

## **Paper 5.3**

# **Flow Computers and Control Systems - Interface or Integrate?**

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### **1 INTRODUCTION**

Following the initial development of the flow computer in the 1970's, flow computers have been used to measure North Sea hydrocarbon product flow in accordance with International and Government standards; i.e. acting as the critical cash register of organisations operating in this sector. Despite dramatic changes in both technology and within the industry itself, and alternative approaches being mooted for many years, flow computers are still being used to perform this duty.

This paper considers the potential for the use of Control Systems to appropriately measure hydrocarbon product flow and hence whether they can be considered as a viable alternative to traditional metering computer systems; i.e. flow computer metering systems.

### **2 DEVELOPMENT OF THE METERING COMPUTER SYSTEM MARKET**

The first UK onshore petroleum discovery was made in Nottinghamshire in 1918, the first UK offshore gas field discovery was West Sole in 1965 and the first UK offshore oil field discovery was Arbroath in 1967. These discoveries were made prior to the creation of silicon chips and prior to the creation of flow computers. Product was measured using mechanical counters and other such devices and levels of accuracy were lower than those expected today.

Technology developed quickly and by the early 1970's advancements in silicon technology resulted in the development of electronic counters that enabled more accurate measurement and calculation of product quantities. This was followed shortly by the availability of the Central Processing Unit (CPU) which offered far greater capability, flexibility and calculation power. Consequently the oil and gas metering flow computer was developed with a primary role of accurately and reliably recording quantities of oil and gas passing metering points.

Since 1970's there has been significant technological change, and change within the North Sea oil and gas sector. A number of these changes are summarised below:

- The availability of more powerful Central Processing Units – 1000's of times more powerful
- The availability of high density Random Access Memory (RAM) – 1000's of times more compact
- The availability of Erasable Programmable Read Only Memory (EPROM) and Electrically Erasable Programmable Read Only Memory) EEPROM
- The availability of surface mount technology
- The availability of Personal Computers (PCs)
- The availability of the internet
- The reduction in cost of CPU power and computer memory
- The development of new metering techniques
- The development of the North Sea, now totalling in excess of 240 oil and gas platforms
- The creation of numerous oil and gas operating companies and associated companies providing complimentary products and services
- Significant organisational restructuring within the majority of the oil and gas North Sea operators

- The North Sea is now at the mature stage of its product life cycle. Many of the oil and gas fields are depleted, rendering them somewhat marginal and hence the introduction into the sector of new operators specialising in operating such fields. Platform tie-backs are common, very few new platforms have been built in recent years and some of the majors are now selling off their assets in order to invest in overseas opportunities

Despite the extensive changes detailed above, there has been relatively little change in the approach being taken to convert metering system field signals into measured quantity of product. This is especially surprising as for many years there has been a desire expressed by many Oil and Gas majors to utilise an alternative approach. This desire was strengthened substantially when it became apparent that the majority of the flow computer metering systems supplied over five years ago are now no longer supported by the original supplier; i.e. they have become obsolete.

This lack of change, in what is clearly a fast changing environment, begs the question - why has there been no change? There are a number of factors that have contributed, as detailed below:

- The oil and gas industry as a whole has traditionally been very conservative.
- There are a limited number of personnel whose role requires them to get involved in the detailed workings of flow computers, and hence the number of people with an understanding of relevant requirements is somewhat limited. Many engineers involved in metering consider the metering computer system to be a "metering black box".
- It has been in the interests of flow computer suppliers to continue to supply flow computers. Hence they have not encouraged the development of alternatives and where possible have developed computers that are difficult to replicate and have tried, with some success, to influence the industry in adopting these techniques.
- There has been industry concern with the use of Personal Computers to perform this duty; from a perspective of accuracy, reliability, susceptibility to computer viruses and ability to automatically return to full operation following a power failure.
- It requires significant investment to develop a metering computer system.
- Existing Measurement Manuals, Allocation / Pipeline Agreements and Measurement Guidelines usually make reference to approaches that shall be adopted when implementing metering computer systems and hence have constrained associated change.

### **3 INITIAL ASSESSMENT OF THE POTENTIAL APPLICATION OF CONTROL SYSTEMS TO IMPLEMENT METERING CONTROL SYSTEM FUNCTIONALITY**

Early in 2002 Swinton Technology was involved in separate discussions with two of the major North Sea Oil and Gas Operators regarding alternative approaches to traditional metering computer systems; i.e. an alternative to flow computers and supervisory computer systems. During these discussions, both expressed a desire for Swinton Technology to evaluate whether this functionality could be implemented within Control Systems.

Initial benefits considered from such an approach were:

- The use of single technology for systems where both metering and Control Systems are required, rather than a bespoke metering computer system (flow computers and supervisory computer) in addition to the Control System.
- Reduced cost for large systems as the cost of many flow computers would be likely to be higher than a Control System, far more so on applications where a Control System is also required as the additional metering hardware costs may simply be the additional Input / Output (I/O) cards.

Swinton Technology had initial discussions with Honeywell regarding the potential of implementing metering applications in their Control Systems, as Honeywell are a major Control System supplier in the North Sea, their latest Control System is scalable and their latest technology appeared appropriate, including the fact that it's controller function blocks utilise 64 bit Institute of Electrical and Electronics Engineers (IEEE) double precision numbers. Honeywell had also been contacted by a number of customers regarding the potential use of their systems for metering applications and hence there was a strong desire by both companies to ascertain the associated feasibility. Honeywell Senior Management were very keen for the evaluation to take place and their support was considered to be essential, as without it it would be unlikely that any required system changes would be implemented and hence the evaluation would not be completed.

It was therefore agreed that Swinton Technology and Honeywell would work together in order to establish whether the latest Honeywell Control System was suitable for both custody transfer and allocation metering applications.

#### **4 SUITABILITY OF CONTROL SYSTEMS TO IMPLEMENT METERING CONTROL SYSTEM FUNCTIONALITY**

In order to assess the overall suitability of the Honeywell Experion PKS (EPKS) system, as a representative Control System, for metering applications it would be necessary to review the available functionality, verify that the system is secure and reliable, would return results that were accurate enough and ultimately when used in typical applications would result in a system with overall uncertainty limits within prescribed limits.

A representative gas orifice metering system was selected for the purpose of evaluating the suitability of EPKS as this was considered to be the worst case application utilising the following calculations:

- International Standards Organisation (ISO)5167 – 1:2003 (E) – to calculate mass flow rate
- American Gas Association (AGA)8:1994 (detailed method) – to calculate line density, standard density and compressibility
- ISO 6976:1995 – to calculate calorific value, standard density and Wobbe Index

There were two primary factors that led to the conclusion that this was the worst case application:

- It utilised both the AGA8 and ISO 5167 calculations which are two of the more complex metering calculations.
- It required integration with respect to time, to develop mass totals from mass flow rate, and hence took into account the accuracy of the system clock.

##### **4.1 System Set Up**

In order to evaluate the suitability of the EPKS system a typical gas orifice metering system with the following instrumentation was simulated:

- One pressure transmitter located upstream of the orifice plate
- One differential pressure transmitter
- One temperature transmitter located downstream of the orifice plate
- One densitometer located downstream of the orifice plate
- One chromatograph located on the header

## EPKS System

- EPKS Server
- EPKS C200 Controller comprising the following cards:
  - CPU
  - Power Supply
  - Analogue input card – used to measure pressure, differential pressure
  - PRT input card to measure temperature
  - Pulse input card – used to measure density
  - Serial interface card – used to interface to chromatograph controller simulator

A standard C200 Controller was used to perform the majority of the testing. A second standard C200 Controller, populated with a different set of I/O cards, was used during the latter stages of the trial to increase our confidence that the results obtained were representative.

## Simulation

- Pressurised pipe work with pressure transmitter and differential pressure transmitter to provide analogue input signals
- Calibrated Digital Volt Meter (DVM) to accurately determine the magnitude of the analogue input signals
- Calibrated resistance box to provide simulated PRT signals
- Pulse signal generator to provide a pulsed signal representing density
- Calibrated high precision frequency timer counter ( $10^{-9}$  s) to accurately determine the period of the density pulse train and the accuracy of the system clock
- Chromatograph controller simulation software package

## Peripherals

Laser Printer

### 4.2 Functionality

The EPKS system is a very flexible and feature rich system. Like many of the primary Control Systems available today, in order to survive in what is a fiercely competitive market the system has to keep pace with modern technology and provide all of the features that would be expected of a modern Control System. This differs from the traditional metering computer system flow computers and supervisory computers which are bespoke machines built for a specific purpose and hence are produced in relatively small numbers. Metering computers have far less time expended on implementing latest technologies and features, and are less user configurable than Control Systems. Consequently it was verified that the majority of the functionality required to implement a metering system was available through configuration within the existing system. The following functionality was verified as being available:

- Temperature measurement
- Pressure measurement
- Differential pressure measurement
- Density measurement
- AGA function blocks to run in the controller including both AGA3 and AGA8
- Totalisation - see note
- Maintenance mode
- Chromatograph controller interface and composition normalisation
- Display mimics – some automatically generated
- Alarms and events
- Reports
- Historical archiving
- Trending

- Flow weighted averages
- Networking capability
- Communication interfaces such as Modbus, Object linking and embedding for Process Control (OPC) and Open DataBase Connectivity (ODBC)

Note: Both stream and station totalisation is performed in the controller which has a number of benefits over traditional metering computer systems; i.e. the controller is not prone to software virus's and totals are stored in battery backed memory.

The following required functionality was not available in EPKS as standard functionality and hence was implemented within special function blocks in the controller by Honeywell:

- ISO 5167 calculation
- ISO 6976 calculation
- Capability for the controller to automatically restart following a power failure

Once these were implemented, and the system configured, it was concluded that the EPKS system had all of the required system functionality.

### **4.3 Security**

Security of metering data is considered paramount within a metering computer system. Consequently most systems have a concept of password protection, with differing passwords providing differing levels of system access; e.g. operator level, technician level and supervisor level.

The EPKS system has a comprehensive set of approaches to security that can be adopted:

- Operator stations can be set to only access the primary operator window; i.e. no access to the Windows desktop or taskbar.
- To make changes to the Controller configuration it is necessary to use Control Builder, a system tool used to generate the Controller configuration. Hence if Control Builder is not present during normal operation it is not possible to modify the Controller configuration.
- Function blocks can be write-protected from manual inputs and changes.
- Operator actions can be assigned password security.
- Qualification Version Control System (QVCS) is an EPKS security package developed for use in the pharmaceutical industry, in accordance with 21 Code of Federal Regulations (CFR) Part 11 – Electronic Records, Electronic Signatures: Scope and Application, where the associated security requirements are far more stringent than those applicable to traditional metering computer system.

It was concluded that the EPKS security system was far more comprehensive than the security system available with traditional metering computer systems.

#### 4.4 Reliability

Many modern day Control Systems have been designed for use on critical applications where reliability / availability is paramount. The EPKS system is such a system with:

- Availability figures for the trial system of 99.9966%
- Mean Time Before Failure (MTBF) figures for the trial system (hours): 29480

Furthermore there are numerous redundancy options available with the EPKS system:

- Redundant I/O
- Redundant Controller
- Redundant Server

Even without taking the available redundancy options into account it was concluded that the EPKS system has more than adequate availability and mean time before failure figures for it to be considered to be reliable enough for use as a metering computer system. However, we would anticipate that most customers would require that redundant controllers to be used in order to negate the potential impact that would be realised if the Controller failed on a single Controller system.

#### 4.5 Accuracy / Uncertainty

There are three key aspects of accuracy that need to be considered:

- I/O accuracy
- Calculation accuracy
- Clock accuracy

##### I/O Accuracy

The following signal accuracies were measured:

Pressure and Differential Pressure (4-20 milli-amps (mA))

Input accuracy was determined by sinking current via a precision current source and measuring the voltage across a 100 ohm precision resistor using a calibrated DVM. For each parameter measurements were taken at 4, 8, 12, 16 and 20 milli-amps. The maximum error was less than 0.02%.

Temperature (3 wire Platinum Resistance Thermometer(PRT))

Input accuracy was determined using a calibrated decade box and ISO 60751:1995 tables. Measurements were taken corresponding to 0, 25, 50, 75 and 100 degrees Centigrade. In all cases the error was less than 0.1 degrees Centigrade.

The EPKS system only supports three wire PRT inputs and hence for applications where four wire PRT transmitters are used either HART or Foundation Fieldbus transmitters should be used or four wire PRT / 4-20mA signal converters fitted within the control panel or in the head of the PRT element. It should be noted that through the selection of appropriate signal converters, or through the use of digital transmitters, the associated error may be reduced.

Density (periodic time)

Input accuracy was determined using a stable pulse generator and a calibrated rubidium frequency counter timer.

Measurements were taken corresponding to density values of 25, 50 and 75 kg/m<sup>3</sup>.

The maximum error was 0.0027%. To put this in context, typically the densitometer measurement itself has an error of 0.15% [2]. Therefore the total density subsystem error is 0.157%, of which the C200 error contributes 0.007%

To verify that the measurements were representative the same exercise was repeated using a second controller and I/O cards. The conclusion was that the measurements detailed above were representative, although it was of a small sample of I/O cards.

It should be noted that the actual signal accuracies measured were significantly superior to the actual card specifications.

### Calculation Accuracy

Many metering requirement specifications stipulate a calculation accuracy within 0.001%.

Providing that calculations have been correctly implemented, a 64 bit computer system should exceed this requirement by many orders of magnitude.

To verify that calculations had been correctly implemented they were verified against a third party calculation package. The primary calculations (ISO 5167, AGA8, ISO 6976, gas component normalisation, mass totals, standard volume and energy flow rates and totals, upstream / downstream pressure compensation) within the system were checked and the resultant values were all well within 0.001%.

### Clock Accuracy

A calibrated rubidium frequency counter timer was used to measure the overall accuracy of the controller clock, as this is where the integration with respect to time is performed.

To establish the system clock accuracy a flow rate was set to one unit per second and was left to run for a period of time. The accumulated total during this period therefore reflected the number of seconds that the system had registered during this period and this value was compared with the value shown on the counter timer.

The test was performed on two controllers and the worst-case error was -0.00289%.

### Overall System Accuracy

A further test was performed in order to determine the overall accuracy of the entire metering computer system.

This test involved simulating system input signals, noting the measured values within the EPKS system, keypad entering these values into the system and allowing the system to run for a period of time.

The resultant flowrates and totals were then compared with those returned from a third party verification package by keypad entering the relevant time period and the actual simulated signal values. The resultant errors, taking into account I/O, clock and calculation errors were:

Description	Error %
Mass Flow Rate	-0.023
Mass Total	-0.025
Standard Volume Flow Rate	-0.023
Standard Volume Total	-0.025
Energy Flow Rate	-0.023
Energy Total	-0.025

Table 1: Overall Metering Computer System Accuracy

### Uncertainty

It is imperative that the uncertainty of the entire metering system is within the specified limits – as detailed below:



North Sea Flow Measurement Workshop  
26–29 October 2004

Approach	Typical Uncertainty in Mass Flow Rate Measurement (%)	
	Liquid	Gas
<b>Custody Transfer</b>	0.25	1.00
<b>Allocation</b>	0.50 – 5.00	2.00 – 5.00

Table 2: Measurement Approaches and Typical Uncertainties [1]

In order to verify that the EPKS system did not have a significant detrimental effect on the overall system uncertainty, the system uncertainty for a typical North Sea gas orifice metering application using EPKS and typical instrumentation was calculated at both maximum and minimum differential pressures and with both measured and calculated (AGA8) density.

Pertinent data of the typical system is detailed below:

Description	Value / Transmitter
Operating Pressure	85 barg / Yokogawa model EJA 430A
Maximum Differential Pressure	500 mbar
Minimum Differential pressure	30 mbar
High Range Differential Pressure Transmitter Calibrated Span	500 mbar / Yokogawa EJA130A
High Range Differential Pressure Transmitter Calibrated Span	125 mbar / Yokogawa EJA130A
Operating Temperature	$^{\circ}\text{C}$ / 4 wire class A PRT element
Operating Density	$\text{kg} / \text{m}^3$
Pipe Calibration Diameter	132.40000 mm
Pipe Calibration Temperature	18.00000 $^{\circ}\text{C}$
Pipe Expansion Coefficient	0.000011 mm / $^{\circ}\text{C}$
Orifice Calibration Diameter	78.80000 mm
Pipe Calibration Temperature	20.00000 $^{\circ}\text{C}$
Pipe Expansion Coefficient	0.000016 mm / $^{\circ}\text{C}$
Viscosity	0.01199 cP
Isentropic Exponent	1.32719

Table 3: Typical North Sea Gas Orifice System Data

The resultant uncertainties are detailed below:

	Measured Density	Calculated Density (AGA8)
<b>Maximum Differential Pressure</b>	0.53676	0.54934
<b>Minimum Differential Pressure</b>	0.89344	0.90105

Table 4: Calculated Mass Flow Rate Uncertainties Of Typical North Sea Gas Orifice Metering Application

At maximum differential pressure (measured density) 0.50000 of the 0.54934 uncertainty can be directly attributed to the orifice plate discharge coefficient uncertainty. The uncertainty associated with the pressure transmitter, differential pressure transmitter, temperature element, densitometer and metering computer system is 0.04% in total. This demonstrates that for this application the uncertainty associated with the metering computer system is minimal.

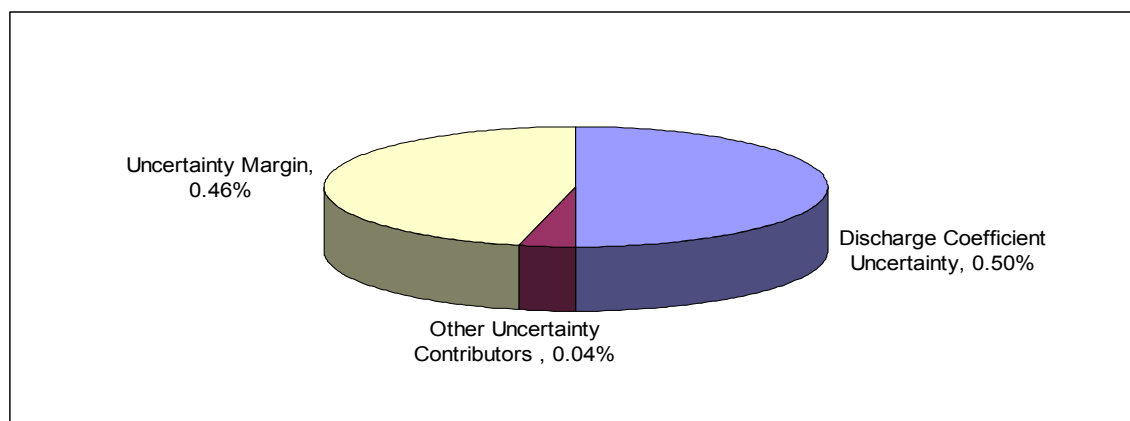


Chart 1 - Sources Of System Uncertainty – Typical Gas Orifice Application – Maximum Differential Pressure and Measured Density

At minimum differential pressure (measured density) 0.50000 of the 0.89344 uncertainty can be directly attributed to the orifice plate discharge coefficient uncertainty. The uncertainty associated with the pressure transmitter, differential pressure transmitter, temperature element, densitometer and metering computer system increases to 0.39%, primarily as a consequence of operating at the low end of the calibrated range of the differential pressure transmitter.

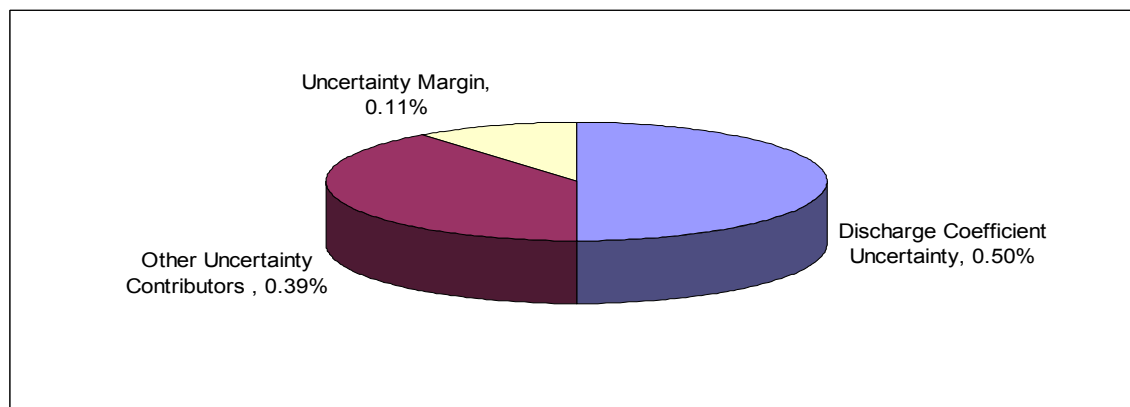


Chart 2 - Sources Of System Uncertainty – Typical Gas Orifice Application – Minimum Differential Pressure and Measured Density

It was concluded that the metering computer system had minimal effect on overall system uncertainty and the associated accuracy was such that it was suitable for both custody transfer and allocation metering applications.

The other contributory values can be reduced further through the use of digital transmitters as this negates the requirement, and hence the associated uncertainty, to convert the digital signals to analogue signals within the transmitters and then to measure the analogue signal at the metering computer system in order to convert it back into a digital value.

## **5 ASSESSMENT OF THE BENEFITS AND DRAWBACKS OF USING CONTROL SYSTEMS TO IMPLEMENT METERING SYSTEMS**

During the evaluation process it became apparent that there were more advantages of using Control Systems to perform metering functionality than had originally been anticipated, as summarised below:

- Prior to the evaluation it had been identified that under circumstances where both a Control System and a metering computer system are required there were benefits from combining the two systems together. What was not fully appreciated at this time was the implication that this had:
  - Single system technology rather than Control System and bespoke metering computer system:
    - Simplifies the architecture - a single database rather than one database for the Control System, one database for the supervisory computer and one database per flow computer.
    - Reduces training time and costs.
    - Reduces spares holding requirements and overall maintenance costs.
  - Single vendor required to implement the Control System and metering computer system, hence reducing project ambiguity, project risk and end user procurement and management effort / costs.
  - With a traditional system comprising a metering computer system and a Control System, prior to installation and commissioning, significant time is usually expended designing, implementing and testing communication links between flow computers and supervisory computers and between supervisory computer and the Control System. Furthermore during the installation and commissioning process incompatibilities and discrepancies are identified and corrected. Where a single Control System is used all of this time, effort, cost and risk is removed, as all of the data is present within the single system.
- Traditionally the hardware cost overhead associated with supplying even a small Control System was substantial in comparison to the hardware price associated with supplying a small metering computer system. However, where modern scalable Control Systems are used this is no longer the case. Typical hardware costs for small Control System metering systems are comparable with small traditional metering computer systems, however the hardware costs associated with large metering systems are typically far lower for Control Systems than for traditional metering computer systems. Where suitable Control Systems already exist the computer hardware costs associated with adding metering functionality is primarily the addition of required I/O cards, which in some cases, and dependent on spare capacity in the existing system, may be negligible.

- Metering computer systems are typically bespoke systems where relative volumes, when compared with Control Systems, are very low. It does not make economic sense for traditional metering computer system suppliers to keep abreast with the tremendous rate of change in technologies that we are currently encountering. However, for the Control System suppliers it is essential that they keep their systems up to date, otherwise they will lose competitive advantage. Consequently when a metering system is implemented using a Control System there is likely to be a whole suite of functionality available that is not available within traditional metering computer systems; such as the availability of user configuration tools, communication interfaces, trending, scheduling, historian, advanced control capability etc. Some of these areas of functionality may provide significant benefits; e.g. (i) interface to digital transmitters which improve accuracy, reduce uncertainty and enable user to operate improved preventative maintenance regimes and asset management (ii) interfaces to other data systems utilising leading edge communication protocols as and when they are introduced to these markets.
- Many Control Systems have been developed so that when the Controller I/O is configured the associated server screens are automatically created. This coupled with the ease of use and configuration tools reduces the time required to implement systems.
- Security is usually detailed as a prime consideration when selecting a metering computer system. Many of the systems in use in the North Sea today are not secure with personnel having access to areas from which they should be restricted. As there are a number of differing security options available with Control Systems the Operator is able to adopt an approach that is less likely to be compromised; e.g. by not loading the configuration builder tools onto the workstations it is not possible to change the configuration of the controllers.
- With Control Systems all totalisation can be performed within the controller, which is battery backed and is specifically designed such that it will restart following a power failure. Traditional metering computer systems utilise PC's to perform some of this functionality and they are not specifically designed to automatically restart following a power failure and furthermore there is a far higher chance that they will not recover from a dip in power; this is likely to occur if the PC is accessing the hard disk when the power fails.
- There is significant concern throughout the oil and gas industry regarding susceptibility of computers to software viruses. Where Control Systems utilise a Controller to implement functionality such as metering calculations, totalisation and sequencing there is minimal risk when compared with traditional metering computer systems that utilise PCs running Microsoft Operating Systems to perform these functions.
- As a consequence of Control System I/O being modular and utilising high density terminations, in most applications the required panel footprint will be less than that required with a traditional metering computer system. Footprint savings can be significant for applications where a single system is used to provide metering and Control System functionality. Footprint can be further reduced through the use of digital transmitter communication networks.
- Improved control can be achieved as a consequence of the fact that the metering system is being controlled by a single unit, rather than a series of discrete units which need to communicate with each other in order to issue commands and provide associated feedback. In addition Control Systems have advanced control programmes, schemes and modules available, including in the case of EPKS model based control algorithms that are not available in traditional metering computer systems. Furthermore improved quota management techniques can be adopted to more accurately achieve periodic quota requirements.

- Control Systems offer many differing redundancy options as their suppliers have such a wide variety of customers who have many differing requirements. This therefore provides a number of additional redundancy options / combinations for consideration; i.e. redundancy at I/O rack level, redundancy at controller level, redundancy at server level and complete redundant systems. Also as the data for all streams is available in a single Control System, it is simple to make comparisons between them and hence improve associated fault tolerant approaches and robustness.
- Due to the extensive investments that organisations have made in Control System over the years, Control System suppliers need to be able to provide their customers with an appropriate upgrade path and hence they invest significant Research and Development costs in order to be able to offer this. Consequently Control Systems are less prone to the obsolescence issues that have been encountered in the UK metering computer system market in recent years.
- As many Control Systems are supplied on a global basis a support infrastructure is already in place for such systems in many territories, rather than having to rely on remote support from suppliers in other territories as is currently the case with many bespoke metering computer systems. Another associated advantage when both Control Systems and metering systems are required, is the need for only a single support contract, rather than discrete contracts for each system.

There are a number of advantages of using traditional metering computer systems rather than Control Systems, as summarised below:

- Traditional metering computer systems utilise a discrete flow computer per meter stream which provides redundancy at the stream level. This can be a significant advantage when compared with a non-redundant Control System; however the associated advantage is negated when redundant Control System architecture is adopted. Furthermore where the number of streams is low discrete Control System controllers could be used in much the same way as discrete flow computers per stream.
- Many flow computers utilised in traditional metering systems provide a local user interface, thus enabling associated functionality to still be available in the event of failure of the supervisory computer. This can be a significant advantage if the supervisory computer system does not have high availability and this is analogous to a Control System server which does not have high availability. Where the Control System has high availability it is unlikely that the system will not be available and hence the advantage of a local display is minimal and is almost entirely negated when a redundant architecture is used.
- As traditional metering computer systems have been in use for many years, there are numerous applications that are currently available. Most Control System suppliers have not yet implemented metering applications and hence for these suppliers some of applications will not be available for some time to come.
- Some existing pipeline agreements either state a requirement for individual flow computers per stream to be utilised in order to meter hydrocarbon product flow, or make reference to other agreements or standards that do. Where such agreements need to be strictly adhered to the traditional metering system is likely to be more readily accepted; however in many situations a suitably reliable and accurate system will be accepted.

## 6 CONCLUSION

Control Systems can be considered suitable for both custody transfer and allocation metering applications, providing that:

1. The Control System has suitable core functionality.
2. The Control System has sufficient accuracy specifications – hardware and software.
3. The Control System is reliable and secure.
4. The Control System supplier has the desire to revise specific functionality, or makes the tools available for the implementer to modify the systems accordingly.
5. The implementer has sufficient metering computer system knowledge and experience to suitably implement the systems.
6. The implementer is able to invest adequate resources to implement the systems.
7. The entire system (metering computer system, field instrumentation etc.) results in an overall uncertainty within specified limits.

Having established that Control Systems are capable of performing the duty of metering computers systems, the pressing question is :

### **When is it appropriate to use a traditional metering computer system and when is it appropriate to use a Control System?**

There are many factors that need to be taken into account when determining which is the most appropriate route to adopt for a specific application. All too often the primary consideration taken into account when making such decisions is the Capital Cost, although on a long term basis it would be far more prudent to look at Life-Cycle costs.

Where capital cost is the prime consideration many factors need to be taken into account:

- Hardware costs
- Software costs – license and implementation costs
- Additional Control System functionality – added value benefits realised through the use of additional functionality associated with Control Systems when compared with traditional metering computer systems
- Training single technology savings – applicable only to Control Systems when both a Control System and metering system are required.
- Spares single technology savings – applicable only to Control Systems when both a Control System and metering system are required.
- Single vendor contract savings – applicable only to Control Systems when both a Control System and metering system are required..

The following additional costs need to be taken into account when full life cycle costs are considered:

- Installation and commissioning costs
- Quality of support and associated support costs
- Cost of future modifications – hardware and software
- Requirements for implementation of future changes in order to take advantage of future technological advancements
- Upgrade path / obsolescence support

Detailed below are a number of tables which can be used as a rough guide to the most appropriate approach to be taken under differing circumstances. These tables have been raised based upon EPKS system prices for the Control System (using redundant controllers), typical metering computer system prices, assumes that the relevant metering application is available on both the traditional metering computer system and Control System and that a competent system implementer with knowledge of both metering and the relevant technologies is used.

System Size	How Important Are Control System Benefits?		
	Low	Medium	High
<b>2 Stream</b>	Traditional Computer System	Traditional Computer System	Control System
<b>5 Stream</b>	Either	Control System	Control System
<b>&gt; 10 Stream</b>	Control System	Control System	Control System

Table 5: Guide Approach Where Capital Cost Is The Prime Consideration And Only A Metering Computer System Is Required

System Size	How Important Are Control System Benefits?		
	Low	Medium	High
<b>2 Stream</b>	Control System	Control System	Control System
<b>5 Stream</b>	Control System	Control System	Control System
<b>&gt; 10 Stream</b>	Control System	Control System	Control System

Table 6: Guide Approach Where Capital Cost Is The Prime Consideration And Both A Metering Computer System And Control System Are Required

System Size	How Important Are Control System Benefits?		
	Low	Medium	High
<b>2 Stream</b>	Traditional Computer System	Control System	Control System
<b>5 Stream</b>	Control System	Control System	Control System
<b>&gt; 10 Stream</b>	Control System	Control System	Control System

Table 7: Guide Approach Where Life-Cycle Cost Is The Prime Consideration And Only A Metering Computer System Is Required

System Size	How Important Are Control System Benefits?		
	Low	Medium	High
<b>2 Stream</b>	Control System	Control System	Control System
<b>5 Stream</b>	Control System	Control System	Control System
<b>&gt; 10 Stream</b>	Control System	Control System	Control System

Table 8: Guide Approach Where Life-Cycle Cost Is The Prime Consideration And Both A Metering Computer System And Control System Are Required

## 7 REFERENCES

- 1 – Department of Trade and Industry, Licensing and Consent Unit – Guidance Notes For Petroleum Measurement Issue 7
- 2 – Solatron Density Transducer Data Sheet B1025