Final Audit Report:

Event audit to identify sources of UFG in respect of Tawa A gas gate for May 2009 & June 2009

Audit commissioned by Gas Industry Co under rule 66 of the Gas (Downstream Reconciliation) Rules 2008

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1 Background

1.1 Circumstances giving rise to the event audit

The initial allocation of Tawa A (TWA35610) gas gate for May 2009 resulted in very high unaccounted for gas (UFG). The gas injected at the gate was 249.6 TJs. The sum of the retailers' allocation data (as submitted to the Allocation Agent) was 196.5 TJs, leaving 53.1 TJs unaccounted for (21.3%). This meant that the Allocation Agent had to scale non-TOU data provided by retailers for Allocation Groups 4 and 6 by a factor of 1.337509.

Similarly, the initial allocation for June 2009 resulted in very high UFG. The gas injected at the gate was 277.5 TJs. The sum of the retailers' allocation data (as submitted to the Allocation Agent) was 236.5 TJs, leaving 41.0 TJs unaccounted for (14.8%), and a scale factor for non-TOU data of 1.20517.

Several retailers were concerned about these scale factors and contacted Gas Industry Company (GIC) regarding a possible investigation into the cause(s) of this high UFG. The GIC decided to initiate an event audit of this matter under rule 66 of the Gas (Downstream Reconciliation) Rules 2008.

1.2 Auditor

GIC commissioned Tetenburg & Associates Ltd to carry out this event audit under Terms of Reference dated 20 July 2009.

Tom Tetenburg is the auditor responsible for this audit. No other persons were used to perform this audit.

1.3 Objective

The objective of this event audit was to investigate the possible cause(s) of excessive UFG at the Tawa A gas gate (TWA35610) for the consumption periods of May and June 2009.

1.4 Methodology and scope

ICPs examined

The number of ICPs at the Tawa A gas gate is approximately 28,000 (with meters).

In order to make the audit achievable, the number of ICPs to be examined were limited to only those ICPs that:

- have a meter size greater than or equal to an AL425 (or equivalent); and
- use greater than 1 TJ per annum.

By limiting the number of ICPs in this way, all domestic users and small commercials users were excluded. This approach also meant that retailers were not asked to provide information for an excessively large number of ICPs, which would have been cost-prohibitive and time-consuming to gather.

Scope of the investigation

As anticipated under the Terms of Reference, the following matters were investigated as part of this event audit:

- material under-submission of estimated consumption for non-TOU sites;
- metering set-up errors in billing/reconciliation systems;
- metering equipment malfunctions and/or inaccuracies at gate metering or medium-large commercial sites;
- medium-large commercial sites not being billed;
- medium-large commercial sites incorrectly flagged as de-energised or decommissioned.

These matters were investigated using the following approach:

- gathering data from allocation participants (meter owners, retailers, distribution and transmission system owners) as well as from the gas registry and the allocation system and cross-checking so as to identify any discrepancies. For example, variations between:
    - metering parameters in meter owners' systems and the corresponding parameters in retailers' systems;
    - aggregate as-billed volumes for a retailer compared with submission quantities.

The scope of my investigation is consistent with the Terms of Reference for this event audit, but was limited so as to focus on important matters and avoid time being wasted by gathering less important information. Accordingly, some less-relevant matters listed in the Terms of Reference were not investigated, but the GIC was kept informed during the audit process, and changes to the scope were agreed during the course of my investigation.

1.5 Terminology

Retailers were requested to provide the auditor 3 data sets for comparison: "As Billed", "Allocation" and "Network Billing" GJs, for the previous 24 months, for the ICPs supplied by meter sets > or = AL425 and using > 1 TJ pa.

In this report, the terms “As Billed data”, “Allocation data”, and “Network Billing data” all refer to the data as submitted to the Auditor.

Any reference to data provided to other parties in the industry will be clarified in this report as either:

- the allocation data (as submitted to the Allocation Agent), or
- the network billing data (as submitted to the Distributor).

References to the “rules” are to the Gas (Downstream Reconciliation) Rules 2008, unless stated otherwise.

“MPE” means maximum permissible error.

1.6 Information provided by retailers

The following comments provide detail regarding the extent to which information was provided to the auditor, as well as noting areas for improvement in record-keeping by retailers.

While I do not consider that any retailers failed to comply with their obligations under rule 69 to provide information to the auditor, I note that retailers provided data sets of varying degrees of completeness. Some provided the whole 24 months requested. Others provided only the last 12 months’ data, and others chose to only provide data for October 2008 to June 2009 (the period covered by the new rules). Changes to retailers’ computer systems meant that some data was difficult to access (from old systems, or archives), and this resulted in gaps in datasets.

These information gaps have frustrated the audit process, however I have tried to identify trends and possible UFG sources from the information received.

Some ICPs were in the wrong Allocation Group (ie in Group 6 when using more than 250 GJs per annum). This meant that, for some retailers, my initial request for information did not capture all the meters ≥ to AL425 (as these had incorrectly been assumed to be contained within Allocation Group 4). Another request had to be made for the missing information, thus causing delays in obtaining all the necessary data.

During the course of this audit, it was also found that several retailers did not provide information on ICPs for customers who have switched to other retailers. This resulted in an inability to check for step changes at some switches.

As future audits are inevitable (and retailers have record-keeping obligations under rule 28.4), it is recommended that retailers review the way their data is

stored so that delays in accessing data are minimised, and that records are maintained in a complete and accurate manner.

1.7 Draft Audit Report

A Draft Audit Report was circulated for comment to GIC, the Allocation Agent, and all allocation participants in accordance with rule 70 of the Gas (Downstream Reconciliation) Rules 2008, on 19 November 2009.

Before preparing the Final Audit Report, I took into account all comments received on the Draft Audit Report. Where comments provided additional information or sought clarification on points raised, I have addressed these issues in the Final Audit Report. I have not addressed comments that are matters of opinion or raise issues outside the scope of the audit.

2 Findings

2.1 Summary of Findings

UFG found as a result of interim allocation

While the audit was underway, the Allocation Agent performed the interim allocations. For May 2009, the sum of the retailers' interim allocation data (as submitted to the Allocation Agent) was 227.8 TJs, leaving 21.8 TJs of unaccounted for gas (ie 8.7%). At the time of the initial allocation, 53.1 TJs were unaccounted for (ie 21.3%), so essentially 31.3 TJs were "found" as a result of the interim allocation.

For June 2009, the sum of the retailers' interim allocation data (as submitted to the Allocation Agent) was 253.5 TJs, leaving 24.0 TJs of unaccounted for gas (8.6%). This compares with the 41.0 TJs (ie 14.8%) that were unaccounted for at the time of the initial allocation. So 17.0 TJs were essentially "found" as a result of the interim allocation.

Accuracy of initial consumption information

Rule 37.2 requires that the accuracy of the consumption information provided by the retailer, for the initial allocation as compared to the final allocation, must fall within the percentage of error set by GIC (+/-15%). At this early stage between initial and interim allocations, the change in initial consumption figures for retailers with a large proportion of domestic consumers significantly exceeded 15% (several were in the order of +24% for May 2009). The final allocations for May 2009 and June 2009 will not be known until June 2010 and July 2010. Although it is anticipated that consumption information provided for final allocation by retailers with a large proportion of domestic consumers is unlikely to fall within the percentage of error set by GIC, I do not consider that there has been a rule breach at this time.

Retailers' estimations of allocation quantities for ICPs in Allocation Groups 3-6 are a combination of historic estimate and forward estimate.

There were a variety of methods used by retailers for forward estimating, including:

- flat profile;
- forward projection of the SADSVs shape;
- using last year's SADSVs shape;
- averaging the corresponding months' consumption from the previous 3 years.

None of these methods coped very well with the unseasonably cold weather experienced in May 2009.

Taking out the initial/interim allocation differences, we are left looking for the causes of long-term UFG amounts of 21.8 TJs and 24 TJs for May 2009 and June 2009 respectively.

Under-submission of allocation data by EGas Limited

A key finding of this event audit is that EGas Limited has been understating its allocation figures (ie submitting figures to the Allocation Agent that are significantly different than its As Billed data).

During the course of this audit, sizeable differences were detected between datasets from EGas Limited. Further information was requested, and a visit to their premises to check a small sample of ICPs confirmed the errors. EGas Limited subsequently provided two further revisions of their datasets.

I received the latest revision on 17 December 2009. On comparing this data with the interim allocation data (as submitted to the Allocation Agent), the under-submitted amounts are 8.2 TJs and 9.3 TJs for May 2009 and June 2009 respectively. There also appears to be a long-term issue. Over the 12 month period of October 2008 to September 2009, the difference between EGas Limited's interim allocation data (as submitted to the Allocation Agent) when compared to As Billed data was approximately 12% (ie 34 TJs).

The latest revised data, covering 592 ICPs, has not been verified against invoices. To determine more accurately the amounts under-allocated and contributing to the UFG, I recommend that this be comprehensively investigated as part of a performance audit of EGas Limited.

Gate metering

Late in the audit process, on 2 December 2009, Powerco sent the auditor information from their check metering for Tawa A compared to Vector Transmission Tawa A gate data, for the period May 2009 to November 2009. Analysis of this data shows that the Tawa A gate volume could have been slightly overstated from May 2009 to 6 October 2009 due to a Waitangirua gate meter running slightly fast.

As there is no meter at the Tawa A gas gate, the Tawa A gate volume is calculated as the Waitangirua volume minus the Tawa B volume. Vector Transmission exchanged the Waitangirua gate metering on 6 October 2009. The Waitangirua gate meters removed were tested in December 2009, and Vector Transmission sent copies of the test results to the auditor on 23 December 2009. These results confirm that the Waitangirua gate metering was running slightly fast, and consequently the volumes calculated for the Tawa A gas gate were also slightly overstated.

Since the gate metering exchange, there is a very good correlation with the check metering. Using the percentage difference trend from May 2009 to 6 October 2009, it appears that the gate metering contributed approximately

2.1% and 2.4% towards the UFG at Tawa A for May 2009 and June 2009 respectively.

This matter has only recently come to light. However, I understand that Vector Transmission Metering will be correcting the Tawa A gate volumes shortly. I expect that the gate volumes will be corrected in time for the final allocations.

Conversion to energy

The following summarises my findings in relation to various conversion factors:

The monthly consumption data provided did not show any step changes at switches, nor did I detect any x 10 variations arising from meter changes. However, there are some gaps in the data as some retailers did not provide consumption information for all of the ICPs they had lost during the two year period.

Metering pressures used in retailers' billing systems differ from Meter Owners' records in 57 of 343 ICPs investigated (16.6%), although the differences are in the order of a few kPas. This can still equate to a few percent per ICP, however further analysis may show that the unders balance out the overs.

For a few ICPs, the number of dials to be read differed between retailer and Meter Owners' records. However, when comparing retailer monthly usage information with meter model capacity, the usage appears to be appropriate.

Only two retailers are applying Joule-Thomson effect in addition to their base temperature profile.

Powerco have said that there are approximately 38 sites which are supplied off the 12 bar steel system, although not all of their ICP numbers could be identified from GIS records. This high inlet pressure means that the Joule-Thomson effect could produce a temperature drop of up to 6 degrees Celsius when the metering pressure is reduced to very low pressure(s). Inlet pressures in the registry are all set to 180 kPa at Tawa A by Powerco.

A (TOU) corrector at a large site was found not to be compensating for gas temperature. At another corrector site, the temperature being compensated for was closer to that of the warm metering room interior than the actual gas temperature.

There are only 13 ICPs in Allocation Groups 1 and 2. However, it may be appropriate for more sites to have correctors, as evident from the 38 connections off the 12 bar steel system. This is not necessarily because these ICPs are using > 10 TJs per annum, but because NZS 5259:2004 states that "[f]or large pressure drops or high flow rates it is recommended that the actual temperature drop be measured".

Incorrect altitudes are used in some retailers' billing systems, due to a misunderstanding about how altitude is compensated for. Two retailers believed that the height of the gate station (approximately 200 metres) was the figure they needed to adjust to/for. However, it is the height of each individual ICP above sea level that is to be used in the corresponding Fa calculations. The gate volumes are converted for altitude (back to sea level) as part of the conversion to standard conditions and then converted to energy values.

There are also variations in the way retailers are applying altitude factors. Some retailers are applying altitude in 20 metre bands, starting at 0 metres. One retailer has chosen to not apply altitude for ICPs less than 100 metres above sea level. However, this has resulted in the registry being populated with an altitude of 0 metres for all their ICPs under 100 metres. This can lead to incorrect information being used after ICP switches.

Overall, there is room for improvement in some retailers' processes for conversion to energy. While none of these matters appear to significantly contribute to UFG, I recommend that retailers make corrections in order to make small improvements in UFG and to ensure that customers are being billed more accurately.

2.2 Conversion to energy (section 2.7 of NZS 5259:2004)

Rule 28.2 provides:

> "Every retailer must ensure that the conversion of measured volume to volume at standard conditions and the conversion of volume at standard conditions to energy complies with NZS 5259:2004 for metering equipment installed at each consumer installation for which the retailer is the responsible retailer."

Section 2.7 of NZS 5259:2004 Gas Measurement covers the Conversion of Measured Volume to Standard Value of Energy.

Gas meters only measure the gas volume at the (non-standard) conditions present at the individual gas measurement system. The retailer's billing system contains processes to convert the gas volume to standard conditions, by applying factors for pressure, temperature, altitude, and compressibility. Finally, the calorific value of the gas is applied to convert the gas volume to energy.

Any problems discovered with retailers' conversions within their billing systems would contribute to long-term UFG. Each of these conversion factors is examined in Section 1 of Appendix 1.

As part of my audit of UFG, I examined the following conversion factors:

- Pressure factor (Fp, MPE +/- 1.5%);
- Temperature factor (Ft, MPE +/- 1.5%);
- Joule-Thomson effect;
- Altitude factor (Fa, MPE +/- 1.5%);
- Compressibility factor (Fz, MPE 0.25%);
- Calorific value.

A full explanation of my findings in relation to each of these conversion factors is set out in Section 1 of Appendix 1 (**attached**).

During my investigations, I found that there were some areas for improvement, including the following:

- Cross checking of retailers' metering pressures with meter owners' records (as metering pressures used in retailers' billing systems differ from Meter Owners' records in 57 of 343 ICPs investigated (16.6%)).
- Possible improvement in temperature measurement (for correctors), application of ground temperature profiles, and application of Joule-Thomson effect (or corrector installation).
- Application of correct formulae and/or altitudes to determine accurate altitude factors.

Such improvements will assist in reducing UFG, although the GJ amounts involved are not material. However, these improvements will also assist in ensuring that customers are being billed more accurately.

2.3 UFG found as a result of interim allocation

While the audit was underway, the Allocation Agent performed the interim allocations.

For the May 2009 interim allocation, the sum of the retailers' allocation data (as submitted to the Allocation Agent) was 227.8 TJs, leaving 21.8 TJs of unaccounted for gas (i.e. 8.7%). This compares with the 53.1 TJs (21.3%) that were unaccounted for at the time of the initial allocation. So, 31.3 TJs were essentially "found" as a result of the interim allocation for May 2009.

For the June 2009 interim allocation, the sum of the retailers' allocation data (as submitted to the Allocation Agent) was 253.5 TJs, leaving 24.0 TJs (8.6%) of unaccounted for gas. This compares with the 53.1 TJs (14.8%) that were unaccounted for at the time of the initial allocation. So, 17.0 TJs were essentially "found" as a result of the interim allocation for June 2009.

Accuracy of consumption information for initial allocation

For retailers with a large proportion of domestic consumers, the change in their initial consumption figures significantly exceeded the +/-15% of error for the accuracy of consumption information (albeit that the accuracy requirements under rule 37.2 relate to the comparison between information provided for initial and final allocations). Several of the changes were in the order of +24% for May 2009.

Retailers' estimations of allocation quantities for ICPs in Allocation Groups 3-6 are a combination of historic estimate and forward estimate.

There were a variety of methods used by retailers for forward estimating, including:

- flat profile;
- forward projection of the SADSVs shape;
- using last year's SADSVs shape;
- averaging the corresponding months' consumption from the previous 3 years.

None of these estimation methods coped very well with the unseasonably cold May temperatures experienced this year.

The following table shows the Allocation Group 4 and 6 aggregated changes in GJs and as a percentage between initial and interim allocations, across all parties, for May 2009. I note that, because the percentage change for the initial to final comparison will use the final as the base figure (under rule 37.2), I have used the interim figure as the base in Table 1 below.

Table 1. Comparison of Initial and Interim Allocation Data (as submitted to the Allocation Agent)

	GJs	Initial	Interim	Diff	Diff%
VCTX	Injection	249611	249586		
AGCL	All Grp 4	11714	12941		
AGCL	All Grp 6	14150	21224		
AGCL	Total	25864	34165	8301	24.3%
CTCT	All Grp 4	11571	14378		
CTCT	All Grp 6	34025	45695		
CTCT	Total	45596	60073	14477	24.1%
EDNZ	All Grp 4	2221	2329	108	4.6%
EGAS	All Grp 4	739	726		
EGAS	All Grp 6	550	662		
EGAS	Total	1289	1388	99	7.1%
EGLT	All Grp 4	11201	12918		
EGLT	All Grp 6	2018	2200		
EGLT	Total	13219	15118	1899	12.6%
GENG	All Grp 4	6890	6616		
GENG	All Grp 6	35732	39783		
GENG	Total	42622	46399	3777	8.1%
GNGC	All Grp 4	9744	9781		
GNGC	All Grp 6	1	1		
GNGC	Total	9745	9782	37	0.4%
GNVG	All Grp 4	2721	2803	82	2.9%
MEEN	All Grp 4	3	4		
MEEN	All Grp 6	9576	11365		
MEEN	Total	9579	11369	1790	15.7%
Total				30570	

It is probable that the final allocation figures will be close to these interim figures.

The changes in GJ amounts are significant. However, because the accuracy requirement in Rule 37 relates to the measure between the consumption information provided at initial and final allocations, there has not been a breach of this rule at this time.

These under-estimations caused some of the short-term UFG experienced prior to the interim allocations for May and June 2009. However this was remedied by the interim allocations (correcting wholesale and transmission quantities), in accordance with the reconciliation process set out in the rules.

The global allocation methodology set out in the rules is designed to progressively improve accuracy of consumption submissions (for Allocation Groups 3 through 6) as successively greater proportions of data are based on actual meter reads.

However, I consider it unfortunate that the upstream balancing is based only on the initial allocation figures, and is not re-opened when more accurate information becomes available.

In summary, I believe this issue has been dealt with adequately via the rules as they are currently stated, and that parties have complied with the rules regarding their interim allocation obligations.

2.4 As Billed data compared to Allocation & Network Billing

Retailers were requested to provide 3 data sets for comparison:
As Billed, Allocation and Network Billing GJs, for the previous 24 months, for the ICPs supplied by meter sets > or = AL425 and using > 1 TJ pa.

This data was expected to be a subset of the complete data set used in the monthly allocations. The Allocation Agent only receives a total GJ amount for each of Allocation Groups 4 and 6, so direct comparison with the Allocation Agent's data is not possible, hence my request for information by ICP.

Mercury Energy do not have any ICPs meeting the above criteria, hence the blank fields in Tables 2 and 3 below.

Some retailers provided more data than requested, covering all of their Allocation Group 4.

The table below shows the variation between initial Allocation data and Network Billing data, when compared to As Billed, for May 2009.

Table 2. Comparison of Initial Allocation and Data Received for May 2009

		AsBilld	Netwk	Alloc	Netw%	Alloc%	
AGCL	All Gp4			11714			
AGCL	All Gp6			14150			
	Total	26338		25864		-1.8%	
CTCT	All Gp4	10810	9397	8619	-13.1%	-20.3%	
CTCT	All Gp6						
EDNZ	All Gp2	14901	14901	14901	0.0%	0.0%	
EDNZ	All Gp4	2065	2152	2201	+ 4.2%	+ 6.6%	
EGAS	All Gp4	690	722	739	+ 4.6%	+ 7.1%	
EGAS	All Gp6						
EGLT	All Gp2	4848	4848	4848	0.0%	0.0%	
EGLT	All Gp4	12445	11154	11200	-10.4%	-10.0%	
GEND	All Gp2	3319	3418	3418	+ 3.0%	+ 3.0%	
GENG	All Gp4	6440	6889	6889	+ 7.0%	+ 7.0%	
GENG	All Gp6						
GNGC	All Gp1	14061	14061	14061	0.0%	0.0%	
GNGC	All Gp2	1810	1810	1810	0.0%	0.0%	
GNGC	All Gp4	8804	8804	8804	0.0%	0.0%	
GNGC	All Gp6						
GNVG	All Gp2	4598		4598		0.0%	
GNVG	All Gp4	2747		2713		- 1.2%	
MEEN	All Gp4						
MEEN	All Gp6						

For most retailers, any + or – variation cancelled out when months either side were taken into account. For Contact, the large As Billed figure above was found to include some ICPs that were not billed in April, and so included 2 months of billing. Across a whole 12 month period, the Allocation difference was –1.0% and the Network Billing difference was –1.6%, when compared to As Billed (see table below).

The table below shows the variation in Allocation data and Network Billing data, when compared to As Billed, for extended periods (eg 8 months, 9 months, 12 months, 15 months, 24 months). I had to use “extended periods” because some of the data sets I received were not complete or consistent across the whole 24 month period requested.

Table 3. Comparison of Data Sets Received for Extended Periods

		AsBilld	Netwk	Alloc	Netw%	Alloc%	Period
AGCL	All Gp4						
AGCL	All Gp6						
	Total	159523		157414		-1.3%	12 mth
CTCT	All Gp4	74562	73367	73783	-1.6%	-1.0%	12 mth
CTCT	All Gp6						
EDNZ	All Gp2	66773	66773	66773	0.0%	0.0%	24 mth
EDNZ	All Gp4	23653	23939	23939	+ 1.2%	+ 1.2%	24 mth
EGAS	All Gp4	4851	4925		+ 1.5%		Oct08-Jun09
EGAS	All Gp6						
EGLT	All Gp2						
EGLT	All Gp4	47118	42154		-10.5%		Oct08-Jun09, subset
GEND	All Gp2						
GENG	All Gp4	42058	40894	40826	- 2.76%	- 2.93%	8 mth
GENG	All Gp6						
GNGC	All Gp1						
GNGC	All Gp2						
GNGC	All Gp4						
GNGC	Total	303416	304961	304673	+ 0.5%	+ 0.4%	15 mth
GNVG	All Gp2	43515		43515		0.0%	12 mth
GNVG	All Gp4	24639		24781		+ 0.6%	12 mth
MEEN	All Gp4						
MEEN	All Gp6						

Genesis dataset comparison

The Genesis dataset contained large gaps, especially in their As Billed figures prior to October 2008, hence I have only compared the data for the 8 month period of October 2008 to May 2009. The data for this most recent period is more consistent. The comparison in the table above shows an 8 month difference between As Billed and Allocation figures of –2.93%. It is estimated that the trend will average out over a 12 month period to +/- 1%.

EGas dataset comparison

The long-term difference of –10.5% (shown in Table 3 above) between EGas Limited's Network Billing data when compared to As Billed, was of concern.

Comparison of As Billed figures to Network Billing figures for a sample of 29 larger ICPs found that:

- for the period October 2008 – June 2009, Network figures were 10.5% below the As Billed;
- for the period October 2007 – June 2008, Network figures were 7.0% below the As Billed.

No EGas Limited Allocation figures were provided.

There also appeared to be a step change in the EGas Limited (As Billed) usage patterns, with the period October 2008 – June 2009 totalling 8.0% less than the period October 2007 – June 2008 (for the same ICPs supplied continuously). Comparing the months of May 2009 to May 2008, the As Billed total was less by 34.0%, even though May 2009 was colder.

These inconsistencies in data sets prompted me to arrange a visit to EGas's premises, where information could be checked at the ICP and customer invoice level. A check of a small sample uncovered that the As Billed data the auditor had received was not correct, as these did not match invoiced kWhrs (even with an allowance for possible normalisation of data). With revised As Billed figures, the Network figures were 41.0% and 40.0% below the As Billed for May 2009 and June 2009 respectively. EGas Limited also stated that their Allocation figures were equal to the Network Billing figures.

This raised concerns about the accuracy of the As Billed data that had been previously provided to me by EGas. An accurate data set for all of EGas Limited's ICPs for the last 12 months was then requested to expand the size of the sample, and to gauge the extent of the impact on UFG and previous allocations.

EGas Limited provided me a revised data set on 11 November 2009, for 530 ICPs. For this dataset, the long-term difference between their Network Billing data when compared to As Billed is 18%, or 48 TJs over the 12 months of October 2008 – September 2009. The trend of the monthly percentage differences shows higher percentages in winter than in summer. The percentage differences found on the earlier visit to their premises were confirmed by this revised data.

I noted in my Draft Audit Report that further analysis was required to check this data against the allocation data (submitted to the Allocation Agent), and that there appeared to be gaps. Some Allocation Group 4 ICPs seemed to have dropped off the data set between versions (ICPs assigned to EGas Limited in the registry for May 2009), and ICPs which were lost during the year were not included.

A further set of As Billed data was received from EGas Limited on 17 December 2009 (in response to the Draft Audit Report), which appears to contain the missing ICPs. On comparing this data to the interim allocation data (as submitted to the Allocation Agent), the under-submitted amounts are approximately 8.2 TJs for May 2009 and 9.3 TJs for June 2009. This latest

data set shows that the difference between EGas Limited's interim allocation data (as submitted to the Allocation Agent) when compared to As Billed data is approximately 12% (ie 34 TJs) for the period October 2008 to September 2009.

The latest revised data (provided 17 December 2009) covers 592 ICPs. However, it has not been verified against invoices. To determine more accurately the amounts under-allocated and contributing to the UFG, I recommend that this be comprehensively investigated as part of a performance audit of EGas Limited.

As all the other retailers' data sets exhibited sufficient consistency between As Billed, Allocation and Network Billing information, I did not consider it necessary to visit the premises of retailers other than EGas Limited to check data against customer invoices.

2.5 Gate metering

The gate volume for Tawa A, provided by Vector Transmission, is determined by difference. Total Tawa volumes are measured by two meters and correctors within a compound at Waitangirua. Further on down the steel outlet pipework from this is another gate compound, Tawa B, which contains two meters and correctors used to determine the volume of gas entering the NovaGas distribution system. The Tawa A gate volume is calculated as the Waitangirua volume minus the Tawa B volume.

The metering at both Waitangirua and Tawa B is owned and operated by Vector Transmission. The Waitangirua meters and correctors were exchanged within the last 12 months, and the Tawa B meters and correctors were exchanged within the last 24 months. In the absence of any information to the contrary, the meters are assumed to be accurate because the metering at both sites is regularly exchanged and tested. Therefore, the GJ difference which is used for allocation purposes for Tawa A is also assumed to be accurate.

There was a slight change to the Tawa A GJ gate volume between the initial allocation and the interim allocation. This was due to one of the meters at Tawa B being exchanged on 30 May 2009, and during subsequent testing it was found to be slow at low flowrates (ie. outside of tolerances). A correction was written for the meter, which resulted in 24 GJs being added to Tawa A for May 2009. Notice 5229 was published on OATIS detailing this correction.

Late in the audit process, on 2 December 2009, Powerco sent the auditor information from their check metering for Tawa A, compared to the Vector Transmission Tawa A gate data, for the period May 2009 – November 2009. Analysis of this data shows that the Tawa A gate metering could have been slightly overstated from May 2009 to 6 October 2009, due to a Waitangirua gate meter running slightly fast.

Vector Transmission exchanged the Waitangirua gate metering on 6 October 2009. The Waitangirua gate meters removed were tested in December 2009, and Vector Transmission sent copies of the test results to the auditor on 23 December 2009. These results confirm that the Waitangirua gate metering was running slightly fast, and consequently, the volumes calculated for the Tawa A gas gate were also slightly overstated.

Since the Waitangirua gate metering exchange, there is a very good correlation between the Powerco check metering and the Tawa A gate data. Using the percentage difference trend from May 2009 to 6 October 2009, it appears that the gate metering error contributed approximately 2.1% and 2.4% towards the UFG at the Tawa A gate for May 2009 and June 2009 respectively.

This matter has only recently come to light. However, I understand (based on my conversations with Vector) that Vector Transmission Metering will be correcting the Tawa A gate volumes shortly (in accordance with their obligation under rule 26.3 to use reasonable endeavours to reduce UFG). I expect that the gate volumes will be corrected in time for the final allocations.

2.6 Other UFG causes investigated

Attached as Appendix 1 is a discussion of other possible UFG causes that I investigated as part of this audit.

In addition to various conversion factors (noted in Section 2.2 above, and detailed in Section 1 of Appendix 1), I also checked for:

- discrepancies in the number of meter dials; and
- network losses.

Neither of these matters were found to be materially contributing towards UFG. A discussion of my findings in respect of these matters is set out in Sections 2 and 3 of Appendix 1 (attached).

2.7 Summary of UFG figures

The following table summarises the UFG figures for May and June 2009 at the Tawa A gas gate, including the approximate amounts from significant contributing UFG sources uncovered during this audit.

Table 4. Summary of UFG Figures

TJs	May 2009 (TJs)	May 2009	June 2009 (TJs)	June 2009
Injected	249.6		277.5	
Initial UFG	53.1	21.3%	41.0	14.8%
Less Interim	-31.3	-12.5%	-17.0	-6.1%
	=21.8	= 8.8%	=24.0	= 8.7%
Less EGas	-8.2	-3.3%	-9.3	-3.4%
Less Gate	-5.2	-2.1%	-6.7	-2.4%
UFG left	= 8.4	= 3.4%	= 8.0	= 2.9%

It should be noted that the amounts of correction at the interim allocation for May and June 2009 of 31.3 TJs and 17.0 TJs respectively, would have been found even without this audit, as a part of the reconciliation process in the rules. This process is designed to progressively improve accuracy of consumption submissions (for Allocation Groups 3 through 6) as successively greater proportions of data are based on actual meter reads.

Although under-estimations at the time of initial allocation caused some of the short-term UFG, this was remedied by the subsequent interim allocations (correcting wholesale and transmission quantities) in accordance with the reconciliation process under the rules.

The EGas under-submission amounts of 8.2 TJs and 9.3 TJs for May 2009 and June 2009 respectively are key findings that were discovered as a result of this audit.

The gate metering errors were discovered very recently. By following the reconciliation processes set out in the rules, these corrections will be included in the final allocations.

As shown in Table 4, after accounting for the significant sources of UFG discussed above, the UFG amounts are reduced from 21.3% to approximately 3.4% for May 2009, and from 14.8% to 2.9% for June 2009. The remaining UFG percentages are approaching a realistic UFG level of 2%, albeit still a little higher than desired.

3 Compliance with the Rules

This section of my audit report addresses the circumstances in which there could be an issue as to compliance with the rules.

However, I note that not every instance of UFG is a material breach of the rules. For example, the rules include processes which allow for some estimation and a certain percentage of error. Over time, however, there are improvements in accuracy as a result of processes set out in the rules for revising allocations.

3.1 Understating of allocation figures

Rule 26.2 provides:

> "26.2 Every allocation participant must provide the information required under these rules in a manner that is:
>
> 26.2.1 Accurate and complete; and
>
> 26.2.2 Not misleading or likely to mislead; and
>
> 26.2.3 Timely."

EGas Limited provided the Allocation Agent figures for allocation that are not in line with EGas Limited's Billing data. Although it is inevitable that there is some variation between the allocation figures for a particular month when compared with As Billed data, over a 12-month period these variations generally average out to approximately +/-1%. However, the allocation amounts provided by EGas Limited were significantly understated. Over the 12 month period of October 2008 to September 2009, it appears that EGas Limited's figures were understated by approximately 12%. This inaccuracy in allocation figures appears to breach rule 26.2.1. Accordingly, I conclude that there is a material issue as to EGas Limited's compliance with this rule.

3.2 Other matters considered

Accuracy of consumption information

Rule 37.2 provides:

> "37.2 For a consumption period, the accuracy of the consumption information provided by a retailer under rule 31 for initial allocation must, when compared with the consumption information provided by that retailer under rule 33 for final allocation, fall within the percentage of error determined and published by the industry body under rule 37.3."

Some of the retailers' consumption estimates exceeded a +/- 15% margin of error at interim allocation. However rule 37.2, which sets the requirements for

accuracy of consumption information, relates to the information provided at *final allocation* rather than interim allocation.

Given that retailers will not provide the relevant consumption information under rule 33 for final allocation until June and July 2010, the acts or omissions that would constitute a breach of rule 37.2 have not yet taken place.

As it is too early to determine a breach of rule 37.2, this matter will need to be determined by the industry body in due course. At this point in time, however, retailers have not breached rule 37.2. Accordingly, I conclude that there is not currently a material issue as to compliance with rule 37.2.

Gate metering error

Rule 26.3 provides:

> "26.3 Where an allocation participant is or becomes aware of a cause of UFG at a gas gate, it must use reasonable endeavours to remedy the cause of UFG or reduce the UFG occurring at the gas gate."

Vector Transmission have only recently become aware of the gate metering error in December 2009. Given that the meters were already exchanged in October 2009, the cause of the UFG has already been remedied (i.e. the previous meter running slightly fast). Based on my conversations with Vector, I understand that they will also follow a process of corrections to reduce the UFG that occurred at Tawa A gas gate for previous periods (including May and June 2009) by correcting the information on OATIS. The corrected gate volumes are thereby incorporated into subsequent allocations (e.g. interim or final allocation, or special allocation if necessary), so that the UFG for the relevant periods is reduced.

As the cause of the UFG has been remedied, and I expect that Vector Transmission will reduce the UFG by correcting the metering information in time for final allocation, I do not consider there to be a material issue as to Vector Transmission's compliance with rule 26.2.

Metering pressures, temperature correction, and altitude factors

Rule 28.2 (stated previously in section 2.2 above) relates to retailers converting volumes to energy using NZS 5259:2004.

Where retailers have been using a different metering pressure to that of the Meter Owner, it is not possible to assess whether rule 28.2 has been complied with until the true metering pressure for the individual ICP has been ascertained.

Where gas temperatures have been estimated to be close to ground temperature, it is not possible to assess whether rule 28.2 has been complied

with until the true metering gas temperature for the individual ICP has been ascertained.

Where incorrect altitudes have been used, it is not possible to assess whether rule 28.2 has been complied with until the true height above sea level for the individual ICP has been ascertained, and the difference between altitude factors can be calculated.

In any case, I do not consider the findings with regard to metering pressures, temperature correction, and altitude factors to be material issues or to have materially contributed to UFG at the Tawa A gas gate. The UFG amounts from these issues are not significant in GJ terms (ranging in the order of +250 GJs to –140 GJs), given that the long-term UFG to which this audit relates is in the order of 20,000 GJs per month. However, these are areas where retailers must ensure they are complying with NZS 5259:2004 for each individual ICP, and where amendments in methods used can lead to a small improvement in the percentage of UFG, and improved accuracy of the billing of the end consumer.

4 Rule 75. Responsibility for audit costs

Rule 75.2 provides:

> "75.2 In relation to an audit under rule 66, the following provisions apply:
>
> 75.2.1 If the auditor concludes that a material issue has been raised in relation to compliance with these rules, the allocation agent or the allocation participant to which the material issue relates must pay the costs of the auditor, and if the material issue relates to more than one person, then each person must pay the costs of the auditor in such portions that reflect their contribution to that material issue as determined by the auditor; and
>
> 75.2.2 If the auditor concludes that no material issue has been raised in relation to compliance with the rules, the costs of the auditor must be apportioned between such of the allocation agent and allocation participants, as the case may be, as the industry body determines in its sole discretion."

The Terms of Reference for this audit require me to provide certain information in relation to the allocation of audit costs under rule 75. I provide the following information (as to whether there is a material issue or issues) in accordance with the format in the Terms of Reference:

- I have determined that the apparent understating of allocation figures (submitted to the Allocation Agent) by EGas Limited is a material issue as to EGas Limited's compliance with rule 26.2.1. It appears that this under-reporting has contributed to approximately 8.2 TJs of UFG for May 2009 and 9.3 TJs of UFG for June 2009. There is also a long-term issue (over the period of October 2008 to September 2009, it appears that EGas Limited's under-reporting resulted in a total of approximately 34 TJs of UFG).
- At this point in time, the understating of allocation figures by EGas Limited is the only material issue in relation to compliance with the rules.
- EGas Limited's contribution to the material issue is 100%.

Further explanation of other matters

Some of the responses to the Draft Audit Report disagreed with the apportionment of audit costs. However, I do not have discretion to determine the apportionment of audit costs because this is determined by the process set out in rule 75.2. My role is to determine whether there is a material issue or issues as to compliance with the rules.

Section 3.2 above contains further explanation of matters which I have concluded are not material issues as to compliance with the rules at this time.

5 Conclusions

Estimated consumption figures for Allocation Groups 4 and 6 for the initial allocation were inaccurate, as evidenced by the results of the interim allocation. Interim allocation reduced the UFG by 31.3 TJs for May 2009 and 17 TJs for June 2009, however this did not account for all of the difference between gas injection and gas allocation figures.

The most significant issue arising from this event audit is that EGas Limited has been understating its allocation figures (and possibly network billing figures). This equated to approximately 8.2 TJs of UFG for May 2009 and 9.3 TJs of UFG for June 2009. There also appears to be a long-term issue. Over the 12 month period of October 2008 to September 2009, the difference between EGas Limited's interim allocation data (as submitted to the Allocation Agent) when compared to As Billed data was approximately 12% (ie 34 TJs).

It has recently been discovered that the previous gate metering for Tawa A was running slightly fast. The gate metering figures will be corrected by Vector Transmission, which I estimate will reduce the UFG at the Tawa A gas gate by 5.2 TJs for May 2009 and 6.7 TJs for June 2009.

After accounting for these three significant sources of UFG, the UFG amounts are reduced from 21.3% to approximately 3.4% for May 2009, and from 14.8% to approximately 2.9% for June 2009. The remaining UFG percentages are therefore approaching a realistic UFG level of 2%.

There is a variety of minor metering and billing system errors by retailers that could potentially be contributing to the remaining UFG, however these do not appear to be significant contributors to UFG.

6 Recommendations

The recommendations resulting from this audit are as follows:

- For retailers with a large proportion of domestic consumers, improvements need to be made in their estimating methodologies so that initial allocation figures are more closely aligned with the interim and final allocations.

- As there is sufficient evidence to conclude that the accuracy of allocation data provided by EGas Limited is in question, it is recommended that GIC initiate a performance audit of EGas Limited under rule 65.

- It is recommended that special allocations be initiated by GIC under rule 51 (to correct for any unfairness that has resulted from the under-reporting of allocation data by EGas Limited).

- It is recommended that retailers cross-check their information with the Meter Owner's records, particularly metering pressure.

- It is recommended that Vector Transmission and Network Owners collaborate where downstream check metering is in place, to identify discrepancies promptly and resolve any issues in a timely manner.

In addition, I also suggest that the following steps be undertaken in due course:

- Powerco to identify all the ICP connections off the 12 bar steel system, revise the registry information, and notify the responsible retailers.

- These retailers should apply Joule-Thomson effect for these ICPs, or install correctors so that the actual temperature drop can be applied.

- Further research into current gas temperature profiles to be undertaken by retailers and meter owners.

- Processes to be initiated by distributors, meter owners and retailers whereby the accuracy of data within the registry is improved and then maintained.

- Retailers to review their record keeping and data storage systems, in light of future audits.

Appendix 1 – Other possible UFG causes investigated

This Appendix provides a detailed discussion of other possible UFG factors that I have investigated during the audit. Some of the matters discussed in this Appendix were areas where there is room for improvement, but none were found to be significant contributors to UFG.

1.0 Conversion to energy

Any problems discovered with retailers' processes for conversion to energy within their billing systems would contribute to long-term UFG. As part of my audit, I therefore assessed retailers' application of the conversion factors under NZS 5259:2004. These are discussed in turn below.

1.1 Pressure factor Fp, MPE +/- 1.5%

All retailers are applying the pressure factor formula correctly, and all except one are recording metering pressures in kPa (gauge). Mercury Energy are using bar (gauge), and the pressure factor formula has been adjusted accordingly.

All of the ICPs in scope were checked for metering pressure discrepancies.

Metering pressures used in retailers' billing systems differ from Meter Owners' records in 57 of 343 ICPs investigated (16.6%), although the majority of differences are in the order of a few kPas (rather than 10's of kPas). However, the metering pressure only needs to be out by a few kPa at low pressure sites to exceed the Maximum Permissible Error (MPE) of +/- 1.5%

The table below summarises the differences discovered:

Table 5. Meter Owner Metering Pressure vs Retailer Metering Pressure

Meter Owner's recorded metering pressure in kPa (gauge)	Retailer's recorded metering pressure in kPa (gauge)	Difference between metering pressure recorded by meter owner and retailer (in kPa)	# of sample ICPs where meter owner's records differed from retailer's	Effect on UFG for May 2009
5.0	35.0	+30.0	1	+144 GJs
2.5	7.0	+4.5	1	+2 GJs
3.0	7.0	+4.0	1	+39 GJs
6.5	10.0	+3.5	1	+16 GJs
5.0	7.0	+2.0	1	
5.0	6.2	+1.2	1	
2.5	3.5	+1.0	1	
2.0	3.0	+1.0	1	
1.5	2.5	+1.0	3	
3.0	3.5	+0.5	3	
2.5	3.0	+0.5	1	
1.5	2.0	+0.5	2	
2.5	2.8	+0.3	1	
1.5	1.8	+0.3	1	
2.5	2.6	+0.1	1	
5.0	4.5	-0.5	2	
3.0	2.5	-0.5	6	
2.5	2.0	-0.5	5	
2.0	1.5	-0.5	4	
7.0	6.0	-1.0	1	-4 GJs
2.5	1.5	-1.0	16	
2.5	1.0	-1.5	1	0 GJs
3.0	1.2	-1.8	1	-5 GJs
7.0	5.0	-2.0	1	-3 GJs
			57 ICPs	

Most retailers are accepting the pressure information on the switch file as the figure to be used. This audit has used the Meter Owner as the database of record for the metering pressure. It may be more appropriate for metering pressure to be recorded and maintained in the registry, to allow retailers to more readily cross-check figures to ensure accuracy.

The last column of Table 5 contains a few calculations to assess the effect on UFG for May 2009, in order to examine the instances where there were extreme differences between the metering pressures recorded by the meter owner and the retailer. Note that the May 2009 UFG GJs would increase if the

retailer has been overbilling due to using a metering pressure that is overstated.

In conclusion, these metering pressure errors are not significant in GJ terms as contributors to UFG (and the unders could possibly cancel out the overs).

1.2 Temperature factor Ft, MPE +/- 1.5%

For Energy Direct, only corrector sites compensate for temperature.
All other sites use 15 degrees Celsius, so the temperature correction factor is Ft = 1.0000. This would lead to volumes being over-allocated in summer months and under-allocated in winter months.

The following is a rough calculation that gives an indication of the approximate effect on UFG:

> The May 2009 monthly error is approximately (15-11.6)/288.15 = 1.2%. For Energy Direct's sites, this equates to approximately 25 GJs extra of UFG in May 2009.

All other retailers use a profile of ground temperatures across a year, which is used to derive an average gas temperature for the billing period (between reads). Some retailers have a profile of only 12 monthly figures, whilst other retailers have a profile of 365 daily figures. For comparison purposes, the daily figures have been averaged to monthly figures in the table below:

Table 6. Comparison of Retailer Ground Temperature Profiles

Deg C	NVG AGL	CTCT	OnGas	MEEN	EGAS EGL	GENG	EDNZ
Jan	18.2	18.0	19.0	19.9	19.2	16.9	15.0
Feb	18.0	18.0	18.8	19.8	18.8	17.1	15.0
Mar	16.6	16.6	17.4	18.4	17.3	15.8	15.0
Apr	14.0	14.2	14.7	16.1	15.3	13.8	15.0
May	11.1	11.6	11.7	13.4	11.9	11.5	15.0
Jun	8.7	9.4	9.1	11.1	9.6	9.5	15.0
Jul	7.6	8.5	8.1	9.8	8.6	8.8	15.0
Aug	8.3	9.1	8.8	9.8	9.7	9.2	15.0
Sep	10.0	10.5	10.6	11.3	10.6	10.6	15.0
Oct	12.3	12.4	13.0	13.6	11.5	12.0	15.0
Nov	14.7	13.3	15.3	16.3	13.4	13.4	15.0
Dec	16.8	16.3	17.5	18.6	17.9	15.3	15.0

To get a better understanding of the actual gas temperatures being experienced, the following table compares the daily figures recorded by TOU devices:

Table 7. Comparison of Gas Temperatures Measured by TOU Devices

	Site 1	Site 2	Site 3
1 May	11.6	12.3	12.5
2 May	11.1	12.3	12.1
3 May	11.3	11.6	11.7
4 May	12.1	13.1	11.9
5 May	12.6	13.2	12.4
6 May	11.6	10.4	11.1
7 May	12.2	11.1	11.7
8 May	11.2	11.5	11.0
9 May	11.2	12.1	11.0
10 May	9.5	9.6	10.2
11 May	9.7	9.9	10.1
12 May	10.4	10.4	10.5
13 May	11.6	12.6	11.1
14 May	13.0	14.9	12.0
15 May	13.8	14.9	12.9
16 May	15.0	15.4	14.2
17 May	14.2	16.0	14.0
18 May	12.3	12.7	12.6
19 May	11.5	13.1	11.9
20 May	9.6	10.3	10.3
21 May	8.8	9.7	10.0
22 May	8.8	9.1	10.0
23 May	9.7	9.9	10.1
24 May	10.0	9.9	10.3
25 May	9.6	9.8	10.2
26 May	10.0	9.6	10.5
27 May	9.8	9.8	10.6
28 May	9.1	9.2	10.4
29 May	11.3	12.4	11.2
30 May	10.1	10.8	11.0
31 May	6.4	6.4	8.5
Average	10.9	11.4	11.2

It can be seen from this table of gas temperatures, measured and recorded by the temperature probes of correctors, that an average gas temperature of around 11 degrees Celsius is reasonable for May, but also that the temperature can vary markedly from day to day.

The data in Table 7 also shows that the gas temperatures at Sites 1, 2, and 3 are reflective of the ground temperature.

1.3 Joule – Thomson effect

Table 8. Lower Gas Temperatures Measured at Site 4

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
1 May	11.6	12.3	12.5	9.4			
2 May	11.1	12.3	12.1	9.4			
3 May	11.3	11.6	11.7	10.1			
4 May	12.1	13.1	11.9	10.1			
5 May	12.6	13.2	12.4	10.0			
6 May	11.6	10.4	11.1	8.2			
7 May	12.2	11.1	11.7	9.4			
8 May	11.2	11.5	11.0	8.3			
9 May	11.2	12.1	11.0	9.3			
10 May	9.5	9.6	10.2	7.4			
11 May	9.7	9.9	10.1	7.3			
12 May	10.4	10.4	10.5	7.8			
13 May	11.6	12.6	11.1	10.4			
14 May	13.0	14.9	12.0	11.7			
15 May	13.8	14.9	12.9	12.4			
16 May	15.0	15.4	14.2	13.0			
17 May	14.2	16.0	14.0	12.9			
18 May	12.3	12.7	12.6	9.9			
19 May	11.5	13.1	11.9	9.9			
20 May	9.6	10.3	10.3	7.9			
21 May	8.8	9.7	10.0	7.2			
22 May	8.8	9.1	10.0	6.8			
23 May	9.7	9.9	10.1	7.3			
24 May	10.0	9.9	10.3	7.9			
25 May	9.6	9.8	10.2	7.4			
26 May	10.0	9.6	10.5	7.6			
27 May	9.8	9.8	10.6	7.4			
28 May	9.1	9.2	10.4	7.5			
29 May	11.3	12.4	11.2	9.4			
30 May	10.1	10.8	11.0	7.5			
31 May	6.4	6.4	8.5	4.4			
Average	10.9	11.4	11.2	8.9			

Sites 1, 2, and 3 are metering gas at pressures of 50, 35, and1 kPa respectively. These sites are most probably fed from the Powerco polyethylene systems, which have pressures ranging from 180 kPa to 7 kPa. So these temperatures will be a fairly good representation of the gas temperature within these systems, which will be very close to ground temperature.

Site 4 is metering gas at a pressure of 350 kPa. This site is fed from the Powerco 12 bar steel system.

1.4 NZS 5259:2004 2.7.4.3 Joule – Thomson effect

In the absence of other factors, the actual gas temperature of the gas entering the GMS will be somewhere between ground and air temperature.

Section 2.7.4.3 of NZS 5259:2004 provides:

"For the methods mentioned under 2.7.4.2 (b), (c) and (d) correction may be made for the temperature drop due to pressure reduction if this reduction is made in the same installation and immediately upstream of the GMS. The temperature drop is about 0.5 deg C per 100 kPa of pressure drop. For large pressure drops or high flow rates it is recommended that the actual temperature drop be measured."

Reducing pressure from 1200 kPa to 350 kPa would cause a theoretical temperature drop of 4.25 degrees Celsius. In Table 8 above, compare this theoretical drop with the actual difference between the monthly average temperatures of Sites 1-3 (=11.2 degrees Celsius) and the monthly average temperature of Site 4 (=8.9 degrees Celsius). There is a monthly average temperature at Site 4 that is lower than Sites 1-3 by 2.3 degrees Celsius. This temperature decrease is a direct result of the Joule – Thomson effect.

Where a meter is a significant distance downstream from the regulator, the gas will re-heat to air temperature. This may be a factor with Site 4, as the measured temperature drop averaged 2.3 degrees Celsius rather than the theoretical 4.25 degrees Celsius.

Powerco have 38 HP connections off the 12 bar steel system. There are only 13 ICPs for which TOU data is provided to the Allocation Agent, not all of which are supplied from the steel system.

Only NovaGas/AuckGasCo are compensating for the Joule-Thomson effect.

I note that the registry has been populated with inlet pressures (called Network Pressure) of 180 kPa for every ICP on the Tawa A network. When questioned about this, Powerco said: "…this is because we did not have readily available pressure information for each ICP. We discussed this with the GIC as part of the registry implementation project and it was determined that, since network pressure is not used by the retailers in their calculations and [they were] not interested in how this field was populated, …we would put in the highest operating pressure for each gas gate for all ICP's off that gate."

I consider that retailers should be interested in the inlet pressures, as not compensating for the Joule-Thomson temperature drop will contribute towards UFG, albeit to a small level.

The Joule-Thomson effect can only be applied accurately if the network pressure in the registry for an ICP accurately reflects the nominal operating pressure of the network supplying that ICP.

Note that a pressure drop from 180 kPa to 1.5, 2, 3 or 7 kPa (as the range of metering pressures for most of the fixed factor sites examined as part of this audit) would result in a temperature drop of around 0.9 degrees Celsius. Moving the 12 month temperature profile curve downwards would mean less reduction in volume during the summer months to get back to 15 degrees Celsius (possibly removing the UFG gains), and would mean more increase in volume during the winter months to get back to 15 degrees Celsius (thus reducing the UFG losses).

1.5 More on temperature

Table 9. Comparison of Gas Temperatures Measured by TOU Devices

	Site1	Site5	Site6	Site7	Air Max	Air Min	Grd 10
1 May	11.6	15.4	16.5	16.8	11.3	8.3	11.8
2 May	11.1	14.7	16.0	16.4			
3 May	11.3	14.7	15.8	16.0	13.3	6.5	11.6
4 May	12.1	14.4	16.0	16.0	12.8	9.0	12.0
5 May	12.6	14.7	15.9	15.8	15.2	5.3	12.3
6 May	11.6	15.1	15.7	15.7	13.1	7.4	10.6
7 May	12.2	14.1	15.5	15.1	13.9	5.4	11.2
8 May	11.2	14.4	15.4	15.2	13.3	6.7	10.5
9 May	11.2	14.1	14.7	14.8			
10 May	9.5	13.6	14.6	14.7	11.4	6.6	9.6
11 May	9.7	13.2	14.9	14.5	8.9	6.2	9.0
12 May	10.4	12.5	14.8	14.4	11.2	6.6	9.4
13 May	11.6	13.1	14.6	14.3	15.4	5.2	10.6
14 May	13.0	13.6	14.6	14.8	16.0	10.0	10.9
15 May	13.8	14.0	14.7	15.1	15.2	12.3	11.7
16 May	15.0	14.8	14.9	15.3			
17 May	14.2	15.2	14.9	15.5	15.9	12.2	12.1
18 May	12.3	15.4	15.1	15.3	13.2	9.7	11.3
19 May	11.5	14.8	15.0	14.7	14.8	6.4	10.2
20 May	9.6	14.2	14.9	14.3	10.6	6.2	8.2
21 May	8.8	12.4	14.7	13.9	8.9	5.2	7.6
22 May	8.8	12.2	14.4	13.6	9.8	2.5	8.2
23 May	9.7	12.4	13.7	13.3			
24 May	10.0	12.1	13.5	13.3	10.1	8.2	9.6
25 May	9.6	12.1	13.9	13.3	9.2	7.8	9.2
26 May	10.0	11.9	13.8	13.4	9.8	7.3	9.5
27 May	9.8	12.0	13.7	13.5	9.4	8.1	9.7
28 May	9.1	12.2	13.7	13.1	11.4	4.3	9.6
29 May	11.3	12.3	13.6	13.3	13.9	8.9	10.5
30 May	10.1	12.9	13.3	13.5			
31 May	6.4	12.5	13.1	13.1	7.9	2.4	6.4
Average	10.9	13.6	14.7	14.6			10.1

In the table above, Site 1 has been left for reference. The last three columns contain data from the NZ Herald newspaper (information supplied by NIWA), being the maximum temperature, minimum temperature, and the 10 cm soil depth temperature at 6pm. Note that the 10 cm data follows Site 1 fairly closely. (I am not advocating the use of temperature data 10 cm in the ground, it is just that this data is readily available for comparison purposes).

The temperature data for three other TOU sites (Sites 5, 6 & 7) are shown. At these sites, not only does the temperature trend not follow that of the ground temperature, but it also exceeds the maximum air temperature on many days.

As the gas is not being pre-heated at any of these metering installations, the accuracy of the temperature data is called into question. At Site 5, it was found that the metering was in an enclosed metering room which was very warm inside, and that the thermowell did not have any heat transfer media in it to assist the temperature probe in measuring the true gas temperature.

A (TOU) corrector at a large site was found to not be compensating for gas temperature. The retailer was not making any manual correction for this.

A rough calculation to assess whether there is a material effect on UFG is as follows:

The May 2009 monthly error is approximately (15-11.6)/288.15 = 1.2%. For this site, this equates to approximately 170 GJs of UFG in May 2009. If the Joule-Thomson effect is applied due to high inlet pressure and large pressure drop down to metering pressure, this would be a higher percentage error as the gas temperature would be lower, and so more GJs would be added. In any case, it appears that the effect on UFG is small in terms of the 20,000TJs of long-term UFG being investigated in this audit.

In summary, there is room for improvement in temperature measurement (for correctors), application of ground temperature profiles, and application of Joule-Thomson effect (or corrector installation). Such improvements will assist in reducing UFG (albeit in relatively small amounts).

1.6 Altitude factor Fa, MPE +/- 1.5%

Vector Transmission convert the gate metering volume to volume at standard conditions (ie adjusted if necessary for altitude, back to sea level) and then to energy. The retailers must also convert customers' volumes back to standard conditions (ie adjusted if necessary for altitude, back to sea level) and then to energy.

Two retailers, OnGas and EnergyDirect, have used the height of the Tawa A gas gate above sea level (199.4 metres) as the height h in their equations for Fa. This is incorrect. The height h is the altitude in metres of each ICP metering installation. Adjustments for altitude are to convert the volume back to that which the volume of gas would be at sea level.

$Fa = 1 - ((h/8500)/Fp)$

My calculations to try to assess the effect on UFG show that, for May 2009, the monthly errors are approximately 250 GJs of UFG (= 1.0%), and approximately 140 GJs of UFG (= 0.8%) for the two retailers if all their ICPs were down at sea level, rather than at 199.4 metres, (ie the worst case scenario). These percentages are the average across the set of ICPs for which data was received. The effects are different, as each retailer's set of customers have differing metering pressures.

At many ICP sites with low metering pressure, this may have led to the Maximum Permissible Error (MPE) of /- 1.5% being exceeded (depending also on the real altitude above sea level, of course). At low metering pressures, eg 2.5 kPa:

Fa = 1 – (199.4/8500)/1.02467) = 0.9771

In the data set that EGas sent, all the ICPs had an altitude of 1 metre, and Fa = 0.9999. At low metering pressures, the MPE exceeds 1.5% if the height of the ICP is greater than 130 metres.

Contact uses the equation Fa = 1.0000 for sites at 0 – 100 metres.
Above that, ICPs are placed into bands of 20 metres,
eg for 100 – 120 m, these ICPs are assigned an altitude h = 120 m
120 – 140 m, these ICPs are assigned an altitude h = 140 m.
So, in the registry, any Contact ICP in the 0 – 100 m range has an altitude of 0 m recorded. This poses the questions - If an ICP switches to another retailer, what height do they get? 0 m? Where do they go for the correct height?

For most retailers, the altitudes recorded in the registry are in 20 m bands from 0 m up. There may be errors introduced during switches if the previous retailer uses a different approach to that of the gaining retailer.

In the registry, the OnGas sites have altitude = 200m.

NovaGas/AGCL have all sites Fa = 1.0000, unless manually entered.

In conclusion, there is room for improvement in the application of altitude factors, although the GJ amounts involved are not material in terms of UFG.

1.7 Compressibility factor Fz, MPE 0.25%

All retailers are applying a factor for compressibility only where metering pressure is greater than 50 kPa.

1.8 Calorific Value

All retailers are sourcing their CV data from OATIS, and are applying this correctly.

2.0 Meter dials

All of the ICPs in scope were compared against the retailer's and meter owner's records to check for discrepancies in the number of meter dials to be read.

For a few ICPs, differences were discovered. However, when comparing retailer monthly usage information with meter model capacity, the usage appears to be appropriate and of a similar level with other ICPs using the same meter model. In most instances, going up to the higher number of dials would have taken the usage over the capability of the meter. In some instances, I requested that the meter owners perform site visits to verify the correct number of dials (amongst other checks for metering pressure, inlet pressure, etc).

No under-billing by x 10 was detected.

3.0 Network losses

As part of this audit, network losses were also investigated as a possible UFG contributing factor.

Powerco were asked to quantify any gas released as a normal part of the operation of their network, and report whether there had been any accidental escapes of gas due to third party damage during May 2009.

Powerco reported that they consider any leakage to be small/immaterial, and that the Network Operations Manager is not aware of anything significant which happened on the network in May 2009.

From this information, it is concluded that physical gas escapes from the network did not materially contribute towards UFG.