A SCADA system takes its name from the term ‘Supervisory Control and Data Acquisition.’ This is a very broad concept, which has found applications in virtually every industry. In this short paper, I will explain the basic components of a typical SCADA system as found in a large natural gas distribution system. I will also provide some useful guidelines which my department has developed, through experience, for the installation and operation of our SCADA system.

SCADA SYSTEM COMPONENTS

1. **Host Equipment.** At the heart of the SCADA system is the host computer, which serves as the ‘command and control center’ for the system. The typical system will include the following host functions:

   **Alarm Functions** — The system alerts the operator about exceeding pressure limits, non-responsive controllers, equipment malfunction, abnormal flow conditions, high/low odorant injection rates, to name a few. Alarms are grouped and prioritized by urgency. We are keeping alarm logs for 30-35 days. These logs are not being archived.

   **Display Screens** — There is a group of display screens to display the current operating variables for each station, including city gate stations, district regulator stations, and system control (low) points. Displays of system values are also included, such as group pressures, station outlet pressures vs. set points, and current supplier volumes. Historical data can also be displayed in a graphic format. We are using 3 operator stations with 3-4 monitors per station to provide adequate display flexibility for our operators. Although we only have one operator on duty, the additional stations are useful for supervisory use or as additional displays for the duty operator.

   **Control Logic** — This is implemented via script programs in the host to supervise automatic control loops involving data from multiple sites (e.g., system low point pressure control), and for general system housekeeping functions such as daily RTU time synchronization.

   **Historical Data Logging** — All station “real time” values deemed important for trending and historical purposes should be logged and archived. We are keeping our historical logs for 35 days and archiving once per month, eventually recording the files on writeable CDROM’s.

2. **Field Equipment.** The RTU’s at the station sites are at the opposite end of the SCADA system. The generic name ‘RTU’ comes from an old mainframe term ‘Remote Terminal Unit’, which now refers to a broad variety of field devices, including flow computers, PLC’s, electronic volume recorders, etc., which collect and process data from various sensor inputs, direct output to various output devices, and store and/or transmit data back to the host. In a gas SCADA system, the typical RTU is a flow computer at a city gate station with one or two meter runs. The RTU is assigned several tasks, such as pressure monitoring, volume calculations (AGA 3 for orifice meters, AGA 7 w/ NX19 for turbine meters), alarm generation and notification, PID loop control for pressure and flow rate, output signal for odorizer, historical data storage (limited), and regular communication with the host. Some of the I/O devices used at a typical gas SCADA site include: static and differential pressure transmitters, temperature transmitters, pulse or frequency transmitters for meter flow signal, pressure controllers, injection odorizers, valve actuators, and gas samplers. These devices connect to the RTU
through its analog, discrete and pulse input/output slots.

FIELD EQUIPMENT INSTALLATION GUIDELINES

1. **Grounding and Surge Protection.** Proper grounding of all field equipment is required in order to protect the equipment from surges on the power lines or induced by lightning. The ground rod should be located near the equipment to be protected, and the ground cable from the equipment should be as short and straight as possible, and of a larger gauge than normally used, preferably AWG no. 10 or larger. Surge protection devices are recommended on all inputs to the RTU, and the a.c. power (if a.c. is available) should be filtered by a surge protector before going into the RTU’s power supply. If dial-up communications are being used, a telephone line input protector is highly recommended. There are several good pressure transmitter surge protectors available, and will extend the life of the transmitter. We are not installing them at present, and have had good success with proper grounding and use of surge protection devices on the RTU inputs.

2. **Sensing Lines.** The pressure sensing lines should be as short and direct as possible, to reduce the pressure drop in the line. For the same reason, 3/8" tubing is the minimum size recommended for sensing lines. The lines should slope slightly downwards, away from the transmitter or controller, to prevent any liquid buildup in the lines. We are also installing stainless steel insulated fittings on all of our pressure sensing lines to protect against pipeline induced electrical surges, and to prevent accidental grounding of the cathodic protection system. We are using SS fittings and valves in our sense lines exclusively, as a result of previous rust and corrosion problems using galvanized fittings.

3. **Interference from High Voltage Transmission Lines.** Occasionally we will install a station in or near an electrical transmission line corridor. This can create a high degree of electrical interference, which can be reduced to some extent by arranging the conduit runs to be as short as possible and primarily perpendicular to the direction of the power lines. Use of a.c. filter capacitors and/or heavily shielded and grounded cables between the transmitter and the RTU will further reduce the a.c. interference, often to an acceptable level.

4. **Other Recommended Practices.**
   - We have been installing galvanized conduit exclusively at our SCADA sites for several years. PVC conduit is more economical, but is more easily damaged, and the electrical code requires a below-ground transition to be galvanized at every riser anyway.
   - It is recommended that the SCADA system planners be familiar with and keep in mind the National Electrical Code (NEC) as it pertains to the installation of electrical equipment in a natural gas environment. Guidelines are given for graded classification of hazardous locations based on proximity to gas facilities, and on types of gas releases to atmosphere (normal or abnormal). This investigation will determine what type of circuits can be used without protection, and what type, if any, of spark suppression devices must be used to comply with the code.
   - Use of licensed electricians for installation of a.c. circuits to the RTU is required in most locations and is a good idea anyway, but it is permissible for non-licensed personnel to install the conduit runs for the a.c. wiring.

HOST OPERATION GUIDELINES

Backup Communication. It is recommended that a manual backup scheme for communication with the RTU’s be implemented, in the event of an operational problem with the primary communication routine. Example: A modem goes out for some reason (noise on the phone line, loose phone line connectors, bad modem at one station tying up the channel, etc.), resulting in loss of communication with the stations on that channel. The backup plan involves calling the stations from a separate PC, running the RTU manufacturer’s user interface software.

1. **Backup, Backup, Backup!** The SCADA system operator should always maintain a good backup copy of every file that would be impossible, difficult or just inconvenient to recreate. If in doubt about a file, back it up. The extra effort to set up a regular archiving routine is well worth the time involved, and sooner or later it will pay off at the loss of a hard drive or other PC failure. Don’t forget to back up the RTU configuration files, which are useful when the RTU must be rebooted or replaced. These files should be routinely archived along with the host system files. Consider the use of writable CDROM’s for archive data storage. The advantage of this method is low cost, convenience, and local control and retrieval. Note: A copy of the CDROM’s should be stored off-site at the corporate archive facility, if possible.

2. **Taboo Timeframes.** The SCADA system operator should avoid implementing host system changes on Fridays, on days before a holiday, or late in the day, unless he is operating on a 7/24 basis, including engineering/development personnel. The developer should be available the next day to either make any indicated corrections/adjustments or to restore the previous version if all else fails.
3. **Non-SCADA Workstation.** It is very useful to have a non-SCADA workstation in the Control Room designated for use in viewing the distribution system maps (GIS viewing station), leak reports, customer record lookup, Internet weather forecasts, and e-mail correspondence with other departments.

**CONCLUSION**

It is hoped that this paper has provided the readers with an overall picture of the general components and some of the complexities involved in installing and operating a gas distribution SCADA system. Actually, it has barely scratched the surface, when considering the vast array of SCADA hardware and software available today and continuously being developed or improved, and the almost limitless variety of options available for performing tasks, limited only by the user’s imagination.