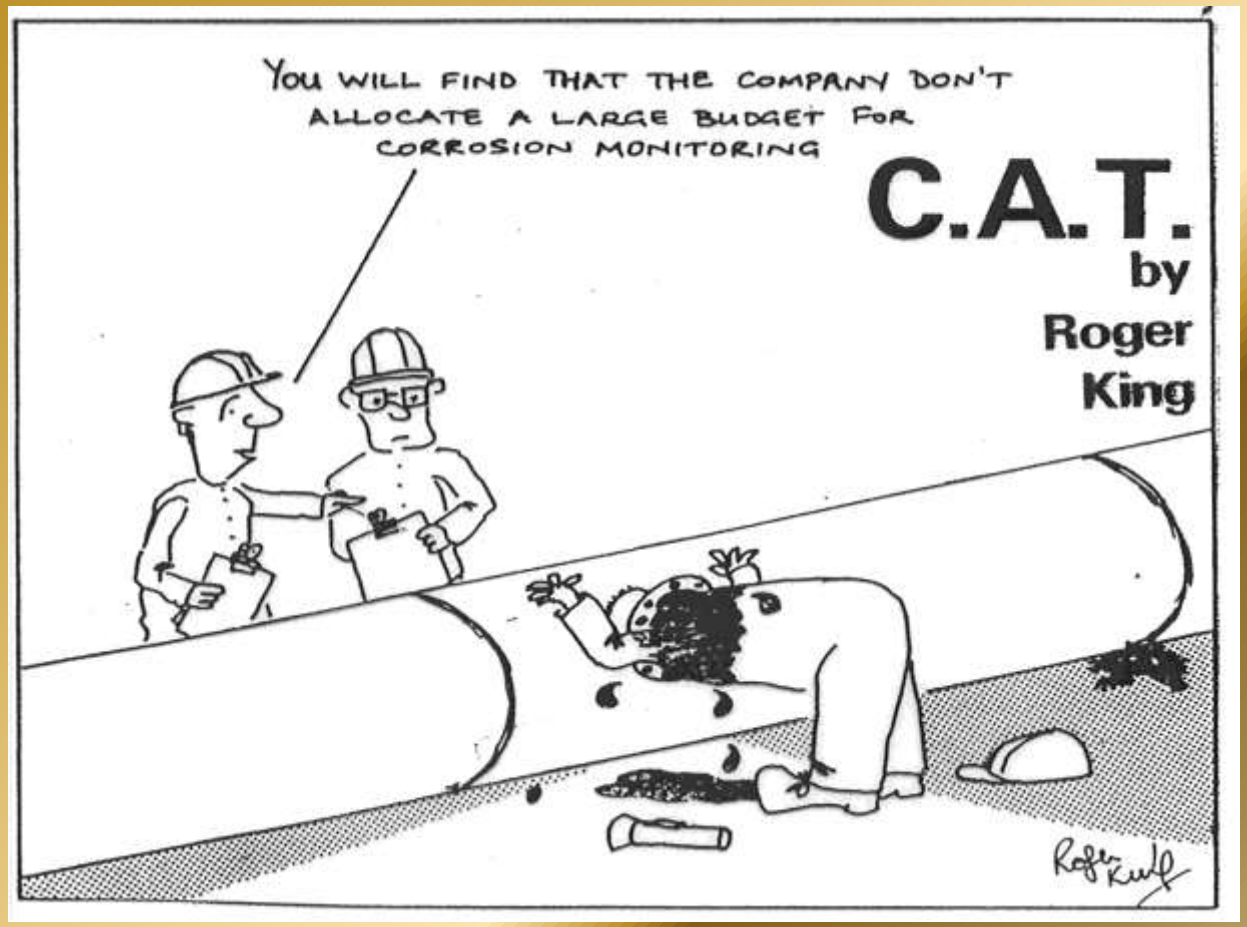
- Storage Tanks
- Fuel, Product, Water
- Internal (Water), External (Floor Plates)

- Industrial Plant Piping Systems

- Concrete Structures

Monitoring of CP Systems

- One of the critical issues facing owners and operators of CP systems is that of Monitoring and Maintenance.



- Installations may be in remote or difficult to access areas

- Working environments are often hazardous

- Monitoring can be time consuming and a drain on personnel resources

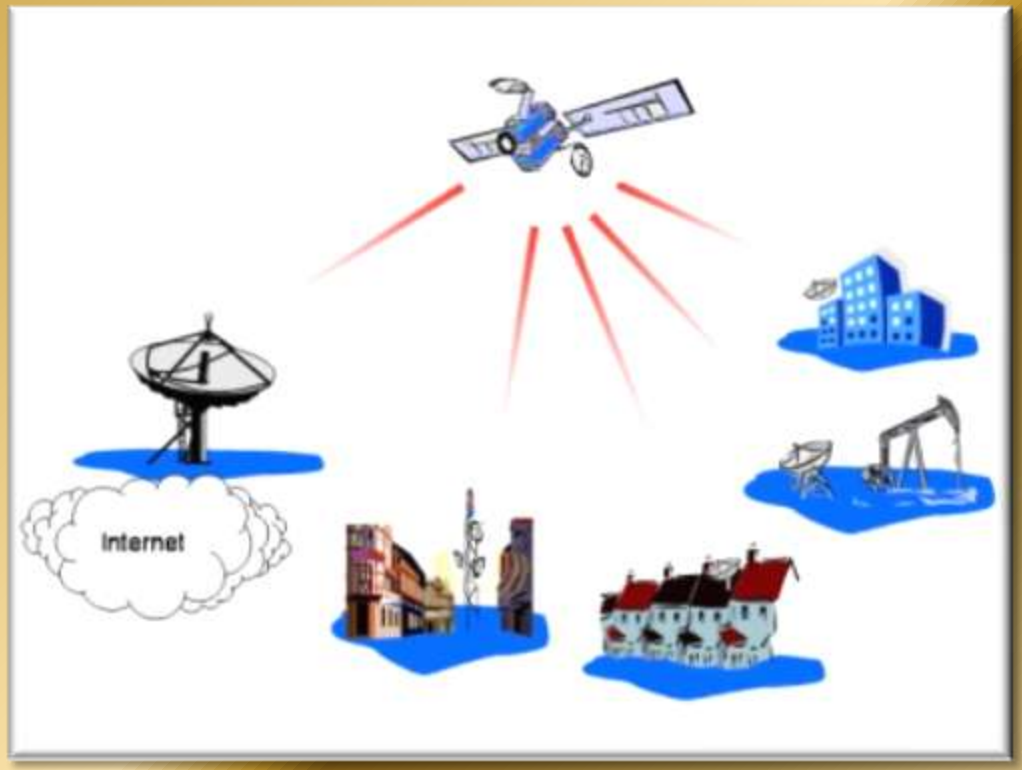
The Need for Remote Monitoring

- Improperly executed Monitoring and Maintenance regimes are a frequent cause of premature system failure.
- Remember – incorrect operation of CP systems may result in lack of protection and may even cause harm.

The Need for Remote Monitoring

- Asset owners and operators have been examining a number of Remote Monitoring (RM) technologies for CP systems.

- Emerging wireless technologies have expanded the possibilities for remote CP application.
- Uptake however has been limited due to factors such as
  - High implementation cost
  - Recurring licensing fees/costs
  - Requirements for satellite uplink/downlinks via 3rd parties
  - Etc..



The Need for Remote Monitoring

- Recent world-wide, major corrosion events are now leading companies to look for new, low cost alternatives for cathodic protection remote monitoring
- The benefits to asset owners are obvious:
  - Reduced 'windshield time'
  - Reduced operator exposure to potentially hazardous environments
  - 'Real time' access to accurate system operational data
  - Automated reporting and alarming via inputs to existing SCADA systems
- Enables more effective use of personnel resources to achieve timely and targeted maintenance tasks

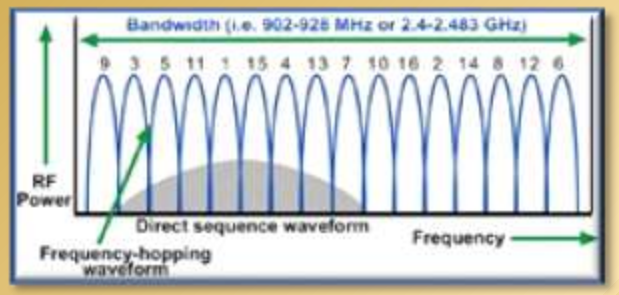
Frequency Hopping Spread Spectrum (FHSS) Wireless Technology?

- Recent technology development of low cost, fully integrated, cathodic protection remote monitoring units (CP RMU) may provide the answer.

- New, unlicensed, frequency hopping spread spectrum, wireless, application specific CP RMU's extend current technology with increased economical viability enabling more companies to remotely monitor more assets.

What is Frequency Hopping Spread Spectrum Wireless Technology?

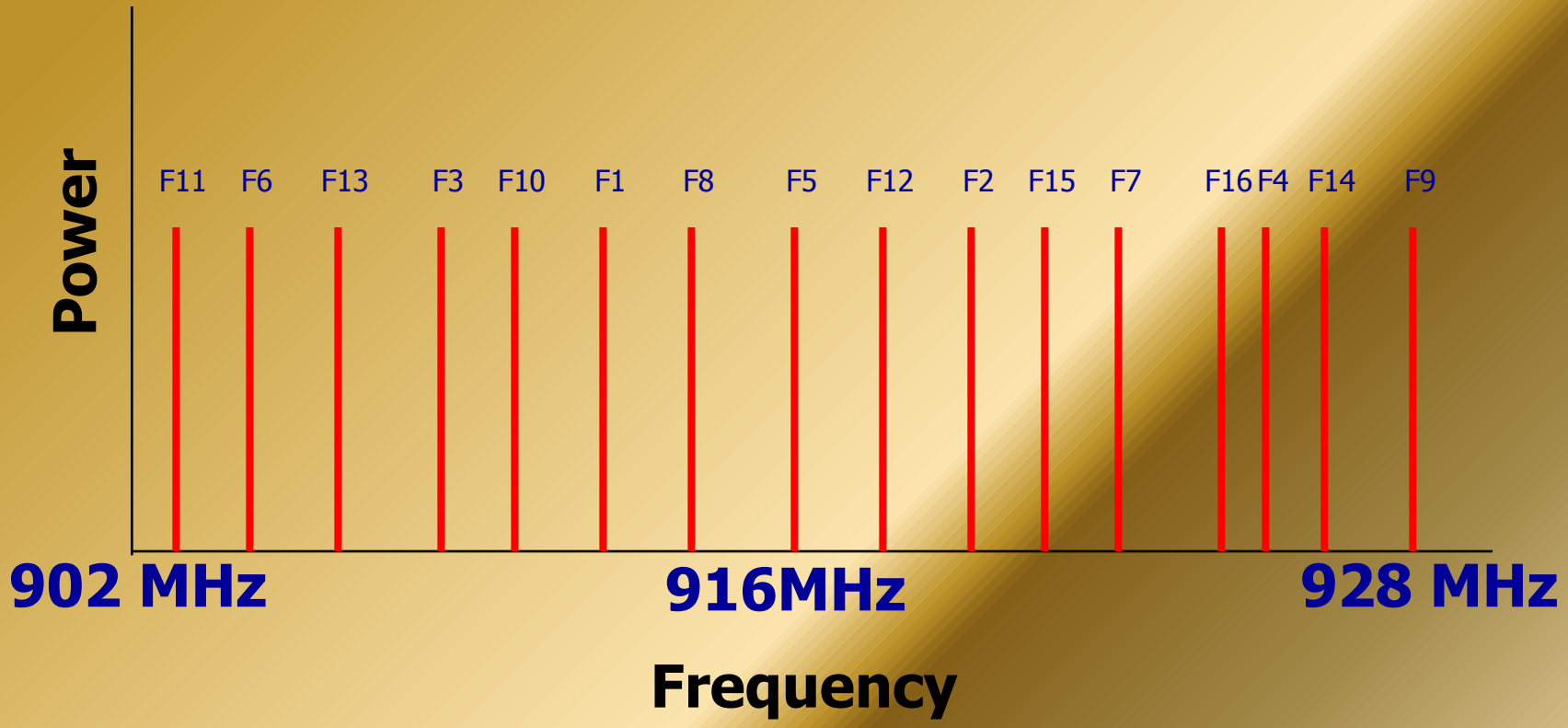
- Correctly referred to as frequency hopping, spread spectrum radio technology, it is simply a wireless radio communication design that, rather than operating at a fixed frequency within a band, as with licensed radios, the radio communication signal actually hops from one frequency to another in a fast, well-choreographed, engineered manner along with other similarly programmed radios within the network.



- Frequency hopping spread spectrum, (FHSS), technology allows multiple users to set up multiple networks within the same radio frequency band, greatly increasing the utilization of the narrow communication band.

What is Frequency Hopping Spread Spectrum Wireless Technology?

FHSS: Hopping through the spectrum



What is Frequency Hopping Spread Spectrum Wireless Technology?

- Provided all radios within each network hop at the same rate within the same frequency band, network communications are effective.
- Provided all networks within the band hop at different rates from each other using frequency hopping techniques, then network communications are effective.
- Early FHSS systems did not include the same levels of proprietary communication protocols, encryption, network ID's, hopping patterns, packet size selection, or hopping frequencies thus were prone to failure due to data collisions, lost data or corrupted data.

- FHSS radios offered today have 6-level security features, proprietary protocols and can hop up to 1,000 times per second - making data collisions almost impossible.

What is Frequency Hopping Spread Spectrum Wireless Technology?

- Today, FHSS Manufacturers offer wireless CP RMU products with a wide variety of selection, security, encryption and speed specifications as follows:

1. High Speed Communications: 115.2 Kbps true data throughput
2. Long range: up to 60 kilometers line of sight, ability to extend range through infinite repeaters.
3. Error Free Communications: 32 bit CRC with automatic retransmission.
4. Industrial Grade Specifications: Temperature cycle tested -40ºC to +75ºC.
5. Repeater Capabilities: Each CP RMU can perform as a remote test site, a repeater site and as a simultaneous test site/repeater. Repeaters can infinitely repeat.
6. Wide Supply Voltage Range: Supply voltage 10 to 30 VDC.
7. Ultra Low Power Consumption: Current draw as low as 6 mA, 12 VDC in sleep mode, and less than 86 mA in receiving mode. In sleep mode, CP RMU can awaken, synchronize and be ready to transmit data is less than 150 microseconds.
8. Separate Diagnostics Serial Ports: Allows real time simultaneous local diagnostics and setup without tying up main CP RMU communication port.

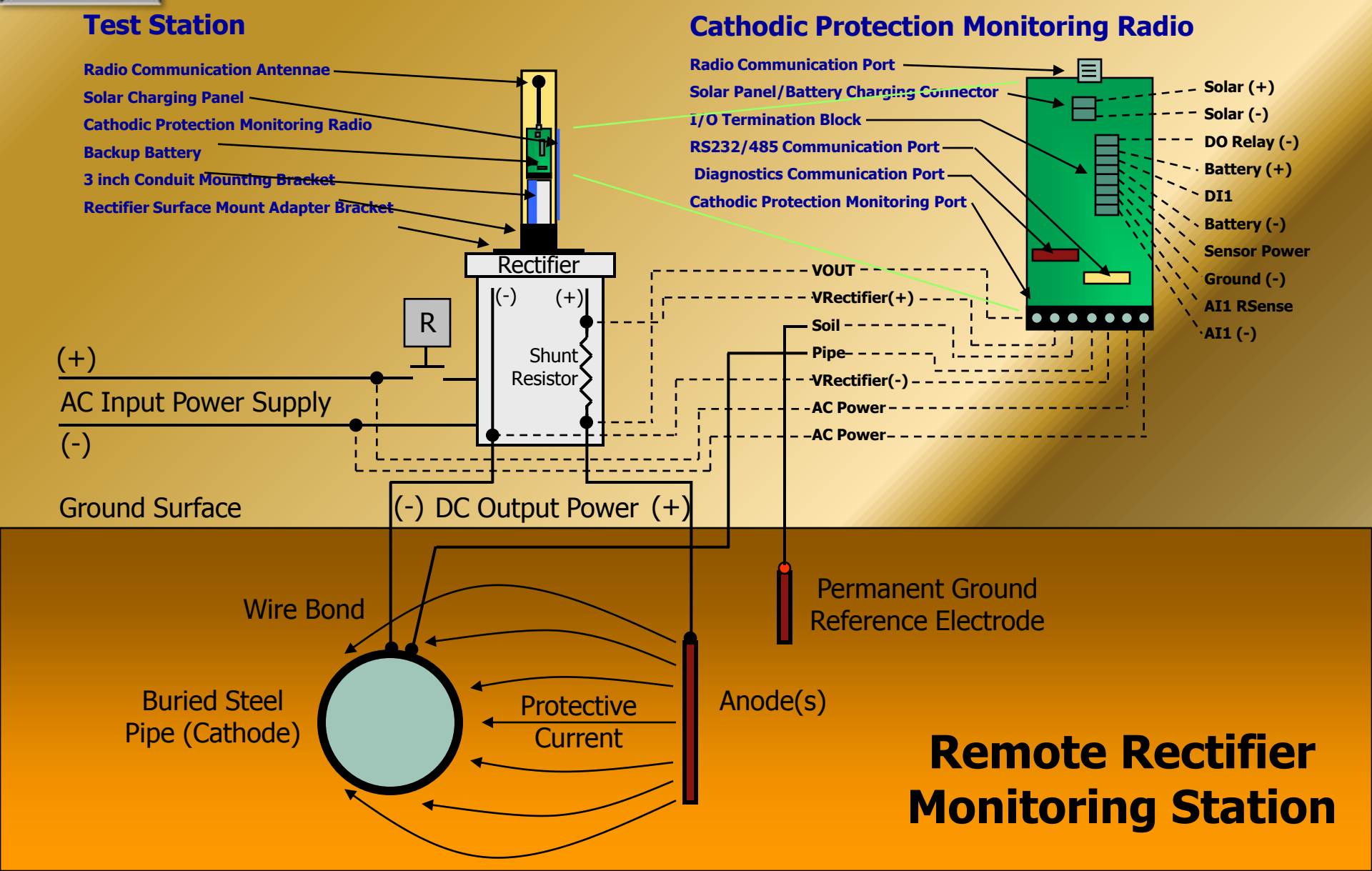
FHSS Technology has come a long way since the 1930's

- FHSS technology offers the end user the flexibility of installing remote monitoring equipment where it makes sense without concerns over monthly fees, radio band licensing, network interferences or security.
  - No monthly recurring fees or costs
  - No initial or monthly licensing fees
  - Minimized network interferences
  - Maximum network security
  - Operates behind company firewall
  - Own your own data
  - Open protocol communications
  - Maximum system flexibility
  - Infinite repeatability
  - Maximum implementation into cabinetry
  - Minimized field wiring

CP RMU Field Implementation

- Cathodic protection remote monitoring units, RMU's, typically monitor and report key corrosion protection activities including:
  - Pipe-to-soil potential
  - Rectifier output voltage
  - Rectifier output current
  - Rectifier input power status
- CP RMU's can offer remote operation of CP activities such as rectifier interruption for maintenance purposes.
- Modern CP RMU's also monitor radio temperature and if connected to a solar power generation system will also monitor the battery voltage of the back up battery supply.

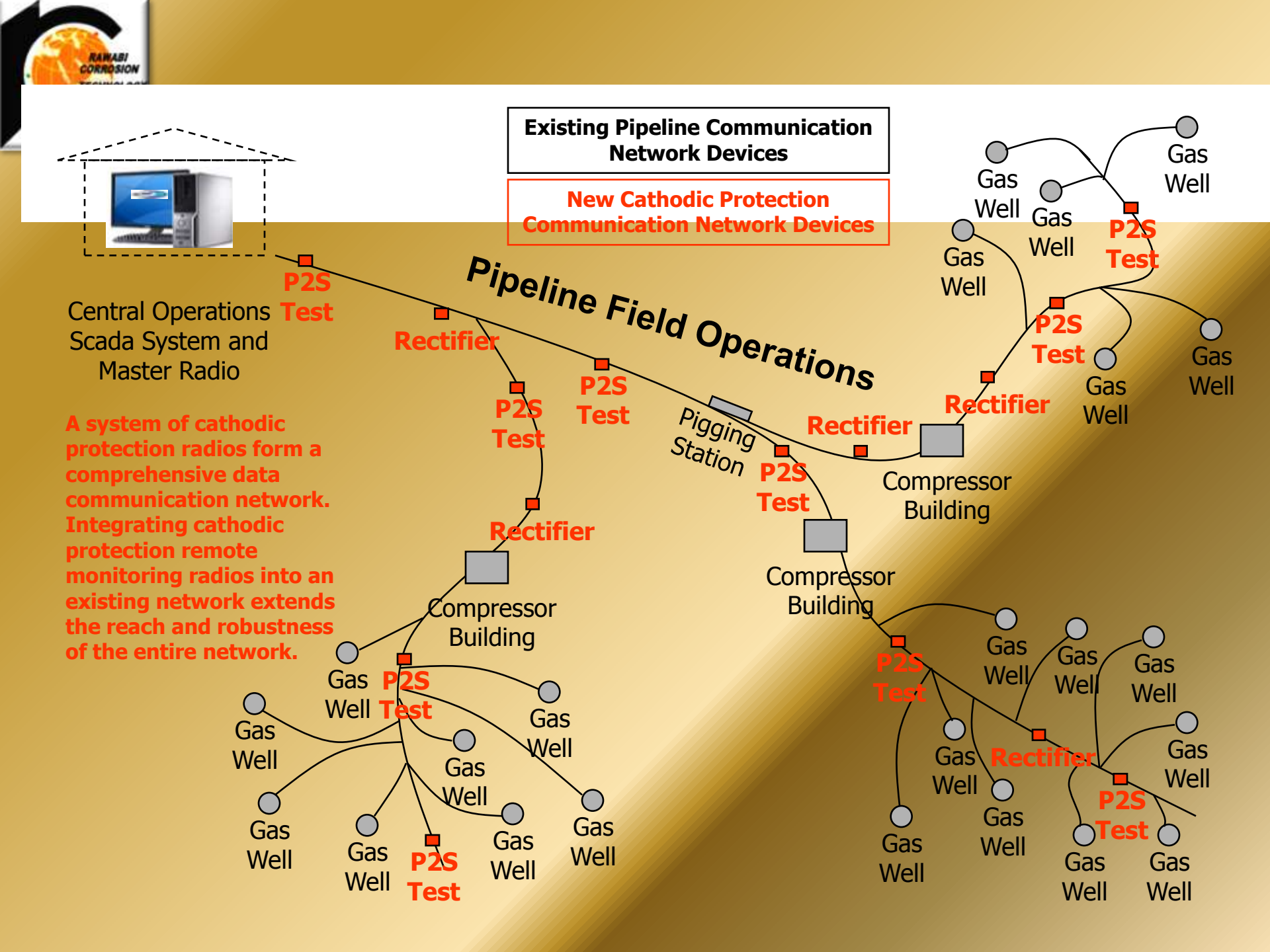
A typical CP RMU Installation Schematic



Remote Rectifier Monitoring Station

Other RMU Options

- In addition to monitoring the four process variables mentioned previously, FHSS CP RMU's may have additional channels to monitor, record and report:
  - Pipeline pressure
  - Pipeline temperature
  - Pump station sump level
  - Pump status on/off
  - Tank level
  - Ambient temperature


Existing Pipeline Communication Network Devices
New Cathodic Protection Communication Network Devices
Pipeline Field Operations
Central Operations Scada System and Master Radio
A system of cathodic protection radios form a comprehensive data communication network. Integrating cathodic protection remote monitoring radios into an existing network extends the reach and robustness of the entire network.
P2S Test
Rectifier
Pigging Station
Compressor Building
Gas Well

CP RMU Field Implementation

- The FHSS CP MRU monitors, records and stores the measured variables, mentioned previously, within the radio and makes them available to a centrally located, remote data acquisition computer offering supervisory control of CP functionality.
- The centrally located, data acquisition computer will collect all the field data from the CP RMU's and store them within a local data base.
- CP RMU's communicate to the centrally located, data acquisition computer, much like many remote field located RTU's and PLC's using a communication protocol of either a proprietary nature or an open communication protocol such as OPC or Modbus.
- The communication protocol is the language used by the remote field device to transmit data from the remote device to the central SCADA computer.

Modbus is a serial communications protocol published by Modicon in 1979 for use with its programmable logic controllers. It has become a de facto standard communications protocol in industry, and is now the most commonly available means of connecting industrial electronic devices. The main reasons for the extensive use of Modbus over other communications protocols are:

1. It is openly published and royalty-free.
2. Relatively easy industrial network to deploy
3. It moves raw bits or words without placing many restrictions on vendors

CP RMU Field Implementation

- Many companies already own and operate a centralized located computer network specifically designed and implemented for the express purpose of remotely collecting field data from remote terminal units, RTU's, programmable logic controllers, PLC's and now cathodic protection remote monitor units.
- The SCADA computer or computer network is used to drive the software processes to collect field data into a central database for local storage, field event alarming, regulatory and company reporting, CP value trending and for further technical and engineering analysis.

CP RMU Field Implementation

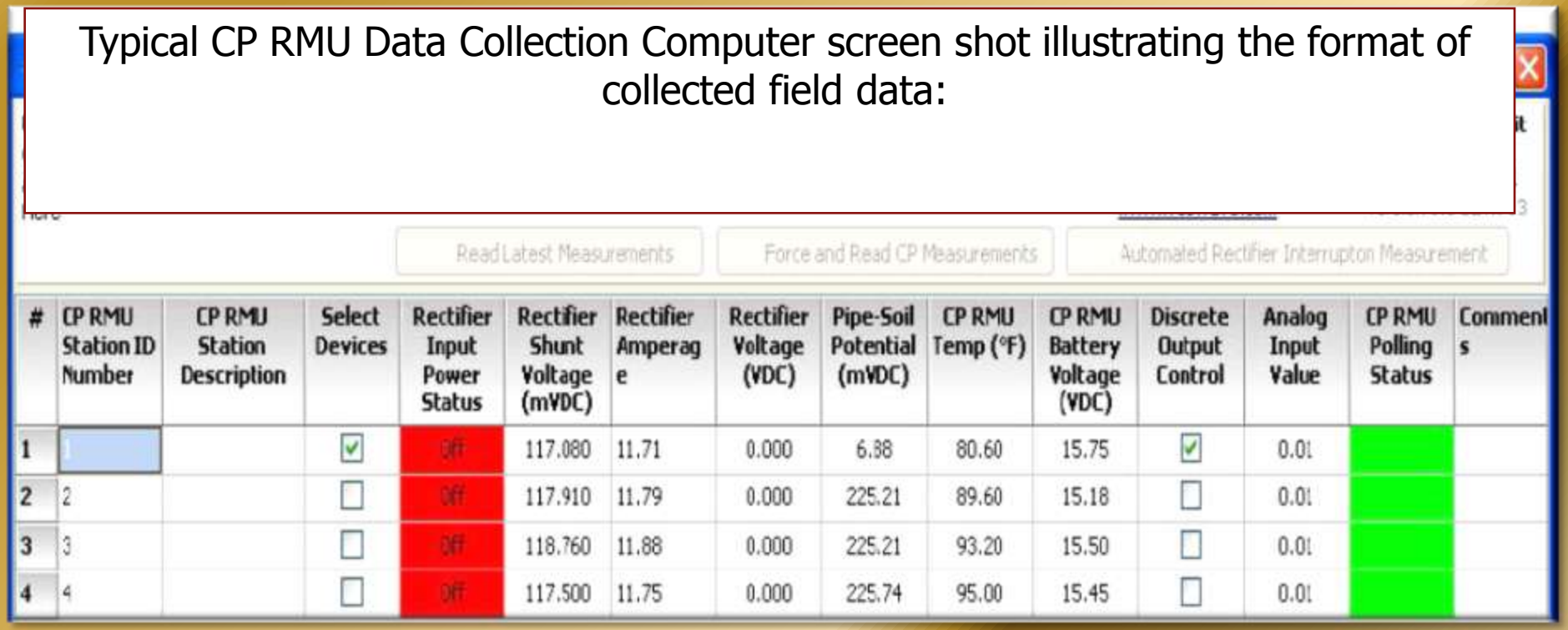
- The SCADA software enables CP personnel and operators to manage and manipulate the collected CP field data into proper formats.

- SCADA software typically will format the collected data into the following:

  - **Reporting** (daily operator reports, company reports, regulatory reporting)
  - **Alarming** (Identifies and classifies CP field events for local display or remote operator notification via cell phone, pager)
  - **Trending** (trending tools enable engineers to monitor long term events over time and track overall system performance)
  - **Graphical User Interface** (operators can quickly identify CP system performance and optimization using recognizable, intuitive graphic representations of company piping and structure systems.

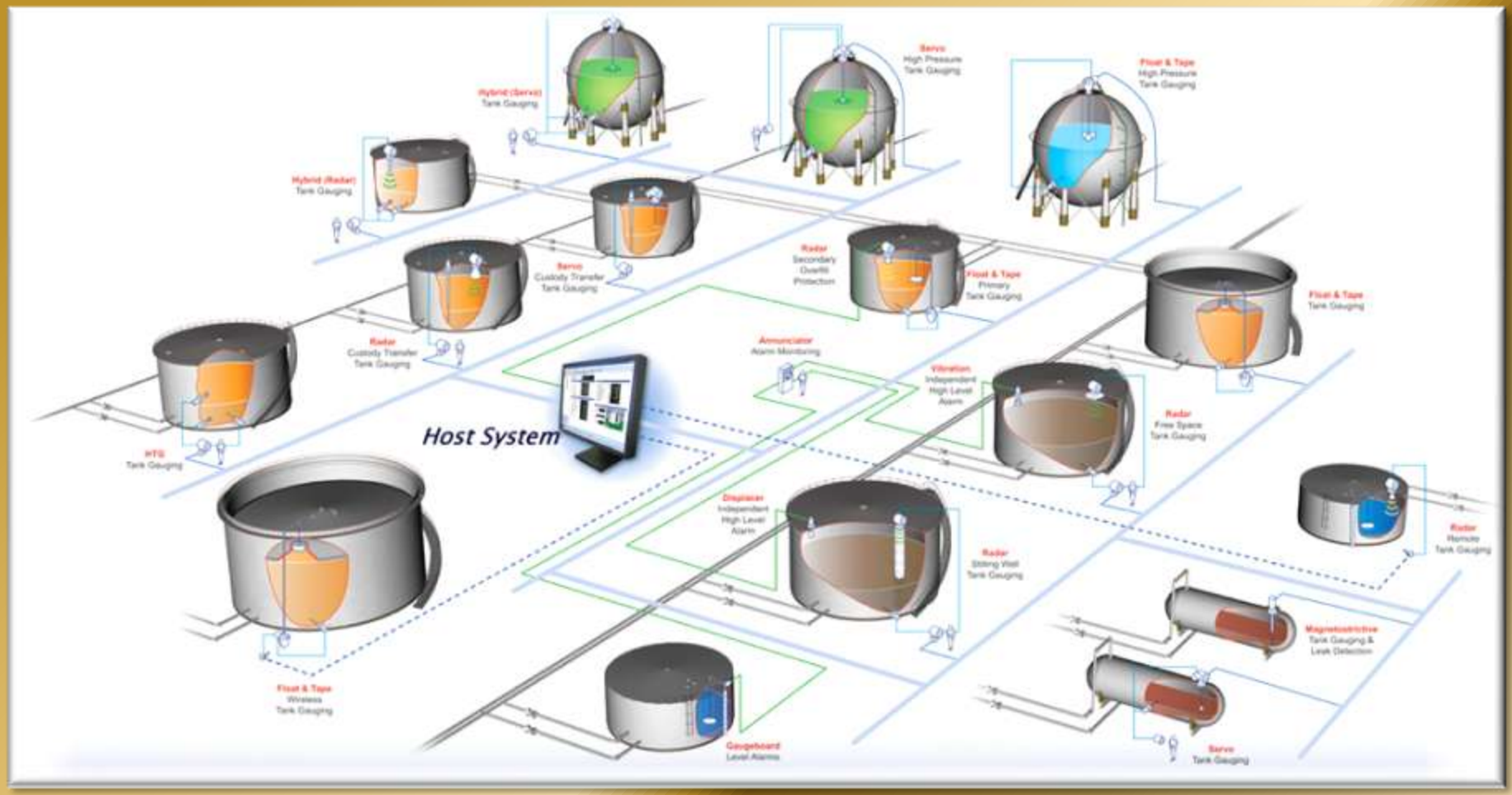
CP RMU Field Implementation

Typical CP RMU Data Collection Computer screen shot illustrating the format of collected field data:



#	CP RMU Station ID Number	CP RMU Station Description	Select Devices	Rectifier Input Power Status	Rectifier Shunt Voltage (mVDC)	Rectifier Amperage	Rectifier Voltage (VDC)	Pipe-Soil Potential (mVDC)	CP RMU Temp (°F)	CP RMU Battery Voltage (VDC)	Discrete Output Control	Analog Input Value	CP RMU Polling Status	Comments
1	1		☑	Off	117.080	11.71	0.000	6.88	80.60	15.75	☑	0.01		
2	2		☐	Off	117.910	11.79	0.000	225.21	89.60	15.18	☐	0.01		
3	3		☐	Off	118.760	11.88	0.000	225.21	93.20	15.50	☐	0.01		
4	4		☐	Off	117.500	11.75	0.000	225.74	95.00	15.45	☐	0.01		

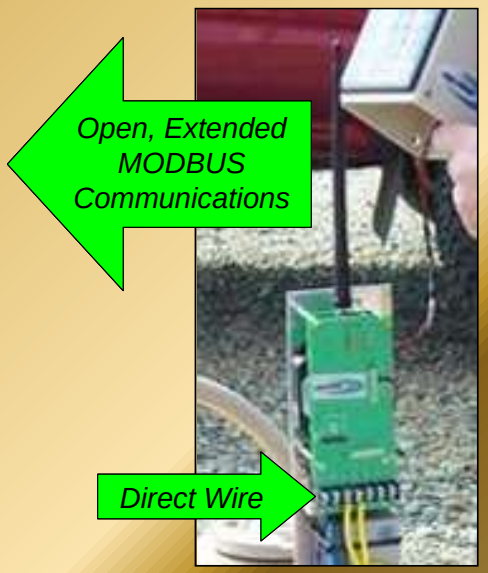
- Once the initial systems are in place, it can open the door to additional data collection opportunities benefiting not only the Cathodic Protection group, but other operational groups within the company as well.
- Plan for this.

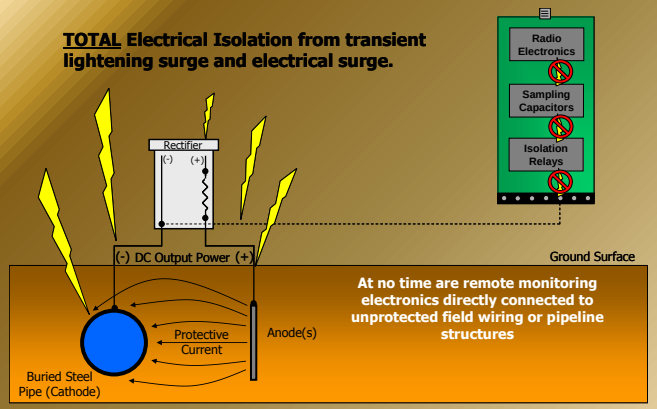


CP RMU System Considerations

When evaluating and selecting cathodic protection remote monitoring equipment, take the following into consideration to ensure the best long term performance of both architecture and equipment is achieved:

1. CP RMU's should directly read the CP test points with no additional transducers required.
2. CP RMU's should communicate with an open communication protocol such as OPC or Modbus.
3. LIGHTNING is the leading cause of CP RMU failure. Ensure that your CP remote monitors have adequate surge protection, or better yet, full isolation.
4. CP RMU's should have an extended warranty.





CP RMU System Considerations

5. CP RMU's should have user programmable flexibility, measuring and storing field data as frequently as hourly to as infrequently as monthly.
6. CP RMU's should use sleep mode technology, low power modes, and possibly have an integrated solar power regulator to minimize power draw for remote solar powered applications with battery backup.
7. To minimize installation costs, CP remote monitoring equipment can be installed within existing rectifier cabinetry or in standard enclosures for remote locations.
8. Preferably, the CP RMU will have no monthly recurring fees.
9. Ideally, the CP RMU will not require data importation from outside the protection and security of the company firewall.
10. Infinite repeater capability of the FHSS CP RMU's provides more paths and opportunities to get data back to the centrally located data collection system.

Conclusion

- Aging buried metal pipelines and structures protected from corrosion for many years by remote cathodic protection test sites and impressed current rectifiers can now be economically remotely monitored and operationally optimized using new frequency hopping spread spectrum, wireless CP RMU technology.

- This new, low cost technology is license free, with no recurring costs, is fully open, firewall secure, robust, lightening isolated and relatively easy to deploy.

- Past wide-scale deployment of existing SCADA systems over the past 15 years and the advent of new low cost, easy to use PC-based SCADA systems, FHSS CP remote monitoring is now more economically viable.

Questions?