

UNACCOUNTED-FOR GAS

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Unaccounted-for gas can be defined as the “difference between the amount of gas purchased and the amount of gas sold through a measured gas distribution system.” This difference is commonly described as a percentage of gas purchased: “**PERCENT UNACCOUNTED-FOR GAS.**”

Example:
Unaccounted-for Gas

Gas Purchased	50,000 cubic feet
Gas Sold	<u>-45,000 cubic feet</u>
	5,000 cubic feet

Percent Unaccounted-for Gas

Unaccounted-for Gas	<u>5,000 cubic feet</u> x 100 = 10%
Gas Purchased	50,000 cubic feet

Unaccounted-for gas figures can be either positive (more gas purchased than sold) or negative (more gas sold than purchased). In either case, it is important to determine what factors are contributing to the unaccounted-for gas and eliminate them. We are concerned about unaccounted-for gas for two reasons; safety and economics. Concern about unaccounted-for gas for public safety include: leakage, third party damage and gas theft. These factors contribute to unaccounted-for gas that can adversely affect the safety of our customers. Economically, unaccounted-for gas represents lost revenues that are not recoverable. It is gas purchased from a supplier but not sold to customers (positive unaccounted-for gas).

There are two types of unaccounted-for gas:

1. Operational
2. Accounting

Individually or together they make up the total unaccounted-for volume for a natural gas distribution or transmission system.

OPERATIONAL UNACCOUNTED-FOR GAS

Operational unaccounted-for gas exists because of the day-to-day practices of purchasing, transporting and selling of natural gas.

Events resulting in operational unaccounted-for gas could be:

- A. Leakage
- B. Measurement
- C. Pressure Regulation
- D. Third Party Damage
- E. Construction Activity
- F. Theft

Leakage

Leakage is the action of unmeasured gas passing from within a transmission/distribution system to the outside atmosphere. Leaks can occur on pipe walls, at welded, screwed, or flanged connections, at couplings and at valve stems. Generally, leaks can appear at any point on a pipeline/main/serviceline and on any object attached to the system (Figure 1). Causes of such leaks on the system might be: improper assembly or maintenance, faulty material, damaged equipment, or corrosion.



FIGURE 1. Leakage in a gas system can have an effect on unaccounted-for gas.

The volume of gas lost is dependent upon the size of the hole (or orifice) and the pressure on the system. The larger the size of the hole or the higher the pressure, the greater the volume of gas lost. If a pipe has a one-inch hole with 25 psig of pressure on it, then 39,700 cubic feet per hour will escape. However, if the pressure was only 10 psig, then only 18,600 cubic feet per hour would escape. A very economical way of reducing unaccounted-for gas associated with leakage is reduction of system pressure. A gas system should be operated at the safest minimum pressure that will allow adequate service to the customer. Controls can be added to the system, in the form of telemetering, temperature boosters and regulator stations, to ensure that the customers' demand can be met. Figure 2 illustrates the effect system pressure has on a 0.250" hole.

We have discussed how pressure effects leakage, but the size of the hole can also effect leakage. A .125 inch hole on a pipeline with 25 psig on it will pass 620 cubic feet per hour. If this leak is not detected for a year, then 5,430,000 cubic feet of gas will be lost. Therefore, a small leak can be just as detrimental as a large leak.

EFFECTS OF SYSTEM PRESSURE ON UNACCOUNTED-FOR GAS

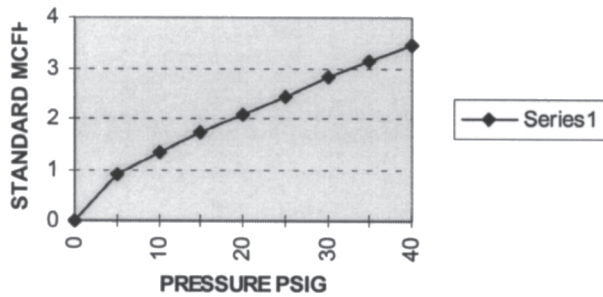


FIGURE 2. The effect of system pressure on leakage.

Some companies have set up departments dedicated to conducting leak surveys. These surveys require personnel to walk the facilities with equipment specifically designed to detect leaks. The two primary devices are combustible gas indicators and flame ionization units.

It is also possible to visually inspect the pipeline/service by conducting a vegetation survey and soap test. Gas seeping through the soil to the atmosphere will kill vegetation on the surface. This provides a tell-tale sign of leaks. The soap test consists of applying a foaming agent to the suspected object and looking for bubbles. Gas leaking through will cause the soap to foam.

Another method of detecting leaks is increased odorization. If the amount of odorant injected into a system is increased for a short period of time, an increased number of customers will call in leak complaints. This procedure puts customers to work in surveying the system for leaks. This practice should only supplement, not replace, company leak surveys.

Once leaks are found, they should be reported promptly to the construction department. The construction department will correct or repair the leaks by placing clamps over them, replacing the section of pipe or installing new fittings.

Measurement

A new meter placed in service is designed to measure dry, clean natural gas accurately. However, the gas flowing through our systems is not always dry or clean. As time goes by, the gas condition can affect the meters, causing them to measure inaccurately. Dirt and grit may collect on the impellers of a rotary meter, distillate may dry out the bearings of a turbine meter, or an orifice plate may get nicked. These are some of the reasons why meters are field tested periodically or incorporated into an exchange program. Most companies have a meter exchange program for their residential meters. After a period of time, the meters are removed from service and

brought back to the meter shop to be tested. They are then put back into service.

If a meter allows one cubic foot of gas to pass, it should register the same amount. Assume that the actual quantity of gas purchased is 10,000 cubic feet, but the purchase meter is 1% fast, measuring more gas than actually passes through the meter. Then it will register 10,100 cubic feet. If the company that bought the gas sold it to a customer where the meter was 1% slow, measuring less gas than it actually passes through the meter, the meter would record only 9,900 cubic feet. The total difference would be 200 cubic feet or 2% unaccounted-for gas (Figure 3). This is why it is necessary for meters to be tested routinely. Untested meters can have detrimental effects on the percent of unaccounted-for gas.

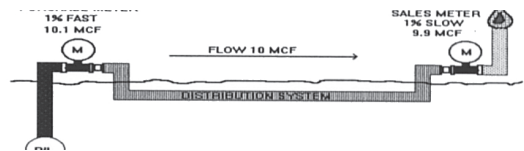


FIGURE 3. The meters must be measuring the gas correctly or there will be errors.

Pressure Regulation

Most residential and small commercial customers' appliances require a pressure of 4 psig to work properly. In some cases, the equipment may require a higher pressure. These customers' volumes should be compensated for by using a fixed factor multiplier or a pressure compensating index. In either case, it is important that the regulator be set at the correct pressure.

If a regulator is set at a pressure different from that for which the customer is being billed, there will be unaccounted-for gas. Figure 4 illustrates the effect on measurement at pressures other than that for which the customer is being billed. The customer in Figure 4 is being served at an elevated pressure of 5 psig and billed on a fixed factor multiplier. If the dial difference for the month is 743.1 mcf and the multiplier for 5 psig were applied, the customer would be billed for 1000 mcf. If in fact the pressure was 8 psig, for example, the customer would actually receive 1153 mcf. This represents a loss of 153 mcf or 15.3% unaccounted-for. Therefore, service personnel must take care to ensure that a newly-installed regulator is set at the pressure for which the customer is being billed.

Also, if the regulator is not responsive to changes in the load, the pressure will fluctuate, causing the same type of unaccounted-for error. The effects of boost and droop must be considered when choosing a regulator for fixed factor measurement.

Third Party Damage

Outside contractors working near natural gas pipelines and mains will inadvertently damage the pipe, causing

EFFECTS OF PRESSURE DEVIATION ON FIXED-FACTOR MEASUREMENT

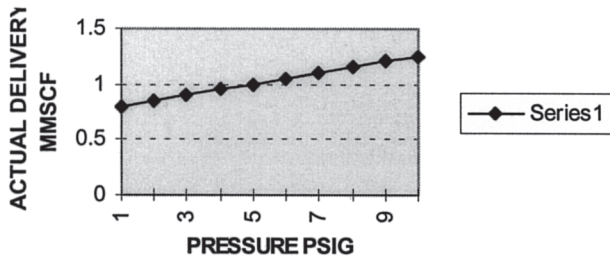


FIGURE 4. The effect of deviation in pressure on unaccounted-for gas.

gas to escape to the atmosphere. This not only causes an increase in the unaccounted-for figure, but also endangers human life. The best way to prevent third party damage is through a “call before you dig” program. This requires contractors who are installing water mains, roads, storm drains, etc., to notify utility companies of impending construction near their facilities. Once notified the company will send personnel to the site to mark the company’s facilities. Most companies estimate the gas loss and expense incurred in repairing damaged facilities and charge the contractor responsible for the incident. However, the gas escaping from a damaged pipeline can only be estimated.

Construction Activity

Gas that is purged from a pipeline during construction can be a factor in the unaccounted-for. During major construction projects, it is advisable to estimate the amount of gas that will be purged throughout the operation. The figure could be useful in understanding the cause of unaccounted-for gas in a system. This could be insignificant if this is a normally high volume system. However, it can be a factor in smaller systems.

Theft

The unaccounted-for gas attributable to theft is an economic and safety concern of the natural gas industry. We are interested not only in lost revenues, but also in eliminating dangerous customer actions such as making illegal connections or tampering with meters. The percentage of customers that steal gas will vary in every region of the country. In some areas the problem is so wide-spread that special departments have been set up within companies to investigate and prosecute gas theft. In other areas, meter readers are on the alert to look out for illegal connections and meters that have been tampered with. Another method is to seal all meters and monitor the seals. If a seal is broken and the meter has been tampered with, then the customer should be prosecuted. This has proven effective in reducing incidents of gas theft.

ACCOUNTING UNACCOUNTED-FOR GAS

Accounting unaccounted-for gas results from transferring actual information into data and then into reports. This consists of:

- A. Contractual
- B. Data Entry
- C. Cycle Billing
- D. Report Compiling
- E. Chart Integration

Basically, accounting unaccounted-for gas takes place in the office, while accounting operational unaccounted-for gas occurs in the field.

Contractual Unaccounted-for Gas

Contractual unaccounted-for gas is a constant percentage specified in a contract between the buyer and seller. This clause might be written into a contract when gas is bought and sold through the same meter. If the seller believes he is losing gas due to compression, fuel usage, meter wear or leakage, he may require the buyer to compensate him for the gas. The following example shows how the contract with 5% unaccounted-for gas would be used in calculating the total amount of gas purchased.

Example:

Volume measured by the meter	50.000 cubic feet
Percent unaccounted-for specified in the contract	<u>x 5%</u>
Volume added to the bill	2,500 cubic feet
Total volume purchased	52,500 cubic feet

The contractual unaccounted-for gas also may be allocated as fuel usage, such as gas that is used to fuel a compressor, power pneumatic controllers or supply pilot regulators.

Data Entry

Once the charts are calculated and the meters read, the data is entered into the computer. The computer can be utilized to generate the customers’ volume statements and gas bills. Incorrect data entered into the computer or a mistake made in data entry, will result in billing errors. Errors show up as unaccounted-for gas. In some offices, the data is entered twice and compared to ensure that data entry errors are caught and eliminated. Also, auditing the existing customer data files allows errors to be found. If a customer is served on elevated pressure (any pressure above 4 osig), he must be billed for it. This can be done by using a fixed factor multiplier. It is important that the correct factor be used in calculating the volume. If incorrect factors are used, then the unaccounted-for gas will be affected.

Cycle Billing

A distribution company cannot read all of the residential, commercial or industrial meters in one day. Therefore, the meters are divided up into routes with each route being read by a different meter reader on a different day. Each day that the routes are read is called a billing cycle. For instance, a meter may be read on February 3rd, with the gas usage being accounted-for in February. Even though the gas was actually consumed during the previous month of January.

Transmission companies usually have a limited number of large volume customers. Therefore, they can read most of their meters in one day (or during one billing cycle). The difference in billing cycles between the transmission and distribution company can add to the accounting unaccounted-for gas. This is most evident during the winter months when cold weather does not occur in two consecutive billing periods (the two months do not have the same number of Heating Degree Days.) If colder weather occurs in the previous month, then the unaccounted will be positive. This is because more gas was purchased by the distribution company in the previous month than was billed to the customers.

Reports

Unaccounted-for gas reports can be helpful in highlighting systems with unaccounted-for problems. Reports can be compiled to show monthly unaccounted-for information or 12-month unaccounted-for history. The monthly reports provide detailed information on each system such as the volume of gas purchased and sold, the amount and percentage of unaccounted-for gas, and yearly information. To compile a report like this, it is beneficial to assign source of gas codes to each customer. These codes represent the source from which the gas is allocated to the customers. This way, customer volumes can be compiled by supplier or gas system (town). If the source of gas code is incorrect for a particular customer, then their volume will not be used in calculating the unaccounted-for gas for that system. This could result in a large unaccounted-for figure. The monthly report only gives you monthly information. In order to evaluate the validity of the monthly report, a 12 month report is used to provide the monthly percent unaccounted-for gas for 12 months. This can be used to spot trends for each gas system. If the percentages are increasing, it might be worth investigating.

Charts

Charts are used to record the pressure, volume and temperature. The first step in reducing the unaccounted-for gas associated with charts is to ensure that the recorders are recording the three variables correctly. Are the pens marking? Is the mechanical clock wound up? Is the chart installed correctly? Is the recorder calibrated? If the answer to any questions is no, then the volume will be incorrect. You may end up estimating the customer's

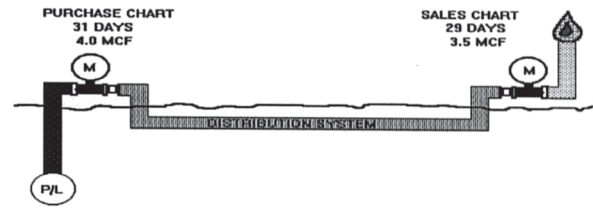


FIGURE 5. The number of days that a chart is left on the meter can effect the accounting unaccounted-for gas.

bill, thereby increasing the percentage of unaccounted-for gas.

Once the chart is removed it must be correctly integrated to provide the correct volume. If the pressure on the chart is constant this is easy to do. However, this does not always happen. Sometimes the pressure fluctuates. If three people integrated these charts you could not expect their results to be closer than $\pm 1\%$ to $\pm 3\%$. In order to alleviate this problem, an equipment change would be required in the field. Changes could include installing a more responsive regulator, a mechanical integrating gauge, an electronic integrating gauge, a flow computer, or a real time measurement system.

The day that a chart is taken off the meter can effect the unaccounted-for figure. Some suppliers change the charts at the end of the month, while the company that purchased the gas may remove their charts on the closest workday (Figure 6). This can have an effect on the difference between the amount of gas bought and sold for that month. If the purchaser removes his charts early and then cold weather occurs, the supplier may record more gas sold than the purchaser. The end result would be a high percentage of unaccounted-for gas, even though no gas was actually lost.

The volume would be recorded on the next month's charts thus balancing out the previous month's unaccounted-for gas. One month the unaccounted-for gas may be 25%, but the next month it might be -20%. If the two months are added together, the total unaccounted-for gas is 5%.

REDUCING THE UNACCOUNTED-FOR GAS

So far we have talked about the different types of unaccounted-for gas and their related causes. Also, we discussed different ways of reducing the unaccounted-for gas. Before we begin reducing the unaccounted-for gas, we must determine what type it is. The best way is to systematically investigate the gas system (Figure 7). Once a thorough investigation is completed, then the appropriate steps can be taken to correct the problems. It is important that while conducting the investigation you stay calm, understand the layout of the system, and talk to the individuals who operate the system. These three steps will make it easier to begin narrowing down the causes of the unaccounted-for gas.

**REDUCING THE
UNACCOUNTED-FOR GAS
(A SYSTEMATIC INVESTIGATION)**

Type of Unaccounted-for Gas	Action
<u>OPERATIONAL</u> Leakage	<ol style="list-style-type: none"> 1. Leak survey the system. 2. Report all leaks found to the construction department. 3. Increase the odorant injection rate and follow up on all customer leak complaint calls. 4. Soap test all connections on new equipment installations. 5. Conduct a pressure study of the system to determine the minimum pressure required. 6. Install regulators, boosters, or telemetry equipment to reduce the system pressure.
Measurement	<ol style="list-style-type: none"> 1. Witness the supplier's field tests of purchase meters. 2. Set up a program to routinely field test large meters. 3. Set up an age change program to test small meters. 4. Continually monitor all meter test results. 5. Retire meters that are continually out of proof.
Pressure Regulation	<ol style="list-style-type: none"> 1. Inspect all regulators used to serve customers on fixed factor billing. This will ensure that they are set on the proper pressure. 2. Monitor the performance of the existing regulators, retiring regulators that are not responsive enough to flow fluctuations.
Third Party Damage	<ol style="list-style-type: none"> 1. Advertise a "call before you dig" phone number for contractors use. 2. Send individuals to the field to mark your facilities before construction begins. 3. Charge contractors for the expenses incurred repairing damaged pipelines.
Construction	<ol style="list-style-type: none"> 1. Estimate the amount of gas purged during construction activities. Include this amount in the unaccounted-for gas reports. 2. Install valves to allow you to isolate sections of the pipeline when purging.
Theft	<ol style="list-style-type: none"> 1. Alert meter readers to watch for illegally by-passed meters. 2. Set up an award program for employees finding customers stealing gas. 3. Seal meters and monitor the seals. 4. Prosecute customers stealing gas. 5. Generate a report of customers with uncharacteristically low gas consumption.
<u>ACCOUNTING</u> Contractual	<ol style="list-style-type: none"> 1. Locate all areas where contractual unaccounted-for gas is used. 2. When renewing gas purchase contracts, negotiate the percentage of unaccounted-for gas.
Charts	<ol style="list-style-type: none"> 1. Replace as many charts as possible with fixed factor billing, mechanical integrating gauges, electronic integrating gauges, flow computers, or real time measurement systems. 2. Set up a program to have the charts audited by an outside firm. 3. Install regulators that are responsive to flow variations. This will provide a constant pressure which is easier to integrate on a chart.

FIGURE 6. A systematic investigation of gas system allows you to narrow down the reason for unaccounted-for gas. (continued next page)

**Type of
Unaccounted-for Gas**

Action

ACCOUNTING (cont.)

Data Entry

1. Write down all data to be used for calculating volumes so that it is legible.
2. Generate a report listing customers that are fixed factor billed. Use the list to ensure that the correct factors are being used.
3. Audit customer data to ensure that it is coded correctly.

Reports

1. Monitor the monthly and 12 month unaccounted-for gas reports.
2. Check to ensure that the source of gas codes are correct for each customer.
3. Report all changes in a gas system, such as new suppliers or tying systems together so that the unaccounted-for gas reports can be corrected.

Sanity

1. Stay calm while investigating causes of unaccounted-for gas.
2. Understand the layout of the system being investigated.
3. Talk to the individuals who operate the system for leads.

FIGURE 6 (Cont'd.) A systematic investigation of gas system allows you to narrow down the reason for unaccounted-for gas.



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