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Scada, Controls, and Leak Detection Alphabetical Glossary

Accuracy – The ability of the leak detection system to determine the location, rate of the leak, and the volume lost.

Acoustic/negative pressure wave – When a leak occurs there is a sudden reduction in pressure right inside the pipe as the first molecules move through the new opening. Almost immediately the next molecules take their place and squeeze through the opening. That creates a pressure wave traveling away from the leak site towards both ends of the pipe. Instruments located along the pipe detect the wave front as it passes. Signals from instruments feed back to a processor that compares when the waves arrive. The processor calculates the leak location based on this timing.

Alarm filtering strategy – The philosophy regarding which conditions or events justify an audible alarm versus just an indication, or perhaps even no indication. Upset conditions normally trigger many alarms and the filtering strategy determines which of these are filtered so the controllers get the information they need without overloading them with alarms.

Alarms – When indicators go beyond prescribed limits they can become a*larms*, a visual or audio alert to a controller that an upset condition exists. Alarms are vital, but they can confuse and frustrate controllers if they are not designed properly

Application interface – Data stored in the data base are sometimes extracted for use outside the direct scada system. That calls for an interface or hook to allow data to go from the data base to the application. For example, the leak detection process needs pressures and flow rates; the corporate accounting system needs meter readings for invoicing purposes.

Command processing time – The time from when the HMI accepts a command until that command is processed or received by the field device.

Communications latency – The transmission time for data to move from the remote device to the host system.

Compensated mass balance method – Temperature changes have a large impact on line pack volume. Natural gas may leave the compressor station in excess of 100^0 F and rapidly cool to equal ground temperature. Modified volume balance only compensates for temperature loss as an average between the input temperature and the output temperature. Compensated mass balance segments the pipeline based on the location of available instruments and models the temperature and pressure along the pipeline between measurement locations. These values are used to adjust line pack, yielding a more accurate number and allowing improved sensitivity of leak detection.

Configuration tool – Any database needs to be configured for the specific application. Like a spreadsheet, the data base starts as a blank page, with rows and columns waiting for data. The users configure it (the spreadsheet or the data base) by writing instructions or commands in the case of the scada data base, or equations in the case of the spreadsheet, using functions and macros. The functions and macros available to the programmer for writing instructions and commands are what make up the configuration tool.

Corrupted data – Missing, incorrect, or old data. Corrupt data can happen due to communication failures or failures in the field devices or network. Corrupted data may be an indication of an abnormal situation. Scada systems contain validity checking routines that attempt to determine if data is good or bad. The bad data is excluded from the system and an alarm or warning is generated.

Device status – Rather than a numeric value, these signals give the state of being of a device. For example, a valve may be open, closed, or in transition; an engine driving a compressor is off, on, starting, or stopping.

Displays – The physical device on which information is displayed, usually a computer monitor.

Events – Changes to the pipeline or actions taken by an operator or by the scada system.

External leak detection systems – Systems that use sensors which may or may not be physically connected to the pipe. Some sensors are in the ditch with the pipe, involving fiber optics or tubing for example. Other sensors are portable and are transported along the pipe, such as vapor detectors or side scanning sonar.

Fixed interval reporting – A device reports its data on some regular basis.

High motor winding temperature – The temperature monitor is located on the motor windings is similar to the bearing alarm. It protects the motor from getting too hot.

High station discharge pressure – A pressure sensor located on the pipeline just before the pipeline crosses the station boundary monitors pressure, shutting down compressors or pumps if the station pressure exceeds a preset limit, protecting the pipeline from over pressure.

High station manifold – A pressure sensor monitors pressure in metering stations shutting down the station if readings reach a preset limit. This protects the typically lower pressure-rated metering equipment in the station.

High station sump level – Some stations have sumps, small buried tanks used to drain down station piping or pump units for oil pipelines and for catching liquids for natural gas pipelines. A float switch located in the sump tank sends an alarm when the fluid level reaches a critically high level.

High unit bearing temperature – The temperature of the bearings on the motor, pump, compressor, engine, and turbine are monitored by a sensing device located on the bearing housing. It shuts the units down if a predetermined temperature is reached.

High unit pressure – Similar to the high station discharge switch, a high pressure sensor may be located on the discharge of each pump or compressor. It protects the pump or compressor from over pressure in the event one of the valves associated with that piece of equipment is accidentally closed.

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High unit temperature – A sensor monitors the temperature of the fluid in the unit, shutting down the unit before the temperature reaches a dangerous level.

High unit vibration – Vibration sensors located on compressors, pumps, motors, engines, or turbines and shut down the unit if vibration becomes excessive.

Historical data access time – The time from a request for historical data until it appears on the display.

Historic database – From the real-time operating database, some operating data is archived in a historical database. What is historic data used for? Changes happening over time may not be spotted using only real-time values, but may be when trends are examined, leading to better understanding and optimization of the pipeline. Logs documenting controller commands is also a valuable tool for troubleshooting problems and understanding controller performance.

Human machine interface – The human-machine interface, HMI is the link between the controller and the control system, providing visualization, and access to controls. It includes computers, screens, keyboards, and mice, usually located on the controller's console.

Incomplete station sequence – Stations are designed to follow a prescribed sequence during start up. A device with a timer tracks the sequences at the station. If the sequence does not occur at the rate and in the order dictated, the device generates an incomplete sequence signal or alarm.

Indicators – Display information that show what is happening on the pipeline. They can be lights, numbers, colored lines, animation, and sometimes audio cues (a bell ringing when an event is complete.)

Internal leak detection systems – Systems that utilize data from field sensors monitoring, pressure, temperature, flow rate, viscosity, density, and velocity. These parameters are used in algorithms (mathematical equations) designed to simulate pipeline operation. The actual operations of the pipeline are compared to the simulated values. A significant difference between the modeled and actual operating conditions indicates a probable leak. This type of software-based leak detection is commonly called computational pipeline monitoring (CPM). Rudimentary versions of this type model compare one value, such as pressure or flow to preset thresholds or limits. Advanced systems perform extensive analysis of multiple variables with dynamic (changing) thresholds. Numerous kinds of computational schemes are used in the industry.

Line pack – The amount of material in the pipeline at current operating pressure. The line pack of long, large diameter natural gas pipelines can be quite different at low and high operating pressures, but liquid line pack remains the same for the specific section of pipe. For oil, a 12 inch diameter pipeline with 0.2 inch wall thickness, 100 miles long, filled with gasoline, has a line pack of approximately 69,000 barrels.

Local scada – Individual pump, compressor, or meter stations may have local station scada, but that does not mean they are not controlled centrally. Local scada is often included as a convenience for station operators or maintenance people, providing them an easy way to open and close valves and start and stop equipment. Many times local station scada is manufactured by different vendors and has only one display and a keyboard to view equipment status, input data, and issue commands.

Logs – Logs capture events and commands and are an important part of the historic database for troubleshooting, optimization, and training. They are routinely generated by the scada system and (normally) distributed only to those involved with operations. However, when an accident occurs, logs are of great interest to all types of constituencies, both within the pipeline company and outside.

Low pump suction pressure – Pumps must be supplied with a minimum amount of pressure at the suction to prevent damage to the pump. A pressure sensor located upstream of the pump monitors pressure to insure the required amount of pressure is present, shutting down the unit when the pressure drops too low.

Modified volume balance method – Sensitivity is improved with modified volume balance over volume balance by using the *dynamic bulk modulus*, a calculation that takes into account the amount of each product in the pipeline. For natural gas pipelines, the bulk modulus is fairly constant, so modified volume balance does not help much. For oil pipelines, particularly those moving a variety of crude oils or refined products, using the actual value improves sensitivity compared to using a representative or average value.

Operating data – The important variables associated with pipeline operations - pressures, flow rates, position of valves, status of motors, meters, engines and the like. Having operating data in real-time is critical to allow controllers to see and respond to changing conditions and keep the pipeline operating at peak safety and efficiency.

Other non-parametric data – This includes alphanumeric labels for batches, names of operators who initiate commands, and names of commands.

Parameter deviation method – Parameter deviation establishes thresholds at the high and low values of pressure and flow ranges and issues an alarm when readings cross these preset thresholds. Parameter deviation works best when the pipeline is in steady state. They may be disabled or the thresholds widened during startup, shutdown, or other transient situations to avoid false alarms.

Parameter values – Numbers generated by instruments measuring something – pressures, temperatures, flow rates, for example.

Points – The origin and destination of data going to and coming from a device are points. For example, the incoming motor-operated valve at Explorer Pipeline's Greenville, Texas delivery facility can have five different points, two command (open and close) and three status (open, closed, and in transition .) The valve itself is one point with a point tag or a point name. All the data concerning this valve is transmitted from the origin point (the valve) to a destination point, the place in the computer where it is captured and stored in a points database.

Poll – During a poll or scan the central system asks a device for data.

Rate of change method – Conditions are not supposed to change too quickly on pipelines. Sudden changes in flow and pressure can indicate a problem. The primary item affecting flow rates in operating pipelines is friction loss. If nothing else changes to impact friction loss per mile (density, viscosity, and diameter) but flow rate goes up quickly at the upstream end, it probably means there is less total friction loss because some of the oil or natural gas is escaping before it reaches the next station.

Another indication of a problem is a rapid fall in pressure, even if it is still within preset limits. The scada system or leak detection system monitors flow and pressure and issues an alarm when they change more quickly than with normal operations. Rate of change can easily detect large leaks in both natural gas and oil pipelines, but not small ones.

Real-time – What is happing to the pipeline at the present time (Within a few seconds of the present is sometimes referred to as near real-time because of the time it takes for a signal to travel from a remote location to a display.)

Real-time transient modeling – Line balance methods work best when the pipeline is in steady state condition – the pipeline is flowing smoothly with no changes. Pipelines are quite frequently not in steady state flow so the leak detection must be desensitized to accommodate transient conditions. Real time transient models compensate for the pressure waves generated by compressors and pumps starting and stopping and valves opening and closing. Real time transient models are used in conjunction with the previously described models, calculating more accurately the variation in line pack and improving leak detection capabilities.

Redundancy – Adding redundancy to a scada system eliminates *single points of failure.* If one piece of equipment fails, another takes its place; if one communication path falters, another assumes the load.

Reliability – Whether a leak exists when the system says a leak exists determines its reliability. Pipelines regularly experience transient conditions, sporadic pressure and flow changes that interrupt steady state operations. Starting and stopping compressors or pumps, opening and closing valves and other operating situations cause short term transient pressure waves. Leak detection systems based on pressure changes can be fooled by these normal transient waves. Reliability requires filtering transient conditions so that alarms are generated only when leaks really exit. Otherwise operators may be desensitized to real alarms when they happen.

Report by exception – A device reports only a change in value or status. If a pump turns off, it alerts the control system. But as long as it is running, it does not report its status. Some method of periodic integrity checking is usually implemented for report by exception to insure data changes are not lost.

Reports – Scada systems generate various reports automatically and distribute them electronically or in paper form within the pipeline company and to customers. Within the pipeline company, various groups can request that a*d hoc* reports be generated. The data sharing philosophy greatly impacts the decisions around report generation and distribution.

Robustness – The leak detection system has to be able to work under less than ideal situations and changing conditions. The minimum level of sensitivity, accuracy and reliability the system can sustain under these conditions determines how robust it is.

Scan tables – These tables establish how frequently the devices are polled. Pressures may be reported quite often; meter readings from a natural gas delivery point may be collected only once per day.

Scan time – The times required to access or poll all devices.

Screen density – The amount of information contained on one screen. Higher screen density means less need to navigate between screens but could affect screen ease of use.

Screen ease of use – How easily operators can understand and absorb what is on the screen. Graphs are sometimes easier and quicker to understand than tables and charts.

Screen interoperability – How well the screens can be used in conjunction with one another. Easier and more intuitive navigation between screens improves interoperatilibity.

Screen shot – A picture of what is shone on the display, normally acquired by performing a print screen.

Screen update time – The time from the request for a new screen until that screen is shown on the display. (This is a bit different from update time, since this metric is system dependent as it uses data already available in the system.)

Screens – The pages of information displayed on the computer monitor. Screens are the visual information link between controller and pipeline. Easy to read screens with a high level of *information density* (lots of information on one screen help the operator quickly grasp current operating conditions to effectively monitor and control the pipeline.

Security – Security, and as it relates to scada, *cyber security,* is of importance from a safety and a commercial perspective. Restricting system access uses firewalls, passwords, encryption, intruder detection, and secure protocols. Control rooms, computer rooms, compressor stations and other company facilities are sometimes secured with live guards.

Sensitivity -- Leak detection sensitivity has to do with leak rate and time to detect. Leak rate is usually measured as percent of flow rate. A one percent leak in a pipeline pumping 2,500 barrels per hour is 25 barrels in an hour or 600 barrels in a day.

Simple line balance method – This method has been in use for many years. It compares the amount pumped into the pipeline versus the amount delivered out of the pipeline. Receiving meter readings at the end of one hour are subtracted from receiving meter readings at the beginning of the hour giving total received during the hour. This number is compared to an equivalent number at the delivery end. An imbalance between the two numbers larger than a predetermined limit indicates a leak.

Station Alarms – Alarms which apply to an entire station rather than just one piece of equipment

Statistical analysis – This is a hybrid form of leak detection often used in conjunction other leak detection methods. Statistical techniques look for abnormal imbalances. By "training" the system during various normal situations, the statistical systems have an advantage when attempting to minimize false alarms.

System availability – The time all components of the system are available for use. (This could be a percent of the total time elapsed while the system is functioning as intended, that is all components running and available with no redundancy called in to play. It could also be the percentage of time the overall system is available for use even if some components or processes have failed. In this case, redundant components been called in to use or the failed process is not critical.)

System utilization – The time the computing system resources are available at different scada load levels. (This is a measure of the surplus capacity to handle processing problems or large processing loads.)

Tuning – Tuning is a detailed and painstaking process. The model starts as a theoretical mathematical description for the operation of the pipeline. Theory does not necessarily agree with reality, so pipeline tuners make small changes to the model in an attempt to make it match actual pipeline operation as closely as possible. Tuning takes patience and detailed knowledge about the model and the pipeline.

Unit Alarms – Alarms which apply to an individual piece of equipment rather than to the entire station.

Update Frequency – To handle the job of gathering all the data in an orderly fashion, an established protocol dictates how often and when the data is gathered. The frequency and manner falls into one of three categories, polling (also called scanning), report by exception, and fixed interval reporting

Update Process – The update process acts as traffic control for the polling, exception reporting, and fixed interval reporting. If devices do not respond when scanned, or do not report at their appointed time, the update process initiates a diagnosis. If it cannot determine the problem, it feeds that information to the alarm process that either generates logs for future action or notifies the controller. The update process continually performs checks of data validity by comparing selected incoming data to past data for the same device or to preset data.

Update Time – The time from a change of state of a field device until that change of state is displayed on the control consol displays.

Volume balance method – This method takes line balance one step farther by compensating for changes in line pack. It uses average pressures, temperatures, and compressibility (the *bulk modulus* for liquids and the compressibility factor for natural gas pipelines) to adjust for line pack changes. These adjustments improve sensitivity.