Allocation of Unaccounted For Gas

Gas Industry Company

June 2007

MAUNSELL | AECOM

Allocation of Unaccounted For Gas

Prepared for

Gas Industry Company

Prepared by

Maunsell Limited
10th Floor, KPMG Centre, 135 Victoria Street, Te Aro, Wellington 6011
PO Box 27 277, Marion Square, Wellington 6141, New Zealand
T +64 4 382 2999 F +64 4 382 2998 www.maunsell.com

June 2007

60024689

Quality Information

Document	Allocation of Unaccounted For Gas
Ref	60024689 i:\dept_65\gic\ufg allocation\report\final a.doc
Date	June 2007
Prepared by	Guenter Wabnitz
Reviewed by	Graeme Hughson

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
Final	07/06/2007		G. Wabnitz	
Final a	25/06/2007		G. Wabnitz	

Table of Contents

Glossary of Acronyms

GIC	Gas Industry Company
GJ	Giga Joule
OFGEM	Office of Gas and Electricity Markets (a UK government agency)
TJ	Terra Joule, measure of energy equal to 1000 GJ
TOU	Time-Of-Use (applies for metering devices, e.g. hourly data loggers)
UFG	Unaccounted-For-Gas

Executive Summary

Maunsell was commissioned to propose a methodology for the allocation of **Unaccounted-For-Gas** (UFG) of New Zealand gas distribution networks. This report refers to the long-term, permanent UFG and not to the monthly variations of unbilled or misallocated gas quantities, which is reported in a separate work stream.

We looked at overseas regulations for comparison and at comments provided by the New Zealand gas industry to GIC's discussion paper of January 2007. We also discussed some of the concerns with a selected group of the industry.

Our key findings were:

a) The New Zealand UFG in 2006 was on the average 2.5%, see Appendix A, but some networks had much higher figures, up to 80%. Such high figures are clearly unacceptable and will need to be addressed as soon as possible.
b) The term UFG was used by a number of people in the context of monthly allocation of gas, which caused confusion. We therefore reviewed the definition of UFG.
c) In the UK, the concept of UFG is called "shrinkage", which only relates to physical gas losses; annual shrinkage factors are disclosed by networks; network companies have to follow quality assurance guidelines to minimise shrinkage. In Victoria, Australia, it is the network operators' responsibility to control UFG, which is mostly losses from leakage, and they get penalised if UFG exceeds given benchmarks.
d) From our discussions with selected Retailers we got the feedback that the equal allocation of UFG to all gas consumers by energy volume is the most equitable solution.

As a result of our investigations, we recommend the following:

A) Definition:

1) UFG in the meaning of *long-term* unaccounted for gas as previously referred to in the Reconciliation Code of 2000 is defined as **annual UFG**.
2) UFG includes leakage, theft, operational use of gas, metering errors, data transfer errors, database system errors and all inaccuracies of the billing methodology.
3) The monthly variation of over- or under-billed accounts, mainly caused by uneven meter reading cycles, does not fall under the definition of UFG; a term like "monthly variation" may be used instead.
4) UFG is the difference between energy quantities entering a network at its gate stations and the energy quantities having passed through that network and being accounted for as a percentage of the quantity measured at the gate station.
5) The UFG figure is positive for losses and negative for gains.

B) Calculation:

6) The (annual) UFG is determined by the Reconciliation Agent for each distribution network at a specific date once per year.
7) This date is chosen for maximum data accuracy, e.g. at the end of the summer season, when monthly variations have the least impact on the annual UFG figure.
8) Where a distribution network has more than one delivery point, the UFG of that network is related to the aggregated energy quantities passing through the respective delivery points; in the annual UFG table, these delivery points are identified together with the network that they belong to.

9) The (annual) UFG of a particular network is based on actual meter readings, e.g. 12 monthly readings or six two-monthly readings for the respective customer groups; estimated accounts shall **not** be used for the determination of UFG.
10) The conversion from meter reading to energy quantity is based on NZS 5259:2004 and a "**Standard Billing Methodology**" that is to be applied by all retailers; this methodology will need to be developed and will describe the conversion process including daily and seasonal variations; the standard billing methodology will be auditable.

C) Allocation:

11) The (annual) UFG is equally allocated to all accounts, to those with Time of Use (TOU) devices and to those without as a fixed factor on energy; the UFG factor is an additional component of the Standard Billing Methodology, which converts meter reading to energy quantity.
12) It is up to the Retailers to estimate monthly accounts for the purpose of billing. However, the allocation and reconciliation of (annual) UFG is to be based on actual meter readings and the conversion is to be in accordance with the Standard Billing Methodology.
13) The fixed annual UFG Factor will substitute the Loss Factor that has been used for monthly allocations by the Allocation Agent in the past; the Loss Factor has been applied to multiple networks of entire regions without change since 2002.
14) After the end of each UFG year, the difference between UFG from the previous year and the actual UFG from the past year is calculated by the Allocation Agent and the balance is equally allocated to all accounts by energy quantity and debited or credited to the respective parties together with the first monthly account of the new "UFG-year".

D) Data Quality Assurance:

15) **UFG is disclosed by network** in a table that is sorted in a clear and concise manner similar to Appendix B; this table includes the names of the network owners, annual quantity and UFG in GJ, UFG in % of annual quantity, annual quantity in GJ of TOU accounts and the relative portion of TOU accounts.
16) The UFG calculation **must be auditable** for each individual account; retailers that use estimates for monthly billing purposes shall reconcile the accounts at the end of the "UFG-year".
17) For control purposes and in addition to the annual UFG, the Monthly Variation and the 12-month rolling UFG is disclosed for each network and for every calendar month.
18) **Novagas** has the same rights and obligations as other Retailers with regard to UFG allocation.
19) TOU **check meters** are to be installed upstream of large groups of consumers with non-TOU metering devices, where aggregated annual consumption is greater than 50 TJ.

A key concern of the industry is the accuracy and consistency of billing data produced by Retailers and we believe that this is the main contributor to UFG. To reduce UFG, the involved parties have to set up quality control measures for their billing processes, which include the technical aspects of metering as well as the data processing.

In order to implement the proposed rules and to improve the metering and billing accuracy of the gas industry, we propose the following:

a) The billing methodology should be described in a **Standard Billing Methodology** prepared by GIC after consultation with Retailers.
b) Part of the Standardised Billing Methodology is the determination of conversion factors as described in NZS 5259:2004 and their application between meter readings; this is of particular importance for the Temperature Conversion Factor F_T.
c) Retailers are obliged to apply the Standardised Billing Methodology and to work towards reducing the annual UFG of each network to below +/-2%.

d) Retailers and network companies are obliged to investigate the reasons for UFG exceeding +/- 2% and mitigate the causes as soon as practicable.

e) Retailers disclose their methodologies for the estimation of gas accounts.

f) Each network has facilities to verify the demand profile of the non-TOU accounts for every month.

g) The billing process of each Retailer, including the applied algorithms, must be auditable and is to be audited by an independent auditor as determined by GIC; GIC determines the time and frequency of such audits.

h) GIC is provided with copies of all audit reports.

i) Retailers develop standardised Billing and Meter Asset Management processes that promote ongoing improvement of data accuracy.

j) Metering devices at delivery points shall be tested and calibrated in accordance with NZS 5259:2004; the results of such tests and calibrations are made available to Retailers and GIC.

1.0 Introduction

1.1 Scope of Work

Maunsell was commissioned to propose to GIC a methodology for the allocation of UFG for New Zealand gas distribution systems.

The proposed rules should consider:

a) industry comments on the GIC discussion paper of January 2007,
b) exemplary overseas regulations,
c) UFG trends found in New Zealand.

1.2 History

The following dates explain the historic development of the discussion around UFG:

July 2000	-	NZ Gas Industry Reconciliation Code
Oct 2002	-	Tom Tetenburg started to reconcile Retailer data,
May 2005	-	GIC established
Aug 2005	-	Maui Pipeline Final Operating Code
Dec 2005	-	I Wilson, GIC: Paper outlining the regulatory process
May 2006	-	HP Invent report on “Allocation and Reconciliation in Overseas Gas Markets”
Jan 2007	-	GIC Discussion Paper on Reconciliation of Downstream Gas Quantities
Feb 2007	-	deadline for submissions
March 2007	-	meeting of GART with GIC

1.3 Objectives of UFG Allocation

We believe that rules and regulations for the allocation of UFG should be:

a) efficient, fair, equitable and reliable;
b) consistent and uniform;
c) simple to implement and to monitor,
d) transparent to all parties;
e) minimise risks to individuals and to the entire market;
f) minimise compliance cost.

1.4 Regulatory Context

With regard to UFG, the regulatory objective of this task is:

"to recommend to the Minister by June 2007 arrangements for more efficient and accurate downstream allocation and reconciliation of gas quantities. Such arrangements should:

a) be consistent with the other issues relating to the reconciliation of gas quantities;
b) provide for more accurate identification and fairer allocation of the amount to unaccounted for gas."

1.5 NZ Reconciliation Code 2000

a) This Code was developed by "a group of service providers", who agreed that any person wishing to be involved in the transport or trading of gas on an open access facility must comply with this Code.
b) The Code referred to a number of other industry wide instruments, such as the Gas Act 1992, the Gas (Information Disclosure) Regulations 1994, the voluntary "Access Code" and "Information Memoranda" of respective gas transporters.
c) Further, the Code refers to contracts of the respective service providers such as the Transmission Services Agreements (TSA) or Use of System Agreements (UOSA).
d) Parties transferring gas at receipt points must be party of an Allocation Agreement, which is bound by the Code.
e) The Code specifies the role of the Allocation Agent.
f) The chairperson of the "National Allocation Group" was meant to facilitate an annual review of the Code (the National Allocation Group has not been established).
g) The Code sets out core principles and defined UFG as "long-term" unaccounted for gas.
h) The Code allocates responsibility for UFG to transport system owners.

2.0 UFG

2.1 Definition of UFG

In accordance with the Reconciliation Code of the New Zealand Gas Industry of 1 July 2000, "Unaccounted For Gas (UFG)" means the *long-term* difference between the metered quantities of gas entering a transport system at a Receipt Point and the metered quantities of gas leaving the transport system at a Delivery Point, expressed as a percentage of the metered quantities of gas entering the transport system at the Receipt Point.

We understand that the emphasis of the UFG definition of the Reconciliation Code is on "long-term" and has the meaning of unaccounted for gas quantities remaining unaccountable. This definition was used in New Zealand prior to deregulation of the gas industry and is commonly used overseas.

In the context of monthly billing and reconciliation, the term "monthly UFG" has been used for the monthly difference between in and outgoing energy bills. The "monthly UFG" has been quite volatile in the past, as meters of the residential and commercial market sectors are read two-monthly or even less frequently. Retailers estimate the gas quantities of consumers without time-of-use (TOU) meters on the basis of assumed load profiles. The estimates can be reconciled with the actual readings and certainty is in most cases achieved after a period of about four month, when most meters have been read.

The "monthly UFG" is therefore not identical with the annual, or long-term UFG. We excluded the discussion on the "monthly UFG" as part of this paper, as this is largely dependent on the estimation methodology applied. We understand that the "monthly UFG" is outside the scope of this paper and a separate work stream deals with this as part of the monthly allocation process.

The annual UFG have less fluctuation, particularly if the UFG-year was chosen to end in summer, when the non-TOU customers have minimum consumption. Retailers can chose similar meter reading cycles every year to avoid fluctuations and to minimise variations from year to year.

We recommend not using the term UFG for the monthly variations, as the monthly variations mainly relate to uneven meter reading cycles.

By using a longer time frame for the definition of UFG, UFG gets the meaning of ultimately "unaccountable" for gas.

2.2 Gas Losses

The UK regulations use the term "shrinkage" for gas lost through leakage, gas used for operational purposes and theft. These losses need to be physically replaced to meet the difference between what goes into the system and what is actually consumed by paying customers. It may be useful to make this distinction also in New Zealand.

Gas leakage from the distribution networks is estimated to be small in New Zealand, as the networks use modern materials and jointing techniques. We estimate that leakage is below 0.2%.

Losses for operational purposes are by our estimate also very small and mainly occur when gas has to be vented for maintenance reasons or new connections.

Theft has been investigated in the past and was found to be low in New Zealand.

We therefore believe that the responsibility for UFG should not exclusively be allocated to network companies, as leakage and operational losses are estimated to be below 0.5%. This is similar as in the UK, where "shrinkage" as disclosed per distribution network is typically below 1%.

UFG as defined in New Zealand is the sum of the billing errors, including metering and data processing. We therefore believe that the Retailers should account for most of the UFG (currently 2.5%).

Before the industry was deregulated in the early to mid 1990s, the total UFG as identified by distribution networks was in the order of 2%. Gas companies usually published UFG figures in their annual reports, and the Gas Association of NZ may still have these records.

The "billing error" as distinct from "shrinkage" would then have been in the order of 1 – 1.5%.

As the table in Appendix B shows, some networks have significantly higher UFG figures. We know from experience that the Lower Hutt networks downstream of the Belmont gate station used to have UFG figures of typically 2%. Appendix B shows that this figure is now approximately 5%. We believe that this trend is the result of deregulation and changed billing processes.

2.3 Billing Process

The billing process includes a chain of technical and non-technical processes that all can have individual errors, which, in their sum, make up the total billing error.

The following list describes the individual processes, and may not be complete, but demonstrates the complexity of the billing system:

a) technical specification of metering equipment and its inherent metering accuracy;
b) design of meter size versus actual load;
c) choice and installation of correct meter index;
d) index multiplication factor application by meter installer, meter reader or billing system;
e) pressure, temperature, altitude, compressibility and Joule-Thompson factors installed and applied;
f) maintenance of meters and correcting devices;
g) setting up of fixed factors on the billing system;
h) discrepancy of fixed factors used and seasonal fluctuations of temperature;
i) timing and accuracy of meter reading;
j) electronic data storage by data loggers and transfer through communication systems;
k) data input into the billing system;
l) setting up of billing systems;
m) transfer of accounts between Retailers;
n) fluctuation of calorific value of gas over billing periods;
o) allocation of meter numbers and readings to customer accounts;

p) allocation of customer accounts to billing address with regard to gate station and network;
q) timing and alignment of invoicing and data allocation;
r) accounting process;
s) allocation by the Allocation Agent.

3.0 Issues Relating to UFG

The responses of the industry to GIC's discussion paper of January 2007, and our discussions with various Retailers, revealed a number of issues relating to UFG that are categorised as follows:

3.1 General

a) the physical origin of UFG is not sufficiently known in NZ;
b) anecdotal "impressions" are not supported by fact;
c) deregulation and switching of Retailers has led to losing track of accounts;

3.2 Equitability

a) some Retailers expressed the opinion that TOU accounts had smaller UFG than non-TOU accounts due to the fact that TOU metering was more accurate;
b) other Retailers were of the opinion that non-TOU accounts had smaller UFG as individual errors had less weight compared with those of large accounts;
c) estimated billing is inherently inaccurate;
d) where customers are lost due to switching or other reasons, all of the other customers have to carry that loss;
e) Novagas is excluded from disclosure of gas quantities;

3.3 Consistency and Uniformity

a) UFG is not applied consistently as either annual or monthly;
b) it is in the discretion of Retailers how they apply conversion factors;
c) Retailers do not use all correction factors as described in the NZ Gas Measurement Standard 5259:2004;
d) large variation of UFG exists between networks;
e) fixing of metering and billing errors does not always happen;
f) lack of standardised estimation methodology, (e.g. weather based);

3.4 Reconciliation Code

a) the Code does not clearly define UFG;
b) a clear definition of UFG is required as distinct from imbalance, physical loss, etc;
c) the Reconciliation Code has not been reviewed since 2000;

3.5 Industry Relations

a) downstream (distribution) reconciliation is not co-ordinated with upstream (transmission) reconciliation;
b) unclear responsibilities;
c) the regulatory role of GIC;
d) the inability of the industry to agree;
e) GIC is not in the position to check the allocation prepared by the Allocation Agent;

f) Confidentiality if gate station data were published;

3.6 Data Accuracy

a) data provided by Retailers is not accurate;
b) meters are not read often enough;
c) large seasonal variation of UFG;
d) loss of historic data after switching of retailers;
e) timing of wash-ups;
f) conversion factors are incorrectly applied;

3.7 Allocation

a) some Retailers believe that the allocation by the Allocation Agent has errors;
b) calculations between Retailers and the Allocation Agent are different because of the use of differing formulae;
c) data provided to the Allocation Agent is not correct;
d) UFG is mainly caused by Retailers and not by network operators;
e) Wash-ups should include upstream UFG;

3.8 Transparency

a) the accuracy of gate station meters plays a significant role on the UFG of a distribution network, and metering errors and recalibrations need to be disclosed
b) disclosure of UFG is currently not required;
c) alignment of data from Maui and Vector will lead to greater transparency;
d) disclosure of gate station data including UFG, TOU/Non-TOU quantities is desired;

3.9 Quality Assurance

a) billing data is incorrect and inconsistent;
b) the billing by Retailers needs to be auditable and audited at regular intervals;
c) insufficient quality assurance is in place on meter management and billing;

3.10 Compliance Cost

a) cost of increased data retrieval could be high;
b) there is a lack of resources in the NZ gas industry.

4.0 Regulations in Overseas Gas Markets

4.1 United Kingdom

The United Kingdom (UK) was one of the first countries to deregulate its gas industry, and no doubt the New Zealand energy industry reform has been inspired by the UK example.

In the UK, OFGEM is the regulatory body for the electricity and gas markets. The role of OFGEM is similar to that of GIC and the Electricity Commission in New Zealand, however it has a much wider scope, including price control (where applicable), security of supply, harmonisation with European legislation and renewable energy.

OFGEM has a good web-site, where a large number of publications can be found that describe relevant rules and regulations of the industry. We browsed through a number of documents and found some concepts that might be applicable to New Zealand with regard to UFG. These are listed below. Overall, we believe that the British regulations on the allocation of UFG cannot simply be adopted because of the many differences of the markets and regulations.

The below listed references to web sites is for information only. They may be useful to GIC or interested parties from the NZ gas industry, who wish to study the UK regulations in further depth:

i) Review of Reconciliation by Difference (RbD) of 31 March 2006:
http://ofgem2.ulcc.ac.uk/temp/ofgem/cache/cmsattach/14554_RbD_FinalV1.1.pdf

ii) Code of Practice for Meter Asset Managers:
http://ofgem2.ulcc.ac.uk/temp/ofgem/cache/cmsattach/5176_MAMCoP_Final.pdf?wtfrom=/ofgem/work/index.jsp&section=/areasofwork/metering/metering

iii) Uniform Network Code – Transportation Principal Document, Section N – Shrinkage, Joint office of Gas Transporters, V2.0, 1 January 2006:
http://www.gasgovernance.com/NR/rdonlyres/2FD6465A-618F-4521-9BEF-A3172837AA2E/8223/02_15_TPDN.pdf

The concepts that we found useful for the New Zealand UFG allocation were the following:

a) disclosure of UFG by distribution network;
b) the use of a Reconciliation Code;
c) a Universal Network Code;
d) the application of an annual UFG factor per network throughout one year;
e) the principle of mandating the use of uniform meter asset management practices.

From our study of UK publications, the “shrinkage” factor, which accounts for the physical losses and theft, is for most networks below 1%.

UFG as it is defined in New Zealand is similar to the UK concept of shrinkage. The allocation of shrinkage, as proposed by OFGEM in the above reference i) is similar as proposed in this paper, on

an annual basis by network or Local Distribution Zone (LDZ). It appears that OFGEM has not made a decision on the reconciliation of gas since its issue of the Consultation Paper of 31 March 2006.

4.2 Australia

In Victoria, the Essential Services Commission regulates the gas market and open access to gas transportation networks. A reference relating to the treatment of UFG can be found in:

Gas Distribution System Code, dated 28 March 2007:
http://www.esc.vic.gov.au/NR/rdonlyres/6D5B6C1E-BB1A-4633-950C-88D186E88F13/0/CODGasDistributionSystemCode_version81_Final20070330CORRECTVERSION.pdf

With regard to UFG, this code regulates the relationship between the distribution company and the Retailer. Distribution networks have UFG benchmarks that are listed in the code. They range between 3 and 4.5% and reflect the different leakage rate of the distribution networks. The Melbourne networks have a large percentage of old cast iron mains that tend to leak more than modern plastic pipelines used in New Zealand. If the UFG is greater than the given benchmarks, the distribution company has to account for it.

4.3 Canada / USA

We have not studied the North American situation in depth. One interesting paper that we found was:

Unaccounted-For-Gas Allocation Methodology, Alberta Energy and Utilities Board, 9 May 2003:
http://www.eub.gov.ab.ca/bbs/documents/decisions/2003/2003-042.pdf

This paper referred to average UFG in North America to be 0.5% for gas transmission pipelines and 2.15% for distribution networks.

These figures confirm what we would have expected in New Zealand for transmission and distribution networks (prior to de-regulation).

5.0 Quantification

5.1 Billing Errors Causing UFG

Errors can occur on individual accounts and can be significant on small networks. This becomes particularly clear when looking at the table in Appendix 8.2. For example, the Matangi gate station, a small NGC/Vector network with 100% non-TOU meters has a UFG of -83%, which suggests that the meter at the gate station has been defective. Possible reasons could be the meter not turning freely or the meter being over-rated for the actual, small quantity passing through it and gas simply “slipping” through the meter without being registered.

The following list is an estimate of the error potential caused by technical or administrative malfunctions.

a) Meter calibration error: (residential +3% … – 6%, commercial +/- 3%, large meters +/- 1.5%)
b) Meter Operational Fault: -5 … +100%
c) Temperature conversion: -3 …… + 5%
d) Pressure Conversion: +/- 1.5% …. +/- 100%
e) Altitude Conversion: +/- 1.5%
f) Joule-Thomson Conversion: 0 …. 0.5%
g) barometric variations (e.g. mean pressure vs standard pressure): +/- 1%
h) Compressibility conversion +/- 0.25%
i) Variation of composition (CV): +/- 1.5%
j) Volume estimation: +/- 100%
k) Meter reading error: +/- 100%
l) Setting up error of conversion factor in billing system: +/- 100%, combination of the above
m) Theft: 0 … 100%
n) Flow rate per installed meter capacity (e.g. high UFG at very low flow rates): 100%;
o) Fixed pressure factors and regulator settings: residential - +/- 1%, industrial - +/- 100%
p) Setting of correction devices: +/- 100%

This list is not comprehensive and mainly focuses on the technical side of the billing process. It demonstrates the variety and potential magnitude of metering errors and shows areas of relativly large or small risks. The management of the metering errors is mainly in the hands of the few meter technicians of the meter owners.

A similar exercise could be carried out on the process steps of the administrative side of the billing.

From the above table, one might get the impression that gas metering is not a very precise technology; however, the practical experience suggests the opposite. The technology has matured over more than 100 years and the industry is very confident in handling the potential faults. Having said this, the available human resource is thinly spread, which is an inherent risk in the New Zealand gas industry.

5.2 Total UFG per year in NZ

As shown in Appendix A, the annual average UFG figures for all of NZ's gas distribution networks was 2.45 % in 2006. This was based on the total volume measured at the gate stations and the total gas quantities billed. The data was provided by the Reconciliation Agent, Tom Tetenburg Associates. We believe that this is an important benchmark for the industry and should be published for long-term statistics.

Open access took effect in about 2002 and reasonable data became available in about 2004. This is from our observation the earliest time that statistics on annual UFG could reasonable be calculated under the new regime. Irrespective of the gap during the first years of open access, UFG statistics from the era of regulated gas markets can be used for comparison.

We believe that a national benchmark of +/- 2% is achievable and encourage GIC to work towards this goal.

5.3 UFG per Gate

Appendix B shows the UFG per gate station, sorted by Retailers and by annual quantity. Some interesting points from that table are:

a) the quantities sold by gate station, Retailer, TOU meters and non-TOU meters;
b) the large variation of UFG between the gate stations;
c) some extreme UFG of above 80%;
d) some large networks (Wellington) have UFG of nearly 8%.

We believe that this level of information is not too much for disclosure and that this is the minimum required to start identifying audits and quality improvements.

Data is available to go to further detail such as the annual volume by Retailer per gate, which could in our opinion also be disclosed. We believe that this is well within the meaning of the Gas Information Disclosure Regulations and recommend consulting the industry about it.

6.0 Discussion on Technical Issues

The following is a brief discussion on some of the technical issues to explain the need for quality assurance in gas meter management. The discussed issues are examples and do not cover the entire range of metering and billing issues.

6.1 Metering Accuracy

One of the key ingredients in the metering of the gas volume are the meters. These are technical devices with moving parts that are driven by a very small differential pressure between the gas upstream and downstream of the meter. The volumetric errors are typically below 1%, but this can increase for example with age, lack of maintenance or insufficient throughput. Proper meter management therefore includes regular recalibration, maintenance and proper sizing in accordance with the expected and measured flow.

6.2 Pressure Correction

The physical principle is the volumetric change of gas caused by pressure. The basis is standard atmospheric pressure of approximately 1 bar or 100 kPa. Low pressure residential meters for example operate at 2 kPa above atmospheric pressure, which would require a pressure conversion factor of 1.02, as the volume is reduced by about 2%. The regulator controlling this pressure may fluctuate between 1.5 and 2 kPa and could therefore create a difference of 0.5% depending on the flow rate of the gas passing through the meter.

Industrial meters may operate at 100 kPa above atmospheric pressure, which means their absolute pressure is 200 kPa. This would require a fixed factor of 2.0 as the gas has approximately half the volume of what it would have at standard, atmospheric pressure. A pressure drop at the regulator or an incorrect setting could be as high as +/- 5%, which would have much greater impact on the overall UFG as a residential meter.

This is an illustration for the argument by some Retailers that the TOU meters cause greater UFG.

6.3 Temperature Correction

The reference temperature for gas metering in New Zealand is 15^{o}C. This is approximately the average temperature in New Zealand throughout the year. Air and ground temperatures fluctuate by geographic location, season and daily temperature changes. Most gas is consumed during the winter months, when and where it is coldest.

Up to the early 1990s, temperature was not compensated for most residential gas consumers. For example, gas consumed in Wellington on a cold winter night with air/ground temperatures of 6^{o}C would have caused the gas passing the meter to have a 3% smaller volume compared with standard conditions and would have caused the gas to be under-billed by that amount.

The temperature correction factor fluctuates over seasons, days and hours and has the greatest potential for being incorrectly used. The billing system should have stored a continuous temperature profile and calculate the correction factor for each individual billing period. The calculation of the temperature correction factor should be part of the proposed “Standard Billing Methodology”.

6.4 Data Conversion and Transfer

The NZ metering standard NZS 5259:2004 explains the calculation of correction factors. However, it is up to the Retailer to apply the factors. For example, the standard explains the physical relationship between temperature and the correction factor in a formula. However, it does not prescribe where, when and how often to measure the actual gas temperature. Retailers have been approaching this in different ways and some may not apply a temperature correction factor at all.

Even where a Retailer has a policy of applying correction factors as proposed in the metering standard, errors can occur along the chain of information from the meter design, to the installer, the setting up of the billing system and the final calculation and allocation of the account.

We have therefore recommended a **Standard Billing Methodology** for the purpose of equitability between all accounts.

7.0 Discussion on Industry Issues

7.1 Perceptions by Retailers / Consumers

It is human nature that we suspect others to make mistakes and we rarely look at our own in particular, when it would disadvantage us. The same perception can be found throughout the stream of arguments by the industry. Often these perceptions are based on anecdotal evidence rather than facts.

New Zealand being a small nation with limited resources will never be able to afford complex systems as used in larger countries. Therefore, gas billing and reconciliation is likely to have greater

tolerances than systems in Europe for example. Having had the advantage of later development, New Zealand has modern pipeline networks, which make up for some of the imperfections of the billing systems in place.

Despite this, we believe that a UFG outside the +/- 2% band is unacceptable, and the respective industry parties should make an effort to improve their quality assurance procedures.

7.2 Allocation Calculations

The greatest concern of the industry is data accuracy. To a large extent, this is in the hands of the Retailers and includes the metering, data processing and the timeliness of information. Historically, the industry has a few years of experience now and should be settled to work on the quality aspects of their systems.

Some concerns have been raised that the Allocation Agent and some Retailers use different formulae for the calculation of UFG. This suggests that existing definitions are insufficient as they seem to allow different interpretation.

This is why we propose the development of Standard Billing Methodology.

7.3 Disclosure

The first step and probably the most effective one towards improving data quality and meter management is the disclosure of the UFG by network as outlined in Appendix B. It will challenge the affected parties to identify errors and should improve the overall result over time. It provides and overview of the New Zealand gas distribution and lets GIC or independent auditors focus on critical issues.

7.4 Audits

It appeared that audits on metering and billing systems have not been carried out since the advent of Open Access. Tom Tetenburg once attempted to audit a small network but had to give up due to a lack of co-operation by Retailers and lack of information.

We recommend that GIC start the process of auditing soon to identify weaknesses in the billing systems and to develop a Standard Billing Methodology on the basis of this experience.

7.5 Role of GIC

With regard to UFG, Retailers appear to seek clarification and improved billing accuracy. GIC has a neutral role and is therefore in a position to drive the improvement processes.

8.0 Recommendations

8.1 Definition

Recommended Rules:

1) UFG in the meaning of *long-term* unaccounted for gas as previously referred to in the Reconciliation Code of 2000 is defined as **annual UFG**.
2) UFG includes leakage, theft, operational use of gas, metering errors, data transfer errors, database system errors and all inaccuracies of the billing methodology.
3) The monthly variation of over- or under-billed accounts, mainly caused by uneven meter reading cycles, does not fall under the definition of UFG; a term like "monthly variation" may be used instead.
4) UFG is the difference between energy quantities entering a network at its gate stations and the energy quantities having passed through that network and being accounted for as a percentage of the quantity measured at the gate station.
5) The UFG figure is positive for losses and negative for gains.

Explanation:

We found that UFG is not clearly defined in the Reconciliation Code as well as in the various applications. The industry sought clarification.

8.2 Calculation

Recommended Rules:

6) The (annual) UFG is determined by the Reconciliation Agent for each distribution network at a specific date once per year.
7) This date is chosen for maximum data accuracy, e.g. at the end of the summer season, when monthly variations have the least impact on the annual UFG figure.
8) Where a distribution network has more than one delivery point, the UFG of that network is related to the aggregated energy quantities passing through the respective delivery points; in the annual UFG table, these delivery points are identified together with the network that they belong to.
9) The (annual) UFG of a particular network is based on actual meter readings, e.g. 12 monthly readings or six two-monthly readings for the respective customer groups; estimated accounts shall **not** be used for the determination of UFG.
10) The conversion from meter reading to energy quantity is based on NZS 5259:2004 and a "**Standard Billing Methodology**" that is to be applied by all retailers; this billing methodology will describe the conversion process and include daily and seasonal variations; the standard methodology will be auditable.

Explanation:

The calculation of UFG is in principle a simple comparison between energy sales and purchases. The greatest problem has been the aggregation of energy quantities at a particular time, e.g. month end,

as not all meters can be read at that one time. The incumbent retailers, who had most of the non-TOU meters, had to base their monthly data on estimates.

Customers are billed on actual meter readings, and this is the only, clearly defined basis for accurate metering and billing. We have therefore recommended that UFG is also based on actual meter readings, even if the exact timing of the readings does not fall on one day. Retailers can arrange their meter reading in a way that guarantees all customers having the correct amount of meter readings per "UFG year", i.e. 12 monthly readings or six two-monthly readings. Even if for unforeseen reasons some meters were read outside the planned metering cycle, the risk of error would be small if the "UFG year" ended in summer, when gas consumption is smallest, particularly during the holiday season in January.

Most correction factors do not change throughout the year, however, the temperature correction factor does. It is quite feasible for billing systems to have installed a "daily temperature correction factor". This would be based on typical temperature measurements in a network and would be related to monthly or two-monthly meter readings at their given dates. We understand that the two mass-market Retailers have based their monthly temperature correction factor on average temperatures provided by meteorological agencies. We are not aware of Retailers preparing temperature checks on pipelines or meters, or check-metering entire suburbs or large groups of non-TOU meters. This could deliver proof of accurate temperature correction.

A Standard Billing Methodology as proposed would describe a uniform billing process and would provide equitable billing results.

8.3 Allocation

Recommended Rules:

11) The (annual) UFG is equally allocated to all accounts, to those with TOU devices and to those without as a fixed factor on energy; the UFG factor is an additional component of the Standard Billing Methodology, which converts meter reading to energy quantity.
12) It is up to the Retailers to estimate monthly accounts for the purpose of billing, however, the allocation and reconciliation of (annual) UFG is to be based on actual meter readings and the conversion is to be in accordance with the Standard Billing Methodology.
13) The fixed annual UFG Factor will substitute the Loss Factor that has been used for monthly allocations by the Allocation Agent; the Loss Factor has been applied to multiple networks of entire regions without change since 2002.
14) After the end of each UFG year, the difference between UFG from the previous year and the actual UFG from the past year is calculated by the Allocation Agent and the balance is equally allocated to all accounts by energy quantity and debited or credited to the respective parties together with the first monthly account of the new "UFG-year".

Explanation:

The simplest allocation of UFG is by energy quantity. This is to our knowledge the most common allocation methodology around the world. The UFG percentage simply becomes a factor on the meter reading and can be calculated in the same way as other correction factors.

This equal (global) allocation of UFG is based on the assumption that billing errors for TUO and non-TOU meters are similar. Retailers appear to argue both ways but have not provided evidence for their

arguments. We therefore recommend equally allocating UFG until relevant evidence has been provided.

8.4 Quality Assurance

Recommended Rules:

15) **UFG is disclosed by network** in a table that is sorted in a clear and concise manner similar to Appendix B; this table includes the names of the network owners, annual quantity and UFG in GJ, UFG in % of annual quantity, annual quantity in GJ of TOU accounts and the relative portion of TOU accounts.
16) The UFG calculation **must be auditable** for each individual account; retailers that use estimates for monthly billing purposes shall reconcile the accounts at the end of the "UFG-year".
17) For control purposes and in addition to the annual UFG, the Monthly Variation and the 12-month rolling UFG is disclosed for each network and for every calendar month.
18) **Novagas** has the same rights and obligations as other Retailers with regard to UFG allocation.
19) TOU **check meters** are to be installed upstream of large groups of consumers with non-TOU metering devices, where this is feasible and the annual consumption is greater than 50 TJ.

Explanation:

UFG is, to a degree, an indicator for the quality of the billing systems of Retailers sharing a distribution network. All parties sharing a network, including the transmission company, have an interest in UFG being small, as metering and billing errors of one party have a direct impact on the profitability of the others. All parties therefore want to know the UFG of the networks that they use, and the disclosure of UFG by network will give them the answer.

The disclosure of UFG is in our opinion the most effective driver for parties sharing a network to investigate the causes of that UFG. A list like in Appendix B gives a quick overview of the magnitude of UFG and its commercial impact.

Retailers and Customers want to have confirmation that the data provided and the calculations by the Allocation Agent are correct and can be traced. The only way to prove this is by independent audit.

Some retailers have concerns about UFG possibly being caused by Novagas. We believe that Novagas should therefore undergo the same scrutiny as any other retailer.

Check meters can quickly verify the correct monthly allocation and annual UFG calculation. While individual consumers with annual gas consumptions above 10 TJ are obliged to have TOU meters, large groups of non-TOU meters do not currently have such an obligation. The obligatory installation of check meters for non-TOU customer groups would provide valuable feedback on the accuracy of the billing process and the recommended threshold of 50 TJ would be a conservative, first step.

Appendix A – Unaccounted for Gas Allocation Summary

GIC: UFG Allocation Analysis as at 30.9.2006

UFG%s Summary - All Gates - TOU vs nonTOU

Data Prepared by:	Tom Tetenburg
Data Prepared on:	9/05/2007
Gas Year	as at end of Sep06
Analysis by:	Guenter Wabnitz, Maunsell
Date:	10.5.2007

Analysis by Network Owner:

Distribution Networks	AQ GJ	AQ %/Total	UFG GJ	UFG %/Total	**UFG % AQ**	TOU % of GJ
Vector (Auckland)	**12,306,003**	38.96%	**310,130**	40.08%	**2.52%**	56.52%
Powerco	**9,463,628**	29.96%	**385,494**	49.82%	**4.07%**	55.36%
GasNet	**1,041,164**	3.30%	**-68**	-0.01%	**-0.01%**	72.10%
Vector (NGC)	**8,775,434**	27.78%	**78,293**	10.12%	**0.89%**	74.67%
Nova Gas (?)						
Total Reconciled	**31,586,229**		**773,849**		**2.45%**	61.73%
Nova Gas not incl						
Total Sales NZ in GJ	**150,000,000**					
estimated						
Share of Distribution	**21.06%**					

Appendix B – Unaccounted for Gas by Distribution Network

GIC UFG Allocation Analysis as at 30.9.2006

UFG%s Summary - All Gates - TOU vs nonTOU

Data Prepared by: Tom Tetenburg
Data Prepared on: 9/05/2007
Gas Year as at end of Sep06

Analysis by: Guenter Wabnitz, Maunsell
Date: 10.5.2007
9/05/2007

-ve = gain
+ve = loss

	UFG%	TOU%	non-TOU%		Annual Gate Q	UFG (GJ)	UFG (%)	TOU (GJ)	TOU (%)
Vector Networks									
Gr. Auck	2.59%	54%	46%		11,886,717	307,531	2.59%	6,415,581	53.97%
Hunua	0.96%	93%	7%		142,694	1,371	0.96%	132,072	92.56%
Tuakau	-0.71%	98%	2%		140,155	-994	-0.71%	137,258	97.93%
Pukekohe	2.06%	38%	62%		42,342	873	2.06%	15,952	37.67%
Drury	-5.56%	34%	66%		41,717	-2,318	-5.56%	14,226	34.10%
Ramarama	7.64%						7.64%		
Waitoki Int.	12.21%	0%	100%		15,488	1,891	12.21%	0	0.00%
Alfriston	1.23%			10 mths			1.23%		
Kingseat	-7.58%						-7.58%		
Total Vector Networks					**12,306,003**	**310,130**	**2.52%**	**6,721,491**	**54.62%**

Powerco	UFG%	TOU%	non-TOU%	Annual Gate Q			TOU GJs	
TawaA	7.88%	31%	69%	1,809,410	142,534	7.88%	564,617	31.20%
Hastings	3.89%	73%	27%	1,655,266	64,453	3.89%	1,209,305	73.06%
Belmont	4.97%	28%	72%	1,611,906	80,096	4.97%	453,338	28.12%
Palm North	4.22%	25%	75%	973,486	41,120	4.22%	240,011	24.65%
New Plymouth	3.15%	31%	69%	752,192	23,694	3.15%	232,871	30.96%
Hawera	-0.09%	75%	25%	424,291	-373	-0.09%	316,973	74.71%
Pahiatua	0.05%					0.05%		
Feidling	1.62%	72%	28%	335,360	5,436	1.62%	242,587	72.34%
Levin	6.54%	47%	53%	312,513	20,453	6.54%	148,206	47.42%
Waitangirua	-4.96%	16%	84%	280,593	-13,908	-4.96%	44,767	15.95%
longburn	5.00%	86%	14%	254,190	12,711	5.00%	219,690	86.43%
Eltham	0.86%	88%	12%	164,525	1,422	0.86%	144,236	87.67%
Dannevirke	-0.01%	92%	8%	143,765	-17	-0.01%	132,808	92.38%
Waitara	10.76%	19%	81%	70,221	7,554	10.76%	13,657	19.45%
Stratford	0.15%	22%	78%	63,863	97	0.15%	14,000	21.92%
Foxton	0.61%	72%	28%	55,652	341	0.61%	39,920	71.73%
Kapuni Lactose	-4.13%					-4.13%		
Waverley	0.19%					0.19%		
Manaia	5.56%	68%	32%	20,134	1,119	5.56%	13,636	67.73%
Inglewood	-5.16%	0%	100%	19,000	-980	-5.16%	0	0.00%
Patea	2.85%	70%	30%	16,272	463	2.85%	11,331	69.64%
Opunake	-2.03%					-2.03%		
Ashhurst	0.62%	0%	100%	7,724	48	0.62%	0	0.00%
Oroua Downs	-3.16%					-3.16%		
Oakura	19.99%					19.99%		
Kairanga	6.40%					6.40%		
Okato	9.35%					9.35%		
Kaponga	-82.79%					-82.79%		
Total Powerco Networks				**9,463,628**	**385,494**	4.07%	**4,501,434**	47.57%

GasNet	UFG%	TOU%	non-TOU%	Annual Gate Q			TOU GJs	
Wanganui	-0.56%	54%	46%	791,106	-4,431	-0.56%	427,260	54.01%
Marton	2.90%	82%	18%	200,868	5,826	2.90%	163,853	81.57%
Lake Alice	-5.54%					-5.54%		
Waitotara	-0.36%					-0.36%		
Total GasNet Networks				**1,041,164**	**-68**	-0.01%	**633,921**	60.89%

NGC Networks	UFG%	TOU%	non-TOU%		Annual Gate Q			TOU GJs	
Gr. Hamilton	3.80%	33%	67%		1,451,599	55,107	3.80%	477,704	32.91%
Edge DF	-1.64%						-1.64%		
Taupo	1.25%	87%	13%		950,577	11,891	1.25%	826,526	86.95%
Gr Mt Maunganui	-3.95%	80%	20%		799,926	-31,610	-3.95%	641,906	80.25%
Reporoa	1.50%						1.50%		
Cambridge	-0.21%	89%	11%		408,898	-842	-0.21%	364,905	89.24%
Rotorua	4.79%	32%	68%		408,439	19,584	4.79%	132,117	32.35%
Gisborne	2.61%	57%	43%		372,522	9,722	2.61%	212,841	57.14%
Harrisville	-1.38%			10 mths			-1.38%		
Whakatane	-1.92%	92%	8%		278,013	-5,336	-1.92%	255,734	91.99%
Waitoa	0.47%						0.47%		
Tauranga	1.78%	19%	81%		252,692	4,492	1.78%	47,759	18.90%
DruryB	-0.83%						-0.83%		
Warkworth	3.52%	90%	10%		184,003	6,477	3.52%	165,542	89.97%
Whangarei	4.34%	38%	62%		160,807	6,974	4.34%	61,543	38.27%
Paraparaumu	8.61%	0%	100%		133,259	11,475	8.61%	0	0.00%
Horotiu	2.24%						2.24%		
Putararu	2.52%	84%	16%		103,328	2,600	2.52%	86,666	83.87%
Te Kuiti South	0.24%						0.24%		
Te Awamutu	-2.74%	30%	70%		91,943	-2,518	-2.74%	27,567	29.98%
Huntly	0.51%	87%	13%		72,374	366	0.51%	62,878	86.88%
Waitoki	2.35%						2.35%		
Tokoroa	1.51%	17%	83%		62,774	946	1.51%	10,855	17.29%
Waikanae	4.84%	0%	100%		51,469	2,492	4.84%	0	0.00%
Morrinsville	-2.52%	30%	70%		45,576	-1,149	-2.52%	13,539	29.71%
Te Kuiti North	3.47%	0%	100%		27,013	937	3.47%	0	0.00%
Te Puke	3.89%						3.89%		
Kinleith Dist	-4.42%						-4.42%		
Otaki	-1.17%						-1.17%		
Kawerau Dist	0.94%	0%	100%		11,280	106	0.94%	0	0.00%
Otorohanga	2.17%						2.17%		
Opotiki	-12.89%						-12.89%		
Tirau	-4.22%						-4.22%		
Ngaruawahia	-70.37%						-70.37%		
Pirongia	24.60%						24.60%		
Paekakariki	8.83%						8.83%		
Matangi	-83.75%						-83.75%		
Edge Dist	-80.72%	0%	100%		124	-100	-80.72%	0	0.00%
Total NGC/Vector Networks					**8,775,434**	**78,293**	0.89%	**6,125,615**	69.80%
Total NZ Networks					**31,586,229**	**773,849**	2.45%	**17,982,462**	56.93%