Setting the Standard for Automation™

Session 2 / Paper No. 2
Not Sample Systems – Process Interfaces

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The 64th Annual Symposium of the Analysis Division

Galveston Island Convention Center, Galveston, Texas, USA; 5– 9 May 2019

Introduction

Jimmy Converse, PhD

"Why condition a tank car of material when only a drop is needed for analysis?"

"We need to extract only the minimum amount of material for analysis in order to reduce the energy and disposal requirements…any more is wasteful!"

Picture courtesy
of Dale Merriman

"It is rather odd to have a sample system supplying thousands or millions of volumes material to an analyser which needs only one volume for analysis!" John Trumpeter, 1971

Introduction

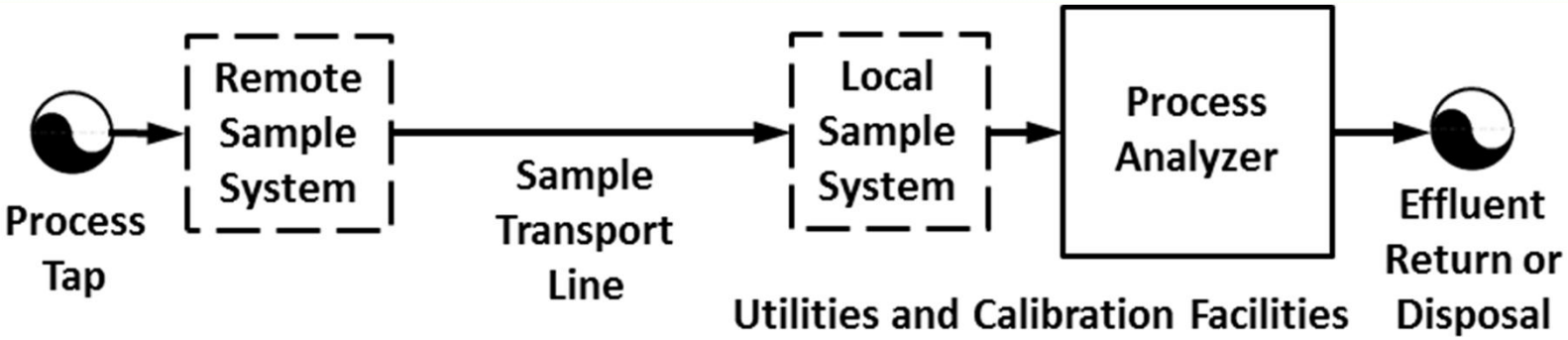
More from Jimmy Converse…

"Why are we still using the same sample preparation techniques that we used forty years ago?" (1983)

"Designing a sample system with continuous flow and filters is ***designing for failure****!"*

"We will find a way with existing hardware and technology to improve reliability and reduce cost!"

Traditional Sample System



- Extract a sample from the process stream
- Provide initial conditioning of the sample for transportation
- Transport the sample to the process analyzer location
- Provide addition conditioning of the sample to be compatible with the analytical measurement technology (the process analyzer) and provide the means to verify and/or calibrate the technology
- Dispose effluent sample

All of the above functions must be performed while maintaining the sample in a representative state of the process to yield an accurate measurement.

Current Situation

- Many sample systems are properly designed for the specific application:
  - Typically “well-behaved” processes
  - Typically “non-complex” analytical technology
- Many sample systems are under-designed for the specific application:
  - Typically “difficult” processes
  - Typically “complex” analytical technology

  Create high operating expense for maintenance (OpEx) and low reliability
- Many sample systems are over-designed for the specific application:
  - Typically “simple” processes
  - Typically “simple” analytical technology

  Create unnecessary capital expense (CapEx) and unnecessary complexity

Current Situation

- Many sample systems that are properly designed for the specific application achieve this status as a matter of chance:
  - Typically use standard, “generic” designs
  - Simply copy what has been done before
  - Move to “standardization”
- Very few sample systems are designed specifically for the particular process application and analytical technology
- There are some notable exceptions:
  - Flue Gas, In-Situ Oxygen
  - Continuous Emission Monitoring Systems (CEMS)
  - Sulfur Recovery Unit (SRU) Tail Gas
  - *Others*

Additional Factors

- Insufficient information in application data sheets:
  - Only normal conditions identified
  - Unusual conditions during abnormal operation not identified
  - Unusual conditions during normal operation not identified
- Insufficient knowledge and experience with applications:
  - Attrition in the work force
  - Availability of training programs or knowledge sharing
  - Lack of comprehensive reference material
- Lack of industry or user “best practices” for specific applications:
  - Industry no longer documents best practices (like API RP series)
  - Even with extensive operating experience, best practices are rarely documented by users and suppliers
  - Users with multiple plants rarely document and share best practices for optimizing designs and performance within the organization

Additional Factors

- Lack of industry requirements for a system performance guarantee:
  - Except for CEMS, performance guarantees are not required or enforced
  - Suppliers do not use performance guarantees as a sales differentiator
  - In most applications, it is difficult to separate analyzer performance from sample system performance
  - Without repercussion, there is no motivation to learn and improve
- Use of “assumed” maintenance to compensate for poor designs:
  - Many process analyzer systems are complex and difficult to operate
  - Many process analytical technologies require routine maintenance to provide measurement performance (calibration, etc.)
  - The assumption of routine analyzer maintenance can mask the improper application of an analytical technology
  - The assumption of routine analyzer maintenance can mask the improper design of the sample system

Goal for Sample Systems

The "proper" sample system design for each applications is a design that provides the optimum operating and maintenance performance for the specific analytical technology with the specific process operating conditions – no more and no less.

Fit for purpose!

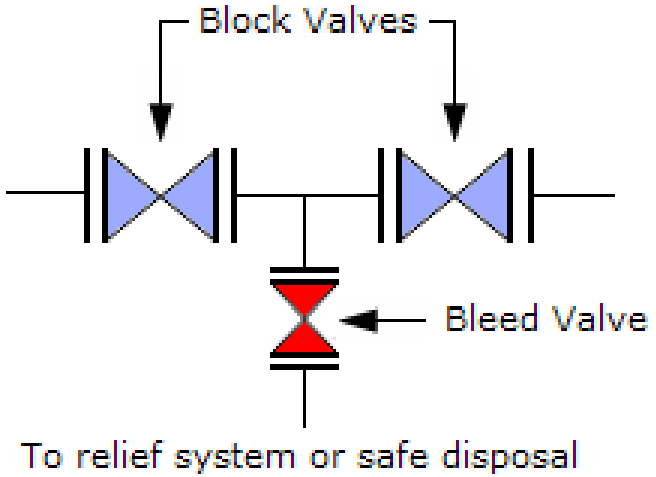
Common Misconceptions

- Because designing sample systems for process analyzer applications is difficult…
- There are design conventions that have been used for many years and have become common place
- These designs are so common that their use is not questioned in any design review or approval process

Unfortunately, what this demonstrates is that a critical evaluation of sample system design is not always being made to confirm that the design is optimized for the specific application –

Fit for purpose!

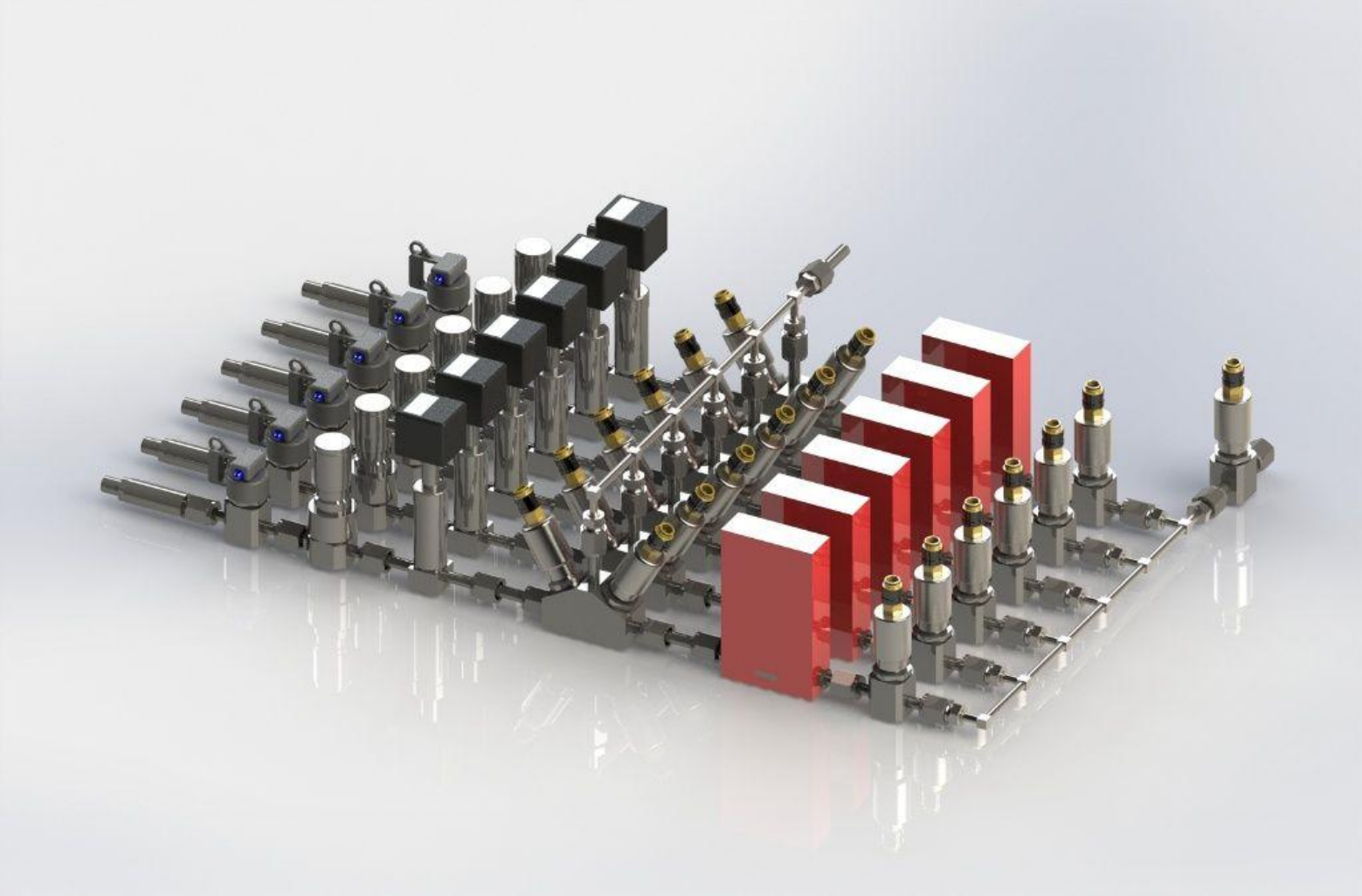
Double-Block-and-Bleed



Picture from Parker Hannifin

Picture from Swagelok

Double-Block-and-Bleed



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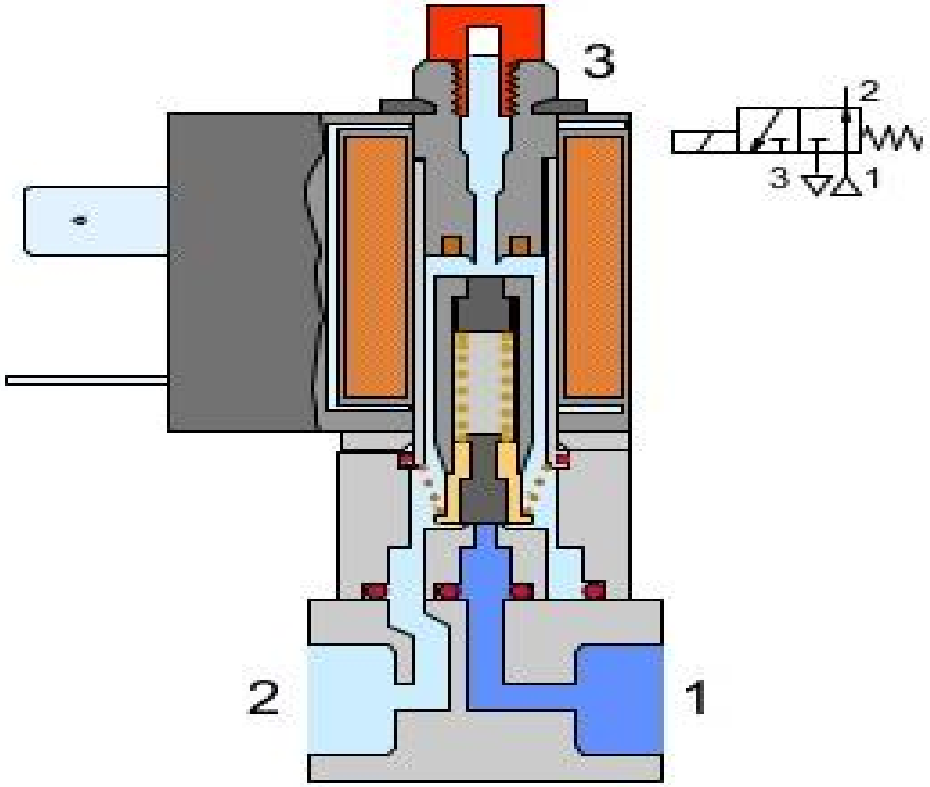
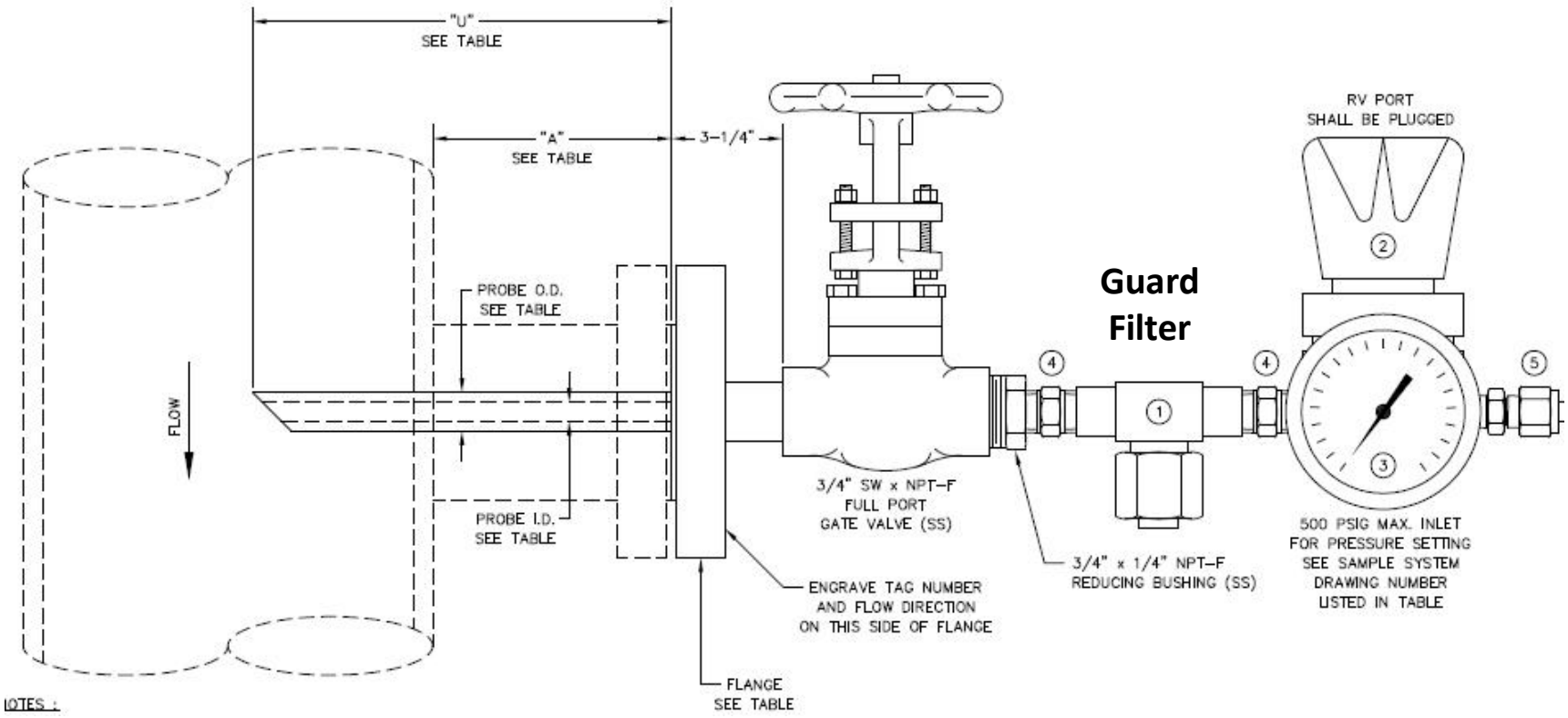
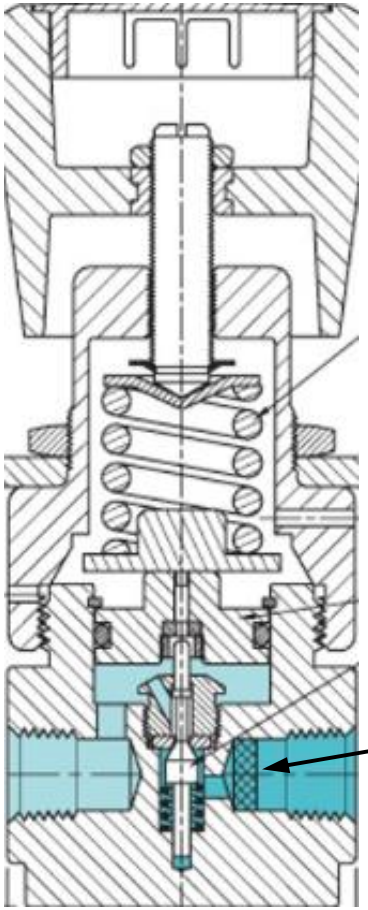


Sample Probe Guard Filter

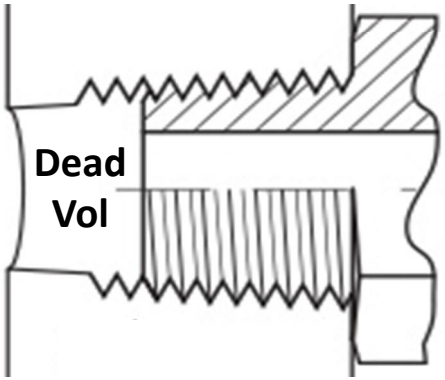


Sample Probe Guard Filter

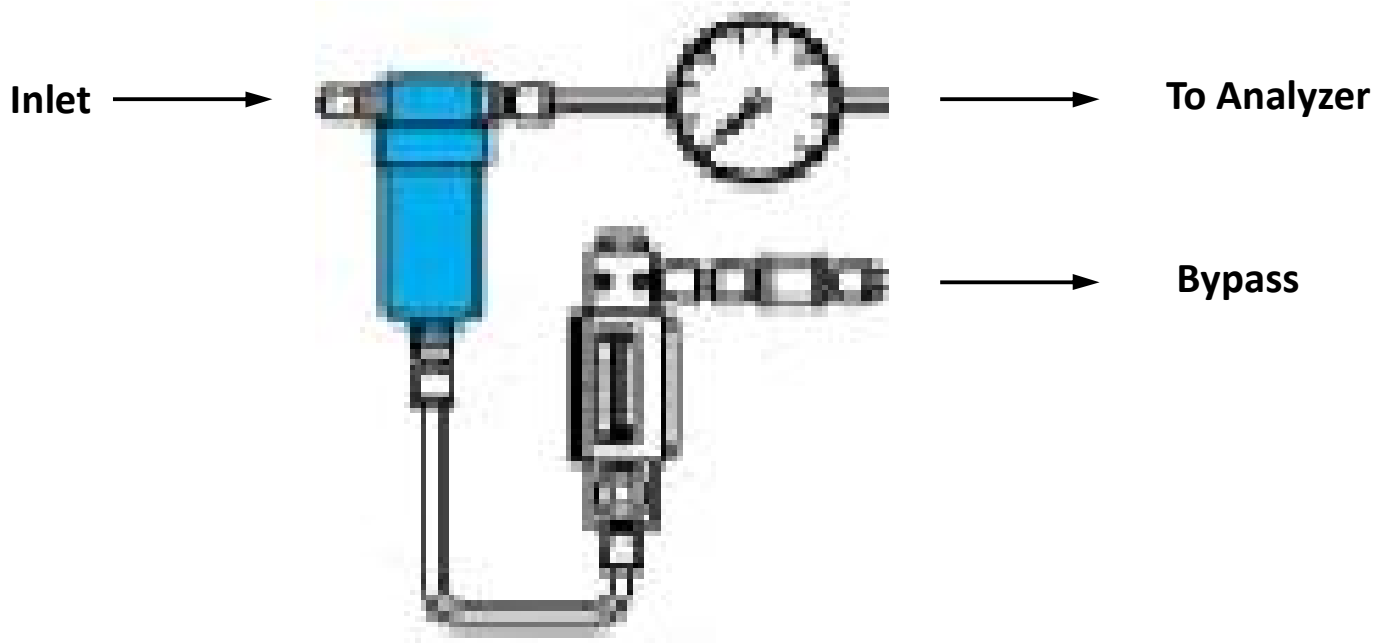


Fitted Filter Element

Probe PR Dead Volume



Filter Bypass Flow



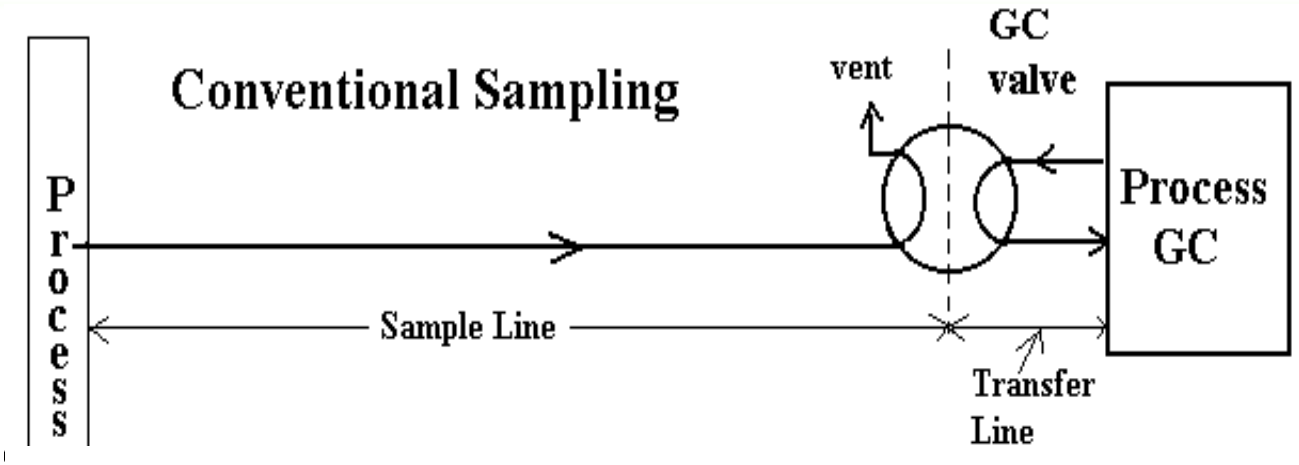
Liquid Sample Vaporization

Critical Evaluation

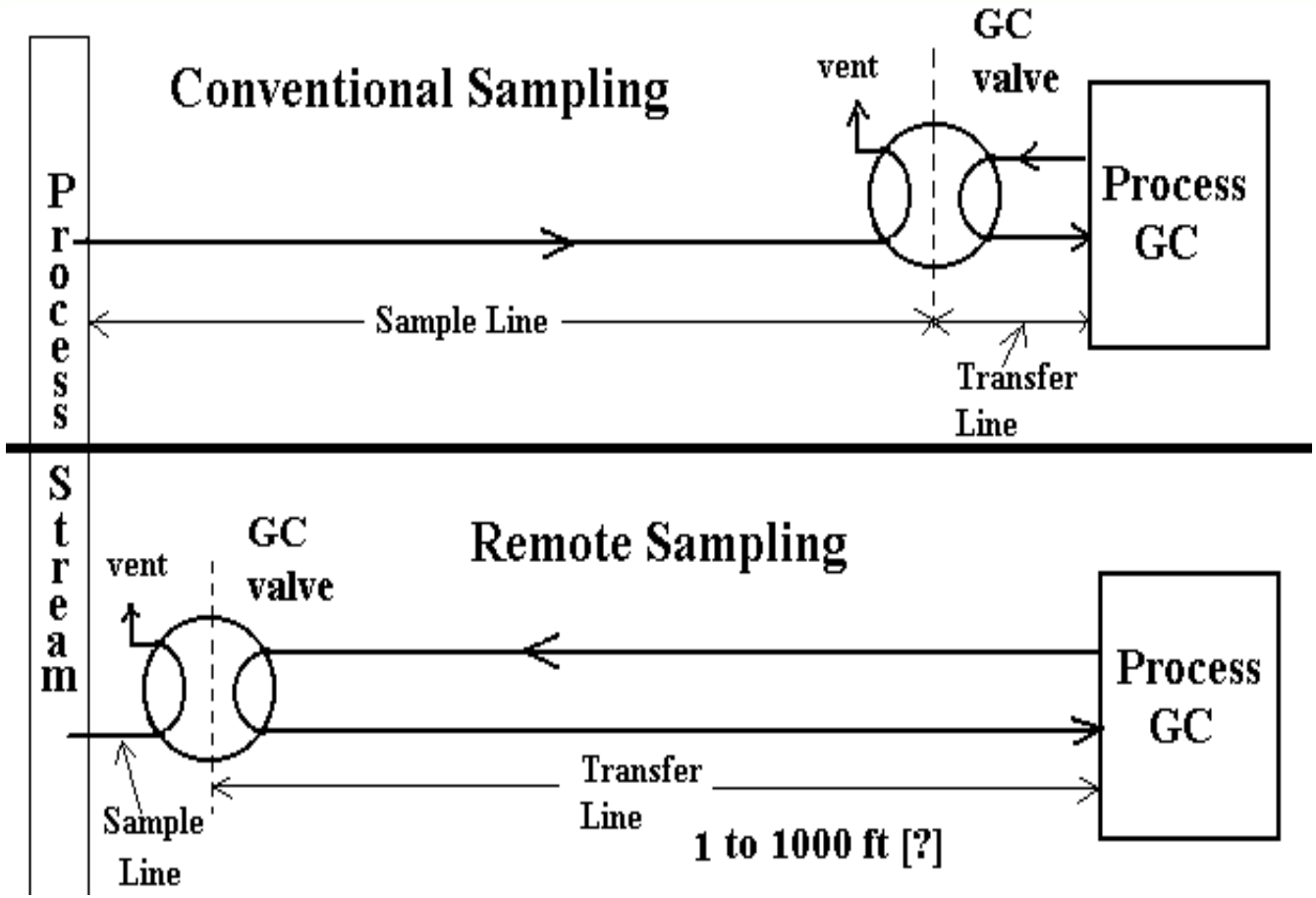
- Although misconceptions and misunderstandings exist in sample system design, it does not suggest that these designs are incorrect – but they are perhaps unnecessary
- Critical evaluation of the requirements is necessary to yield the proper design for a specific analytical technology with the specific process conditions – fit for purpose
- Developing an optimum solution and not just using a standard or traditional approach can create unique opportunities

"We will find a way with existing hardware and technology to improve reliability and reduce cost!" Jimmy Converse

Converse Solution



Converse Solution



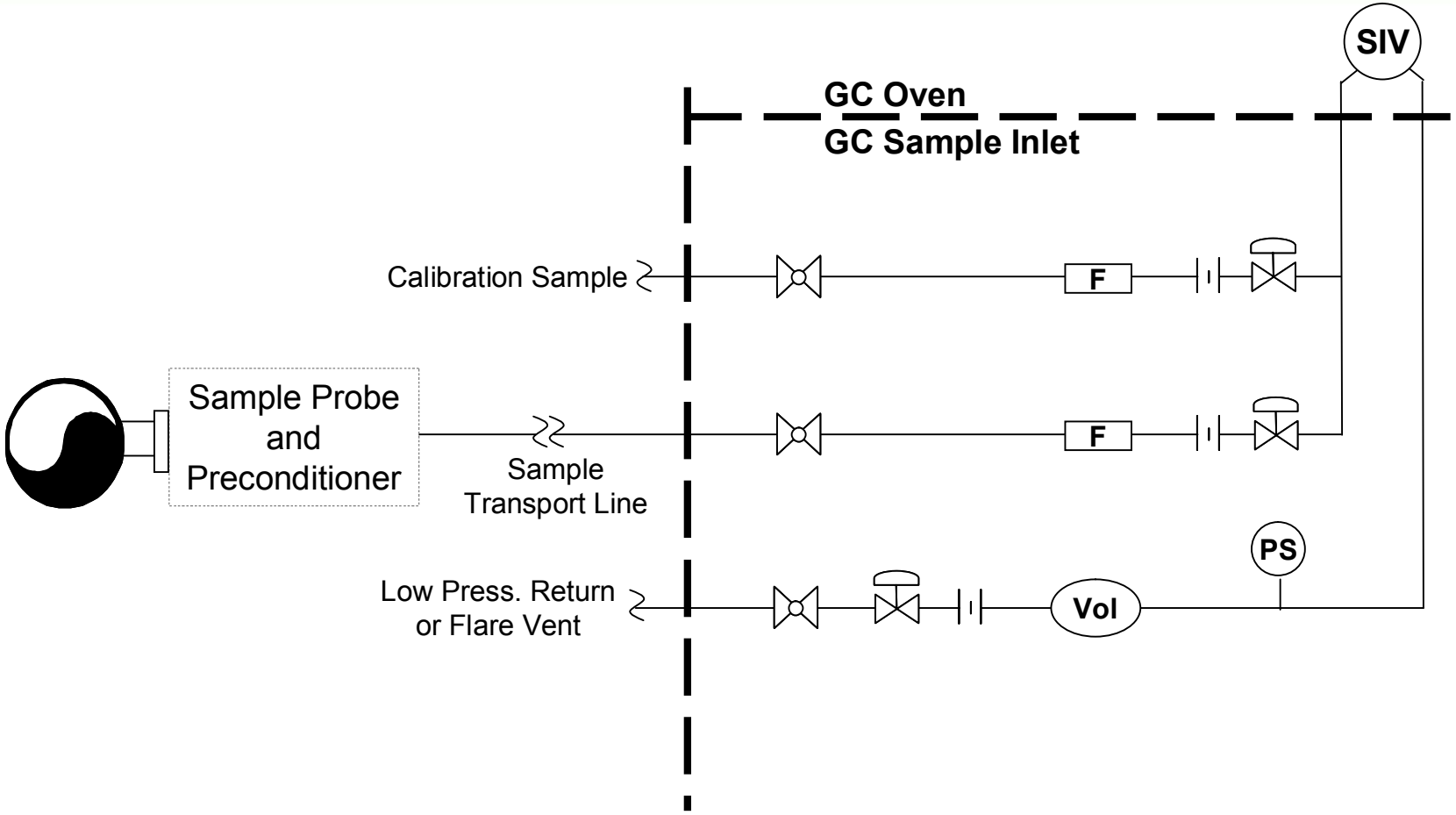
Remote Discrete Sampling (RDS)

Major Advantages of RDS

- Reduced sample conditioning and throughput (waste)
- Reduced residue, emissions, and energy
- Reduced sample duty cycle (not continuous flow)
- Can be adapted to analytical technology with continuous flow cells
- Reduced complexity and maintenance
- Reduced cost

Optimized design for the specific analytical technology with the specific process conditions – fit for purpose

Batch Sample Transfer



Sample Transfers by Differential Pressure

Focus on Process Interface

- Remote Discrete Sampling is only one example of a system that is designed specifically for an analytical technology with a specific process
- Other current examples typically involve photometric measurement technology because the sensing element can be located remotely (laser or fiber optic coupled)
- However, these types of systems are not widely used
- The industry continues to design the traditional process analyzer system for most all applications

Lack the motivation to change…

Focus on Process Interface

- The knowledge and experience to optimize system designs is primarily held by only a few “experts”
- Change is not readily accepted and difficult to implement
- Best practices are not available
- Historic performance data is not readily available

Analyzer Management System

- The Analyzer Management System is potentially the key to facilitating optimized system designs:
  - Document individual application performance
  - Document analyzer validation/calibration performance
  - Document analyzer maintenance requirements
  - Document sample system performance
  - Document sample system maintenance requirements

Analyzer Management System

- With historic data, highly reliable and accurate applications can potentially be simplified:
  - Simplify filtration
  - Eliminate or simplify automatic validation
  - Eliminate or simplify automatic calibration
  - Utilize batch sample transfer
- With historic data, problematic analytical technologies and sample systems can be improved:
  - Utilize alternate analytical technologies
  - Include aerosol and/or liquid removal
  - Include better or redundant filtration
  - Included automatic purging or flushing

Conclusions

- There will always be difficult applications where specials designs are required for the process analyzer system:
  - Cracking or reforming furnace outlet
  - Reaction processes
  - Polymerization processes
  - Scrubber or contactor overheads
  - Distillation column bottoms
  - High temperature processes with condensable components
  - Waste water streams
- These applications should be addressed with a best practice solution that is designed for the specific application and documented from experience

Conclusions

- There are many other applications where simplification of the application is possible:
  - Distillation column overheads
  - Product streams
  - Natural gas
- By optimizing the specific design of the system for the specific application, the reliability can be increased and the cost reduced.

Not Sample Systems – Process Interfaces

Thank You!

Questions?