

# Pipeline Unit/Station Control

*Combining Unit and Station Control into Siemens PCS 7*

## Application Brief



# Pipeline Unit/Station Control

- Application Description ..... 1**
  - Process Description ..... 1
  - Process Drawing ..... 1
  - Control Challenge..... 1
    - Main Control Elements ..... 2
- Industry Trends ..... 3**
  - More Data and Tighter Controls ..... 3
  - Asset Management: Predictive Maintenance/Quality/Reliability ..... 3
  - Electrification ..... 4
  - Electrical/Automation Integration ..... 4
  - Safety ..... 4
  - Security ..... 4
- Siemens Solution ..... 5**
  - Architecture ..... 7
    - Station Architecture..... 7
    - Overall Pipeline Architecture..... 9
    - Architecture Options ..... 9
  - Additional Components ..... 11
    - Automation ..... 11
    - Electrical ..... 11
    - Security..... 11
- Why Siemens? ..... 12**
- Implementation Options ..... 12**
- For More Information ..... 13**

## Application Description

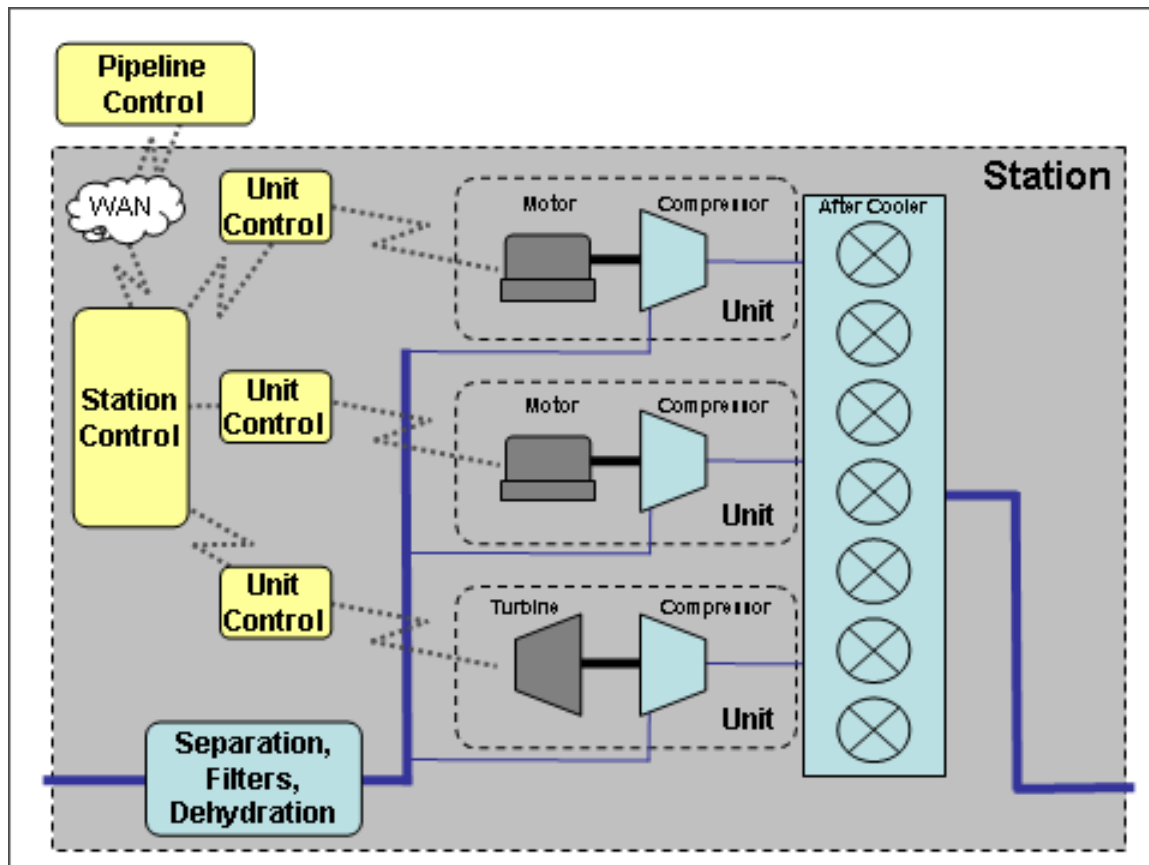
### Process Description

To flow liquids or gas through a pipeline, energy must be added and if the pipeline is long enough, energy must be added periodically along the route. This is done by either Pump Stations or Compressor Stations at locations along the pipeline.



### Process Drawing

A typical Compressor or Pump Station is a group of Compressors or Pumps plus the infrastructure and process equipment needed to support them.



Typical Compressor Station

### Control Challenge

Pump and Compressor Stations have been treated as small, independent units lumped into a facility. Because of the relatively small size of the individual units and need for relatively fast control, the traditional approach either used stand alone, proprietary controllers or stand alone Programmable Logic Controllers (PLCs) with independent operator interface systems. This has lead to lack of integration both of the unit and

station controls and of the individual controllers with the Human Machine Interface and the overall Pipeline SCADA system.

**Main Control Elements**

**Unit Controls**

Unit Controls control the prime mover and the pump or compressor. The following table illustrates the range of controls typically included as Unit Control.

Fluid Mover	<b><u>Pump Controls</u></b>	<b><u>Recip Compressor</u></b>	<b><u>Centrifugal Compressor</u></b>
	<ul style="list-style-type: none"> <li>• Flow Control</li> <li>• Lubricant Controls</li> </ul>	<ul style="list-style-type: none"> <li>• Pocket / load / torque control</li> <li>• Lubrication system monitoring</li> <li>• Power cylinder, compressor and exhaust gas temperature scanning</li> <li>• Horsepower, efficiency and performance calculations</li> <li>• Preventative maintenance</li> </ul>	<ul style="list-style-type: none"> <li>• Surge Control w/Animated performance map graphics</li> <li>• Vibration</li> <li>• Speed Control</li> <li>• Gas Temperature Monitoring</li> <li>• Horsepower, efficiency</li> </ul>
Prime Mover	<b><u>Motors &amp; Drives</u></b>	<b><u>Turbine Controls</u></b>	<b><u>Engine Controls</u></b>
	<ul style="list-style-type: none"> <li>• Exciter Interface and Control</li> <li>• Motor Protection</li> <li>• Substation Relay Interface</li> <li>• Bearing and Winding Temperatures</li> <li>• Gear Monitoring and Control</li> <li>• VFD Monitoring and Control</li> </ul>	<ul style="list-style-type: none"> <li>• Automatic start / stop sequencing</li> <li>• Electronic Fuel Valve</li> <li>• Fuel / speed control</li> <li>• Exhaust Gas Monitoring and Override</li> <li>• Vibration</li> <li>• Cooling water and gas cooler temperature control</li> <li>• Alarm and shutdown</li> </ul>	<ul style="list-style-type: none"> <li>• Air/Fuel Ratio Control</li> <li>• Ignition Timing</li> <li>• Emissions/Burn control</li> <li>• Governor Control</li> <li>• Bearing Temperatures</li> <li>• Performance Calculations</li> </ul>
<b>Unit Controls</b>			

**Typical Approach**

The traditional approach to Unit Control has been to use a Programmable Logic Controller (PLC) because of the relatively small number of control loops on a given unit. The traditional speed of the PLC has also been a factor on compressor and turbine controls where high speed loops are needed for anti-surge and speed control.

**Station Controls**

Station Controls encompass the controls and data monitoring of areas at the station that are common across all the individual pumps and compressors. These include:

<p><b><u>Safety Systems</u></b></p> <ul style="list-style-type: none"> <li>• Fire Detection</li> <li>• Gas Detection</li> <li>• Line Break and Leak Detection</li> <li>• Station ESD and Blow down Svstems</li> </ul>	<p><b><u>Reporting</u></b></p> <ul style="list-style-type: none"> <li>• Data Historian and Trending</li> <li>• Alarm Logging</li> <li>• Station Reports and Log</li> <li>• Emissions Reports</li> </ul>	<p><b><u>Utilities</u></b></p> <ul style="list-style-type: none"> <li>• Air Compressor Controls</li> <li>• Station Auxiliary Controls</li> <li>• Asset Management</li> <li>• Pig Detection</li> <li>• Interface Detection on Product Pipelines</li> </ul>	<p><b><u>Metering</u></b></p> <ul style="list-style-type: none"> <li>• Custody Transfer</li> <li>• Check Metering</li> <li>• Routing</li> <li>• Tie to Accounting</li> </ul>
<p><b><u>Station Controls</u></b></p> <ul style="list-style-type: none"> <li>• Gas Control Center Communications</li> <li>• Remote Unattended Station Start/Stop Sequencing</li> <li>• Station Pressure or Set point Control</li> </ul>	<p><b><u>Energy Management</u></b></p> <ul style="list-style-type: none"> <li>• Motor Control Center Monitoring</li> <li>• Peak Power Shaving and load Shedding</li> </ul>	<p><b><u>Tanks and Storage</u></b></p> <ul style="list-style-type: none"> <li>• Inventory</li> <li>• Tank Level Monitoring and</li> </ul>	
<p><b>Station Controls</b></p>			

**Typical Approach**

With the use of PLCs at the unit level, the traditional approach to station control is to extend the use of PLCs and to layer it with an independent HMI/SCADA.

**Industry Trends**

There are several trends in the industry that are affecting the way stations are designed and operated.

***More Data and Tighter Controls***

Today’s modern control technology provides a much wider range of information than in previous times. New types of sensors, more powerful processors and better diagnostics lead to better data and the ability to monitor the complete status and performance of a station’s equipment.



New technology is opening capabilities for more sophisticated controls at a time when operating and energy costs along with revenues are driving the need for better reliability and efficiencies. Increased amounts of data, coupled with more sophisticated control algorithms allow tighter controls both at the unit level and for optimizing unit operations across the station and pipeline.

***Asset Management: Predictive Maintenance/Quality/Reliability***

Asset Management, the ability to monitor the condition of critical assets like large pumps and compressors, is critical to maintaining operation, and reducing maintenance costs. Because of this, additional burdens are being placed on the control systems to acquire more and better data and to transform that data into useful information that can be used to improve the process. This means a trend to more data points, higher resolution and more “analog” data.

### ***Electrification***

The use of electric motors as prime movers for pumps and compressors is gaining strength. With an ever increasing electrical infrastructure, the ability to use electricity is available in areas where it was previously cost prohibitive. The low maintenance and high efficiencies associated with electric motors compared to turbines and engines means an increase in the use of electrical apparatus. The added efficiency of variable frequency drives further accelerates the trend. Replacing some gas turbine or engine driven horsepower with electric drives also opens options to switch between fuels and optimize fuel costs. Finally, in areas where regulatory changes have made pipelines a utility service means that gas pipeline operators no longer own the gas in the pipe and this can drastically changes the economics of gas powered engines and turbines.

### ***Electrical/Automation Integration***

The trend to Electrification has made the ability to integrate signals from the electrical infrastructure (substations, etc.), motor control centers (MCCs) and drives into the main automation system much more critical. Since many of the key assets are now electrical devices, data from those assets must be carried seamlessly into the overall monitoring and alarm system.

### ***Safety***

There is an increasing tendency in the industry to apply functional safety concepts as described by standards like IEC 61511 to all safety related controls. These functional safety concepts, at their basic level, provide the methodology to define the risks associated with a process and the systems used to control it.

Users concerned about risks to personnel and the environment may use Functional Safety concepts to quantify and address those issues. For organizations that apply Functional Safety to their large processes like Gas Plants and Refining, there is a natural tendency to be consistent in the approach to safety. This drives functional safety concepts across the organizations and down to even small systems.

If these concepts are used, the ability to define the risk reduction levels of the control system and the use of certified safety systems may be required.

### ***Security***

The rising costs of environmental damage, lost production and danger to personnel all dictate that companies take a closer look at how they protect facilities and equipment. Compressor and Pump Stations are now considered potential targets.

## Siemens Solution

Siemens offers a full portfolio of products for all levels of Unit and Station control. Furthermore, as the industry trends begin to converge and the pipeline operator wants a more integrated, more efficient operation, then Siemens can offer unique solutions that can greatly enhance the station and pipeline operation and make it more competitive.

The goals in unit/station automation are:

- Create a safe and secure operation
- Gather additional data on the equipment and operations
- Turn data into useful information that drives production, efficiency, and reliability
- Minimize trips to remote locations

Maximize the effectiveness of trips to remote locations

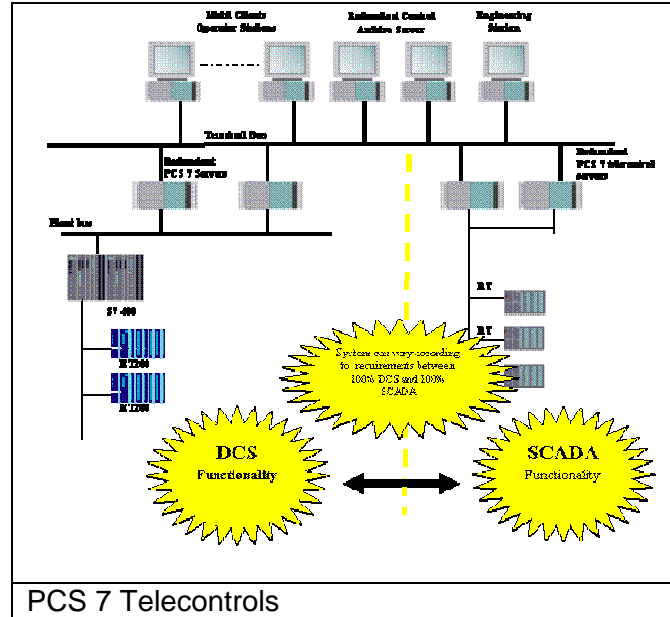
The Pipeline Station is a small process with key process type loops. However, the small number of total I/O, the need for high speed control on some loops and the traditional separation of Unit and Station Control has resulted in the use of PLCs rather than DCS systems for the facility. The resulting interface issues between the various PLCs and with the Station HMI drives the cost of installation and maintenance up and limits the flexibility of the system. The lack of system integration and diagnostics limits the effectiveness of the system for remote maintenance and operations.

Traditional control systems have been rather arbitrarily been divided into two divisions:

- PLCs and SCADA  
Programmable Logic Controllers (PLC) were developed for machine control on the factory floor. PLCs are very good at high speed, discrete logic and have evolved to be more full function. Supervisory Control And Data Acquisition (SCADA) are the monitoring packages designed for collection of data across a wide area. They are typically designed for use with a variety of end devices and handle issues like buffering data and loss of network.
- DCS  
Distributed Control Systems (DCS) were designed for large process systems such as refineries and include both control and monitoring in a tightly integrated package. As they were designed for the process industry, there are built-in libraries for handling typical process loops, flow, pressure, temperature, etc. Since large process plants put a high value on keeping a process running, systems are designed to have complete, seamless redundancy available when needed. Because of the communication infrastructure available at a large process facility, the systems typically assume a real-time network with no buffering of data.

Siemens DCS technology, PCS 7, is based on its industry leading PLC line with added enhancements specific to the process industries. That provides the unique ability to scale the system and to provide both PLC and DCS functionality.

Siemens' introduction of PCS 7 Telecontrols, gives this unique DCS system the added functions of traditional SCADA systems. The Siemens PCS7 Telecontrols system is a unique blend of the functions of the PLC, SCADA and Distributed Control Systems.



Using PCS 7 as the backbone of your automation and control scheme offers unprecedented flexibility and large potential benefits. The ease of a single, integrated automation system eliminates interface issues and provides seamless data flow throughout the system. While providing that integration it maintains the performance at Unit Level and all the flexibility and SCADA functions at Station Level.

The system offers the ability for:

- Real-time process control and optimization
- Diagnostics and status of the control system, major assets, and station operations
- Shared operator control and remote monitoring
- Multi-network SCADA functionality
- Integration of Process Safety functions
- Integration of Electrical functions
- Integrated data management with tag based instructions
- Integrated engineering between control and HMI functions including safety and electrical

The Siemens PCS 7 system offers a proven Network Security System that provides "Defense in Depth" strategies for protecting the control system from outside intrusion and interference.

The Siemens PCS 7 system offers flexible redundancy to tailor the needs of the system to your requirements. The controllers, networks, operator consoles and individual I/O can all be made seamlessly redundant.

## **Architecture**

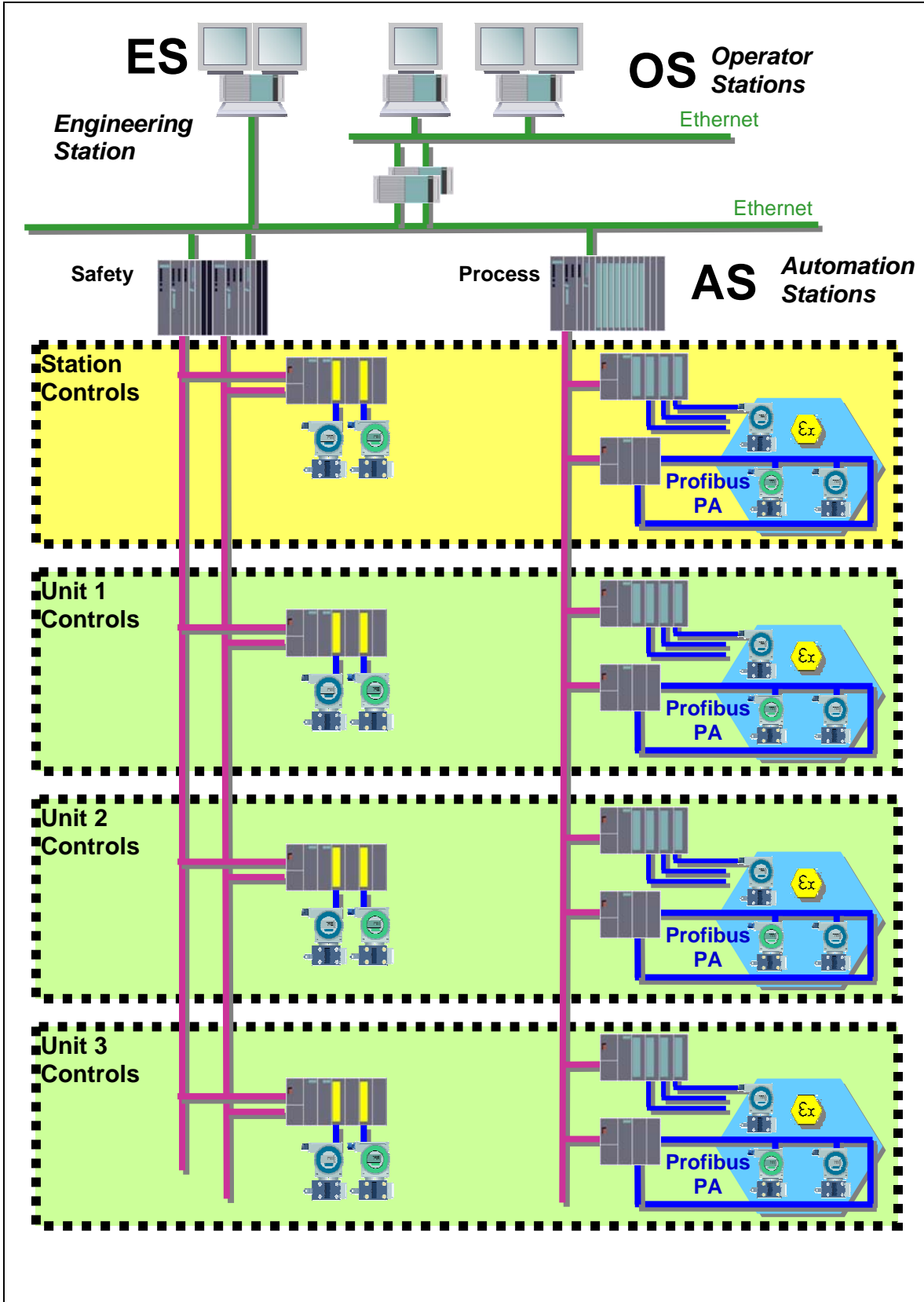
### **Station Architecture**

Using PCS 7 as the Unit/Station Control platform offers a lot of flexibility in the architecture. Combining the Unit and Station Controls into a single platform delivers benefits in both the initial capital cost as well as the ongoing operating cost.

A typical architecture uses a single PCS 7 Automation Station (controller) for multiple units and Station Control with individual I/O racks for each Unit and Process area (separation, cooling or filters, for example). A Safety rated ESD system can also span multiple units leveraging the capital cost over the entire station while maintaining separation of BPCS and Safety.

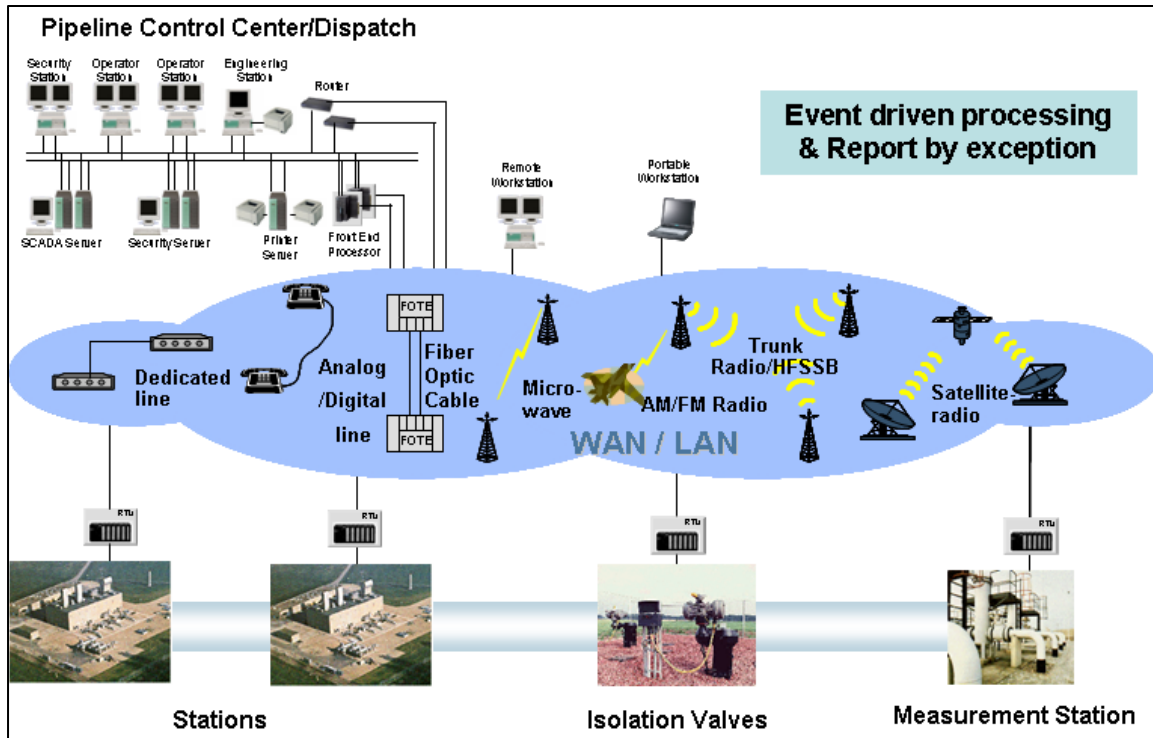
At the Station level, a single Engineering Station configures all systems down to the sensor/final element and provides easy access for maintenance functions.

The Operator Station is tightly integrated to the Automation Stations with loop indicators, plant hierarchy and alarm systems automatically generating from the control configuration. The Operator Station can be implemented in a single client PC for small Stations or in a Server-Client mode for larger facilities.



## Overall Pipeline Architecture

The overall pipeline architecture is a simple extension of the PCS 7 control system at the Station level. Implementing PCS 7 Telecontrols, the entire pipeline including Compressor/ Pump Stations, Valve Stations and Measurement sites can all be easily integrated into a common system over whatever network system is available. PCS 7 can accommodate up to 100,000 I/O points making it a scalable system for large pipeline installation.



## Architecture Options

There are options that can reduce the I/O count, footprint and provide enhanced diagnostics:

### Profibus PA Fieldbus

Profibus PA is a fieldbus that allows the attachment of multiple transmitters and sensors on a common network. Because up to 25 instruments can be added to a single wire pair, and no I/O modules are required, savings can be made in wiring costs, footprint and RTU costs. Instruments over Profibus provide remote diagnostics and the ability to set parameters and reconfigure from a remote location.

Siemens has a ring bus structure for Profibus PA that adds additional reliability. Options for Profibus PA include intrinsic safety for hazardous areas and TUV approved safety protocol for meeting safety system standards.

### Smart Motor Control Centers (MCC)

Siemens offers Smart MCCs based on Siemens Simocode. Simocode provides motor protection but communicates digitally by Profibus DP to send a variety of motor

information such as voltage and current levels, number of starts, overload warnings and bearing temperatures that provide valuable asset data on the motor and the attached pump or compressor.

### **Drives**

When Variable Frequency Drives (VFD) are used, they can communicate directly by using ProfiBus DP. Again, this allows asset data on the motor/drive system and eliminates the need for drive feedback inputs. Configuration of the drives can then be handled remotely as well, reducing commissioning and maintenance time.

### **Emergency Shutdown Systems**

Emergency Shutdown Systems (ESD) can be designed as a stand-alone system or can be incorporated into the main control system. Siemens provides certified safety systems to SIL 3.

### **Fire & Gas**

Fire and Gas sensors are often required for safety. Siemens systems can integrate these sensors into the main control or safety system eliminating the need for additional, diverse systems and providing a common data communication link. Options for Functional Safety designs are available.

### **Video**

Cameras can be incorporated into the station design allowing remote monitoring. These inputs can be incorporated into the control system design or can be part of an intelligent video system.

### **Building Security**

Pump or Compressor stations may have buildings that require access control and monitoring. Siemens can integrate a security access system into the overall system.

### **Intrusion Alert Systems**

For pipelines or perimeter control, Siemens can offer Fiber Sensing systems or intelligent video.

### **Leak Detection**

Since most gathering systems are difficult for hydraulic modeling for leak detection but can be vulnerable to leakage either accidental or deliberate, the Siemens mass balance leak detection utilizing ultrasonic technology is an affordable, accurate and easy to install alternative.



## ***Additional Components***

### **Automation**

#### **Process Instruments**

Siemens has a full range of process instruments to measure pressure, temperature, flow and level. For example, a radar level transmitter is ideal for oil storage tanks. Wireless options and remote setup and diagnostics can save installation and operating costs.

### **Electrical**

#### **Motors and Drives**

The electrification trend is pushing the use of electric motors with variable frequency drives to gain increased efficiencies and lower emissions from traditional gas or diesel engines. Siemens offers a range of motors and drives to enhance efficiency and reliability.

#### **Electrical Infrastructure**

Siemens can also assist with the electrical side of field modernization. From local distribution networks to full scale power plants, Siemens has the ability to offer solutions that meet the local requirements. Of course, the protection, monitoring and data collection on those networks feed seamlessly into the automation systems.

### **Security**

Some of the main risks for the oil and gas facilities are: construction activities near assets, third party activities, tampering, weather-related damage, malicious intent, sabotage, etc. Any of these actions can produce serious damage for people, the environment, processes, installations and continued production. Siemens supplies a wide range of security solutions including technologies in facilities access control, intelligent video and fiber optic sensing.

#### **Access Control and Intrusion Detection**

Siemens offers systems to secure access to facilities including central monitoring control rooms and individual well sites. The products and systems are flexible, scalable and easy to use. Siemens' range of access control and intrusion detection products and systems provide freedom of movement in a secure environment.

#### **Intelligent Video**

Siemens' Siveillance™ SiteIQ™ solution goes beyond traditional video by displaying all surveillance input on a single screen. It is based upon Intrusion, Access and Video applications, installed at well sites, and at pumping, compression and valve stations. Combining a digital map of your site with multiple camera information and other site specific sensor information SiteIQ™ allows you to establish virtual barriers and create intelligent policy zones.

#### **Sensing Fiber Security**

Siemens can integrate a Fiber Optic Sensing system for gathering systems and pipelines. This system detects and locates intrusions and third party interference

anywhere along a buried pipeline, and in real-time before actual pipeline damage occurs. It consists of a sensing cable buried near the pipeline and a sensing control unit. The system can use the existing fiber optic communication cable as the sensor, dramatically reducing both the time to install and the overall installation cost. A laser is transmitted along the fiber optic cable; the returned signal is automatically monitored and analyzed by the sensing control unit. Operating as a single system, up to 40Km can be monitoring with an event localization accuracy up to 150 m. Multiple sensing fiber systems can be tied together to monitor longer pipelines (thousands of Kilometers).

## Why Siemens?

Siemens offers a unique approach to DCS systems that combines the speed of a PLC required for turbine and compressor controls with the process functionality of the DCS system. With the introduction of PCS 7 Telecontrols, the customer now has the ability for a single seamless system across the entire pipeline. PCS 7 offers integrated controls that will save maintenance and commissioning costs by offering better diagnostics and alarming and the implementation of DCS type functions allow more sophisticated controls that increase efficiencies and asset management.

In summary, Siemens PCS 7 can offer:

- **A single integrated control system for the entire station and across the pipeline, including**
  - Performance at the Unit level
  - Flexibility and SCADA functions at the Station level
- **Proven Network Security**
- **Integrated Diagnostics**
- **Asset Management**
- **Integrated Electrical Components**
- **Integrated Process Safety**

## Implementation Options

Siemens can work with you in a variety of ways to make sure the packaging and integration of the systems are completed to your satisfaction. Choose the method that is right for your project and operating style.

- **Siemens can supply products.**  
Siemens can work with your engineering and integration team and supply the required control system products.
- **Siemens can provide turnkey Control System**  
Siemens can provide a turnkey control system with integration into panels and system programming provided.
- **Siemens can provide full system requirements**  
Siemens can provide a complete Automation and Electrical package including equipment, control rooms, integration, programming, commissioning and startup services.

## **For More Information**

### ***Siemens Website:***

- [www.siemens.com/simatic-pcs7](http://www.siemens.com/simatic-pcs7)

### ***Siemens Brochures:***

- Totally Integrated Automation for the Oil & Gas Industry
- SIMATIC PCS 7 Process Control System
- SIMATIC PCS 7 Process Control System  
Intelligent Maintenance Products
- Siemens Process Safety System

### ***Siemens White Papers:***

- Gas Turbine Control  
Siemens Automation in Gas Turbine Controls
- Centrifugal Compressor Control  
Siemens Automation for Centrifugal Compressors