TRAINING FIELD MEASUREMENT PERSONNEL

Russel W. Treat

Gas Certification Institute, LLC
P.O. Box 131525
Houston, Texas 77219-1525
713-521-9950
russel.treat@gascertification.com

INTRODUCTION

Technology in the field of gas measurement and control is constantly evolving. While many are well training in the specific equipment used in their own company's operation, it is important to have a solid understanding of the fundamentals and theory of operation of the mechanical and physical process involved as well. Therefore, the training of field measurement technicians is of the utmost importance. These technicians must be continually educated in order to possess the most current knowledge of the latest equipment, electronics, communications and metering devices on the market. Also, it is essential that this type of instruction should be taught in a controlled environment where the technicians can learn and develop the necessary skills with the least amount of interruptions from external sources.

HISTORY

In the 1980's, many of the larger companies possessed individual training centers, where each engineer attended regularly scheduled training, and where this training was specific to that pipeline, it's equipment and operation. Many of these companies formalized their training programs in order to "Certify" their personnel. A certified technician would be training to operate and maintain each and every type of valve, pipe, EFM, Orifice plate, chromatograph, etc. Companies would often standardize on set of vendors and create programs whereby their measurement technicians would be specifically certified in that equipment.

With deregulation in the 1990's, the industry went through major changes. The major US gas pipelines went from being regulated rate based operators to being deregulated market price based transporters. This change in business drove consolidation, debt restructuring, budget cuts. Most companies eliminated or significantly downsized their training programs, and gas measurement was not a priority. What training has occurred has been largely "on-the-job."

The gas industry has not hired new personnel, and as a result have been able to operate companies by using mature, well trained gas measurement professionals, many of whom were downsized from one company, and then went to work at another.

In 2005, the industry recognizes that the aging of the existing workforce is soon to create an immense need for new measurement and automation professionals. Most companies have an average field technician age of 45, and many have an average age of over 50. In the next 5 – 10 years virtually all of the business expertise in our market will be eligible to retire.

TRAINING NEEDS THEN VERSUS NOW

Most of our current workforce learned measurement when the devices were largely mechanical or pneumatic. They often came from a background where they had formal training or experience in the mechanical aspects of the equipment. Also, they came to work in an environment where time was set aside in large blocks to learn the theory and electronic aspects of their jobs. In the 90's, we were focused on teaching this highly skilled workforce the electronic and computer skills necessary to work with modern measurement equipment.

In today's environment, the entry level measurement technician often has a 2 year college degree in electronics or instrumentation, and has grown up with computers. Typically they are very comfortable with technology, but have had little exposure to the theory, math and hand-on aspects required.

This means that bring new measurement engineers and technicians on board, they need not only on-the-job training, but dedicated theory and hand on application training.

CHALLENGES

In today's environment, it is rare to that any engineer or technician can be released from their normal job duties to attend training for more than four (4) days. Consolidation and downsizing in the gas business has created situations where one employee has more responsibility and accountability for more gas measurement points, making it difficult to release employees for long-term training.

Therefore, for training to be worked into the employee's schedule it needs to be in short segments of 1.5 - 3 days.

To minimize time away from the field, companies are opting for on-site training at a location or facility which is easily accessible by truck to their field personnel. Some of the advantages of on-site training include:

- Save cost of travel to training center
- Customize the class to meet the needs of a specific group of company engineers
- Ability to provide training on company's pipeline or gas plant facility
- Field engineers are close enough to return to their facility in case an emergency should occur.

Manufacturers of EFM hardware, chromatographs, valves and other devices can provide a most effective training class in THEIR product, but all vendors assume that engineer possess the fundamentals of training as a 'starting base."

REASONS & BENEFITS

Even with all the challenges of effectively delivering training, it remains a increasingly important issue. Listed below are some of the most significant reasons for training field measurement personnel.

1. To develop a thorough understanding of gas measurement in order that each technician can contribute to maximizing measurement accuracy thereby directly affecting the revenue generated through the sales, purchase or transportation of natural gas.

2. Gas measurement equipment is consistently being upgraded to accommodate for the changes in technology and the rule making policies required by FERC. Therefore, the technician has more responsibility to operate and maintain the measurement equipment according to the manufacturer's specifications and the standards mandated by the Commission.

3. Formal classroom training provides better control for consistent implementation of company policy and procedure than "On the job training" where senior technicians pass the "tricks of the trade" down to an apprentice, are no longer an accepted methodology for training gas measurement personnel.

4. Hands On Training in a "Live Gas" environment is superior to classroom training only, as training is delivered in virtually the same environment as the technician faces in the field.

5. Training on the most current measurement devices, electronics and software provides even the senior technician with the skill to properly and efficiently implement state of the art techniques into their daily roles and responsibilities.

6. Formal training programs that are integrated into the career development and performance review process enable companies to meet the intent of Operator Qualification requirements.

7. As senior personnel retire and leave the workplace, new employees will need to be training in all aspects of natural gas operations and measurement. A formal training program designed to meets these needs can improve operations and safety.

HANDS ON & LIVE GAS

The most effective method of teaching and training should be done under actual operating conditions. This type of learning technique has a greater impact on the technicians because all the training utilizes equipment that is under line pressure and contains natural gas. When a technician is wearing their safety equipment and working on flow or pressure controllers in a live gas environment, the schooling procedures of "hands on training" create a realistic atmosphere where the technicians learn to perform their tasks under actual conditions.

It is clearly apparent that learning under authentic working conditions in a controlled training environment has a definite advantage. Through this training experience, technicians learn through experience to develop the problem solving expertise that is necessary to develop and enhance their troubleshooting techniques. At the same time, technicians learn proper safety procedures.

In this way, newly developed skills are immediately transferred to daily operations for resolution of operating and/or maintenance problems as they arise in the field. Each technician should be trained so that he or she can handle and resolve a wide range of complex problems when working with gas measurement and control equipment.

In order to be a productive employee in today's market, it is imperative that each technician receives training on different types of measurement equipment available in the gas industry. These diversified skills and knowledge will enable each technician to be a valuable employee who has the ability to increase their company's net profit.

EXAMPLE CURRICULUM

Typically, field measurement technicians have a variety of necessary gas measurement skills. Below, is a list (but by no means comprehensive) of skill sets that every company should insure that their field people possess and fully understand. Ultimately, each employee should understand the relationship between these activities and the company's profitability.

Any training curriculum should include testing and skills demonstration to assure effective learning by the students. In addition, it is important to note that a curriculum should be tailored to the needs of the student population to optimize investment in the program.

Basic Principles of Gas Measurement

This course is designed for classroom presentation as well as for "on the job" study. It deals with both principles and details including hands-on training.

This course develops skills in basic mathematics. This ability enables the student to understand and use the simple equations encountered through the course of further training.

Part 1 - Basic Math
A great deal of work done in the measurement of natural gas cannot be accomplished without a general knowledge of mathematics. The mathematical functions necessary to calculate areas, volumes and flow through a pipeline or an orifice plate are presented in this course.

Part 2 - Fundamental Gas Law
The absolute pressure, absolute temperature and volume of gas are very closely linked. Changes in any of these variables cause changes in one or both of the others. Therefore the behavior of the gas is reviewed in order to enable visualization of physical processes involved when these changes occur.

The study includes purpose and principles of measurement equipment such as manometers, pressure gauges, dead weight testers and recording thermometers.

Boyle's Law, Charles Law, deviation from Boyle's Law, and standard units of measurement are the particulars studied in order to obtain a working knowledge of the relationship between pressure, temperature and volume.

Volume Calculation

In this course, the various correction factors used to calculate gas flow through an orifice are studied in detail. Also calculations pertaining to gas flow through positive and turbine meters are studied.

Orifice Metering

Flow measurement by means of an orifice is studied in detail in this course. Also, the theories of orifice measurement and the physical application are presented. AGA-3 guidelines pertaining to actual dimensions of orifice meter runs and their appurtenances are reviewed. The bellows type orifice meter is also studied in detail.

This "hands-on" training course provides the participant the opportunity to perform inspections to determine if an orifice meter meets AGA-3 specifications. The orifice meters are also inspected, adjusted, and calibrated under actual (gas flowing) conditions in order to teach normal operating and safety procedures to the participants.

Gas Sampling

Natural gas is sampled for many reasons to determine quality and quantity. Techniques for sampling must vary according to the type of test for which the sampling is done. Locations of sampling points, sample size, sample pressure, when and how the sample is taken are all dependent on the desired end result. Participants will acquire knowledge of the general purpose for which a sample is being taken prior to actually taking the sample. Participants will then learn industry accented methods: to transfer a representative sample from a source (usually a pipeline) into a transporting device (usually a sample cylinder), to transport the gas from the source to the lab without affecting the representative sample, and to remove the sample from the transporting device and divert it to the measuring device without distorting the sample.

Determination of Moisture Content

Excessive amounts of water vapor in gas can condense and form liquid or ice-like hydrates which inhibit the flow of gas. Even as a vapor it takes up space, which could be occupied by gas. Water can also combine with other contaminates such as CO_2 and H_2S and form acids that can corrode the pipe. For these reasons, water vapor must be removed from the gas stream. This course discusses in detail the methods used for determining water vapor content and the industry standard "7 lbs of water per MMCF."

Specific Gravity

By definition, specific gravity of gas is the ratio of its density - or weight per volume - to the density of air. In measurement work, especially when using formulas for calculating amounts of flowing gas, the specific gravity of the gas is an important factor. This course discusses how

specific gravity is measured and used and discusses the equipment used to determine specific gravity.

Turbine Meters

Flow measurement by means of turbine metering is studied in detail in this course. Also, the advantages and disadvantages of using a turbine meter, along with its operating principles are presented. AGA-7 guidelines for turbine meter runs and their appurtenances are reviewed.

Positive Displacement Meter

This course begins with understanding the principles of a positive displacement meter and how its individual parts operate. The "Mcf" and how to read the Positive Meter Index are discussed. Much time is devoted to learning the best techniques for repairing positive displacement meters.

Principles of Automatic Control (Controllers)

Automatic controllers to control pressure and flow rate are useful tools, but to use them one must understand the basis principles of automatic control. In this course, the basic principles are given in everyday words. Basic responses of controllers are illustrated with common, familiar devices. Simple graphs show how the measured variable acts under regulation by an automatic controller. "Proportional band, reset action, derivative response, offset" and other terms in the language of instrumentation are simply explained to help people who are not instrument specialists.

Control Equipment (Valves and Regulators)

This course encompasses the study of fundamental gas pressure regulation with special emphasis on the regulator's operation. The essential elements of a regulator and function of each element are thoroughly discussed. The first part of the course is devoted to "self-operated" and "pilot loaded" regulators. The course then goes into a thorough investigation of the operation and different applications of expansible tube type regulators (for examples, the Grove Flexflo).

The third part of the course deals with the selection of control valves. Special attention is given to Fisher diaphragm operated globe valves and also ball valve regulators. Split range control and valve positioners are discussed.

This is primarily a "hands-on" course where the students disassemble and reassemble regulation equipment in order to gain complete understanding of their operation. Students will also field adjust regulators, relief valves, and control equipment on a live natural gas station.

Odorization

This course is intended to provide a complete understanding of natural gas odorization. Information is presented on the many aspects of odorization including odorant compounds, odorization equipment, test methods, and appropriate record keeping.

In order to comply with Department of Transportation's Part 192.625, odor level instruments must be used to assure proper concentration of odorant. Therefore several odorant level test instruments are discussed and actual tests performed to provide training, utilizing the best industry accepted methods.

Basic DC Electricity

This course is primarily designed for the entry-level student, where no sophisticated math background or previous knowledge of electricity is assumed. Therefore, he or she will be able to learn the basic concepts that have enabled man to harness and control DC electricity.

Basic Electronics

Electronics is a field of study that comprises many different components, circuits, and systems. In the interest of time, only those areas that affect electronic measurement equipment will be studied; however, other items may be briefly discussed. Digital electronics will be the main emphasis of this course.

After some preliminary material is covered, a variety of electronic components will be studied (i.e., diodes, transistors, integrated circuits, etc.). Then, some electronic circuits will be presented (i.e., amplifiers, oscillators, power supplies, etc.). The bulk of the course will be devoted to digital electronics (i.e., number system, logic circuits, counters, registers, memories, etc.). Also, analog to digital (A/D) and digital to analog (D/A) conversion will be included.

Electronic test equipment i.e.: multimeter, oscilloscope, etc.) usage will be included in the laboratory type experiments. Overall, this course will provide a very good understanding of the workings of electronic systems.

Electronic Instrumentation

Measurement technology is rapidly changing particularly in terms of the electronic aspects. Process variables are measured and calculations are made instantaneously. The

variable measurements (differential, temperature, etc.) are made by a variety of transmitters or transducers. These devices along with their practical applications and operations are thoroughly reviewed.

Chromatograph

A chromatographic gas analysis provides a quantitative breakdown of gas composition. It is therefore the purpose of this course to provide an understanding of the principles involved and training in the operation of special equipment used to obtain a gas analysis.

Electronic Flow Computer

This course has been prepared to teach operations and maintenance of electronic digital field computers with special emphasis on gas flow computers. The content of this course assumes understanding of basic DC electricity, the use of volt ohm and current meters, and familiarity with basic circuit components. However, no knowledge of computers on the part of the participant is required, as this course develops a fundamental understanding of an electronic computer. Specifications, flow calculations, installation, operation and maintenance are discussed along with "hands on" training, with special emphasis on the Bristol Model 3310 and 3330 flow computers.

SCADA – Supervisory Control and Data Acquisition

In a DOT environment, SCADA gas control skills have become a more “regulated” and necessary operation of the pipeline business. Many companies utilize third party training centers to provide the DOT compliance courses that are required in order to maintain compliance standards. A comprehensive SCADA Course comprehensively covers all the aspects of the system from communications to SCADA database, functionality, and operations.

Pipeline Hydraulics for Engineers

This advance course provides the senior engineer with areas of expertise including pipeline design, codes, basic hydraulic equations, friction loss equations, hydraulic gradient, pipe selection, pumps and/or compression, system control, surge considerations and pipeline simulation software.

Corrosion Control in Pipeline Operations

Pipeline Integrity has brought pipeline conditions to the forefront of management and therefore, field engineers operations. Field Engineer gain experience in basic corrosion, basic principles of corrosion control internal and external knowledge of corrosion cell provides basis for corrosion control, types of protection and cathodic protection systems.

CONCLUSION

Today's field of gas measurement has created an environment where the "learning curve" is no longer a "variable" in the gas industry, but a "constant." Training has evolved into a continuous learning process that proceeds throughout one's professional career. Technology is forever changing to accommodate the world of gas measurement; and as a result, the technician's expertise must be constantly developed and promoted to a level that enables him or her to function according to today's standards. For, it is through these learning and training processes that a measurement technician in today's market, can build a foundation and a desire to gain a greater knowledge.