Developing a Pipeline Supervisory Control Center

API RECOMMENDED PRACTICE 1113
FIRST EDITION, AUGUST 2007

REAFFIRMED, JUNE 2012

AMERICAN PETROLEUM INSTITUTE

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Pipeline Segment

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Contents

Developing a Pipeline Supervisory Control Center

1 General

1.1 Scope

A pipeline supervisory control center is a facility where the function of centralized monitoring and controlling of a pipeline system occurs.

This document focuses on the design aspects that may be considered appropriate for developing or revamping a control center. There are five sections (Sections 2 through 6) that provide lists of general considerations.

This document is not all-inclusive. It is intended to cover best practices and provide guidelines for developing a control center only. It does not dictate operational control philosophy or overall SCADA system functionality.

This document was created by an API Cybernetics Subcommittee task force, based on industry practices used on liquid pipeline SCADA systems. The document is intended to apply to control centers for liquids pipelines; however, many of the considerations may also apply to gas control center design.

1.2 Purpose

The purpose of this document is to assist the SCADA system designer in identifying issues relevant to the development or redevelopment of a control center.

It is recognized that each pipeline company has unique operating philosophies and SCADA systems; therefore, not all elements of this document may be applicable.

For example:

— Some pipeline control centers are a combination of several different SCADA systems.

— Some of these SCADA systems may not have the developer tools necessary to implement the consideration.

— Some operators may have existing control center design philosophies/techniques that bridge over into unique operating philosophies.

Regulatory and individual company standards are not addressed in this document.

1.3 How to Use This Document

The “decisions to consider” points that are written in Sections 2 through 6, do not need to be considered in the order they are presented (i.e. in numerical order). The lists are not all-inclusive but should help stimulate further, detailed analysis.

The reader should have a good working knowledge of pipeline operations and control center design philosophies/techniques, and may have to refer to other documents for background or additional information. Any references to SCADA and control center security have been removed and the reader should refer to API 1164 for best practices and guidelines.

2 Applicable References

API Std 1164, *Pipeline SCADA Security*

API RP 1165, *Recommended Practice for Pipeline SCADA Displays*

3 Definition of Terms

Some of the terms used in this document are defined below.

3.1
API
American Petroleum Institute. The primary trade association of the oil and natural gas industry, API represents more than 400 members involved in all aspects of the oil and natural gas industry. The association draws on the experience and expertise of members and staff to support a strong and viable oil and natural gas industry.

3.2
API Cybernetics Subcommittee
The API Cybernetics Subcommittee monitors the field of science concerned with processes of communication and control to provide education and recommended practices to the pipeline industry for monitoring and operating pipelines from a remote location.

3.3
control center
Physical location where controllers monitor and control the pipeline systems. A control center typically consists of one or more controller consoles which are manned 24 hours a day/365 days a year.

3.4
controller
The terms “dispatcher,” “operator,” and “controller” all refer to the individual who is responsible for supervisory control of the pipeline.

NOTE The term “controller” is used in this document.

3.5
distributed computer system
A system that involves multiple computers, possibly remote from each other, that each has a role in a computation problem or information processing.

3.6
EDI
Electronic data interchange, such as WANs, LANs, Internet, etc.

3.7
fail-over
A transfer of control from one component to a backup.

3.8
PLC
Programmable logic controller (see also **RTU** below).

3.9
publish/subscribe—client/server
A technique in which all processes and devices that supply data “publish” it to the network, and components which require data “subscribe” to it, with the actual supply of the data managed by a broker.

3.10
RTU
Remote terminal unit.

NOTE SCADA systems gather data from field instrumentation using such data acquisition devices known as Remote Terminal Units (RTU), Programmable Logic Controllers (PLC), Field Data Acquisition Servers (FDA), and/or Flow Computers (FC). Each of these data acquisition devices may be interchanged for specific applications on the pipeline system.

3.11
SCADA
Supervisory Control and Data Acquisition, a computer based system in which the Data Acquisition function includes gathering real-time data through a communication network and control functions include controlling field devices.

NOTE SCADA processes, displays, and/or may archive data, and provides warnings and alarms to the Pipeline Controller.

3.12
UPS
Uninterrupted power supply.

4 Developing System Architecture

Control center architecture considers all the hardware aspects that will be employed and also generically the software that will be employed whether it is developed in-house or purchased from a SCADA system vendor.

Item	Decisions to Consider
4.1	Decide whether to install a centralized system or a decentralized system.
4.2	Decide whether to use a single computer system or a distributed computer system.
4.3	Decide if the system will have a hot, warm or cold standby configuration and, if so, which components will be used in that configuration.
4.4	Determine which computer operating systems are acceptable.
4.5	Consider using a real-time/historical database system that is compatible with the corporate database system.
4.6	Consider capabilities for on-line training and maintenance.
4.7	Consider capabilities of off-line development, testing and/or simulation system.
4.8	Consider whether to use “smart” field devices such as microprocessor-based RTUs, flow computers, PLCs, and smart instrumentation devices.
4.9	Consider the data requirements of each of the groups of users throughout the organization before setting up the architecture and processes for accessing SCADA/field data. Consider whether each data user will communicate directly with the field device or will access field data through the SCADA system.

4.10 Consider system loading/capacity to allow for optimum system performance and plan for any required expansion. Determine which, if any, functions should be distributed to the field to best allow for speed, accuracy, and future expansion. Examples of this would be PLC control and digital/analog deadbanding at the field device.

4.11 Consider the option of using a publish/subscribe—client/server approach to facilitate data sharing.

4.12 Consider the software structure or architecture and the ease with which future features and functionality could be added to it.

4.13 Consider where system safety/shutdown functions will be performed.

4.14 Determine data-transmission protocol and determine whether standard protocols between various computers, remote terminal units, and programmable logic controllers will be enforced.

4.15 Determine whether remote communication will be by means of satellite or by terrestrial means, such as leased lines, microwave, frame relay, MPLS, spread spectrum or high-frequency radio, manual entry or non-telemetered data, “dial-up,” and “manual with hand-held devices.”

4.16 Determine whether backup remote communication is required, and if so, which technology will be used.

4.17 Consider using an EDI to link with external information systems.

4.18 Consider data integration with management information systems and power optimization systems. Applicable areas of data integration that might be considered could include integration with, for example, volumetric accounting systems, revenue accounting systems, system inventories, work order systems, operational analysis systems, root cause failure analysis, measurement systems, logistics/scheduling systems, etc.

4.19 Consider data integration with leak-detection, batch-tracking systems and other external applications of the SCADA system.

4.20 Consider remote access to the SCADA system for users and/or maintenance personnel.

4.21 Decide whether or how remote access and/or maintenance will be performed.

5 Developing System Reliability

Reliability of the systems in the control center is paramount not only for economic reasons but also because modern pipelines are so highly automated that they require a control center to function. Reliability is a measure of the ability of the systems to continue to function in all operating circumstances.

Item Decisions to Consider

5.1 Decide the maximum acceptable delay, in case of a failure, before a redundant computer or communications link is available.

5.2 Consider implementation of an automatic fail-over configuration. If manual fail-over is to be used, determine how it will be done and who will be available to perform the task. If field staff is expected to control/operate in the event of a fail-over, they will need to maintain a level of competency in controlling/operating facilities manually.

5.3 Consider the impact of changes to system logic. Ensure audit trails and offline testing and verification for all changes are provided.

5.4 Consider using communication systems with diagnostic capabilities and data reliability checks on your system's communications.

5.5 Decide what the maximum time should be between when an event occurs in the field and when the system notifies the controller of the event, and determine whether all events should be treated in the same way.

5.6 Decide what the maximum time should be between when a command is issued and when it is received in the field.

5.7 Determine the accuracy (in terms of percent) of the analog readings in the system.

5.8 Consider having the control center audited by someone independent of the pipeline system group. Determine the extent of the audit that will be performed, i.e. control center, SCADA, remote locations, etc. A documented audit process may need to be established.

5.9 Consider using backup support systems for the control center, such as backup support communications, power, air conditioning systems, and infrastructure items, such as LANs, switches, routers, phones, etc.

5.10 Consider all single-point equipment or component failures and their effect on system operation.

5.11 Consider using redundant on-line data storage.

5.12 Consider what backups should be performed in regards to the SCADA system, servers, communications, etc. and where these will be stored. This should include the periodic backup of critical data and of system parameters that the controller can change. See 4.9 for further information.

5.13 Consider establishing a procedure that would be implemented when communication with any remote site is lost.

5.14 Consider the use of preconditioning control logic to allow critical switches to be made without being affected by temporary communications outages. This logic would be implemented as close to the switch as possible, removing the need to telemeter the data to a central site for processing and automated response.

5.15 Consider the potential effect of all types of data rollover, especially those related to dates.

5.16 Develop a plan addressing how system maintenance will be provided, including maintenance on-line systems, and any provisions for preventive maintenance.

5.17 Determine what critical equipment spares should be stored on-site or made available to remote locations.

5.18 Consider UPS/backup generator requirements.

5.19 Consider two physically separate and diverse power sources from the utility power grid.

5.20 Consider the failure of corporate voice communication systems, and determine the need for alternate communication methods, such as cellular phones, satellite phones, voice over IP, instant messaging, etc. Also consider whether uninterrupted power supplies should be used for these communication systems.

5.21 Consider diverse routing in the design and planning of communication links.

5.22 Consider the data communications and try to minimize Local Exchange Carriers "LEC" hand-offs and work to get as direct a connection to the Long Haul Service Provider as you can.

5.23 Consider every point of failure in your telecommunications infrastructure and document them.

6 Developing Disaster Recovery Capability

This section considers the possibility that the system in the control center may fail or that the control center itself may be rendered unusable due to a man-made or natural disaster. These considerations discuss how to have a back-up control center so pipeline operational interruption can be minimized. This section considers the possibility that the systems in the control center may fail or that the control center itself may be rendered unusable due to a man-made or natural disaster. These considerations discuss how to have a backup or disaster recovery control center so pipeline operational interruptions can be minimized. Consider the need that other internal departments may need to share your backup control center.

Item	Decisions to Consider
6.1	Consider an alternate control center site for disaster recovery and control. Determine the maximum acceptable delay to activate the alternate system (i.e. travel, system start-up). Consider the degree of independence of the two locations. For example, if the risk is weather, the two locations should not be likely to be affected by the same weather problem.
6.2	Consider system reliability identified in Section 3 when developing disaster recovery capabilities.
6.3	Identify power sources, to ensure that equipment/devices are provided with appropriate power supplies.
6.4	Consider the procedures which will be required to maintain control center operation, or otherwise safely manage facilities, in the case of fire suppression system activation, or other conditions that might require evacuation of the control center.
6.5	Consider impact to operations during fire alarms in adjacent buildings and other floors.
6.6	Consider incorporating building fire alarm information into emergency response or contingency plans to avoid unnecessary evacuation.
6.7	Consider the possibility of water damage and how to minimize the damage.
6.8	Consider each functional component of the supervisory control systems to ensure that they will be operable from the alternate location, without dependence on the primary control center. A determination should be made of the functionality of the backup control center, i.e. fully redundant, etc.
6.9	Consider the methods to be used to restore data, as required, from off-site storage.
6.10	Consider the possibility that the company network used to assist in normal daily activities (spreadsheets, operational instructions, etc.) may not be available during and after the disaster.
6.11	Consider having a written plan (hardcopy) to rebuild the Control Center from ground zero including computer equipment, software, communications, etc. The plan should be kept at the Disaster Recovery Center (DRC).
6.12	Consider having a periodic test at the DRC to verify that necessary functions can be performed at the DRC.
6.13	Determine the emergency procedures required by the center, including a procedure for control center evacuation, and determine the frequency with which they will be reviewed.
6.14	Consider holding mock drills.
6.15	Consider establishing written procedures covering damage-prevention measures to be taken in case a natural disaster, such as a hurricane, is imminent.

6.16 Consider the provision of emergency response information, i.e. telephone numbers, etc. and the association of site-specific information with displayed elements related to that site. This association consideration should include whether the information should be displayed on SCADA displays, IT accessible and how it will be obtained should overall communications not be responsive.

6.17 Consider the reaction times of appropriate emergency response agencies, such as the fire department and utility companies.

6.18 Consider the level and immediacy of backup requirements: whether backup copies must be stored off-site from the SCADA system, how frequently backups should be updated (which determines the scope of potential data loss), what media are suitable for the purpose, and how the backup process is to be monitored for problems and audited for correctness.

7 Developing the Control Room Design

The physical arrangement of the control center will increase efficiency and functionality. The points below provide suggestions for physical features of the control center. Further consideration to human factors, such as controller fatigue should be given to the following items where applicable.

Item Decisions to Consider

7.1 Consider having a specialist design the control room by taking input from personnel who will work in the room. Specialist knowledge should include issues related to rotating or 12-hour shifts.

7.2 Consider placing the equipment and computers in a room that is separate from the controllers. This is due in part to temperature, humidity requirements and human generated contaminant tolerances, of humans and machines, being different.

7.3 Consider aesthetics of control room by selection of color schemes, designs, and furnishings.

7.4 Consider placement of equipment in the design of the control room floor plan in order to minimize or avoid through-traffic.

7.5 Consider the proximity of break rooms and restrooms to the control room and if access to these rooms by controllers can be provided without a requirement to leave and re-enter the security zone of the control room.

7.6 Consider proximity of control console(s) to each other to avoid traffic/noise interference.

7.7 Consider installing technical/supervision monitors that are independent from the control room desk. This will facilitate conducting consultations without directly impacting control room operations with excess noise and activity.

7.8 Consider provisions for both future additions of consoles and modification to the configuration when positioning the existing consoles.

7.9 Consider allocating building space immediately adjacent to the control room to be used for a function which can later be relocated, to allow this space to become part of the control room to accommodate future expansion. In this case, consider providing services to this area which are appropriate to later use as control room, even if not needed for the interim use.

7.10 Consider using a separate area and console for training, engineering, demonstrations and technical support, possibly in one or two rooms adjacent to the control room.

7.11 Consider individual storage areas for controllers that are easily accessible from the control room.

7.12 Consider other storage areas that will be needed for spare parts, etc.

7.13 Consider using a raised floor in the control room and in the computer room to allow for installation and maintenance of wiring, to provide for management of cooling airflow, and to allow for re-configuration of equipment due to expansion or technical changes. Balance under-floor access and headroom considerations, and consider innovating ceiling and lighting designs to improve the functionality and comfort of the room despite reduced headroom due to the raised floor.

7.14 Consider making critical equipment and functions in the control center and computer areas clearly and easily visible or providing the critical equipment and functions with alarms.

7.15 Consider safety and security when locating the UPS, including potential separation of computer and power equipment, to allow access to appropriate staff only.

7.16 Consider clear identification of both lighting and electrical power outlets to indicate the power source, and the provision of only UPS power in the control room to avoid accidental connection of required equipment to an interruptible power circuit.

7.17 Consider building a mock console before final fabrication, so the controllers can “test” the console.

7.18 Consider a design that addresses ventilation for the monitors and other equipment.

7.19 Consider ergonomics of control room personnel when acquiring/replacing furniture/chairs.

7.20 Consider the viewing level and angle, when placing equipment. Consideration should be given to monitoring the equipment while seated and standing, thus not requiring a manual adjustment.

7.21 Consider using a large projection screen to display information of use to all controllers in the room, to free up screen space on individual consoles.

7.22 Consider placement of HVAC vents in the control room to avoid drafty conditions which could lead to vision discomfort.

7.23 Consider a method to control temperature and humidity for improving room comfort and reducing static electricity.

7.24 Consider installing individual light controls on the console and overhead so that while seated at the console, the controller can adjust its lighting without affecting the general control room lighting. Lighting levels and glare should be considered.

7.25 Consider the color of the work surface or desktop and the reflection on computer screens of light from the counter top.

7.26 Consider the space requirements and physical layout of all telephone, radio, and other telecommunications gear on the controller’s workstation.

7.27 Consider the ease of access to the maintained equipment installed in the console when purchasing a console.

7.28 Consider ways to suppress the noise levels in the control room including appropriate floor, wall, and ceiling surfaces.

7.29 Consider an area to station a printer, fax, etc. with attention to sound proofing (enclosed with partitions or something similar) to shield the controllers from additional noise.

7.30 Consider the placement of windows near the ceiling to provide natural light without providing a line of sight from the outside.

7.31 Consider making the training console identical to an operational console so that it can be used as standby equipment if necessary. If such a console is provided, consider methods to control computer network configuration to provide appropriate isolation or access to the control room systems, and methods to clearly indicate the current function of the console.

7.32 Consider installing automatic fire detection and extinguishing system and consider the time delay required for its activation.

7.33 Consider physical security measures such as 24 hours a day/7 days a week monitoring, door jar alarms and control room isolation.

8 Developing the Data-recording System

Ideally, the control center systems will store data values to a historical database. Historical information retrieval is valuable for re-play of events, to examine or analyze normal operation, to examine irregular operating conditions, or to review abnormal operating conditions. The data may also be useful for controller training; or make improvements to control center systems.

Item Decisions to Consider

8.1 Determine appropriate policies regarding the need to keep records of analog signals; delivery schedules; batch tracking, batch changes (or both); tank activity; daily telecommunication instructions; ticket information; upset conditions; and other pertinent activities, conditions, or data. Some of these policies need to satisfy various government regulatory bodies and management guidelines.

8.2 Consider whether statistical values should be calculated in real-time by the SCADA system, at the point of storing data to the historical system, or at a later point. Consider storing only some statistical results for time periods sufficiently far in the past, but consider possible needs to retain complete original data related to incidents.

8.3 Consider whether the records will be kept on hard copy, electronic media or both.

8.4 Determine whether immediate review of past data on the computer is required and, if it is required, determine how long into the past the review should extend.

8.5 Determine the retention period and the availability to access all historical data. Consider both on-line and off-line retention periods.

8.6 Consider the descriptive information associated with analog values, such as equipment identification and units of measure, and how this information is associated with records of the data. If more than one unit of measure can be associated with values in the SCADA system (such as selection between SI and traditional units on displays or in reports, or conversion between units between field devices and the SCADA system), consider which units should be associated with the stored value, how the units should be indicated in retrieved data, and whether to store a data item with a single unit of measure or in all units used in the SCADA system.

8.7 Consider designing the system so that it allows tracing the sequence of events before, during, and after any accident or serious equipment failure.

8.8 Consider providing the capability to use live and/or previously captured SCADA data for training and situation reenactment.

8.9 Consider the consequences of potentially ambiguous multiple storage media. Regardless of storage media chosen, consider requirements for collection of data from multiple SCADA systems running in a redundant configuration, taking advantage of hot-standby SCADA components to reduce the risk of data loss, while reconciling potentially ambiguous data from the resulting multiple sources.

8.10 Consider placing historical data analysis on a separate non-time critical (NTC) computer, not the live SCADA computer.

8.11 Consider ease of access of data by queries and/or reporting in the choice of storage media.

8.12 Consider providing the capability to search records for certain types of data or events. Evaluate the available products that are specifically designed for efficient long-term data archival, quick retrieval, and thorough analysis.

8.13 If considering an existing software product for handling of data, consider the availability of interfaces for existing and future corporate software applications, and the product's support for every other consideration of the data-recording system.

8.14 Determine requirements for control of access to historical data, based on the roles of individual users, and the design of a system to restrict access on that basis.

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