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P15/P18B Data Analysis

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0.1 Initial Draft

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d Changes Forecast

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e Related Documents

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II CONTENTS TABLE

1 INTRODUCTION

1.1 Purpose

This document has been written in order to set out the findings from the analysis undertaken on behalf of the Pricing Issues Modification Group on Modification Proposals P15 and P18B.

This analysis was undertaken in accordance with the instructions of the Modification Group and carried out in line with the timetable agreed between the Authority and the Panel on 27 September 2001.

1.2 Scope

The scope of this document relates to the analysis carried out between the 2 October 2001 and 15 October 2001.

This document presents the results of the initial analysis carried out by ELEXON on behalf of the Modification Group Meeting in respect of progressing Modification Proposals P15 and P18B through the Modification Process.

Please note that the information in the attached analysis has been collated by ELEXON and while all due care has been taken to ensure the accuracy of this information, ELEXON accepts no responsibility for errors.

1.3 Document Summary

The remainder of this document consists of:

Section 2: Provides an overview of the Analysis;

Section 3: Provides some basic market statistics used in the later analysis;

Section 4: Describes Modification Proposal P15;

Section 5: Describes the Interaction between P15 and P18A; and

Section 6: Describes the P18B Modification;

Section 7: Provides some technical conclusions.

1.4 Summary of Analysis

In summary, the analysis shows that there is little evidence to prove that the Modification Proposal P15, in any of its forms, is better at identifying Bid-Offer Acceptances (BOA) assumed to be made for "system" balancing, rather than "energy" balancing purposes, than P18A on its own:

- the background market analysis shows that the majority (75% +) of all plant are instructed with two minutes or less notice to deliver. This effectively means P15 is simply truncating the majority of BOA by a variable amount, depending on when it occurs within a period;
- all the identified alternative definitions for P15 seem to be a blunt instrument when used to identify "system" balancing actions. The one definition ("P15 Reducing P18A") which initially seemed to offer a fine degree of control, actually selects more "fast" plant BOA to remain in the imbalance price calculations than "normal" plant. In addition it may provide

little added benefit when the development effort for what would be seen as a significant development has been taken into account.

Modification Proposal P18B does not attempt to differentiate between "system" and "energy" balancing actions and simply attempts to mitigate the effect of the "system" balancing actions when the volumes are small, and ATT (Automatic Trade Tagging) cannot take effect. The limited analysis shows that it achieves this to a degree, but is no compensation for the inclusion of matching Bids and Offers to provide Regulating Reserve. The analysis also shows that irrespective of P18B, when small volumes are involved there are effects within the imbalance price calculations that may warrant further investigation.

2 OVERVIEW

When Modification Proposals P15 and P18 were raised, they were seen by the Modification Group as alternatives for each other and it was thought that only one would be implemented. This phase of the modification process must consider whether and how they interact given that the existing baseline of the BSC contains P18A. In addition it must be considered whether P18 Option B (P18B) can be implemented in its own right – i.e. with either (P18A) or (P18A and P15).

It is easier to consider P18 Option A (P18A) and P18B first. As stated in the original proposal these were seen as alternative mechanisms for achieving the same objective. However, it was also pointed out there was no reason why they should not both be implemented together. Both attempt to address the underlying problem in different ways and are complementary in the way in which they work. If P18A does not remove what is considered a "system" balancing action, then P18B will ensure it does not have undue influence on the prices should the Bid Offer stack be small.

P15 can be viewed as a direct competitor, in implementation terms, for P18A. This is because P15 and P18A both attempt to remove BOA from the stack of Bids and Offers to be considered in the imbalance calculations. This makes any analysis of the interaction between these harder, as they can effectively alter the decisions being made by the each other.

As P15 was proposed against a baseline of the Balancing and Settlement Code that did not include P18A, it only talks in terms of removing BOA which fail to meet its criteria. However when considered with the current P18A compliant baseline, there is a question of whether a BOA should be removed if it meets **either** the P15 and P18A criteria, or whether it should only be removed if it meets **both**.

Figure 2.1 shows a process for identifying and excluding from price calculations BOA which meet the criteria of P18A **OR** independently meet the criteria of P15. Proportions of BOA volumes shown are purely illustrative. This process will be referred to as "P15 Increasing P18A" within this document, i.e. it reflects that more BOA will be removed as a result of implementing both modifications.

For the purposes of simplicity within the illustration, it assumes that P18A removes only 10% of BOA[1], whereas P15 will remove 50%.

[1] The statistics included in this document show the figure for P18A to be around 6%. The manner in which P15 removes and truncates BOA means it is not so easy to provide a comparable figure for P15, this is explored in more detail later in the document.

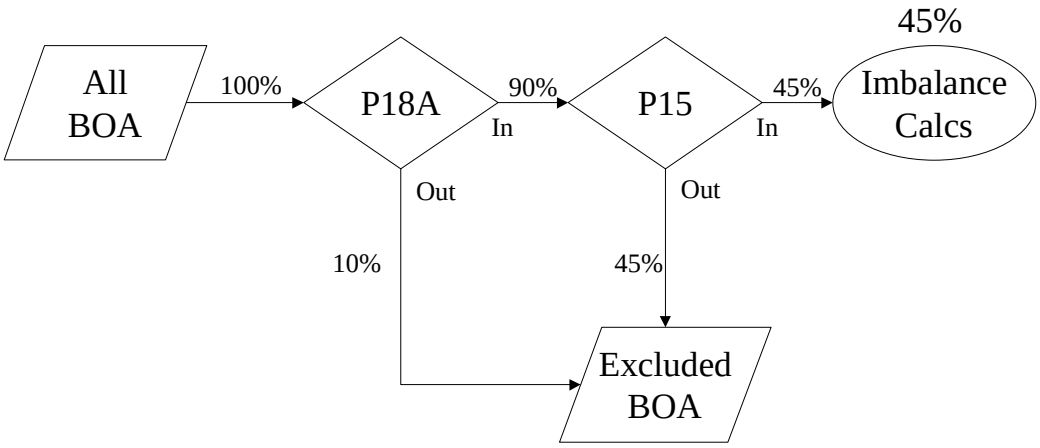

Figure 2.1 - P15 Increasing Effectiveness of P18

It is also possible to alter the structure in figure 2.1 such that P15 is applied prior to the application of P18A. This would not alter the figures given in the example, however, in reality it would make a difference, as P15 truncates BOA as well as removing them.

There exists a further combination of P15 and P18A that shows BOA removed only if they meet both the criteria for both P18A **AND** P15. This will be referred to as "P15 reducing P18A" within this document, as it results in less BOA being excluded from the Imbalance Price Calculation. In this case it is more sensible to apply P18A first as it is the finer filter, as shown in figure 2.2.

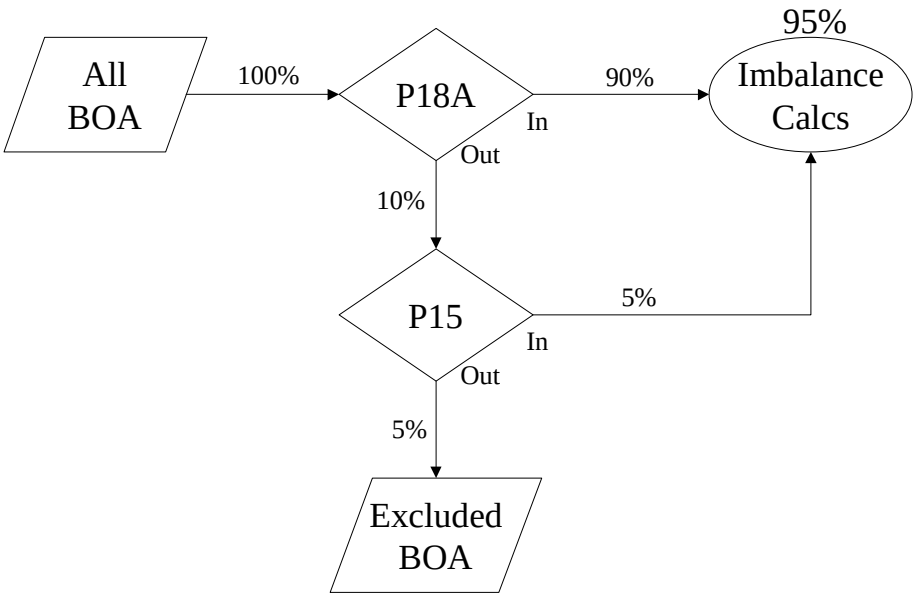

Figure 2.2 - P15 Reducing Effectiveness of P18A

Before it is possible to consider how these modifications interact it is necessary to fully understand how P15 was expected to work.

3 MARKET STATISTICS

3.1 Bid / Offer Stack Sizes

Figure 3.1 shows the number of different Balancing Mechanism Units (BMUs) which were responsible for determining the System Buy Price (SBP) during a sample period of August 2001. The y-axis shows the percentage of Periods during the sample days where the number of BMUs setting the SBP was "n" or less, where n is provided within the diagram key.

The SBP has been chosen because since Go-Live the market has been consistently "long" – i.e. more Bids than Offers are being bought. In addition there has been little need to buy matching Bids and Offers to provide Regulating Reserve, and hence most of the smaller stack should represent "system" balancing actions. This means it is normally the Offer stack which is the smallest, and most susceptible to volatile prices and defaulting.

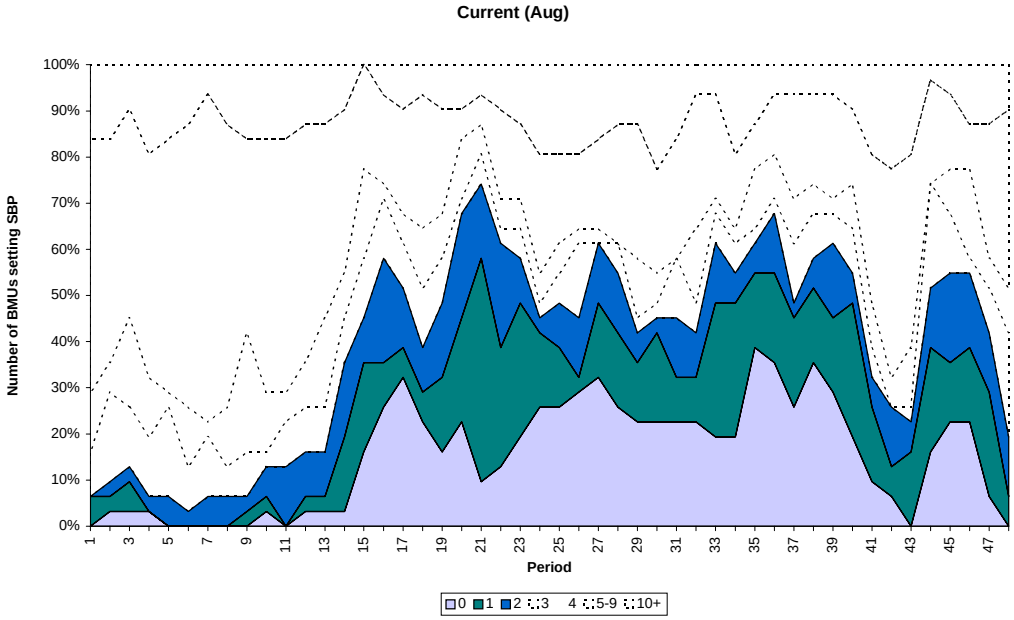

Figure 3.1 - Number of BMUs setting the System Buy Price

The light shaded area, nearest the x-axis, details all the periods that have been set by zero BMUs and hence have defaulted. It shows that during the early afternoon 20-30% of all periods will set a default SBP. However, in some ways it is more important to note the number of periods where the SBP is set by a small number of BMUs, as it is these periods where the SBP can be more volatile. The next two darker shaded areas, moving away from the x-axis, represent those periods where the SBP is set by 1 or 2 BMUs respectively. As can be seen for the same period 50% of the time the SBP is set by 2 or less BMUs. The rest of the graph shows the lines for 3, 4 and then 5-9 and 10+ BMUs setting the SBP.

This highlights two factors about the periods during the middle of the day:

- When the SBP does not default it is likely to be volatile as it is set by so few BMUs
- There is little room to remove further BOA without increasing the level of defaulting and probably increasing the level of volatility when not defaulted.

Table 3.1 shows numerically the level of defaulting that has occurred between 01 July 2001 and 27 September 2001. Again the key point to note is the high level of defaulting that occurs during periods 25 to 36. In addition it is worth noting that there were two periods when there were no Bids or Offers on either of the stacks[2].

Table 3.1 - Defaulting and BRL Statistics

Period	Default SBP	Default SSP	Default Both	BRL Reached
1 to 12	2.8%	5.2%	0.1%	52.6%
13 to 24	18.1%	3.1%	0.1%	21.5%
25 to 36	29.8%	5.8%	0.0%	4.5%
36 to 48	15.6%	1.5%	0.0%	10.7%

In addition table 3.1 shows the frequency with which the level of BRL is reached, i.e. both stacks with 180 MWh of more. The key point to note is how infrequently this occurs in periods 25-36

Once the SBP defaults the price can be either determined from the Offers that could have been used, or else capped to the SSP. The following table gives some idea of how often the latter occurs and what the average prices are during these times.

Table 3.2 – Impact On Prices Of Defaulting

Stack (4224 Periods)	Defaulted Periods	% of Default Periods when SBP=SSP	Average SBP (£/MWh) for Defaulted Periods	Average SSP (£/MWh) for Defaulted Periods
Offers	700	92%	11.05	10.70
Bids	165	26%	36.34	20.39

As can be seen the default price for the Offer stack is regularly capped to the SSP, setting an average SBP during these periods of £11.05. This can be traced to the Offer prices set for Nuclear plant, which have often submitted Offer prices of £5 - £8 /MWh. It is also worth noting that half of those periods where the SBP was not capped by the SSP, the SBP was still controlled by the £5 - £8/MWh Offers, however, on these occasions the SSP was simply less than £5/MWh.

Further analysis of the SBP prices shows that the lowest non-default SBP during the sample period was £11.05 / MWh. This however was a full £1 lower than the next lowest price and over 99% of non-default SBP prices are greater than £15/MWh.

The high level of defaulting, and the low associated prices, should be seen as a major factor in setting the average SBP for all periods.

[2] On the 10 July 01 Period 24 both prices were set to £22.325 due entirely to the SCA/SVA values from BSAD. On the 20 Sep 01 Period 12 both prices were set to £0.00

3.2 NGC Instruction Lead Times

The following graphs (figures 3.2 and 3.3) examine the lead-time that NGC use when issuing BOA (sample period 17 September 2001 to 2 October 2001). The first graph plots the percentage of BOA which are issued with a lead-time (Acceptance Time to first point of delivery) of less than *x* minutes.

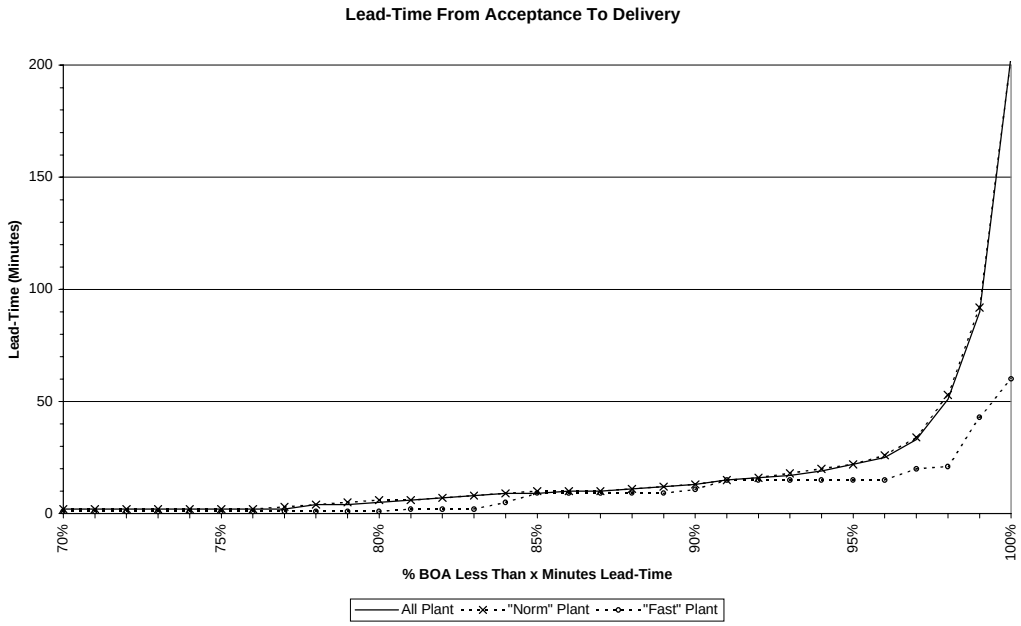

Figure 3.2 - Lead time from Acceptance Time to Delivery

Figure 3.2 shows that more than 75% of all acceptances are made at two minutes or less notice to deliver.

There is some suggestion that short duration (less than 15 minutes) BOA issued on the "fast" plant has an undue influence on this. However, even if we examine the same graph for the short duration BOA, we find the same relationship, and interestingly "fast" plant tend to exhibit the longer lead-times[3]. This is illustrated in Figure 3.3.

[3] Further details on the underlying reason for this are explored in section 5.3.

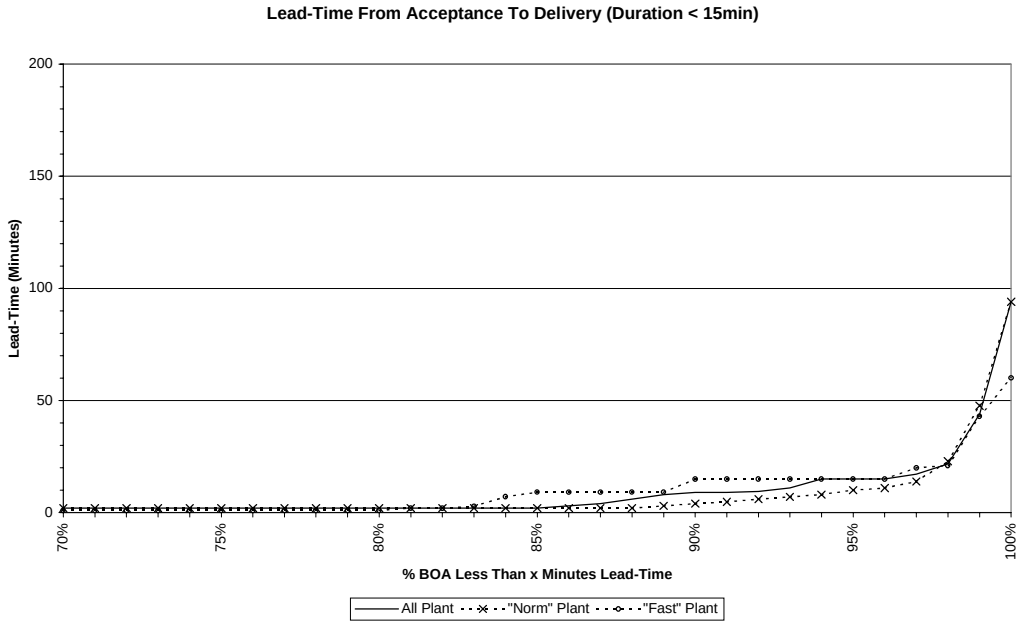

Figure 3.3 - Short Duration Acceptance Lead Time

The dominance of 2-minute lead-times, and "fast" plant having a greater proportion of the longer lead-times for short duration BOA, suggests that P15 may be too blunt an instrument either on its own, or to complement P18A.

4 MODIFICATION P15

4.1 Overview

There are two key points to note about P15:

- P15 decides which BOA to remove/truncate based on the lead-time between Acceptance Time and the first minute of a Settlement Period, rather than duration of the BOA;
- P15 works by truncating the first *x* minutes from any BOA taken with too short a lead-time. A BOA is only fully removed if this truncating effectively removes all of the acceptance.

Both of these features are different to P18A and not easy to visualise without the use of worked examples. A key difference between P15 and P18A is that the portions of a BOA may be removed from Imbalance Price Calculations using the P15 rules, whereas the whole of the BOA is removed using the P18A rules[4]. A further point to note is that only the first two Settlement Periods which a BOA spans are affected by the P15 Rules, although it is worth noting that other periods may be influenced by the removal of other BOA.

The following figure (4.1) provides some examples to help explain how P15 is expected to work – before any consideration of P18A.

The examples are shown twice, once for a P15 Limit of 30 minutes and once for 15 minutes. With these particular examples a P15 Limit of 0 or 5 minutes would be the same as the examples for 15 minutes.

It is important to note that a limit of 0 does not turn off the P15 functionality, there is no way to turn this functionality on gradually.

[4] This would imply a different implementation technique within Central BSC Systems software and may also alter the quantity of data held within the central databases.

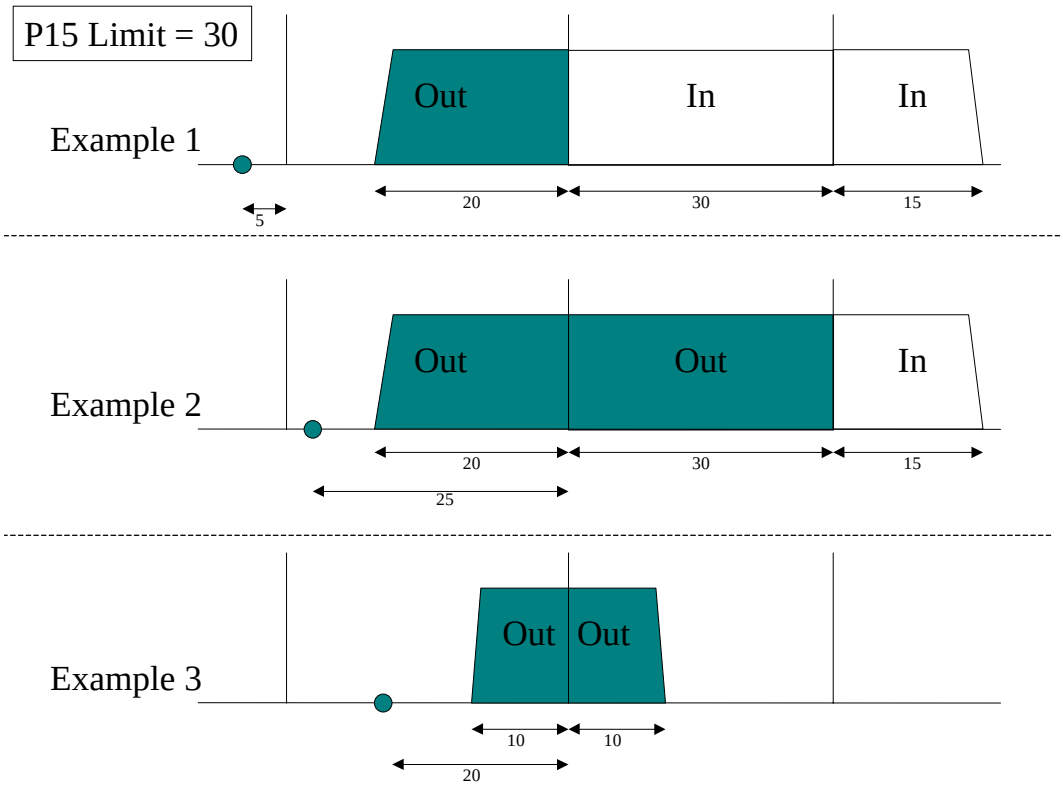

Figure 4.1 - Illustration of P15

Figure 4.1 shows the acceptance time for each BOA being taken at different intervals within each example 1-3. The acceptance is made at 5 minutes before, 5 minutes after and 10 minutes after the Settlement Period within which the Acceptance delivers. The small shaded circle on the x-axis identifies the Acceptance time. The vertical lines in each example represent the commencement of a Settlement Period. In both examples 2 and 3 the acceptance time follows the start of the period within which delivery commences and hence the start of the BOA is truncated when viewed in terms of the Imbalance Price Calculation for this period. The P15 parameter limit has been set at 30 minutes (as included within the original Modification Proposal).

The shaded trapezoids represent the volume of energy removed from the calculation of Imbalance Prices when calculated during that Settlement Period. For ease of reading these are marked "Out".

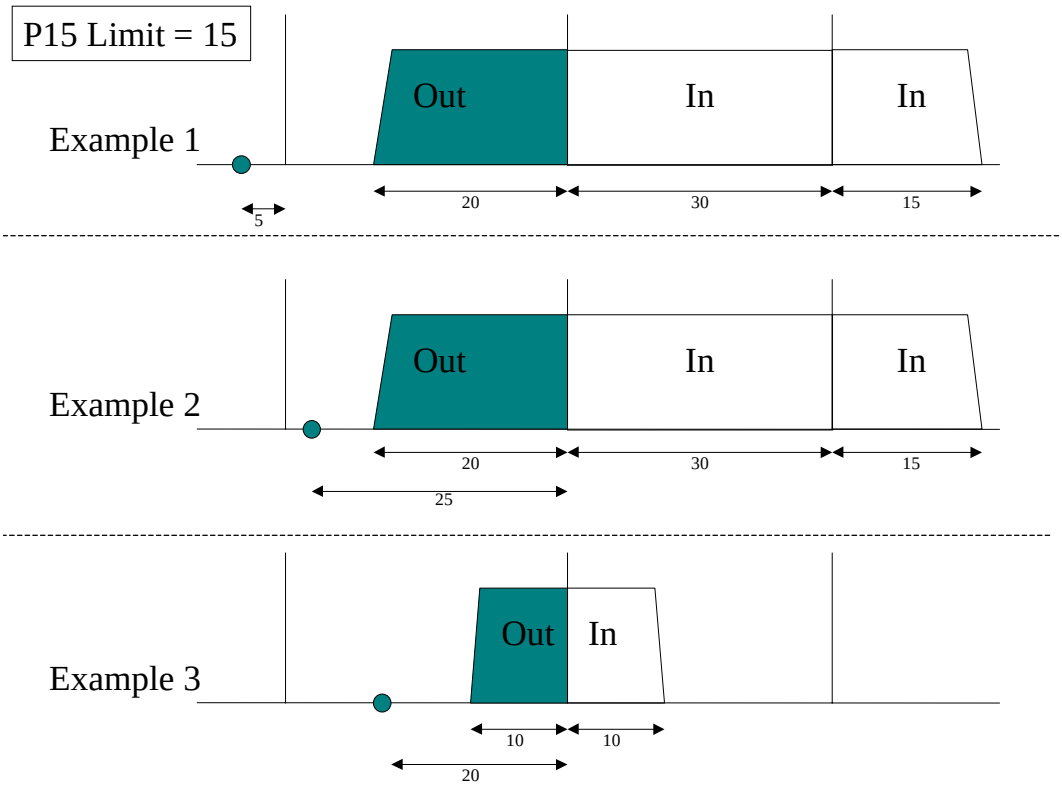

Figure 4.2 - P15 Parameter set at 15 minutes

Figure 4.2 shows the same 3 example BOA with a P15 parameter limit of only 15 minutes. The key difference identified is that examples 2 and 3 now continue to affect the Imbalance Price Calculation within the second period of delivery.

The choice of a limit is a delicate trade off:

- if it is too short i.e. 2 minutes then the software will not remove "system" balancing acceptances, starting on a period boundary and only taken a couple of minutes previously;
- if it is too long it could unnecessarily truncate up to 30 minutes from the front of a 45-minute "energy" balancing acceptance taken in the same circumstances.

The success of P15 is based on the assertion that "energy" balancing actions should have a long lead-time, whereas "system" balancing actions should have a short lead-time.

Figures 3.2 and 3.3 have already suggested that this is not the case and the following sections explore the impact of this.

4.2 Analysing P15 Data

To help analyse the P15 data the following basic metrics are used:

- **# of BOA** – this is a count of remaining number of BOA. It does not include any information on those truncated.
- **Duration (Minutes)** – this is the overall duration of the remaining BOA and hence can be used to measure the degree of truncating.
- **# of Periods** – this is similar to the duration metric except it is a count of the periods for which there exists a Bid/Offer volume for that BMU and Acceptance Number. In terms of

the BSC this would be the count of the different combinations of i,j,k after $\Sigma^{n}(QAO^{nk}_{ij} + QAB^{nk}_{ij})$.

These are fairly crude measures and for example two overlapping acceptances for a single BMU would be counted twice. It is also important to note that the count of Periods is proportional to the number of original BOA and not the number of physical Settlement Periods affected.

In order to illustrate how these metrics can be used, Figure 4.3 shows how they relate to the first two examples originally introduced in Figure 4.1.

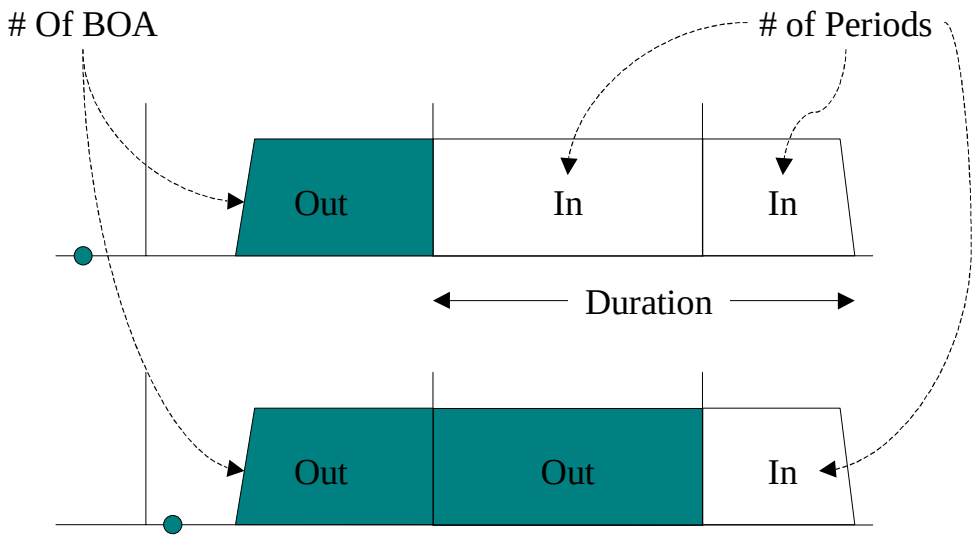

Figure 4.3 - Sample Metrics

Table 4.1 provides samples values for these metrics using the examples introduced in Figures 4.1 (P15 Limit 30) and 4.2 (P15 Limit 15).

Table 4.1 - Sample Raw P15 Statistics

	Before P15	P15 (15 Min Limit)	P15 (30 Min Limit)
# of BOA	3	3	2
Duration (Mins)	150	100	60
# of Periods	8	5	3

For clarity the raw figures in Table 4.1 and are best shown as averages. In the case of # of BOA this is achieved by dividing by the total number of periods for the overall data sample. In the case of the other two sets of figures (duration and periods) by dividing by the # of BOA. However, this introduces another level of complexity, i.e. to divide by the original # of BOA, or those remaining after P15 has been applied. Examples of both approaches are shown in Table 4.2.

Table 4.2 - Sample Average P15 Statistics

		Before P15	P15 (15 Min Limit)	P15 (30 Min Limit)
# of Periods	**Avg for all Periods**	3 / 4 = 0.75	3 / 4 = 0.75	2 / 4 = 0.5
Duration (Mins)	**Avg for all BOA**	150 / 3 = 50	100 / 3 = 33.3	60 / 3 = 20
	Avg for P15 BOA		100 / 3 = 33.3	60 / 2 = 30
# of Periods	**Avg for all BOA**	8 / 3 = 2.66	5 / 3 = 1.66	3 / 3 = 1
	Avg for P15 BOA		5 / 3 = 1.66	3 / 2 = 1.5

Both approaches have meaning in the correct context, however, for general use the average using the original number of BOA (i.e. the first set) has the most meaning and will be the figure used in the rest of this section.

The last useful view is to look at the % Reduction in the averages compared to the data before P15 is applied. Therefore the reduction in duration for a 30 minutes limit will be 60% (i.e (150 – 60) / 150 * 100). Again it is important to remember that the reduction in number of periods would be based on the count of BOA and not related in any way to physical Settlement Periods.

4.3 Analysis of P15

The approach introduced in the previous section has been used to analyse 6844 BOA taken between the 17 Sept 01 and 02 Oct 01 and covering approximately 714 periods. Table 4.3 shows the statistics for all BOA, including the % reduction against the Pre-P15 figure.

Table 4.3 - P15 Statistics – All Plant

All BOA (Fast + Norm)		Pre P15	P15 Limit			
			0	**5**	***15***	**30**
# BOA	**Total**	6844	6070	5724	4773	3313
	Average Per Period	9.5	8.5	8.0	6.7	4.6
	% Reduction		11	16	***30***	52
Duration	**Average**	48	37	34	27	18
(Mins)	**% Reduction**		23	30	***45***	64
Periods	**Average**	2.55	1.70	1.56	1.25	0.84
	% Reduction		33	39	***51***	67

The key points are that even with a P15 Limit of 15 minutes, 30% of all BOA are being physically removed, this is a significant number. In addition there is a 45% reduction in the duration of the BOA, which means the BMUs affected contribute volume into 51% less periods. As there are on average 6.7 BOA per period this could mean that, depending on their distribution, it could affect significantly more than 50% of physical Settlement Periods.

It is also interesting to look at how these figures vary between "Fast" and "Normal" response plant.

Table 4.4 - P15 Statistics – Normal Plant

Normal Plant		Pre P15	0	5	15	30
# BOA	Total	6456	5979	5687	4755	3306
	Average Per Period	9.0	8.4	8.0	6.6	4.6
	% Reduction		7	12	26	49
Duration (Mins)	Average	50	39	36	28	19
	% Reduction		23	30	44	63
Periods	Average	2.63	1.79	1.64	1.33	0.89
	% Reduction		32	38	50	66

Table 4.5 - P15 Statistics – Fast Plant

Fast Response BOA		Pre P15	0	5	15	30
# BOA	Total	388	91	37	18	7
	Average Per Period	0.55	0.13	0.05	0.03	0.01
	% Reduction		77	90	95	98
Duration (Mins)	Average	5.3	0.98	0.43	0.28	0.11
	% Reduction		82	92	95	98
Periods	Average	1.15	0.25	0.11	0.05	0.02
	% Reduction		78	90	95	98

Table 4.5 shows that although the "Fast" response plant are significantly impacted by the use of P15, there is still a lot of impact on the "Normal" plant (Table 4.4).

It should also be noted that although the average duration of a "fast" BOA with a 5-minute P15 limit is 0.43 minutes, this is based on the pre-P15 number of BOA. The average based on the remaining 37 BOA is still nearly 5 minutes[5]. This supports the argument that a P15 Limit of at least 15 minutes would be needed for P15 to be as effective as P18A with a CADL of 15 minutes.

[5] A 10-minute duration BOA taken 6 minutes before the end of the period with a lead-time of 1 minute, would result in a 5 minute duration in the next period.

5 P18A / P15 INTERACTION

5.1 Overview

The analysis for combined P15 and P18A needs to take the 6844 BOA from the P15 analysis and combine them with the associated CAD values calculated within the TOMAS system.

This initial analysis concentrates on the data for both BOA types ("fast" and "normal") and only the number of acceptances physically removed by P15 (# of BOA). It is not feasible at this stage to study the effect of P15 truncating BOA and the impact on the Bid/Offer volumes (currently measured indirectly using "duration" or "# of periods").

Table 5.1 reproduces some of the data from table 4.3, but the reported numbers have been altered to represent the number of whole BOA removed, rather than the total still present:

Table 5.1 - Data Analysis Sample

# BOA Removed		Pre P15 Total	0	5	15	30
Original Data	**# BOA**	6844	774	1120	2071	3531
	%		11	16	30	52

For this subset of data the number of BOA which had a P18A CAD of less than 15 minutes was 433 (6%).

5.2 "P15 Increasing P18A" Description

As stated earlier both P15 and P18A are written in terms of removing BOA and that they can be interpreted as "P15 Increasing P18A" or "P15 Reducing P18A". This section explores the first of these where BOA are removed if either modification decides it represents a system action.

However, trying to visualise this is very hard as the removal of BOA is **all** the modifications have in common:

- P18A calculates which BOA to remove based on **duration** , whereas P15 uses the **lead-time**
- P18A removes the **whole BOA** from all periods, whereas P15 **truncates** the front part of BOA with short lead-times.
- P18A attempts to **group** BOA, whereas P15 treats each BOA **individually**

The differences lead to a number of interacting effects. After careful consideration it was felt that this approach of simply combining the Mods could not be analysed in any great detail. As shown in previous section, P15 is a very blunt instrument and can remove or truncate a significant number of acceptances. Before we even consider any real interaction between the two it is obvious that P15 will obscure the effect of P18A, as it affects so many BOA.

The following Venn diagram gives an illustration of the number of BOA truncated or removed by each modification for a P15 Limit of 15.

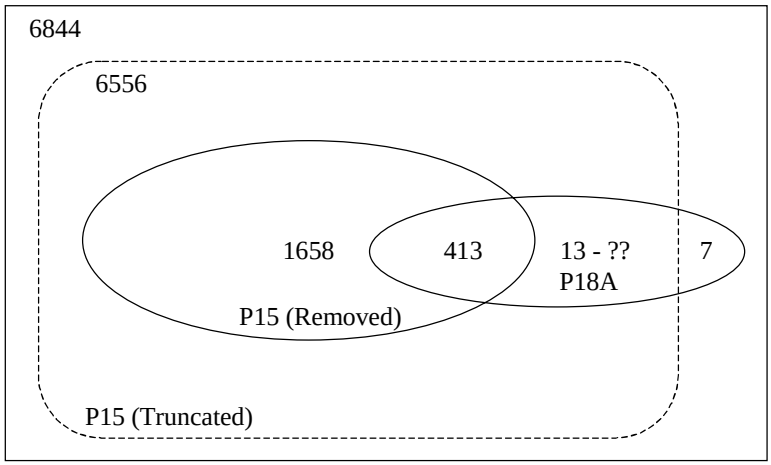

Figure 5.1 - "P15 Increasing P18A"

Only 288 (6844 – 6556) of the original 6844 BOA are not truncated or removed in any form by P15. Even reducing the P15 Limit to 0 will only increase this number to 1038, of which 276 will then have a lead-time of 2 minutes or less.

Of these 288 that are not truncated, 7 of them have a CAD of less than 15 and hence P18A would still remove them.

Only 20 (13 + 7) of the 433 BOA removed by P18A would not have already been removed by P15. However, as a result of P15 truncating BOA, there may be other BOA which should now be removed by P18A. These would have not been originally removed by P15 and would also have an original CAD of more than 15:

- BOA which now have a CAD of less than 15 minutes because another key BOA has been removed, i.e. their original duration is less than 15 minutes. For the sample data there could be up to 6 of these.
- BOA which now have a CAD of less than 15 minutes because the first x minutes of the BOA have been truncated by P15, i.e. their new P15 duration is less than 15 minutes after truncation by P15. For the sample data there could be up to 1334 of these.

Some examples of these last two categories of BOA are shown below, where P15 can alter the calculation of P18A CAD values. In these examples it is assumed that the P18A CADL value is 15 minutes and that the P15 Limit is 3 minutes.

Figure 5.2 shows that the two operations (P15 & P18A) are not associative and highlights some of the potential issues in describing the precise BSC rules

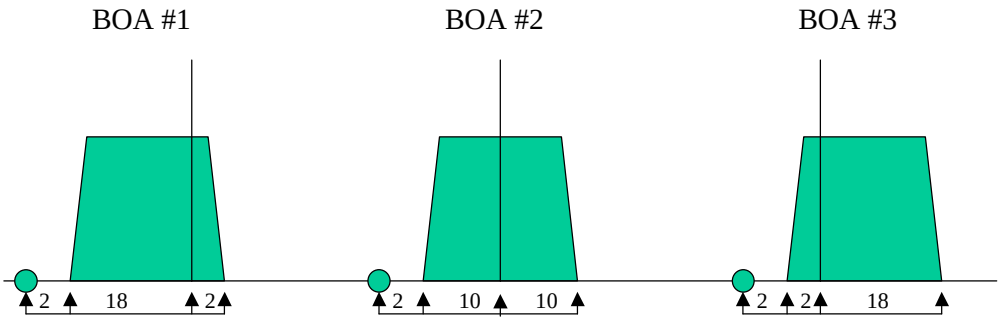

Figure 5.2 - Order Of Applying P15 and P18A

In this figure 3 BOA are shown along with their Acceptance Time. Unlike previous figures the shading of the BOA does not indicate whether they are removed or not:

- On its own P15 would attempt to remove the first part of all three BOA, as it occurs in the same period as when the acceptance was taken;
- On its own P15 would leave the second part of all three BOA, as the Acceptance Time is always greater than 3 minutes before the start of the period;
- On its own P18A would leave all three BOA intact as they are all have a CAD of greater than 15;
- If P15 is applied before P18A, then only the second part of BOA #3 would remain in the calculations. This also raises the question as to whether P18A is allowed to use the CAD value of the BOA before it was truncated. The document assumes this is not the case and hence the CAD for BOA #2 is 10 minutes;
- If P18A is applied before P15, then the second part of all three BOA would remain in the calculations, even though BOA #1 and BOA #2 are now less that 15 minutes in duration.

A similar problem exists when one considers groups of BOA which contribute to a CAD and where the actions of P15 may remove some of this. In the following example (Figure 5.3) all 3 BOA form a continuous acceptance with an overall CAD of 34 minutes. In this case it is assumed that the P15 Limit is 0 minutes, and so only volume within the same period as the when the acceptance is taken is removed. In this example this would mean offer volume V2, however the knock on effect of this is:

- As the first BOA is no longer continuous with the others it means the CAD for V1 is reduced to 10 and will be removed.
- the start time for the second acceptance is now at the start of the period and hence a CAD of 14 is formed from V3 and V4, and hence they are also removed.

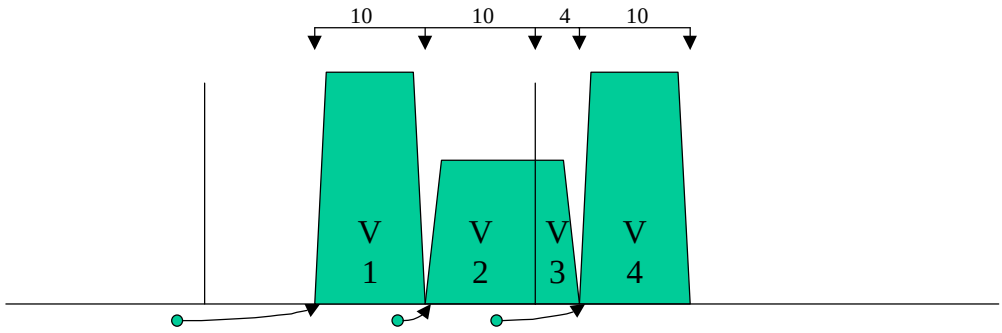

Figure 5.3 - Truncating BOA

5.3 "P15 Reducing P18A" Analysis

It is a lot easier to examine how this option works, as it is already working with a subset of the overall BOA, i.e. only those selected by P18A for exclusion.

Table 5.2 represents how many of the BOA which would be removed by P18A, would also be fully removed by P15, i.e. of the original 6844 BOA, only 433 would have originally been removed by P18A and of these only 263 would also be removed by P15 with a Limit of 0. This represents only 61% of the original P18A selected BOA.

Table 5.2 - P15 Reducing P18A – Definition 1

# BOA Remove		P18A	0	5	15	30
P18A/P15	# BOA	433	263	339	413	424
Def 1	%		61	78	95	98

Further examination of Figure 5.2 reveals an interesting feature. A simple examination of the 433 BOA found that 359 BOA (83%) had a lead-time of 2 minutes or less. This is a higher figure than that for either the P15 Limit = 0 or P15 Limit = 5. This is counter intuitive as even P15 with a Limit of 0 minutes has the potential to remove BOA with lead-times significantly longer than 2 minutes.

Further examination showed that this was caused by a feature of P15 truncating (not removing) BOA which cross period boundaries, as shown in Figure 5.4.

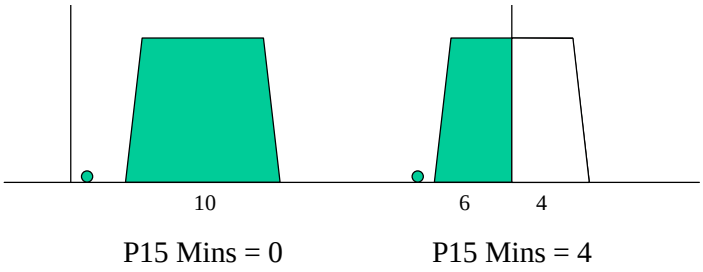

Figure 5.4 - P15 Reducing P18A

The second acceptance in Figure 5.4 is not completely removed by P15, even though it is short and was taken with a very small lead-time. If the concept of using P15 to refine the selection made by P18A is adopted, then the P15 definition would probably need to be improved, such that this anomalous effect around a period boundary is removed.

Table 5.3 shows the effect of such a change, i.e. the BOA is only kept if the number of minutes remaining after P15 equals the original duration i.e. 10 minutes (no truncation).

Table 5.3 - P15 Reducing P18A – Definition 2

# BOA Removed		P18A	0	5	15	30
P18A/P15 Def 2	# BOA	433	388	412	426	429
	%		90	95	98	99

Although this approach of using a pure P15 definition is technically possible, the problems encountered with "P18A/P15 Definition 1" and "P18A/P15 Definition 2" suggest the underlying approach is flawed and that any impact form period boundaries is undesirable. It would probably be better using a simple lead-time approach (i.e. the approach that removed a figure of 359 BOA). This can be shown in a Venn diagram (Figure 5.5), along with data on how this variant "P15+" would cope with simply removing all acceptances with a lead-time of 2 minutes or less. As can be seen in this case the number of BOA removed with just "P15+" is 4922, which is significantly larger than under pure P15. This is because the original P15 is truncating a large number of small acceptances, not simply deleting them.

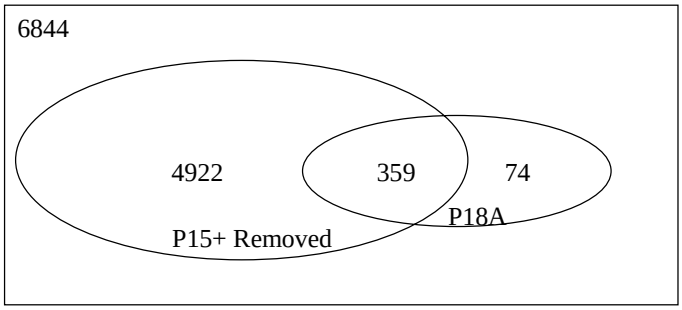

Figure 5.5 - P15 Reducing P18A – Definition 3

In addition the analysis looked at the details of the 74 P18A BOA that would not be removed by this revised approach (i.e. a short duration but long lead-time). In summary they can be grouped into the following, remember these are the BOA that would no longer be removed:

- 12 were for "normal" plant and the other 62 for "fast" plant. This is also counter-intuitive, as it would be expected a greater proportion would be for energy purposes;
- 5 of the "normal" BOA would have been removed under a pure P15 definition with a 0-minute limit. This would increase to 8 with a 15-minute limit;
- 42 of the "fast" BOA have a duration of 1 minute and were spin mode instructions on the DINO BMUs. 2 had a lead-time of 5 minutes, 20 a lead-time of 9 minutes and the other 20 a lead-time of 15 minutes[6];
- 7 of the "fast" BOA had a duration of between 5 and 9 minutes and a lead-time of over 30 minutes, one of which was 60 minutes.

Further examination of these 7 BOA with lead-times of over 30 minutes suggested they were related to planned "TV-pickup". For instance one BOA was taken with 43 minutes lead-time, to provide 6 minutes of delivery starting at 18:29. There was a similar BOA for the following day at the same time. Although planned in advance, it was for a 150MWh, which further suggests it was related to "system" balancing activity. Even if all Parties were almost perfectly balanced over the integrated half hour, this type of BOA would still be needed to address the short term load spike and maintain system frequency[7].

The conclusion from this part of the analysis is that if a variant of P15 was used to further refine P18A, it would have little material impact with regard to "normal" plant and that in all probability it result in more "fast" plant BOA being kept. In addition it suggests that there is little correlation between lead-time and the original intent for the BOA. Not only does P15 initially select more BOA for removal than would appear to be "system" balancing related, but further examination of those that are not selected for removal, suggests they stand a greater chance of being for "system", rather than "energy", balancing purposes.

[6] There is a known weakness in the adopted CAD definition for P18A related to this type of BOA. Although they are normally issued with zero volume, they can be joined to other expensive actions to form a longer CAD value. It is therefore of benefit to the operation of P18A that we take every opportunity to remove the impact of these even if they appear harmless.
[7] In their decision document for P18A Ofgem considered that any actions taken by NGC operationally to control the frequency of the System for very short duration's within particular half hours are more appropriately defined as System balancing rather than Electricity Balancing, given a balancing period of half an hour.

6 MODIFICATION P18B

6.1 Overview

The Modification Group (01 Oct 2001) did not feel that additional analysis of P18B was required. However the consultation will need to include a description of P18B and basic details of its effect and impact. The following is included to indicate the proposed level of detail, and level of data analysis.

P18B does not attempt to differentiate between "system" and "energy" balancing actions, instead it is a dampening mechanism when there is not enough Bid or Offer volume to establish a representative weighted average, and "system" balancing BOA may have an increased influence.

It is recognised that unless NGC need to buy matching Bids and Offers to provide Regulating Reserve[8] the chance of ATT (Automatic Trade Tagging) playing an active role is significantly reduced, especially when the market is as long, and plant are part-loaded, as has been the case since go-live (See table 3.1).

The decision for NGC to buy Regulating Reserve should be independent of the underlying market prices, it would also not be expected for it to have an undue effect on derived prices.

The driver for P18B is that for a similar set of market conditions the resulting price curve would change depending on whether Regulating Reserve is purchased, or not.

The following graphs present a worked example illustrating the proposed operation of P18B and its relationship to ATT. The chosen scenario is based on the smaller stack, which should have little or no pure "energy" balancing actions. The scenario is idealised and contains the following sample offers:

5 MWh @ £5000 / MWh	(Fast Response)
50 MWh @ £100 / MWh	(Systems Constraint)
250 MWh @ £20 / MWh	(Regulating Reserve)

In order to show the potential impact of buying Regulating Reserve, or not, the graph shows how the SBP price varies as more of the offers are progressively added onto the stack, starting with the most expensive first. This means that with an overall offer volume of 100MWh, the split would be 5 MWh @ £5000 / MWh, 50 MWh @ £100 / MWh and 45 MWh @ £20 / MWh[9]. The default price is assumed to be £20 / MWh.

As can be seen the current SBP price initial increases rapidly, but then reduces as more volume is added. The dotted line shows the equivalent profile with P18B included.

[8] Whenever the term Regulating Reserve is used in this section it is being used in the context of matching Bids and Offers used to create reserve, i.e. significant volume on both stacks and hence capable of reaching the BRL limit.
[9] Although unnatural in the way the volume is added to the stack, the underlying data is still representative, as there have been a significant number of periods where small "expensive" offers have dominated the stack.

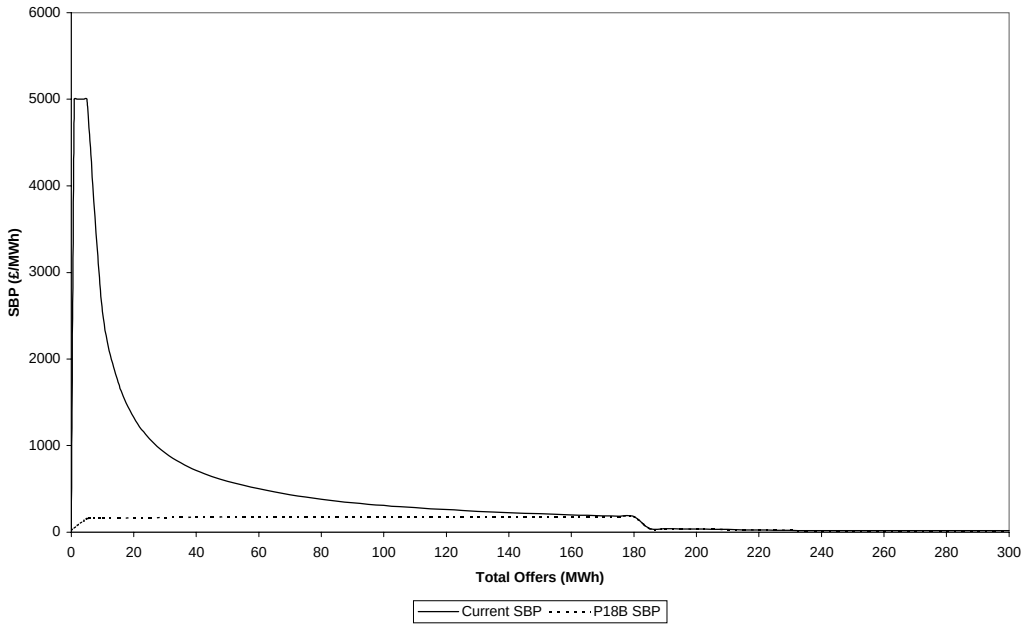

Figure 6.1 - P18B – Full View

The scale of the graph makes it hard to see the effect of ATT starting to occur at 180 MWh, and so the following shows the same data but with the y-axis truncated at £500/MWh.

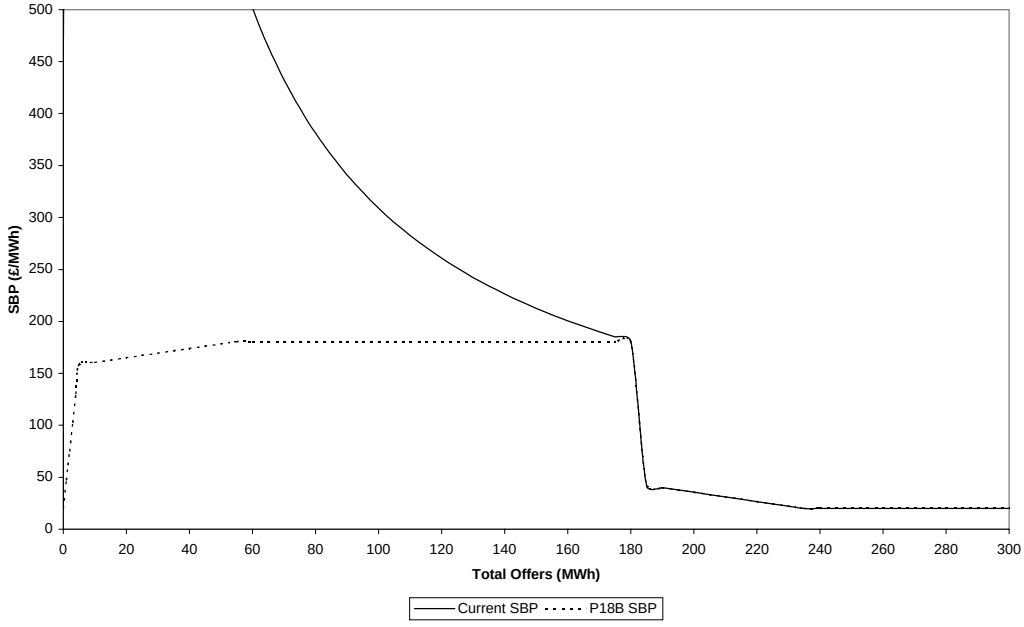

Figure 6.2 - P18B – Zoom View

The effect of ATT can be clearly seen as all the expensive Offers are progressively stripped out of the stack between 181-235 MWh. The price drops quickly between 180 and 185 MWh as the £5000/MWh Offers are removed and then eventually settles down to the base price for the Regulating Reserve, which in this case is the same as the default price. However this only occurs once both stacks reach BRL, which will only regularly occur if NGC buy Regulating Reserve.

If it is accepted that the £20/MWh offers in this example are for Regulating Reserve then one could expect the price curve between 1 and 55MWh to be similar to 181 to 235 MWh. This obviously is not the case and the prices are very susceptible to highly priced Offers when the stack is small.

The purpose of P18B is to make the prices less susceptible to the influence of highly priced Bids and Offers in a thin market, in the same way as would be the case if NGC had needed to buy Regulating Reserve and allow ATT to have an influence.

As can be seen it achieves this to a degree, however as can also be seen the influence of the high priced Offers is still greater when no reserve is purchased.

There is an obvious link between this and the argument that BRL should be set to a lower value. However, this proposal should stand on its own, irrespective of the level of BRL as it provides a dampening effect until the ATT can start to take effect (i.e. BRL is reached). However, the range where prices can be more volatile is obviously greater with a higher value of BRL.

An example of P18B is shown in figure 6.3 for 26 September 2001 (The second day after P18A became effective) where it is believed that a "system constraint" was being addressed by using an offer priced at £240/MWh for significant periods during the day (Periods 21-27 and 32-39). In addition for some periods this was the only offer being considered in the calculation of the imbalance prices. All plotted lines already include the effect of P18A with CADL set to 15. In addition the plot show the effect of setting BRL to 5 and also including P18B[10].

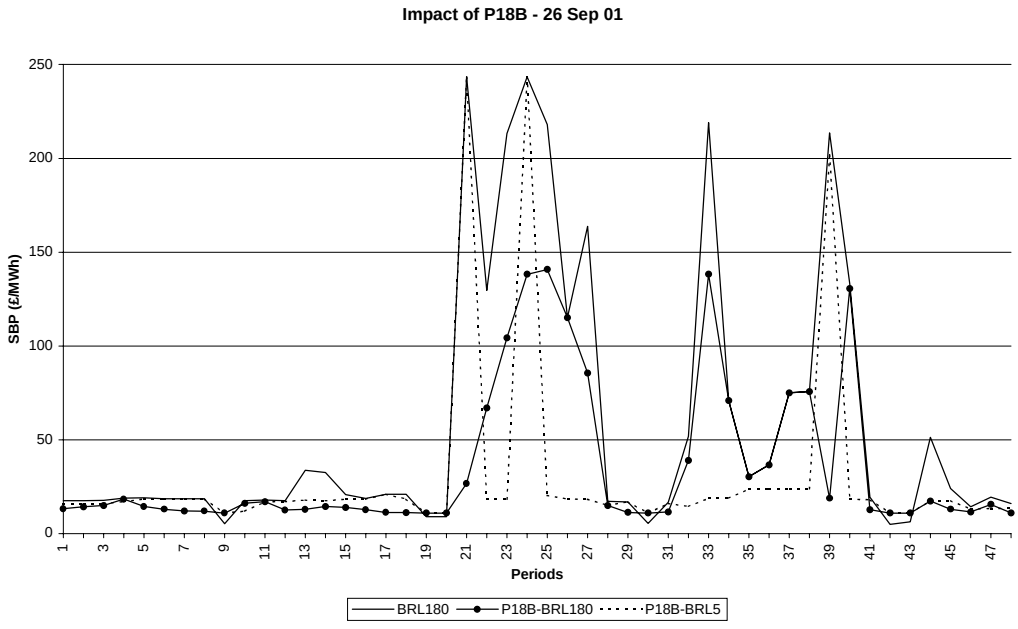

Figure 6.3 - P18B – Example Day

As can be seen neither BRL=5 nor P18B completely addresses the problem of prices being unduly influenced by a single BMU when the volume is small, and in addition P18B has little impact in the case where BRL is set to a low value. Periods 34-38 are interesting as during this

[10] The combination of "BRL=5 without P18B" is not included as it is not materially different from "BRL=5 and P18B"

period ATT was active and removed some of the expensive offers (for period 35 it removed all)[11].

This suggests that the only way to get a price profile, which is not unduly volatile to small changes in bid offer volumes, is to have sufficient "reasonably" priced energy on both stacks, to allow ATT to act on a regular basis. However, in circumstances when this is not the case, P18B can help reduce the impact of fast response (which may not have been removed by P18A) and system constraints.

[11] See Annex A for further details on what percentage of the Offer stack was due to this particular offer.

7 TECHNICAL CONCLUSIONS

This section provides some technical conclusions on the high-level data analysis performed in this document. This is based on simple numerical analysis and does not attempt to link the findings to the BSC Objectives. In addition, with the exception of P18B, which itself is a price based mechanism, it does not attempt to continue the analysis through to volumes or resulting prices.

This document raises significant issues concerning P15. Should it be decided to proceed with a variant of P15, then additional detailed analysis would be recommended in the next phase.

P18A has been effective for less than one month and based on limited experience is performing as expected. A P15 based change would need to improve on an already complex algorithm, and hence it would be advisable to perform a detailed analysis, capable of measuring what should be small improvements in data quality at all stages in the imbalance price calculations. Failure to perform an adequate analysis could miss an unexpected factor, which may eventually cause an unsupported and potentially dramatic change in price level or volatility.

This section's structure mirrors that of the main sections within the document.

7.1 Market Statistics

Section 3 of the document was included to provide some data on how the Balancing Market is performing before considering any of the proposed modifications. The data does not include the effect of modification P18A, which did not become effective until 25 September 2001[12].

The key points to note are:

- the size of the smaller stack of Bids or Offers is consistently too small to allow the imbalance price formula to work effectively. Specifically:
  - default prices are being set on a regular basis;
  - the BRL limit is rarely reached on both stacks, especially during the day and evening, this means ATT is rarely active;
  - even when not defaulted, the prices are regularly set by one or two BMUs, too few to accurately determine a weighted average;
- when a default SBP is set, it is often capped to the SSP (average £11.05/MWh), a level which is lower than when the SBP price is set by one or more accepted offers (99% of non-default SBP prices are greater than £15/MWh);
- the analysis of acceptance lead-times questions the suitability of any mechanism which attempts to differentiate system and energy actions on the basis of lead-time:
  - 75% of acceptances have a lead-time of two minutes or less[13];
  - the average lead-time for acceptances of less than 15 minutes duration is unexpectedly longer for the "fast" plant than the "normal" plant.

[12] There has not been sufficient time to load up sufficient live data to study the impact of P18A on data prior to its formal Implementation Date. However, it is considered that P18A should not significantly alter this data.
[13] Even though NGC may plan to use a particular Offer prior to the real-time period, they can gain benefit from delaying the acceptance of the BOA, to react to any late break changes and to allow fine tuning of the level or timing of the acceptance.

7.2 Modification P15

Section 4 analyses the effect of P15 had P18A not been implemented. It concludes that:

- as suspected from the analysis in Section 3 the P15 mechanism is a blunt instrument;
- The value chosen for the P15 limit is a complex trade-off:
  - a limit of 5 minutes can miss many short duration BOA when they are taken on the period boundary;
  - with such short lead-times, a limit of 15 minutes is needed just to target "fast" response BOA of 15 minutes duration or less (i.e. the equivalent of P18A);
  - a limit of 15 minutes would also remove a significant number of "normal" BOA (26%);
- as P15 also truncates BOA it means even long duration BOA will be regularly truncated:
  - for "normal" plant a limit of 5 minutes can result in a 38% reduction in the number of BOA impacting each period;
  - the information in figure 3-1 suggests that even more periods would default.

7.3 P18A / P15 Interaction

This section examines the interaction of P15 and P18A:

Section 5.1 examines the effect of "P15 increasing P18A" i.e. a BOA is removed if it meets the criteria of **either** modification:

- P15 with a 15 minute limit modifies so many BOA (95% truncated / 30 % removed) that it obscures any effects due to P18A (6% removed – less than 1% are not also removed by P15);
- if P15 is applied prior to P18A, then even more BOA could be completely removed. This is caused by P15 truncating the majority of BOA, which would then allow P18A to remove more of these shortened BOA;

Section 5.2 examines the effect of "P15 reducing P18A"[14], i.e. a BOA is only removed if it meets the criteria of **both** modifications:

- mathematically it is interesting as it may use the issues associated with a short lead-time to work in its favour[15];
- initial analysis showed that the period boundary effect of P15 caused anomalies;
- a pure lead-time definition for P15 seemed to achieve a more intuitive result;
- closer examination of the small subset (74) of BOA that P18A would attempt to remove, but P15 would then keep, showed some interesting features. The majority of

[14] This definition is not really within the spirit of P15 as originally proposed, however, as P18A was not part of the baseline when P15 was submitted, such an option could not have been considered at that time. In addition it was not discussed at the Modification Group on 01 October 01.
[15] If a filter is too aggressive, removing many "energy" as well as "system" balancing actions, then it can be argued what remains stands an increased chance of representing "energy" balancing. The alternative explanation is that it is simply not a good filter.

these were related to "fast" plant BOA with short duration, suggesting they should really be removed[16]:

- enter/exit spin mode instructions;
- planned TV pickup.

The analysis of all the forms of P15 suggests that the lead-time is not an accurate measure of the underlying purpose of a BOA and that when used in conjunction with P18A it does little to improve the ability of P18A to remove "system" balancing actions.

7.4 Modification P18B

This section discusses Modification P18B. There is a view that this is an arbitrary exclusion of energy costs and hence a reduction in the cost signals to balance. An alternative view is that it can compensate for weaknesses in the operation of the imbalance price calculations, and specifically ATT, when insufficient Bids and Offers are available to set a representative price. The Modification Group did not feel there was merit in doing a further numeric analysis and hence this section only includes a basic introduction and examples. However, the key points that can be made are:

- the manner in which the imbalance price calculations treat Bid and Offer volumes is different, depending on whether there is a significant amount of matching Bids and Offers to provide Regulating Reserve, or not;
- currently a major change in the price curve occurs between 0 MWh (default) and even the smallest amount of Offers or Bids;
- with P18B the volatility of prices set by small volumes is reduced;
- Until BRL is reached on both stacks, it is still quite easy for a small volume / high priced BOA, or a medium volume / medium priced BOA to have a significant influence a P18B price;
- the modification relies heavily on the default price, which as table 3.2 shows is artificially low;
- neither P18B, nor a reduced level of BRL, are capable of completely compensating for a lack of matching Bids and Offers being used to provide Regulating Reserve.

Even if it is not felt that P18B correctly addresses the issues, it is considered that there are a number of issues raised in this section that warrant further investigation.

[16] Section 5.3 provides further details on why it is considered these are best removed.

ANNEX A – P18B EXAMPLE DATA

The following table shows the information used to create the figure 6.3, those periods with a SBP of greater than £50/MWh are shown shaded.

Period	Default	P18A Diff (£/MWh)	SBP (£/MWh)	SSP (£/MWh)	Total Volume (MWh)	P18A Volume (%)	Priced Volume (MWh)	System Constraint (%)
1			18	8	62		62	
2			18	6	89		89	
3			18	6	108		107	
4			19	6	166		166	
5			19	6	76		76	
6			19	6	49		49	
7			19	6	25		25	
8			19	5	23		23	
9	Y		5	5	P10		P10	
10			18	5	158		139	
11			18	4	187		156	
12			18	5	44		44	
13		4	34	7	20	26%	15	
14		1	33	8	56	2%	29	
15			21	9	55		55	
16			19	9	42		42	
17			21	10	6		6	
18			21	10	4		4	
19	Y		9	9	P10		P10	
20	Y		9	9	P10		P10	
21			243	9	12		12	100%
22			130	9	85		85	49%
23			213	9	83		83	87%
24			243	9	99		99	100%
25			218	7	115		113	89%
26			115	6	203		180	43%
27			164	6	88		88	64%
28			17	6	115		114	
29			17	6	11		10	
30	Y		5	5	P10		P10	
31			17	5	19		19	
32			52	5	123		123	15%
33			219	3	110		110	89%
34			71	8	281		180	19%
35			30	10	382		180	
36			37	10	372		180	4%
37			75	10	339		180	23%
38			76	9	275		180	23%
39		13	214	5	64	86%	7	86%
40			133	5	176		176	
41			19	5	40		40	
42	Y		5	4	P10		P10	
43	Y		6	6	P10		P10	
44			51	9	29		29	
45		-53	24	7	41	31%	28	
46			14	9	34		33	
47		-12	19	9	120	17%	96	
48			16	9	3		2	

