Technical Publication

Flare Gas Flow Measurement and Control

Jim DeLee, Sr. Member, Technical Staff
Fluid Components International (FCI)

FLUID COMPONENTS INTERNATIONAL LLC

Visit FCI online at www.FluidComponents.com | FCI is ISO 9001 and AS9100 Certified

FCI World Headquarters
1755 La Costa Meadows Drive | San Marcos, California 92078 USA
Phone: 760-744-6950 **Toll Free (US):** 800-854-1993 **Fax:** 760-736-6250

FCI Europe
Persephonestraat 3-01 | 5047 TT Tilburg, The Netherlands | **Phone:** 31-13-5159989 **Fax:** 31-13-5799036

FCI Measurement and Control Technology (Beijing) Co., LTD | www.fluidcomponents.cn
Room 107, Xianfeng Building II, No.7 Kaituo Road, Shangdi IT Industry Base, Haidian District | Beijing 100085, P. R. China
Phone: 86-10-82782381 **Fax:** 86-10-58851152

Flare Gas Flow Measurement and Control

Jim DeLee, Fluid Components International (FCI)

In oil/gas production, refining and storage operations around the globe, flare gas systems are used to burn-off and dispose of waste, excess or off-gases, and as a safety system. The accurate, responsive and reliable measurement of flare gas is essential in order to assure proper operation of the flare gas system, which protects people and equipment from potentially hazardous combustible gas to maintain a safe working environment and to avoid environmental contamination.

The Problem

Flare gas flow meters provide plant operations managers with an intelligent tool to signal abnormal process changes, early leak detection and report on flared gases to comply with safety and environmental agency reporting. Flare gas systems are installed on offshore platforms and in land-based production fields, on transport ships and in port facilities, at storage tank farms and along distribution pipelines.

The dangers of improper hydrocarbon gas handling are well known and are regulated strictly by the United States (U.S.) Occupational, Health and Safety Administration (OSHA) as well as other international safety organizations. The combustible and flammable properties of hydrocarbons make their handling a highly regulated process, requiring flow meter design certifications from multiple international approval agencies including FM, FMc, ATEX and IECEx to name a few.

In their efforts to reduce global warming, the U.S. Environmental Protection Agency (EPA), the European Union (EU) and agencies at multiple levels of government around the globe are imposing stricter regulations that vary by geographic zone for air pollution monitoring, abatement and reporting. The conversion of these waste gases to cleaner burning electric power generating and their integration into the power grid also is being encouraged at multiple levels of governments.

Many oil and gas operations, refineries and chemical plants have flare gas system applications that are uniquely challenged with two diverse and critically important flow conditions: (1) very low flow under normal conditions and (2) sudden very high flows during an upset/blow-down condition. Plant operators, managers and instrument-and-control engineers are then further challenged to comply with the environmental agencies and emissions trading regulations for their flares stipulating flow meter accuracy of ±5% of reading throughout the entire measuring range.

Flow Meter Challenges

Flare gas flow measurement applications present several unique challenges to plant, process and instrument engineers when selecting a flow meter solution. In addition to both low flow rates and then sudden high flow rates during upset conditions, there several other important criteria to consider when selecting a flow meter for flare gas applications:

- Mixed gases – Flow meter calibration specifically for hydrocarbon composition gases and matched to actual process conditions
- Large pipe sizes – As line sizes increase the effective and suitable flow metering technology options (choices) decrease
- Lack of available straight-run – Larger line size and limited real estate, particularly on off-shore platforms, are restrictive to providing required straight run to achieve repeatable flow metering accuracy
- Agency approvals for installation in hazardous (Ex) locations – The entire flow metering instrument should carry agency approval credentials for installation in environments with potential hazardous gases; enclosure only ratings are inadequate (and risky)
- Compliance with local environmental regulations – Meet performance and calibration procedures mandated within local regulations such as US EPA's 10 CFR 40; 40 CFR 98; EU Directives 2003/87/EC and 2007/589/EC; US MMR 30 CFR Part 250, Subpart K, Section 250 and others

- Limited access – Pipe access and re-access for installation, maintenance or servicing is difficult; spool-piece flow meters may require prolonged process shut-down and extensive on-site labor costs to install and maintain
- Offshore platforms corrosive salt water – Offshore platform may require use of stainless steel on all exposed instrument materials, including sensors, process connections and enclosures

Key Criteria For Flow Meter Selection

When selecting a flow meter for flare gas applications, plant operators, managers, process and instrument engineers, will want to have compiled a key criteria check list. There are multiple air/gas flow measurement technologies to choose from and not all of them are well suited to the accuracy, reliability, rangeability and rugged operating environment in the oil/gas industry. For example, some flow meter technologies are better at measuring liquids (volume) than air or gases (mass flow). The accuracy of some flow meters is influenced by heat and some sensor technologies are temperature-compensated to maintain accuracy. Moving parts are acceptable in some operating environments and in other environments they can require high levels of maintenance or repair or replacement.

Selecting a flow meter can be a complicated process. A check list to select a flare gas flow meter should include at a minimum the following capabilities. Creating a simple check-box matrix to compare various flow meters against the following criteria will quickly narrow the choices:

- Wide turndown for both low flow and high flow conditions
- Meet local environmental agency requirements for accuracy and periodic calibration verification
- NIST certified calibration for mixed hydrocarbon flare gases
- Multiple calibrations for variations in composition
- Direct mass flow measurement
- Easy to install, minimal penetration points
- Non-clogging, non-fouling, no moving parts design for lowest maintenance
- Agency approved for installation in explosive gas classified environments
- Stainless steel wetted parts and optional stainless steel process connections and enclosure housings

Figure 2: ST100 Series flow meters

The Solution

Owners, operators, managers and engineers across the petrochemical industry have relied on Fluid Components International (FCI) for gas flow measurement solutions for decades. The company's flow meters are installed in flare gas systems at both land-based and offshore platform systems throughout the world, as well as in petrochemical refineries, storage and distribution plants.

The company's flare gas solutions range from single-line to a large flaring system with a complex array of tributary lines and mixed gases. From ultra-low flow measurement to detect the smallest of leaks and up to 1000 SFPS [305 NMPS] to measure major upset conditions accurately at very high flows, the company's flow meters are a proven solution.

While the company offers at least three flow meter product lines suitable for flare gas system applications, its next-generation ST100 Series Air/Gas Flow Meter *(Figure 2)* provides extensive features and functions that extend and optimize its application in flare flow measurement. The ST100 Series flow meters combine a broad range of easy to install insertion flow elements with the industry's most powerful and flexible electronics/transmitter and specialized, precision flare gas calibrations.

With wide turn downs, specific calibrations for mixed gas compositions, SR2x™ split-range/dual calibration and maximum output flexibility with 4-20 mA analog outputs or bus communications such as HART, FOUNDATION™ fieldbus, or Modbus, this flow meter delivers a state-of-the-art gas flow meter for industrial process, plant and offshore flare applications.

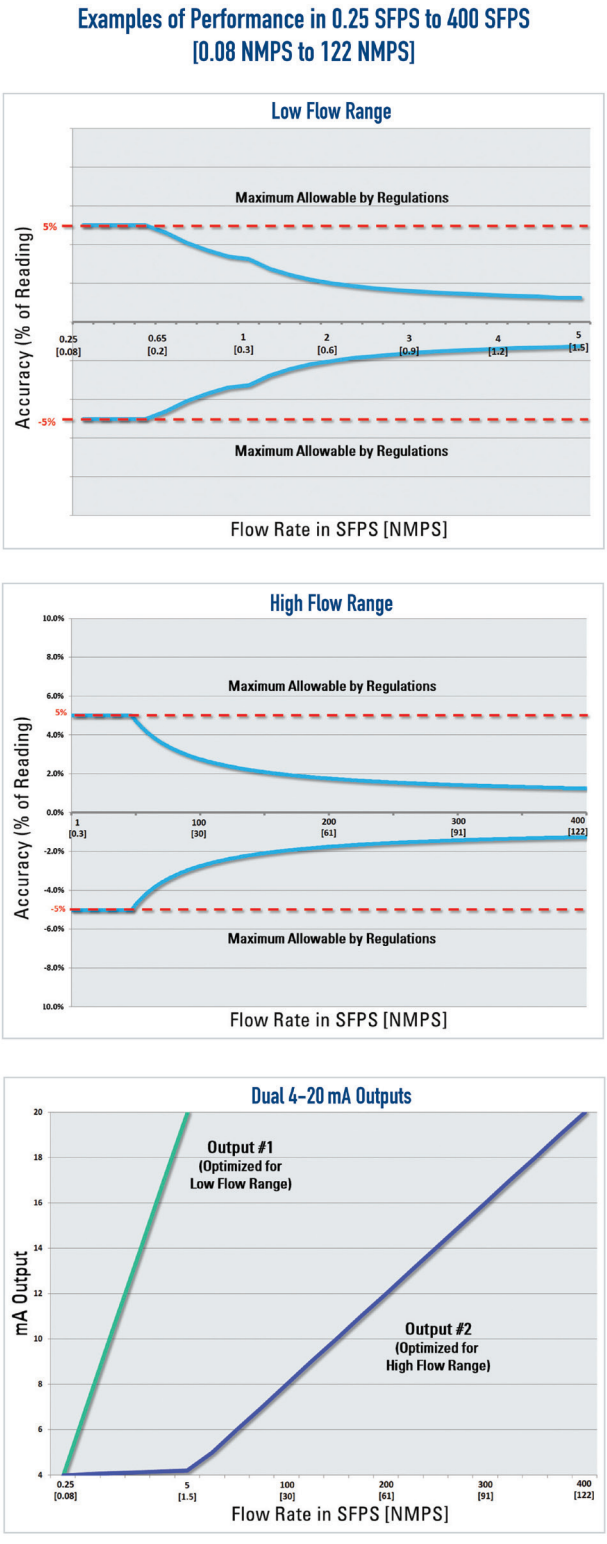


Figure 3: Dual Calibration Performance

Variable Flow Conditions

Many oil/gas operations, refineries and chemical plants have flare applications uniquely challenged with two diverse flow conditions, very low flow under normal conditions and very high flow during an upset/blowdown condition. These industries are then further challenged to comply with environmental agencies and emissions trading regulations for their flares stipulating flow meter accuracy of ± 5% of reading throughout the entire measuring range.

The answer to this challenge is provided with the ST100 Flow Meter's SR2x split range/dual calibration option that provides:

- Split ranges – Two separate and discrete ranges, one optimized in the low flow range and one optimized in the high flow range *(Figure 3)*
- Double calibration points – Strategically placed and optimized in the low flow range and high flow range to achieve ± 0.75% reading, ± 0.5% of full scale to a maximum of ± 5% of reading
- Dual 4-20mA analog outputs – One dedicated to the low flow range and the other to high flow range; this ensures maximum resolution of both the low flow and high flow range at the DCS, or, if any of the bus communications are specified, a single, contiguous high accuracy digital value over the entire flow range is sent to the DCS

Large Pipes

In pipe sizes larger than 16 inches [406 mm] a dual-element averaging system can provide better measurement performance and a more viable solution when it is impractical or impossible to provide the required straight-run or installation of a flow conditioner is difficult. The company's dual-element averaging system *(Figure 4)* available with the ST100 Flow Meter provides

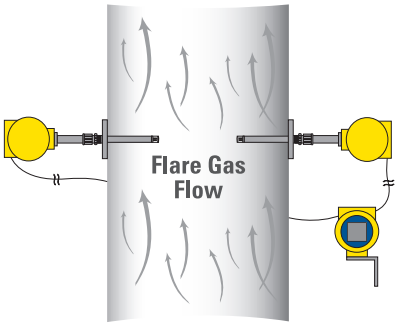


Figure 4: Dual Element Systems

the solution. Contact the applications engineers at the company to determine if a dual-element averaging system will benefit the application.

Communicate the Flow

Local readout, multiple 4-20 mA analog outputs, digital bus communications including HART, FOUNDATION fieldbus, Modbus and more, are all available with ST100 Series to provide the flare flow data *(Figure 5)*. Should the plant need to change or upgrade, the meter is field upgradeable to any of the available outputs.

VeriCal™ In-Situ Calibration Verification

Many flare meter installations, either per plant edict or for compliance with environmental regulations, require regular validation of calibration. Traditionally this has required a cumbersome and costly project to remove the meter from service and return it to a lab, which is particularly frustrating if the meter is found to still be within calibrated specifications.

The VeriCal System *(Figure 6)* provides a simple-to-use tool to verify the FCI flow meter is still within calibration without extracting the meter from pipe. The VeriCal system consists of a special VeriCal ready flow sensor, a portable VeriCal Kit (which can be used with any number of VeriCal-ready ST100 flow meters) and an additional benchmark calibration document to which field verification samples are compared.

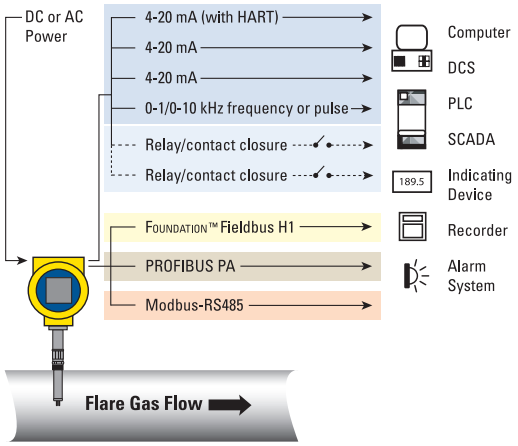
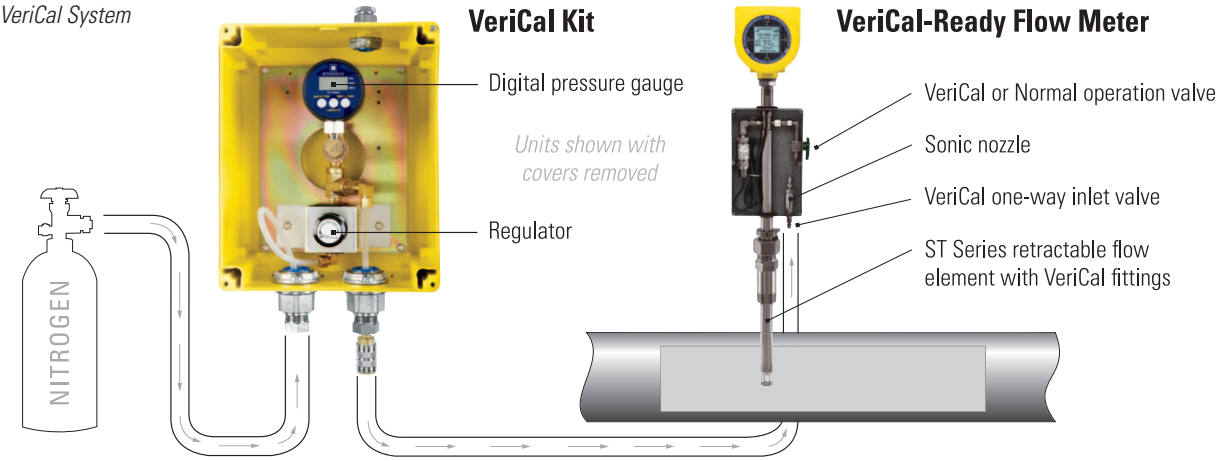


Figure 5: Readouts & Digital Communication

Conclusions

When selecting a flow meter for flare gas systems, be sure to start by developing a check list of key criteria that include performance, the operating environment, environmental and safety criteria. Look for the lowest installed cost, lowest maintenance and longest life flow meter technology. Relying on these simple suggestions will help you reduce the confusion of multiple choices in flow meter technologies to arrive at a solution that performs as intended to ensure the plant operates efficiently, safely and with the minimum environmental footprint. ■

Figure 6: VeriCal System



Nitrogen and hose user supplied