# Determining Lost and Unaccounted For Gas Loss

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## Introduction

Every company involved in the natural gas industry must deal with the issue of determining lost and unaccounted for gas loss. Production, gathering, midstream, pipeline and distribution companies are all impacted with managing the unaccounted for (UAF) gas loss. For years, the cost and impact of the UAF was passed directly to the customer with no direct requirements to manage and reduce the costs associated with this loss. Now, numerous individual companies strive to manage the impact of UAF for their customers.

Federal Energy Regulatory Commission Order 636 was released in 1993 that required pipeline companies to manage the UAF. Around this same time, the price of natural gas increased from $2.00 to $4.00 per MCF doubling the cost of the UAF loss. The price of natural gas has continued to reflect significant volatility. This has emphasized the need for natural gas energy companies to increase their focus on UAF, regardless of where they fall on the energy value chain: production, gathering, processing plant, pipeline, and/or local distribution segment.

## Definition

Exactly how is UAF gas loss calculated?

The UAF gas loss is simply the difference of the physical inputs and the physical outputs of the pipeline system.

- A “LOSS” occurs whenever the physical inputs are greater than outputs of the pipeline system.
- A “GAIN” occurs whenever the physical outputs are greater than inputs of the pipeline system.

Please see *Illustration #1* for a simplistic picture exemplifying the definition of how the UAF gas loss is determined. The more meter types and classes that are involved in a company’s UAF gas loss, the more complicated the actual determination of the UAF gas loss becomes. This paper provides several ideas to effectively begin the determination of an actual system UAF gas loss.

There is not a recognized industry standard that dictates whether to use Inlet minus Outlet or Outlet minus Inlet to determine the UAF gas loss. Be conscious of the fact that a company may perform the calculation differently within multiple divisions of the organization.

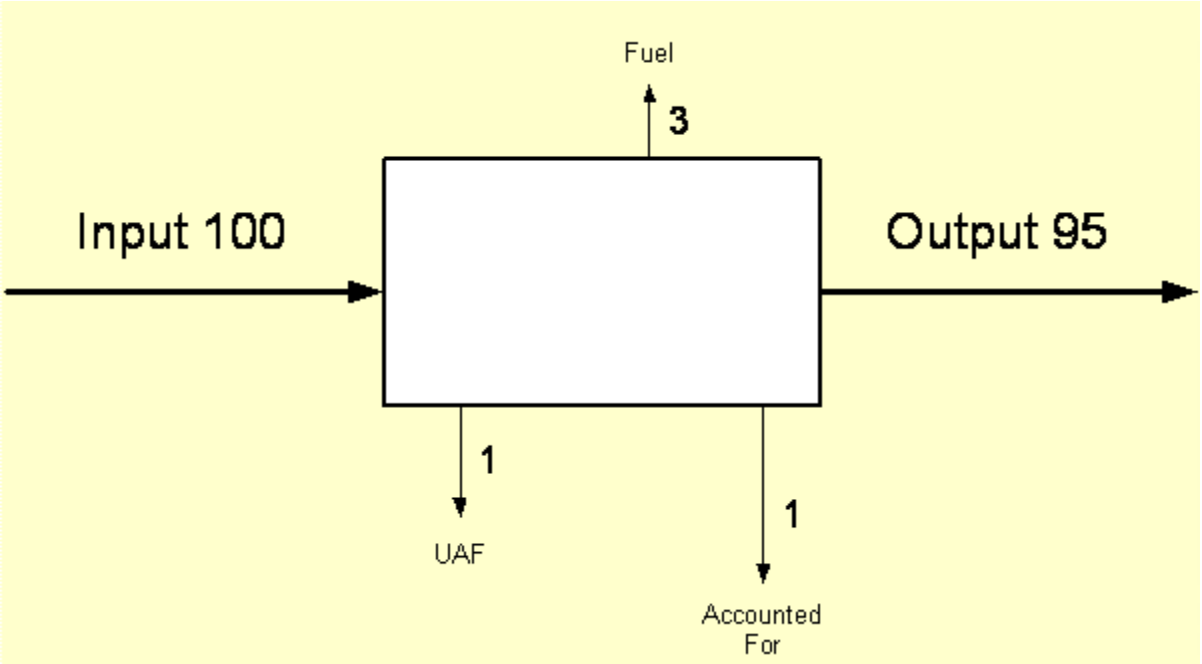



*Illustration #1*

## Dollar Impact

The UAF dollar impact can be significant depending on a company's daily and annual throughput. The dollar impact as seen below in *Illustrations #2 and #3* exemplify the spanning from a $3.00 gas cost to a $9.00 gas cost per Dekatherm. This reflects the potential impact a company can experience based on the annual throughput and the typical annual UAF gas loss. All three factors can have a substantial impact on a company's actual dollar loss. At the time this paper was written, the spot market noted at the Henry Hub was $9.69.

**$3.00 Per Dekatherm**

| Annual Dekatherm Throughput | Loss Using .25% UAF | Annual UAF Loss in Excess of Goal | | | | |
|---|---|---|---|---|---|---|
| | | .4 % | .6% | .8% | 1% | 2% |
| 100,000,000 | $750,000 | $450,000 | $1,050,000 | $1,650,000 | $2,250,000 | $5,250,000 |
| 250,000,000 | $1,875,000 | $1,125,000 | $2,625,000 | $4,125,000 | $5,625,000 | $13,125,000 |
| 500,000,000 | $3,750,000 | $2,250,000 | $5,250,000 | $8,250,000 | $11,250,000 | $26,250,000 |
| 1,000,000,000 | $7,500,000 | $4,500,000 | $10,500,000 | $16,500,000 | $22,500,000 | $52,500,000 |
| 2,500,000,000 | $18,750,000 | $11,250,000 | $26,250,000 | $41,250,000 | $56,250,000 | $131,250,000 |
| 5,000,000,000 | $37,500,000 | $22,500,000 | $52,500,000 | $82,500,000 | $112,500,000 | $262,500,000 |

*Illustration #2*

**$9.00 Per Dekatherm**

| Annual Dekatherm Throughput | Loss Using .25% UAF | Annual UAF Loss in Excess of Goal .4 % | .6% | .8% | 1% | 2% |
|---|---|---|---|---|---|---|
| 100,000,000 | $2,250,000 | $1,350,000 | $3,150,000 | $4,950,000 | $6,750,000 | $15,750,000 |
| 250,000,000 | $5,625,000 | $3,375,000 | $7,875,000 | $12,375,000 | $16,875,000 | $39,375,000 |
| 500,000,000 | $11,250,000 | $6,750,000 | $15,750,000 | $24,750,000 | $33,750,000 | $78,750,000 |
| 1,000,000,000 | $22,500,000 | $13,500,000 | $31,500,000 | $49,500,000 | $67,500,000 | $157,500,000 |
| 2,500,000,000 | $56,250,000 | $33,750,000 | $78,750,000 | $123,750,000 | $168,750,000 | $393,750,000 |
| 5,000,000,000 | $112,500,000 | $67,500,000 | $157,500,000 | $247,500,000 | $337,500,000 | $787,500,000 |

*Illustration #3*

## Causes of Lost and Unaccounted For Gas Loss

There are numerous potential causes that attribute to the UAF gas loss experienced by companies and typically it is a combination of sources. One of the key areas facing companies today relates to the training of all personnel involved in the measurement process. The ability of the measurement staff to understand the fundamental areas that impact measurement accuracy and uncertainty are integral to the overall measurement integrity found in an organization. The knowledgebase to recognize keypunch errors and the timing of meter characteristic events could easily equate to a loss of impact ranging from +/- 2% on the meter.

Meter inaccuracies are another significant contributor to the UAF impact noticed today. When was the last meter tube inspection and cleaning performed on key meter facilities? What differentials are allowed on 8” or 10” meter runs operating with a 0.125” thick orifice plate? What pressure and temperature is the system operating at for meters utilizing a manual pressure and temperature value? This is just a small list of potential issues that can impact a company’s UAF gas loss.

Additional questions that should be addressed in the organization relate to how a company handles line pack, unmeasured fuel, unmeasured company use gas, retrograde condensate, timing of reported gas loss events, and missing gas loss events. All of these areas either have the ability to cause a swing in UAF gas loss on a monthly basis nullifying the annual impact, or attribute to the overall monthly and annual UAF gas loss.

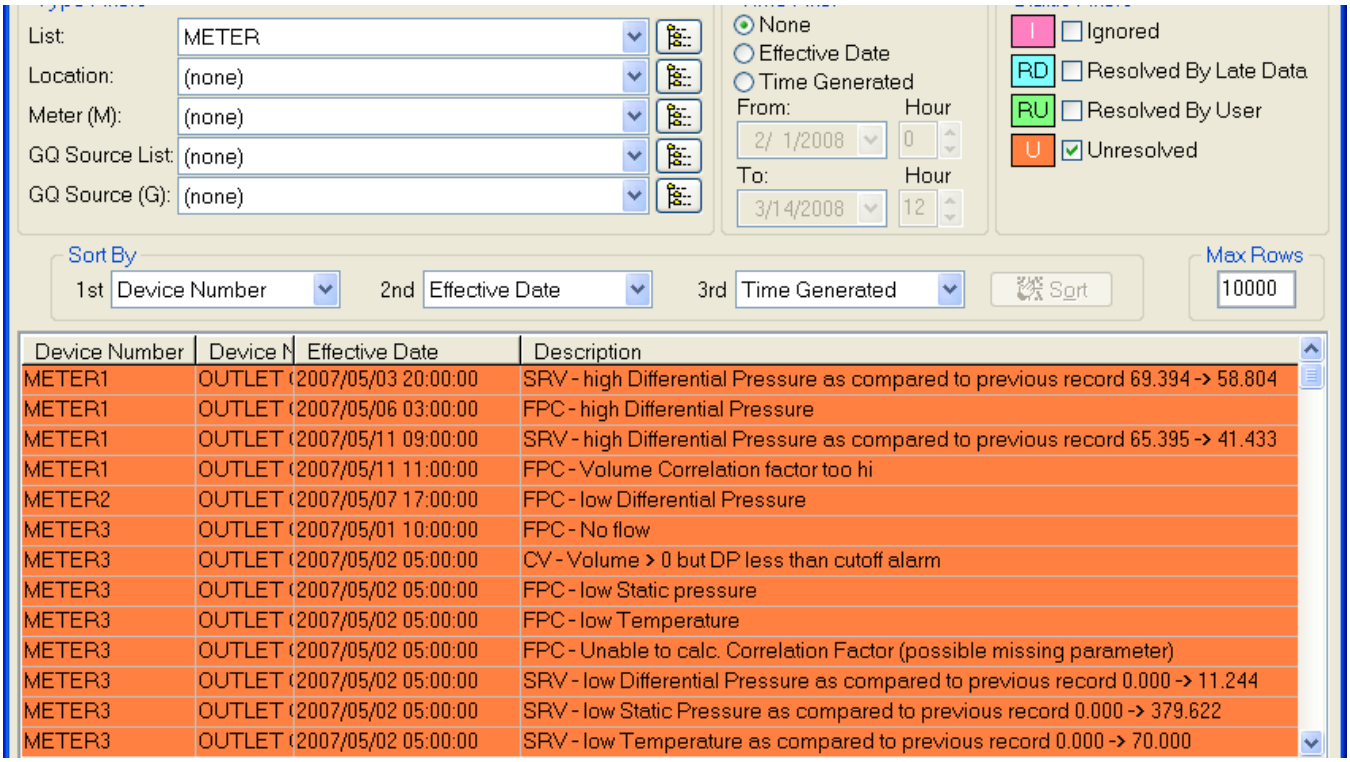
Gas Quality relationships to a meter also have the ability to influence UAF gas loss. Monthly or quarterly samples, as compared to live quality derived from an online gas chromatograph, can easily affect the UAF gas loss swing on a monthly basis. Addressing issues relating to pressure base, heating value pressure base, and the proper coding of meters and their relationship to a regional chromatograph should all be worked through to minimize the potential impact.

There are always benefits to an effective audit program. The audit team should review all third party measurement to ensure accuracy and a reasonable comparison to internal or check measurement with all differences investigated and resolved where applicable. The audit team

should also work with the field to make certain all leaks and potential theft situations are identified and resolved.

## The Measurement System

Being able to configure each meter to automatically validate and estimate missing data based on a set of rules continues to move the measurement industry forward into the 21st century. The example included in *Illustration #4* demonstrates the effectiveness of verifying all of a company's measurement data based on exception anomalies only. This enables the measurement analyst to focus on a specific tree as well as the entire forest.




| Device Number | Device N | Effective Date | Description |
|---|---|---|---|
| METER1 | OUTLET ( | 2007/05/03 20:00:00 | SRV - high Differential Pressure as compared to previous record 69.394 -> 58.804 |
| METER1 | OUTLET ( | 2007/05/06 03:00:00 | FPC - high Differential Pressure |
| METER1 | OUTLET ( | 2007/05/11 09:00:00 | SRV - high Differential Pressure as compared to previous record 65.395 -> 41.433 |
| METER1 | OUTLET ( | 2007/05/11 11:00:00 | FPC - Volume Correlation factor too hi |
| METER2 | OUTLET ( | 2007/05/07 17:00:00 | FPC - low Differential Pressure |
| METER3 | OUTLET ( | 2007/05/01 10:00:00 | FPC - No flow |
| METER3 | OUTLET ( | 2007/05/02 05:00:00 | CV - Volume > 0 but DP less than cutoff alarm |
| METER3 | OUTLET ( | 2007/05/02 05:00:00 | FPC - low Static pressure |
| METER3 | OUTLET ( | 2007/05/02 05:00:00 | FPC - low Temperature |
| METER3 | OUTLET ( | 2007/05/02 05:00:00 | FPC - Unable to calc. Correlation Factor (possible missing parameter) |
| METER3 | OUTLET ( | 2007/05/02 05:00:00 | SRV - low Differential Pressure as compared to previous record 0.000 -> 11.244 |
| METER3 | OUTLET ( | 2007/05/02 05:00:00 | SRV - low Static Pressure as compared to previous record 0.000 -> 379.622 |
| METER3 | OUTLET ( | 2007/05/02 05:00:00 | SRV - low Temperature as compared to previous record 0.000 -> 70.000 |

*Illustration #4*

The inclusion of graphing and trending tools helps facilitate the UAF gas loss research and is vital to the measurement group. With hundreds to thousands of meters included in each balance segment, a means of identifying meters that reflect similar or opposing trends is instrumental in efficiently identifying sources of UAF gas loss. The ability to view this information at a monthly level has been the standard for years. Today, more companies are moving toward a daily review of the system UAF gas loss with several trendsetters moving toward an hourly resolution. The key driver for this review relates directly to the granularity of all meter data received in a measurement system. If all of the meter information is maintained at an hourly level, there should be enough information to perform an hourly review as represented in *Illustration #5* below.

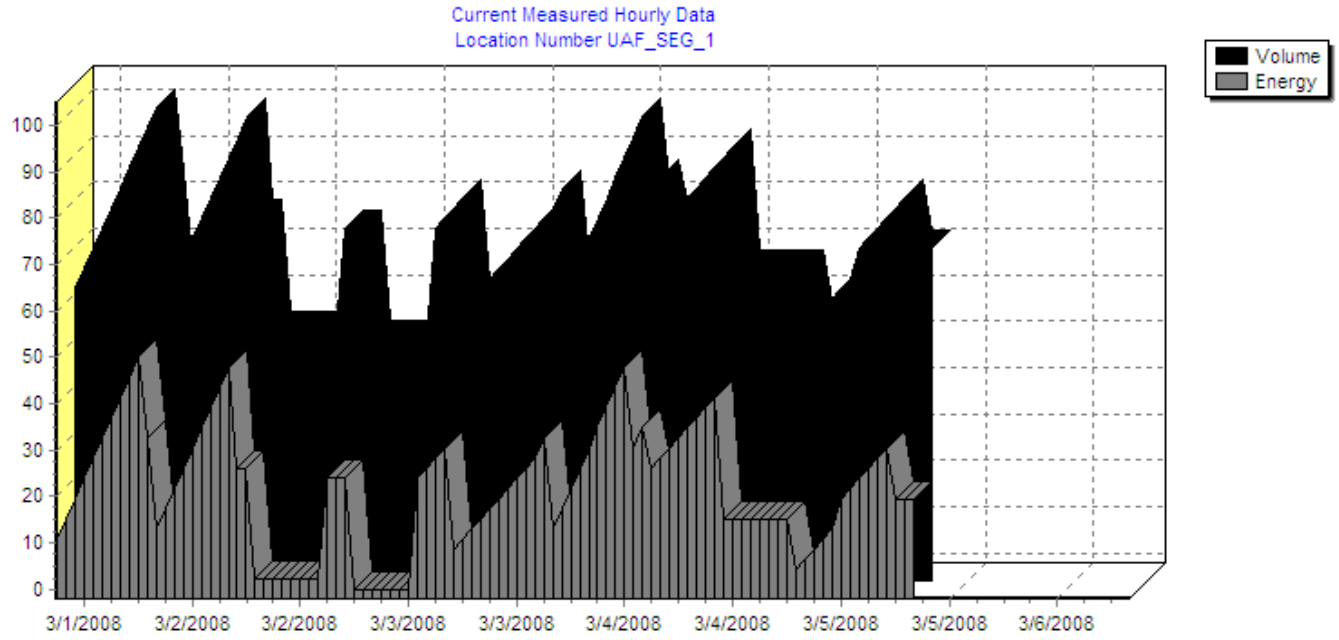



*Illustration #5*

A detailed segment balance relationship should be established for every gathering segment, processing plant balance, pipeline segment, and distribution segment. Where possible, companies should create balances that take advantage of field-to-sales, check-to-sales or similar comparisons. Graphical representations of the physical relationships of meters in a system enable companies to identify the issue when a problem is noted. The relationships that are identified should include:

Inlets

- Physical Receipt Meters
- Storage Withdrawal

Outlets

- Physical Delivery Meters
- Storage Injection
- Measured Fuel
- Unmeasured Fuel
- Accounted For Gas to Atmosphere
- Retrograde Condensate
- Water
- Delta Linepack (+/-)

Calculated UAF Gas Loss (Volume and Energy)
Percentage UAF Gas Loss (Volume and Energy)
Please see *Illustration #6* for a sample report.

**UAF_SEG_1 --- UAF SEG #1**

**BALANCE DETAIL REPORT**

March, 2008

| Number | Name | Volume | Standard Conditions Heating Value | Energy |
|---|---|---|---|---|
| Inlet | | | | |
| 101 | Receipt 1 | 20,208 | 1012.7 | 20,448 |
| 102 | Receipt 2 | 19,340 | 1012.7 | 19,584 |
| 103 | Receipt 3 | 19,244 | 1012.7 | 19,488 |
| 104 | Receipt 4 | 19,436 | 1012.7 | 19,680 |
| 501 | Line Pack Inlet | 220 | 1012.7 | 220 |
| Inlet Total | | 78,448 | | 79,420 |

March, 2008

| Number | Name | Volume | Standard Conditions Heating Value | Energy |
|---|---|---|---|---|
| Outlet | | | | |
| 201 | Delivery 1 | 19,244 | 1012.7 | 19,488 |
| 202 | Delivery 2 | 19,340 | 1012.7 | 19,584 |
| 203 | Delivery 3 | 19,244 | 1012.7 | 19,488 |
| 204 | Delivery 4 | 19,340 | 1012.7 | 19,584 |
| 301 | Fuel 1 | 480 | 1012.7 | 480 |
| 302 | Fuel 2 | 192 | 1012.7 | 192 |
| 401 | Company Use 1 | 96 | 1012.7 | 96 |
| 402 | Company Use 2 | 96 | 1012.7 | 96 |
| 502 | Line Pack Outlet | 136 | 1012.7 | 136 |
| Outlet Total | | 78,168 | | 79,144 |
| (Gain) Loss | | 280 | | 276 |
| (Percent Gain) Loss | | 0.36 | | 0.35 |

*Illustration #6*

## The Identification and Reduction Process

The first step towards the identification, reduction, and management of UAF gas loss relates directly to management buy-in. The approach must include the office and field measurement staff and include agreement from middle and upper management to sustain an effective program.

- Well developed Standard Operating Procedures or Measurement Guidelines
- Well trained field and office staff
- Regional or Area Specialist(s)
- Meter / Pipeline / Plant segmentation for UAF gas loss control
- Documentation Procedures for all noted anomalies
- Focus efforts based on the 80 - 20 rule (Typically 80% of your throughput is measured through 20% of your meters)
- Conduct field brainstorming sessions where meter segmentation coding and gas quality coding is reviewed with field personnel
- Identify meters reflecting unacceptable measurement uncertainty
- Conduct an internal measurement audit focused in your corporate office
- Conduct an internal measurement audit focused on field facilities
- Conduct an internal measurement audit focused on third party measurement
- Continued brainstorming session with office and field

## Conclusion

Time invested in review of a company's UAF gas loss will improve the measurement accuracy and continue to reduce measurement uncertainty. A well documented UAF gas loss project plan should include representatives from the field and office. The project plan should also have management support which will not only improve customer and public relations, but will also significantly reduce and provide a company with the tools to help manage UAF gas loss.

This area of our industry has demonstrated significant improvement. The improvements are primarily due to the industries adoption of robust measurement systems which include advanced features like expert systems - which are designed to efficiently identify and isolate volume/energy anomalies. Companies should be encouraged to stay involved with industry schools and standards as a means of improving the effectiveness of training on, measurement equipment, calibration equipment, and overall UAF gas loss awareness. Industry involvement represents an investment that requires both time and money; however, this investment is fundamental to a healthy measurement program and is easily justified with the countless benefits, both tangible and intangible.