Potential Critical Contingency on 15th April 2015

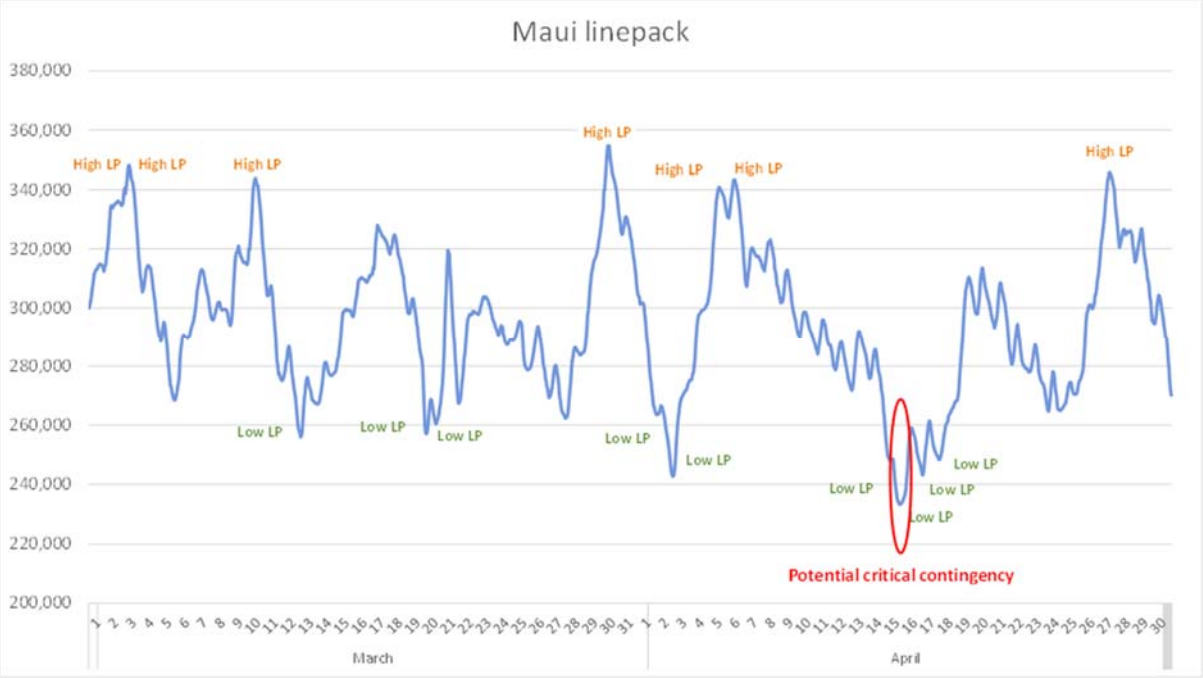
Analysis of data

GAS INDUSTRY COMPANY LIMITED

Introduction

During March and April 2015, there were significant fluctuations in linepack and pressure on the Maui pipeline. In addition to extended periods where pipeline pressure exceeded the upper pipeline limits, there was an occasion, on Wednesday 15 April, where linepack and pressure fell to levels that caused the Critical Contingency Operator (CCO) to issue a 'Notification of Potential Critical Contingency'. Following that notice, the linepack and pressure recovered to levels that allowed the system to get through the evening peak without the CCO needing to determine and declare a critical contingency.

Figure 1 Maui linepack March and April 2015



The chart above shows Maui linepack for the months of March and April 2015. Instances where MDL posted notices of high or low linepack are noted on the chart, and the linepack during the potential critical contingency is circled in red.

Gas Industry Co is concerned that a potential critical contingency was triggered by rapidly changing imbalances; that is, not by a physical supply problem but rather through normal market operations. Given the broad interest in this matter, and the limited public visibility of data, the Gas Industry Co Board has requested that we look into this to understand what caused the situation.

To assist us with looking into this incident, Gas Industry Co requested gas transaction information under our Information Gathering Protocol. This report analyses the information received, with a

view to informing market participants about the event; and considers whether there are any industry governance issues that need to be addressed.

Data provision

Both transmission system owners (MDL and Vector) and all shippers were asked for data for the period from 1 March to 20 April 2015. MDL, Vector and most shippers agreed to the request. However, one shipper would only provide information for the 1st – 20th April period, and another shipper would not provide any information, considering that Gas Industry Co should not be undertaking such a review.

Contact Energy, Genesis Energy, Greymouth Gas, MDL, Methanex, Mighty River Power, Transpower, Trustpower, Vector Gas Contracts Limited, and Vector Gas Limited, and Vector transmission all provided data for analysis in this paper. In this analysis, data for the shipper who declined our information request is part of an aggregated data set labelled "residual". [1]

Shipping gas on the Maui pipeline

The analysis of the information supplied needs to be considered in the context of the existing arrangements on the Maui pipeline. In a nutshell, under the flow-on-nominations regime specified in the Maui Pipeline Operating Code (MPOC):

- shippers nominate the amounts of gas they/their customers require for a given day. Nominations are made from a receipt welded point (generally a producer) to direct connect welded points (generally major gas users) and to transmission pipeline (TP) welded points (where the Maui pipeline connects to the Vector transmission system). Maui pipeline receipt and delivery nominations must always balance; that is, the total amount of gas nominated from receipt points must equal the amount nominated to delivery points;
- welded parties (those parties responsible for the management of the welded points) confirm the nominations;
- MDL approves the nominations, subject to the pipeline model within OATIS confirming that the set of nominated quantities is physically feasible; that is, that the capacity exists in the pipeline to ship the nominated quantities. The total approved nominations at a welded point is known as the scheduled quantity: the amount of gas that is expected to flow to or from that point in a day; and
- shippers are deemed to get gas title to the amounts of their approved nominations.

[1] The residual data set comprises the missing shipper data as well as a range of smaller matters such as differences arising due to timing and meter errors. Methanex and Transpower both gave permission for their data to be provided, but they both had zero positions during the period of this analysis. They are therefore not included in the "residual" data.

Since the quantities of gas scheduled to enter into the pipeline equal the quantities scheduled to leave, the pipeline is expected to remain in balance. In reality, though, the actual gas quantities entering and leaving the pipeline – as measured by welded point meters – differ from the approved nominated amounts. Daily differences accrued at welded points are known as operational imbalance or OI, and accumulations across time are known as running operational imbalance or ROI.

Factors affecting the amount of gas in the Maui pipeline

There are four main factors influencing the amount of gas (linepack) in the Maui pipeline:

1. gas producers at welded points deliver more or less gas to the pipeline than their scheduled quantity;

2. gas consumers directly connected to a welded point take more or less gas than their scheduled quantity;

3. gas consumers downstream of TP welded points take, in aggregate, more or less gas than their retailers nominated for them; and

4. injections or withdrawals of gas from the pipeline occur as a result of MDL buying or selling balancing gas.

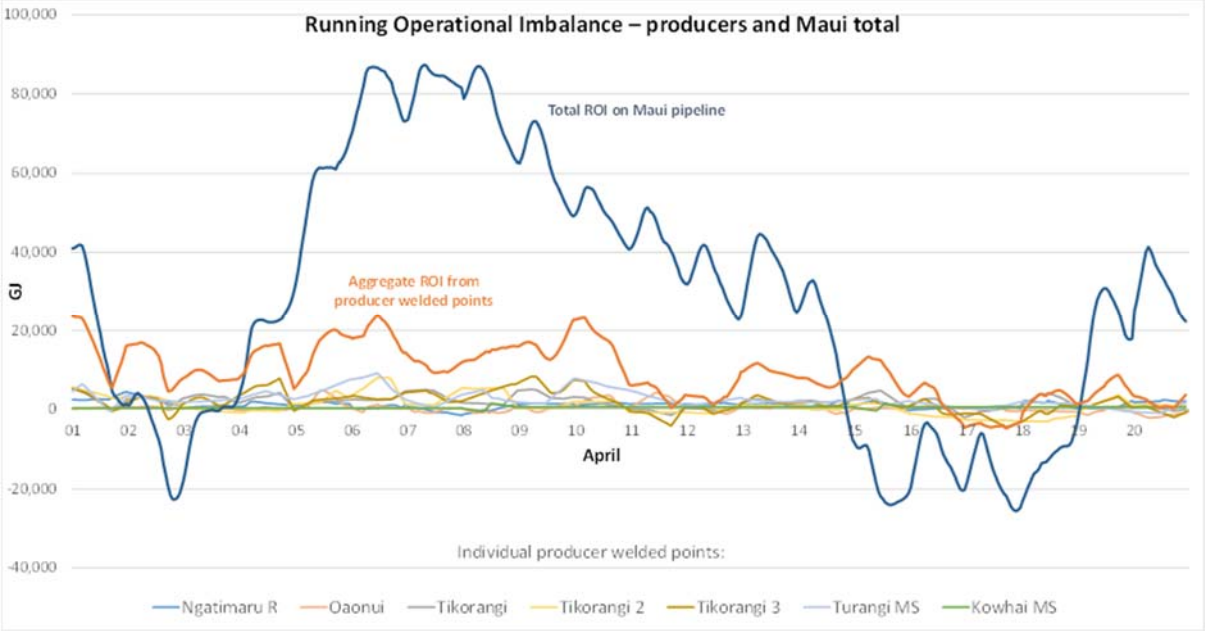
This report examines how each of these factors contributed to the low linepack situation on 15 April 2015.

Running Operational Imbalance

Gas producers at Maui pipeline receipt welded points

The chart below compares the ROI at welded points where gas is received into the Maui pipeline.

Figure 2 Producer ROI



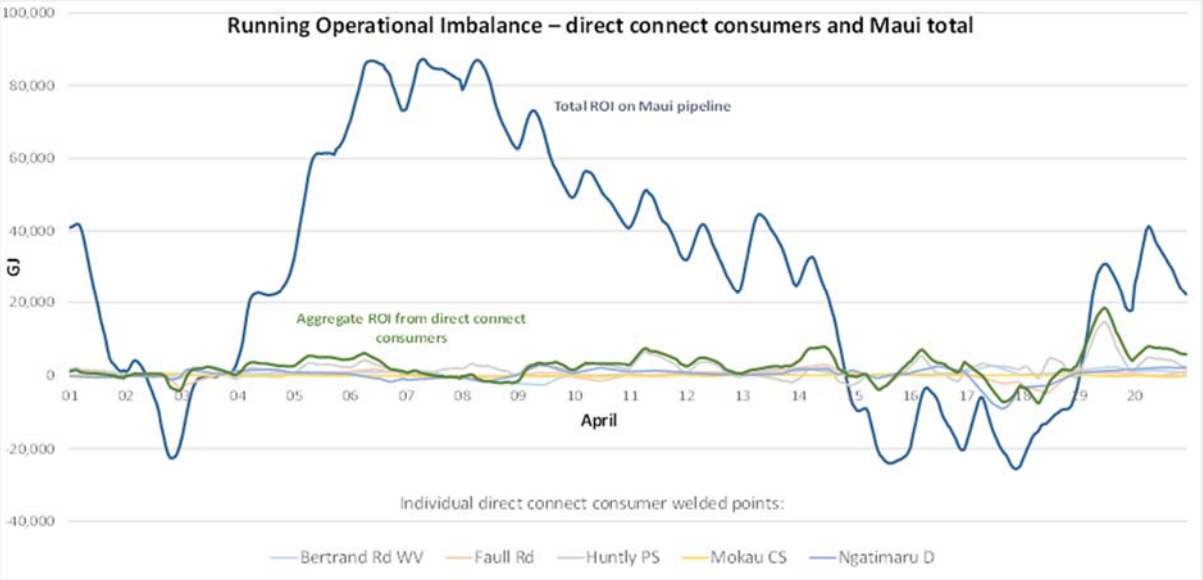
The dark blue line shows total ROI on the Maui pipeline from 1 to 20 April, and the dark orange line shows the aggregate ROI for producer welded points. Each data series contains 24 points per day, and the date label on the horizontal axis corresponds to the first hour of the day.

As the chart shows, producers in total accounted for a small amount of ROI during April. Importantly, the change in producer ROI during 14 and 15 April did not significantly contribute to the precipitous fall in total ROI on the Maui pipeline over those days.

Gas consumers at direct connect welded points

This chart compares the ROI for consumers at direct connect welded points with overall Maui pipeline ROI.

Figure 3 Direct connect consumer ROI



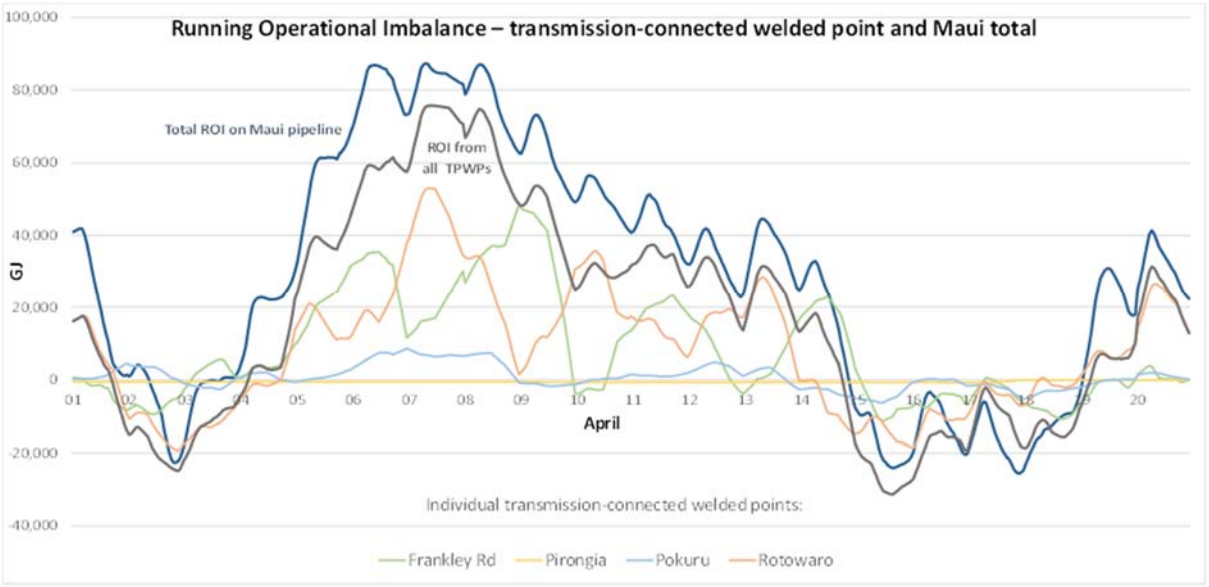
The dark blue line in this chart is the same as in the previous chart and shows total Maui pipeline ROI. The dark green line shows the total ROI from direct connect consumers.

The chart shows that direct connect consumers had relatively low amounts of ROI during 1 to 20 April, meaning that they continued to take about the same amount of gas from the pipeline as they had nominated. Importantly, the change in direct connect welded point ROI during 14 and 15 April did not significantly contribute to the precipitous fall in total ROI on the Maui pipeline over those days.

Vector and its shippers at TP welded points

This chart examines the remaining welded points on the Maui pipeline: the TP welded points through which gas flows into the Vector system for onward delivery to major users and into downstream distribution networks.

Figure 4 Transmission connected welded point ROI



The chart shows that the bulk of the ROI experienced from 1 to 20 April can be attributed to the TP welded points. At their lowest point on 15 April, the TP welded points in aggregate accounted for about 31TJ ROI. Direct connect welded points contributed another -2TJ to ROI, and producer welded points offset ROI by positive 8TJ. Total ROI on the Maui pipeline was -25TJ. Importantly, the change in TP welded point ROI during 14 and 15 April is clearly the most significant contributor to the precipitous fall in total Maui pipeline ROI over those days.

The two TP welded points making the greatest contribution to the fall in ROI over the two days were Frankley Road, through which gas travels to the South system (feeding the distribution systems south of Taranaki, including those in Wellington and Hawke's Bay), and Rotowaro (which serves Greater Auckland and points north).

Figure 4 highlights another interesting aspect: the oscillating movements of ROI at Frankley Road and Rotowaro. It was suggested to Gas Industry Co that these movements could be caused by a shipper nominating in a way that moved ROI around the system in order to avoid being "cashed-out" (ie receiving an allocation of balancing charges). This question is analysed in the appendix to this report.

Incentives for primary balancing

It is worth pausing at this point to consider issues relating to welded point balancing.

Primary balancing (welded parties actively managing their OI on a daily basis with a goal of zero ROI over time) is easiest for those welded parties that are able to exercise a reasonable degree of control over their gas flows. That is likely to be the case at receipt welded points (where a production station can schedule its production to match the scheduled quantity) and at direct connect welded points (where major plants can match their nominations to their daily requirements).

Current arrangements on the Maui pipeline provide only weak incentives for primary balancing. If a welded party's ROI exceeds the allowable tolerance at its welded point, then it may receive an imbalance limit overrun notice (ILON) instructing it to correct the imbalance or risk being cashed-out by MDL. ILONs are issued after the end of the gas day and must provide a minimum of 24 hours for the welded party to correct its position. This, combined with the end-of-day accounting on the pipeline, means that welded parties effectively have up to three days to balance their positions. Because of this time buffer, there is little urgency to correct running imbalances.

At the TP welded points, the downstream load comprises a broad mix of customer types served by numerous retailers. The lack of daily information on each shipper's sales makes it difficult for those shippers to fine-tune their nominations. In addition, as the month progresses, those shippers become increasingly less confident of their respective running positions. The result is that shippers can schedule quantities of gas from their suppliers that do not match the amount of gas taken by their customers. When such forecasting errors are systematic, imbalance will accumulate at the TP welded point.

The different outcomes for the various types of welded point can be seen in the table of ILONs below. There were 39 ILONs issued from 1 to 20 April in respect of 10 welded points – an average of 3.9 ILON notices per welded point. The largest three TP welded points (Frankley Road, Pokuru, and Rotowaro) received the most notices – and were the only points that were subsequently cashed-out.

Table 1 ILONs and cash-outs

	ILONs			Cashouts	
	Number issued	+ILON amount (GJ)	-ILON amount (GJ)	Number issued	Quantity
Producer receipt points					
Tikorangi	3	6,166	0	0	0
Tikorangi #2	3	5,171	-67	0	0
Tikorangi #3	3	5,884	0	0	0
Turangi MS	4	11,033	0	0	0
Direct connect consumers					
Bertrand Road	1	0	-762	0	0
Faull Road	4	562	-2,512	0	0
Transmission pipeline welded points					
Frankley Road	7	45,295	-6,488	2	6,036
Pirongia	2	0	-571	0	0
Pokuru	6	7,833	-2,605	1	123
Rotowaro	6	49,090	-14,422	1	1,231

Vector shipper mismatch

At each TP welded point, the ROI represents the sum of Vector shipper mismatch and Vector own running imbalance on the transmission pipeline connected to that welded point. Shipper mismatch is a similar concept to welded point operational imbalance: it represents the difference between the amount of gas a shipper has purchased from its gas supplier(s) for a particular day and the amount of gas used by that shipper – or that shipper's customers – on that day. Vector running imbalance represents Vector's position as the transmission pipeline owner and consists largely of unaccounted-for gas on the pipeline, and small variations in fuel gas usage.

The table below maps each of Vector's transmission pipeline systems with its associated Maui welded point.

Vector system	Maui TP welded point
Bay of Plenty	Pokuru
North	Rotowaro
South-Kapuni-Frankley Road (SKF)	Frankley Road
Te Awamutu North (TAN)	Pirongia

There are six shippers on the TAN pipeline system: Contact, Genesis, Mighty River Power, Nova, OnGas, and Trustpower. On the Bay of Plenty and North systems, seven shippers operate: the six listed above plus Greymouth. On the SKF system, there are those seven plus Vector Gas Contracts.

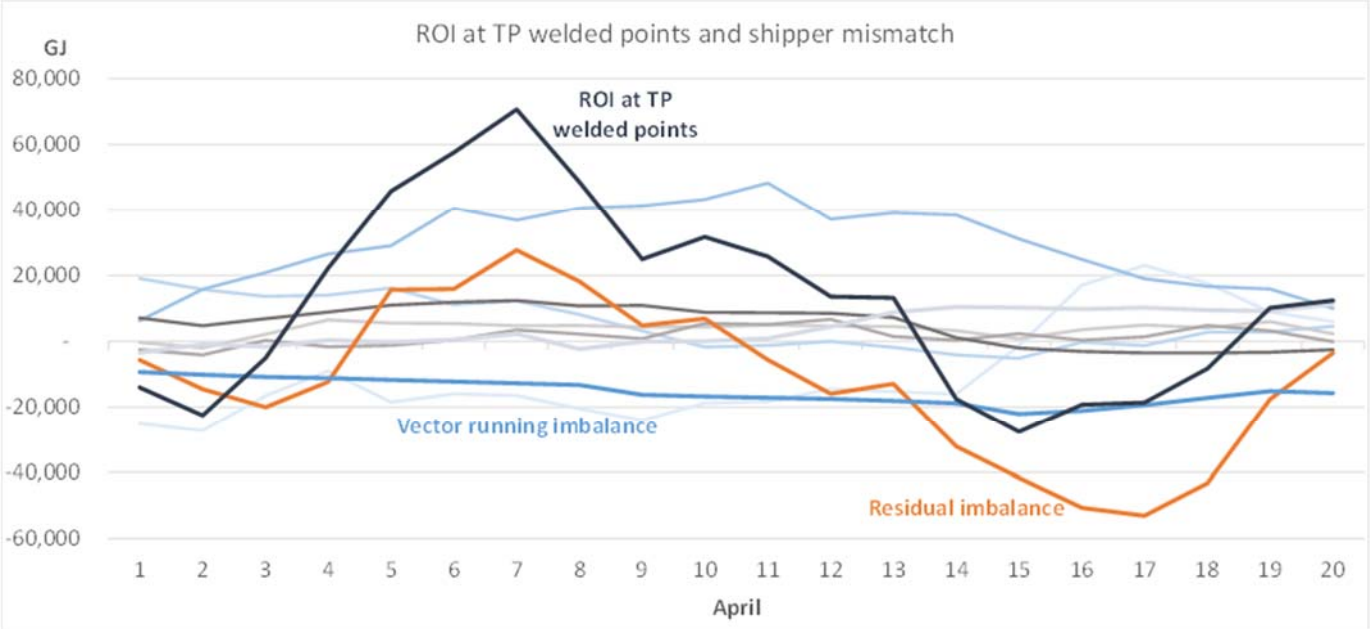
Based on the data Gas Industry Co received from its information request, it is possible to disaggregate the ROI at the welded points into:

- Shipper running mismatch, for the shippers who provided data;
- Vector running imbalance; and
- Residual running imbalance, which comprises the missing shipper data as well as a range of smaller matters such as differences arising due to timing and linepack changes on the Vector system.

Contributions to TP welded point ROI

The following chart shows the sum of the ROI at the four TP welded points compared with shipper running mismatch, Vector running imbalance, and residual running imbalance.

Figure 5 ROI at TP welded points



In this chart, the ROI at TP welded points is drawn from the same dataset used for Figure 4. The charts are different in that the previous charts contained 24 data points for each day, whereas this one shows positions as at the end of the day. Individual Vector shipper running mismatch is portrayed by the light grey and blue lines but not labelled, consistent with Gas Industry Co's undertaking not to disclose individual shipper information provided to us for this investigation.

Data for the days around the potential critical contingency are presented in the table below (amounts are shown to the nearest TJ, so some rounding errors arise).

Table 2 Breakdown of ROI at TP welded points (in TJ)

	at midnight	daily change (TJs):			
	13 Apr	14 Apr	15 Apr	16 Apr	17 Apr
Total ROI at TP welded points	13	-31	-10	8	1
Vector transmission's running imbalance	-18	-1	-3	1	2
Total shipper running mismatch (data provided)	44	-11	3	16	1
Residual running imbalance (computed by difference)	-13	-19	-9	-9	-2

Together, the chart and table show that:

- in aggregate, the TP welded points had a positive ROI as at midnight on 13 April, but total ROI decreased sharply over the following two days before beginning to recover;
- Vector transmission's contribution to the overall ROI was negative but largely stable throughout the period;
- the shippers who provided mismatch data, when taken as an aggregated set, had positive ROI throughout the period but contributed significantly to the overall decline in ROI during 14 April; and
- the residual running imbalance (which includes the running mismatch of the shipper who did not provide its data) was negative on 13 April and continued to decline, accounting for most of the change in total ROI over the next two days.

As the chart shows, there was one shipper whose running mismatch position became rapidly more positive around the 15 April and who continued to accrue positive mismatch for two days following. These increases to the positive running mismatch positions helped to counteract the factors that caused linepack and pressure to decrease. Without the actions of this shipper, in other words, it is likely that the potential critical contingency could have been significantly worse.

The following charts show shipper running mismatch by transmission pool. TAN is excluded, as the ROI at its TP welded point was so small.

Bay of Plenty shipper mismatch

Figure 6 Running imbalance on Bay of Plenty system

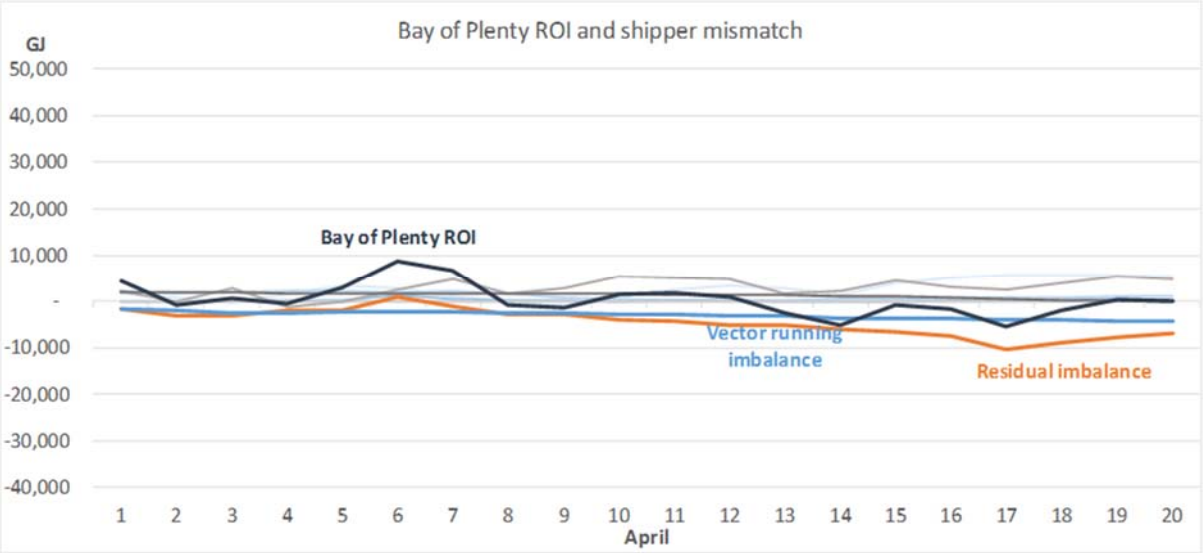


Table 3 Change in ROI on Bay of Plenty system

	at midnight	daily change (TJs):			
	13 Apr	14 Apr	15 Apr	16 Apr	17 Apr
Bay of Plenty ROI	-3	-2	4	-1	-4
Vector transmission's running imbalance	-3	-0	-0	0	-0
Total shipper running mismatch	6	-1	5	0	-0
Residual running imbalance	-5	-1	-0	-1	-3

North shipper mismatch

Figure 7 Running imbalance on North system

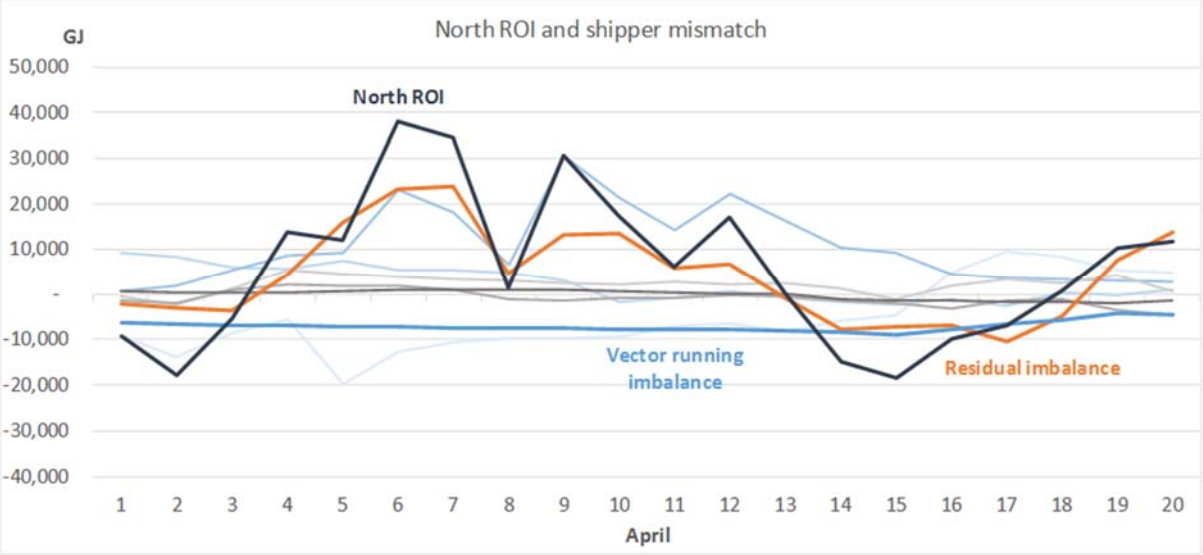


Table 1 Change in ROI on North system

	at midnight	daily change (TJs):			
	13 Apr	14 Apr	15 Apr	16 Apr	17 Apr
North ROI	-0	-15	-4	9	3
Vector transmission's running imbalance	-8	-0	-0	1	1
Total shipper running mismatch	9	-8	-4	7	6
Residual running imbalance	-1	-7	0	0	-4

SKF shipper mismatch

Figure 8 Running mismatch on SKF system

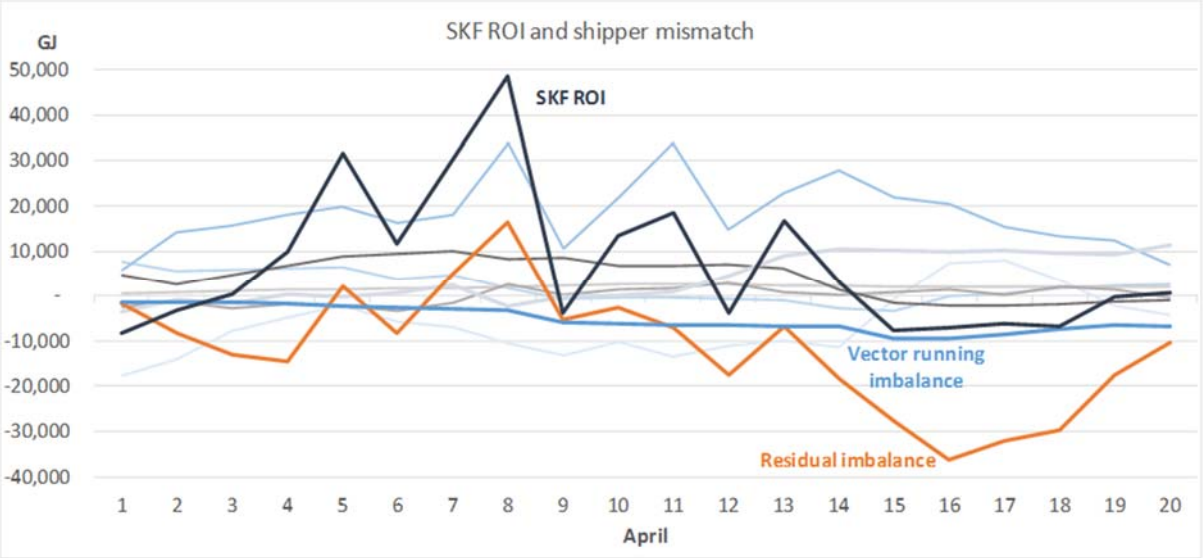


Table 2 Change in ROI on SKF system

	at midnight	daily change (TJs):			
	13 Apr	14 Apr	15 Apr	16 Apr	17 Apr
SKF ROI	17	-14	-11	1	1
Vector transmission's running imbalance	-7	0	-3	-0	1
Total shipper running mismatch	30	-2	1	9	-4
Residual running imbalance	-7	-12	-9	-8	4

The above series of charts and tables shows that SKF was the primary contributor to decline in ROI at TP welded points: ROI on SKF decreased by 25TJ over 14 and 15 April, of which 21TJ can be attributed to the negative and decreasing residual running imbalance. The North system was also a significant contributor; its ROI decreased by 19TJ over the same two days, 12TJ of which was due to shippers correcting their positive positions and 7TJ attributable to the residual running imbalance becoming more negative.

Linepack management by MDL (secondary balancing)

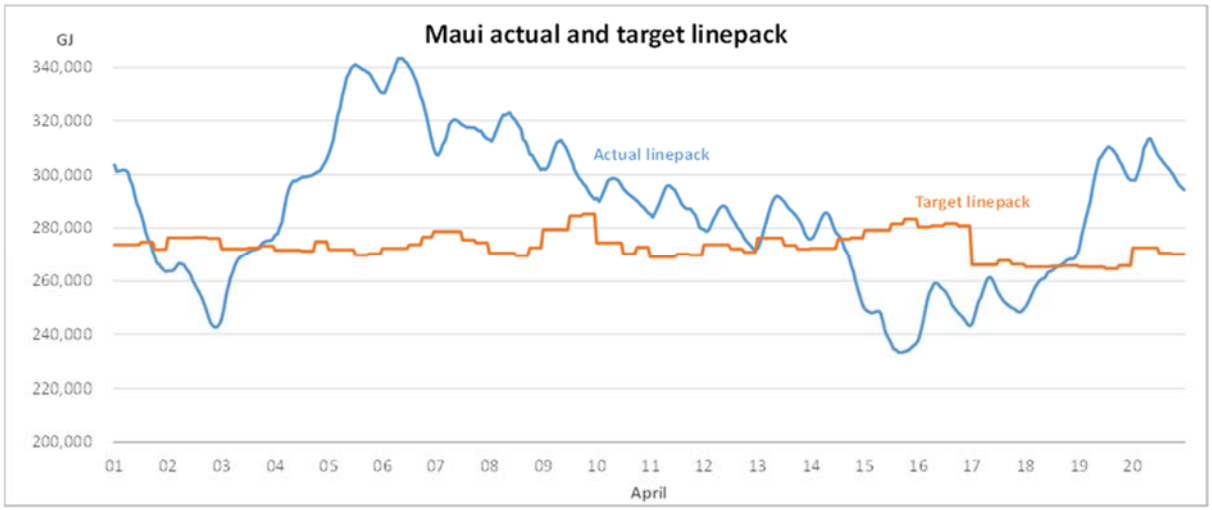
MDL's balancing gas transactions are the fourth possible cause of Maui linepack changes. Before we examine linepack management, it is worth considering the elements of linepack.

Linepack in the Maui pipeline can be thought of as being made up of three components:

- **flowing linepack** - the absolute minimum amount of gas required in the pipeline for the pipeline to deliver the scheduled quantities for a particular day;
- **flexibility linepack** - the additional quantity of gas to provide the daily and hourly tolerances at the various welded points on the Maui pipeline; and
- **contingency volume** - a further quantity of gas provided for unforeseen events (contingency events, pipeline emergencies, and force majeure events).

The sum of flowing linepack, flexibility linepack and contingency volume is the ideal quantity of gas to maintain in the pipeline and is referred to as the "target linepack". Actual linepack at any given time will deviate from the target linepack due to OI, as described earlier, or due to pipeline management actions or changes in unaccounted-for gas. The chart below shows actual and target linepack for 1 to 20 April. The area between the lines is the gross deviation, largely positive 4th to 14th of April, but then becoming negative around the 14th.

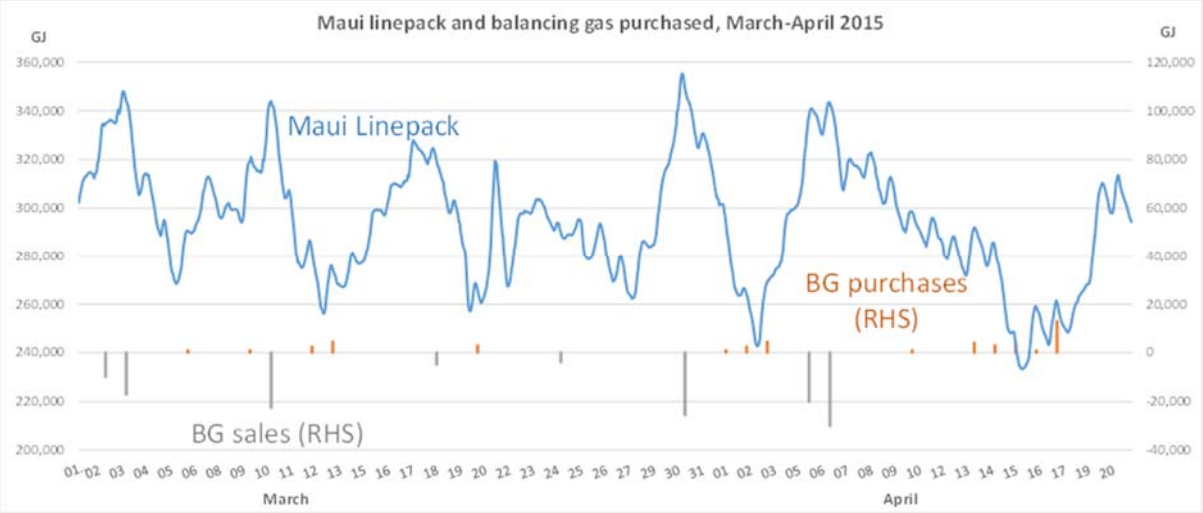
Figure 9 Maui actual and target linepack



At times, MDL buys or sells balancing gas as a way of managing linepack when primary balancing is ineffective. The following chart shows purchases and sales of balancing gas in March and April

2015, along with hourly linepack. As can be seen, many of the high linepack situations were accompanied by sales of balancing gas, including several sales in the range of 10-20TJ.

Figure 10 Maui linepack and balancing gas purchases



There were also purchases of balancing gas during times of low linepack. These situations tended to involve smaller amounts of gas (1-5TJ), but there was one purchase of 13TJ on 17 April.

Analysis of linepack

The difference between actual linepack and target linepack is the gross deviation. Gross deviation can be broken down into ROI – the amount of running operational imbalance at all of the welded points on the Maui pipeline – and net deviation. Net deviation is the difference between actual and target linepack that is not attributable to ROI at the TP welded points.

The table below shows the data as at midnight for the Maui pipeline:

Table 6 Analysis of Maui linepack

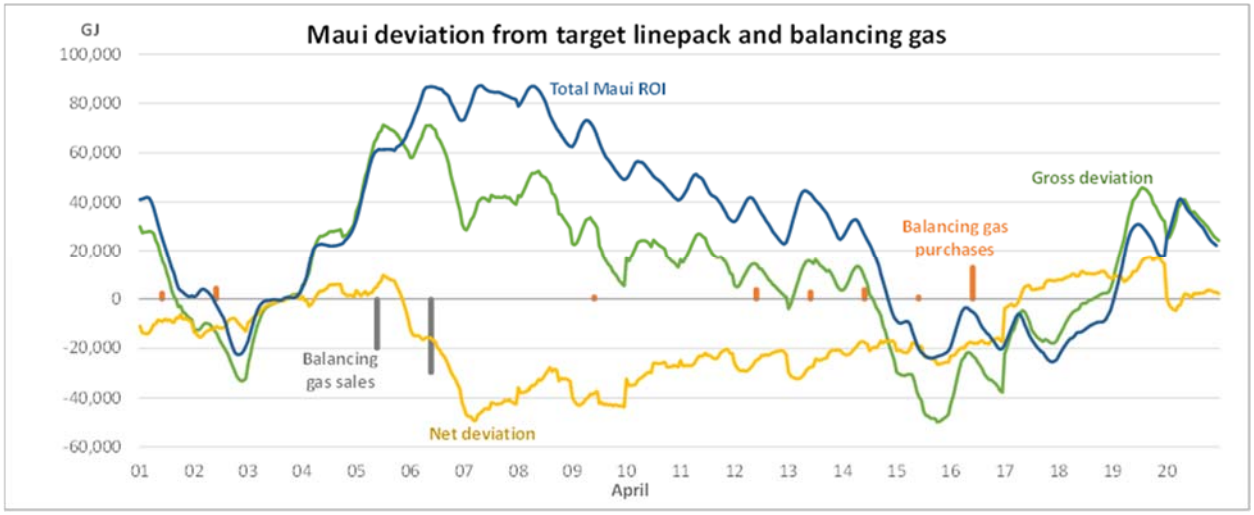
	at midnight	daily change (TJs):			
	13 Apr	14 Apr	15 Apr	16 Apr	17 Apr
Actual linepack	276	-26	-11	6	6
Target linepack	272	4	7	-3	-15
Gross deviation	4	-31	-19	9	21
Total ROI	21	-34	-11	4	-4
Net deviation	-17	3	-7	4	25

As of midnight on 13th April, the actual linepack exceeded the target linepack: the linepack was in surplus and the full contingency volume was available. Thereafter the actual linepack was below

target: linepack was in deficit and the contingency volume was eroded. As the table shows, the decrease in linepack over 14 and 15 April can be attributed almost entirely to the decrease in ROI over the period.

The chart below shows the Maui pipeline linepack gross deviation in more detail for the period 1 through 20 April.

Figure 11 Maui gross deviation from target linepack



The green line on this chart shows gross deviation, the difference between actual and target linepack in Figure 9. Gross deviation is positive when the actual linepack is greater than target and negative when actual linepack is less than target. The blue Maui pipeline ROI line is the same dataset as in previous charts; it is a large component of gross deviation. Net deviation is calculated by subtracting ROI from gross deviation. The bars depict the timing and magnitude of balancing gas purchases and sales.

The chart shows that the 5th/6th April was a period of very high linepack when MDL took contingent event action under s15 of the MPOC, including very significant balancing action (20TJ of put balancing gas on 5th April, followed by another 30TJ of put balancing gas on 6th April), which would have been responsible for the shift from positive to negative net deviation at the time.

In contrast the actions taken by MDL later in the month, to counter the fall in linepack caused by the precipitous fall in total Maui pipeline ROI, were much less significant, and had little impact on the net deviation.

Conclusions

Cause of the potential critical contingency

The rapid fall in Maui pipeline linepack during the 14th and 15th of April 2015, which almost initiated a critical contingency, was caused mostly by a steep decline in ROI at TP welded points. This was principally attributable to shippers on Vector's North and SKF pipelines drawing more gas from the Maui pipeline than they had contracted for. One shipper in particular (the one who did not provide data for this investigation) appears to have been the single largest contributor to the situation.

As far as we know, no party has contravened any governance arrangements; rather, the ineffective MPOC ILON process allowed pipeline users a degree of freedom that, in this instance, almost caused a critical contingency.

However, we note that potential critical contingencies are relatively rare events, which suggests that the pipeline user behaviour that led to the 15 April potential critical contingency is rare, or that MDL has managed to avert similar situations by taking more aggressive balancing actions than it did in this instance.

MPOC changes

Regarding the MPOC balancing arrangements, we note that MDL intends to implement a change to the MPOC on 1 October 2015, replacing the ILON process and introducing a regime known as market-based balancing. Under this new regime, Maui welded point imbalances (over an allowed tolerance) will be cashed-out daily. This change will prevent imbalances at welded points from accumulating – which should improve incentives for all pipeline users to improve primary balancing.

The tighter control over running imbalances should keep pipelines in better balance. However, we note that the other factor affecting Maui linepack is the secondary balancing undertaken by MDL. To ensure that cash-outs of excess imbalances are effective in managing linepack, MDL will need to back up the net of its cash-out transactions with balancing gas, rather than using linepack flexibility to excess.

Industry governance issues

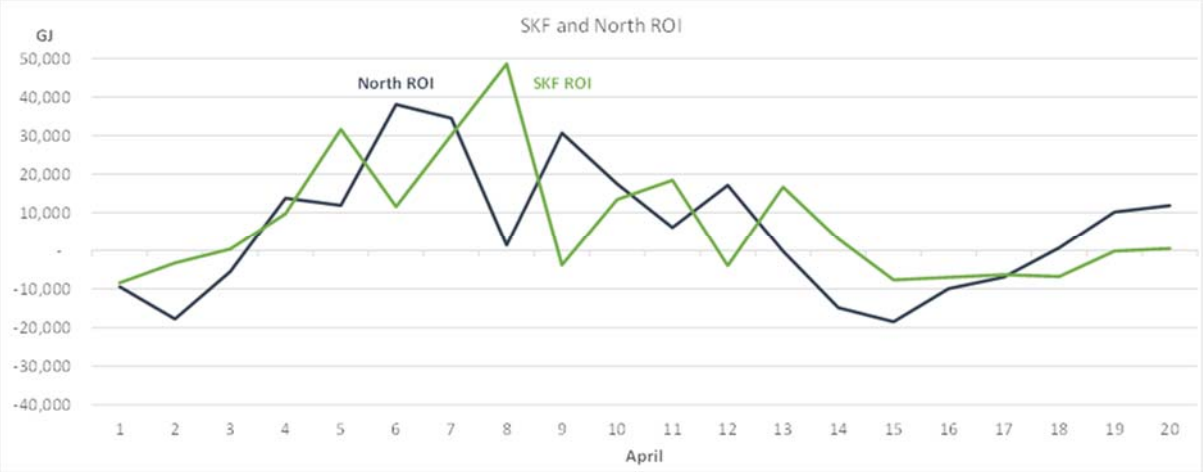
Regarding industry governance issues, we are concerned that our Information Gathering Protocol was not completely effective in the case of this investigation. We believe Gas Industry Co does have a role in investigating situations that may indicate issues with current industry governance, such as where a critical contingency is narrowly averted; and especially where the information necessary to unravel the cause is not publicly available. In this instance, two retailers were able to hinder or/and delay our investigation because they did not agree to provide data requested. This is

of particular concern when we are considering how to monitor the effectiveness of market based balancing when it is introduced on 1 October 2015. We will be reviewing the role of the Protocol in that context.

Appendix

Is ROI being "moved" around the system?

Figure 1 SKF and North ROI

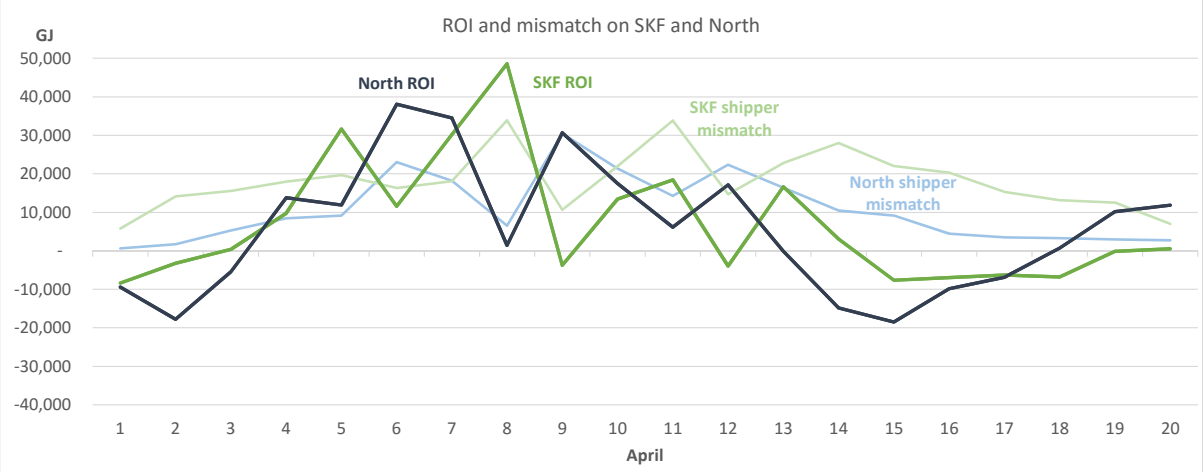


In April 2015, a pattern emerged where increases in the North pipeline system's ROI seemed to be matched by decreases in SKF's ROI, and vice versa.

We noted earlier that there are weak incentives for primary balancing on the Maui pipeline and that the ILON regime contributes to those weak incentives. In particular, we raised the question of whether there is any evidence that one or more parties was using the ILON notice period to help it maintain a position against the pipeline (whether positive or negative) by moving imbalances to/from welded points.

As it turns out, there is a shipper whose mismatch positions on SKF and Rotowaro closely align with the movements in ROI at those TP welded points.

Figure 13 ROI and shipper mismatch on SKF and North



As shown in Table 1, during 1 to 20 April, there were very few significant cash-outs. One occurred at the Rotowaro TP welded point (connected to Vector's North pipeline) on 1 April; and two occurred at the Frankley Road TP welded point (connected to Vector's SKF pipeline) on 7 and 18 April.

This information suggests that a shipper was using the ILON provisions of the MPOC to maintain a positive balance in the pipeline by moving ROI from one welded point to another. The fact that few cash-outs happened during that time suggests that the movements in ROI were consistent with the provisions of the MPOC; that is, they either did not trigger ILONs or the imbalances were moved before the ILONs expired.

An examination of ROI data for the 2015 calendar year to date (which is public information that can be obtained from bgx.co.nx) shows that ROI for the SKF and North systems frequently move in opposing directions – see the set of charts on the next page. In particular, the periods 4 22 February, 27 April – 19 May, and 1 10 July seem to exhibit this pattern.

Gas Industry Co notes that there would be no advantage in shippers moving ROI from one welded point to another in this way once the market-based balancing regime is introduced in October.

Figure 14 ROI for SKF and North, calendar 2015