WHAT DRIVES A SCADA SYSTEM UPGRADE

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ABSTRACT

For many years, SCADA meant that isolated little control system in the back room… no longer. Today's pipeline SCADA system is an integral part of the corporate structure and represents the source, conduit, and depository for much of the company's most important data. This has been made possible by the significant advancements in technologies during the last twenty-five years. Although some SCADA upgrades still fall into the "non-discretionary" category, the majority of system changes are implemented to satisfy the premise: "how do I operate more cost effectively without sacrificing safety." In the pipeline industry, there are four primary drivers that satisfy this criteria: 1) reduction in personnel, 2) reduction in power consumption, 3) reduction in operator error, and 4) faster detection and mitigation of problems. Although the examples given in this paper are oriented toward the liquid pipeline industry, the four drivers are equally applicable to all types of pipeline SCADA systems. As government regulations get stronger and more restrictive and as competition gets fiercer, the need to use technology to satisfy these drivers will become increasingly more important.

SCADA UPGRADE DRIVERS

Similar to people, pipeline SCADA systems reflect their environment and past experiences. Although each of the four drivers are applicable, their specific weighting at any point in time is a function of the SCADA system's current level of technology, what has been done to date, corporate work processes, and the state of systems that interface with SCADA. Although many pipeline companies will have some portion of the following recommendations implemented, all companies have issues and their own agendas. It would be extremely rare to find a company that has optimized all of the following areas:

Reduction in Personnel

Personnel can be reduced anytime a function can be safely automated or eliminated. This is a big driver for pipeline companies due to the high cost of personnel, whether employees or contractors. It also tends to reduce errors that invariably enter when human handling is involved. Relative to SCADA, there are generally four areas where pipeline companies are successfully reducing personnel: 1) in the field, 2) operating personnel, 3) system support personnel, and 4) pipeline support personnel. The following are some recommendations in each area:

1. Reduction in Field Personnel

The basic intent of the following is to move field personnel more into a maintenance position and eliminate their direct involvement with operations, except on an emergency basis:

a. Automate delivery/injection sites to allow all batch/movement changes to be made from central
b. Automate provers to allow all provings to be automatically initiated based on time/batch change and manually from central
c. Provide remotely accessible level gauges on all tanks
d. Provide remote access from central to all ticket and proving data
e. Provide capability to download “batch stack” and other information associated with batch sequencing and associated products
f. Eliminate local pressure recorders (and associated maintenance) by having central retain all DOT pressure data
g. Provide surveillance cameras for monitoring of local field conditions and display on demand to Controllers at central
h. Provide remote samplers and chromatographs for quality monitoring and input to ticketing
i. Provide real-time access to field data, tickets, proving reports, historical data and trouble tickets when maintenance personnel are in field

2. Reduction in Operating Personnel

Particularly if field personnel are also being reduced, an alternate question to reducing operating personnel is how to enable them to do more. In general, the answer is reducing interruptions (e.g., responding to telephone calls), eliminating manual tasks (e.g., writing down meter and tank readings, hand calculating ETAs, etc.), and using an “exception” approach to operations rather than relying on the Controller to continuously monitor all lines. The following are some of the ways this is being accomplished:

a. Implementation of alarm reduction strategies whereby the system does not alarm unless it is an unexpected event (e.g., eliminate rate of change alarms on pressure and flow measurements when pumps are turned on, etc.)
b. System calculation of all ETAs, preferably based on the schedule as well as current line conditions
c. Implementation of automated control sequences to assist in valve line-ups and emergency shutdowns

d. On-line access to on-call lists, right of way and local authority information, and trouble tickets
e. Automatic retention of data needed to support DOT, revenue accounting, and company policy (i.e. paperless operation)
f. System provides enhanced leak detection using, at a minimum, rate of change, deviation processing, meter-in/meter-out reconciliation with line pack compensation. On lines that require greater sensitivity, utilize transient leak detection
g. Provide user access to appropriate movement data to eliminate need to call Controller
h. Provide user-friendly operator interface that provides rapid navigation and access to alarm data
i. Elimination of as much manual data entry as possible (e.g., schedule data automatically moved to batch tracking, etc.)
j. Provide rapid access to historical data, including data playback

3. Reduction in System Support Personnel

The number of support personnel needed to maintain the system is directly proportional to the tool set provided and the number of system changes. While the number of changes may be a function of the business environment, the tool set is not. Basically, the more automated and centralized the tools are, the fewer people needed to maintain the system. The following are some of the ways this is being accomplished:

a. Provide tools that allow all LAN/WAN communications and equipment performance monitoring (e.g., CPU, disk, memory utilization) to be monitored from a centralized location. Provide threshold alarms back through the SCADA alarm subsystem.
b. Provide centralized tools to monitor/maintain all security functions.
c. Provide tools so that all CRT formats, database, control sequences, reports, etc. can be maintained and distributed from a centralized location.
d. Provide a separate development environment so that all system changes can be tested before moving to the production system.

4. Reduction in Pipeline Support Personnel

This area of personnel covers a lot of ground, including MIS, scheduling, regulatory personnel, revenue accounting, to name just a few. Basically, any person whose job is associated with gathering or manipulating data could potentially be reduced or consolidated. The following are some of the ways this is being accomplished:

a. Automate the entire revenue cycle from nomination and scheduling, movement monitoring, custody transfer, to billing. Although each of the following items will require auditing and monitoring, the following is an overview of what needs to be automated:

   i. Provide method for pipeline customers to electronically submit and view nominations
   ii. Provide automated and regularly updated scheduling function that takes into consideration current line conditions, equipment outages, and power optimization
   iii. Provide automated method of transferring schedule to SCADA batch tracking, on Controller command
   iv. Download batch data to field equipment (e.g., flow computers, PLCs, etc.) for local execution and monitoring
   v. In addition to operations and scheduling, provide on-line method for pipeline customers to see progress of their batch movements
   vi. Automate proving functions and automatically apply factors
   vii. At completion of batch and proving functions, automatically validate and route tickets and proving reports to revenue accounting and make available to associated pipeline customers

b. Due the tremendous historical and data query tools available on today's SCADA systems, many maintenance and regulatory functions can be facilitated:

   i. System retention of DOT pressure data (mentioned above)
   ii. Pump on/off cycling counts and times
   iii. Tank level movements to support emissions reporting
   iv. Meter factor monitoring and trending by product, flow, pressure, and gravity to support meter maintenance
   v. Provide both real-time and historical data for calibrating and tuning field instrumentation and control loops

c. Even if scheduling is not totally automated, as mentioned above, provide scheduling personnel with:

   i. Current line conditions (e.g., unit status, flow, etc.)
   ii. Batch interface locations and line pack
   iii. Tank levels and volumes

iv. Estimated ETA for batched movements
v. Current product inventory and summary for hour, day, week, month
vi. Batch summaries and ticket/proving data

d. Similar to the schedulers, revenue accounting personnel would be able to view:

i. Tank levels and volumes
ii. Current product inventory and summary for hour, day, week, month
iii. Batch summaries and receive actual tickets and proving reports
iv. On-line and summary gain/loss projections

e. Pipeline engineering can also be facilitated if a full pipeline simulator is included as part of the SCADA system's trainer capabilities.

Reduction in Power Consumption

Another significant driver for pipeline companies is the use of SCADA to reduce power consumption. Running pumps at the wrong time, even for just a few minutes, can potentially cost pipeline companies tens of thousands of dollars. In general, there are three areas that SCADA can provide assistance: 1) during scheduling, 2) operations, and 3) pipeline design. The following are brief discussions of each area:

1. Scheduling: Power optimization for scheduling is usually either built into the scheduler or a separate program which performs a pass on the scheduling data. SCADA gets involved by providing current line conditions, power usage, and month/year-to-date power consumption information.

2. Operations: SCADA assists operations with power consumption by providing the Pipeline Controller with warnings when peak periods or contract limits are approaching. On-line power optimization can also assist with unit selection when the Controller must deviate from the previous run schedule.

3. Design: If the SCADA system has a full pipeline simulator as part of the system's trainer capabilities, SCADA can also be used to provide initial pipeline conditions and keep track of power usage during simulation runs.

Reduction in Operator Error

While the above two drivers save the pipeline companies money by taking specific actions (i.e., eliminating personnel or reducing power consumption), this third driver, "Reduction in Operator Error", saves the company money by preventing or significantly reducing the possibility that a Pipeline Controller will make an error. Some of the areas that the SCADA system can help are:

1. Hydraulic Profiles: Not only can hydraulic profiles assist in identifying when pipeline operations are exceeding MAOP or operating in slack conditions, it can also be used to operate the pipeline more efficiently (i.e., closer to operating limits). Some SCADA packages are also providing "what if" capabilities to allow the Pipeline Controller to see the effects of a unit or controller change before it is actually transmitted to the field.

2. Compatibility Checks: This feature checks the compatibility of the products on both sides of a valve or in a unit and pipeline before allowing the valve to be opened or the pump to start. Typically, the Pipeline Controller would be provided with a warning that can be overridden. The turning on of a DRA pump into jet fuel would be handled the same way.

3. DRA and Pumping Units: Generally part of the batch tracking function, this feature warns the Pipeline Controller when a batch containing DRA is approaching a pumping unit.

4. Flow Path Verification: This feature, similar to the compatibility checks, provides the Pipeline Controller with a warning that can be overridden, when the controller attempts to close a valve against a running pump or turn on a unit with no delivery path. The feature can also warn the Controller when valves are manually controlled from the field and cause operational hazards.

5. Rate and Volume Alarms: This feature calculates the volume to-fill/empty and provides alarms when potential overflow/dry conditions could exist if the current flow rate is maintained for a predefined period of time.

6. Batch Delivery Warning: In a similar fashion, the system could also provide warnings at predefined times prior to the arrival and/or completion of a batch.

7. Training: One of the best ways to eliminate Controller errors is to ensure that they have been exposed to as many potential hazard conditions as possible and shown the proper way to handle them. This is where the

SCADA Training Systems get heavily involved. The three approaches that are evolving, both as individual tools and used in combination, are Data Acquisition Device Simulation, Playback, and full Pipeline Simulation. Training Systems are also becoming increasingly important as Controller certification requirements are becoming more stringent.

Faster Detection and Mitigation of Problems

The fourth driver for SCADA is to provide functionality that will provide faster detection and mitigation of problems. Similar to reducing operator errors, this driver does not make money for the pipeline company in and of itself, but it does reduce the cost when problems do occur. Although there are many areas that the SCADA system can help, the primary focus for SCADA is leak detection and rapid isolation. Depending on the sensitivity requirements and the level of field instrumentation, SCADA systems generally try to detect leaks using one or more of the follows algorithms:

1. Rate Of Change: Unexpected rapid changes in pressure and/or flow
2. Deviation Detection: Unexpected changes in pressure, flow, or volume (e.g., movement in an inactive tank)
3. Events Monitoring: Delivery at an unexpected or unscheduled location
4. Line Balance: Comparison of change in meter-in/meter-out volume against change in line pack
5. Predictive Model: Comparison of predicted pipeline pressures and flows against actual monitored values.

Once a leak has been detected, the next step is to determine the exact location of the problem, the extent of damage (i.e., volume released), and the fastest way to isolate the problem. Determining the location and volume are a function of the particular leak detection algorithm used. Isolating the problem can be facilitated by the SCADA system providing one or more of the following features:

1. Rapid method to identifying and contacting on-call personnel
2. Rapid method to identifying closest block valves and responsible parties (if manual)
3. Rapid access to emergency information and personnel (e.g., One Call, local sheriff and fire departments. right of way information, etc.)

4. Rapid method of documenting problem (e.g., CRT hardcopies, data snapshots for playback, etc.)

SUMMARY

The above paragraphs have discussed four important “drivers” for the upgrading of SCADA systems. Oddly enough, these same “drivers” are also the basis for the current trends in the liquid pipeline SCADA industry. No single SCADA vendor has all of the above capabilities and features as part of its package, although with each iteration, they get closer. The SCADA vendors pay close attention to what “drives” the industry because that’s what “drives” their sales.

For pipeline companies to continue to be competitive, their SCADA systems must be capable of many of the above functions. Unfortunately, since SCADA is no longer that isolated system in the corner, many of these features also require changes to other parts of the company (e.g., work processes, field changes, etc.). In general, a program of incremental change works best.

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