Real Time Pricing Programme
Treatment of High Spring Washer Price Situations

Transpower New Zealand Limited
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Keeping the energy flowing




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0.1	April 2018	Initial Draft
1.0	April 2019	Version provided to EA

	Position	Date
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SUMMARY

Participant feedback to consultation on the proposed implementation of Real Time Pricing has included discussion on the treatment of high spring washer price situations (HSWPS). These situations have the potential to result in significant and unforeseen pricing outcomes. This paper details the reasons for their existence and Transpower's proposed treatment under the Real Time Pricing project.

HSWPS occur as the result of a binding constraint in the SPD solution. In current final pricing these situations are rare but sometimes result in unusual pricing outcomes. By basing real time pricing from the dispatch schedule, we expect that HSWPS could eventuate more regularly than they currently do in the final pricing schedules, but possibly not persist for the entire trading period, hence the total impact could be lower. Under RTP, the prices resulting from a HSWPS in even one, five minute dispatch schedule would be included in the half-hour average price.

HSWPS are an outcome of real, physical limitations in the power system. The current relaxation applied for HSWPS in final pricing is not appropriate for a pricing regime based on real time dispatch, as the limits modelled in the dispatch schedule are critical for system security. However, there are occasions where the inputs modelled in the dispatch schedule deviate from actual system conditions. In these situations, the system co-ordinators are able to adjust the dispatch schedule to more closely reflect actual system conditions.

We propose that for real time pricing the current process is augmented to ensure the system co-ordinators have sufficient information and situational awareness to ensure the constraints used in the dispatch schedule accurately reflect system conditions as much as possible. This would ensure that any HSWPS in real time is a legitimate pricing outcome.

1 INTRODUCTION TO SPRING WASHER SITUATIONS

SPD calculates the least-cost schedule of dispatchable resources (generation, dispatchable demand and ancillary services) to securely meet the national electricity demand. It makes this calculation within a set of mathematical constraints, which include constraints constructed to limit the flow of electricity over transmission assets to a level that each asset can tolerate; these are known as security constraints. A security constraint 'binds' when the flow over the branch or group of branches has reached its limit.

When a parallel transmission path is available a binding constraint can cause unusual pricing outcomes, known as spring washer situations. This describes the result where nodal prices on one side of a transmission asset with a binding constraint are significantly higher than on the other side of the asset. In the Code, a High Spring Washer Price Situation (HSWPS) is defined as a spring washer where the highest price exceeds the highest cleared energy offer by a factor of 5 or more.

The current HSWPS methodology is 'correlation not causation' – if prices exceed a threshold and a binding AC transmission constraint exists then a HSWPS is deemed to exist; there is no definitive link between the two aspects of the test. There are some examples of previous 'false positive' results. Mainly, these have been driven by instantaneous reserve (IR) costs and prices are trivial, for example, final prices of $0.20/MWh caused by IR offers at $0.18/MW and marginal energy/risk setter energy offers of $0.02/MWh. Coincident with this an AC constraint binds which adds, for instance, ~$0.03/MWh to some GXP prices. With the current 'correlation' test this compelled the pricing manager to declare a HSWPS and the SO to relax the binding constraint.

The Transpower website hosts an animation which describes the spring washer phenomenon, which can be found here[1].

1.1 FEEDBACK FROM RTP CONSULTATION

Ten respondents submitted to the latest RTP consultation on the issue of HSWPS. The consultation paper proposed removing the current HSWPS provisions from the Code, reasoning that introducing default scarcity values for forecast load, as well as the increased opportunity to respond to prices in real time, will in effect limit the impact of a HSWPS.

The consultation paper asked whether readers agreed with the above statements and approach. Of the ten respondents, six agreed without elaboration. Other comments received include:

- One respondent wanted to compare the potential pricing outcomes in HSWPS under both the existing relaxation factor and what might happen under RTP with the proposed scarcity pricing bands;
- Two respondents thought that the frequency of HSWPS could increase under RTP;
- One respondent questioned the treatment of potential negative prices;
- Two respondents proposed applying administered or proxy prices to limit the pricing impact.

[1] https://www.transpower.co.nz/system-operator/about-system-operation-service/learning-centre

2 APPLICATION TO REAL TIME PRICING

2.1 OCCURRENCE OF HSWPS IN RTD VS FINAL PRICING

HSWPS can result within any pricing schedule calculated by SPD. However given the current final pricing case solves on a half-hourly basis, any intra-period variability in demand is naturally attenuated by taking an average value of demand as the input to the schedule. The final pricing case also only uses transmission constraints that were used by the first dispatch schedule (RTD) in the trading period.

RTD solves on a five minute basis with changing load input for each solution. The variable load input can result in different constraints binding at different times within the trading period. This could result in spring washer situations occurring more frequently than they do now, but the pricing effect may not persist for the full half hour of the trading period.

The system operator produces an RTD schedule approximately every 5 minutes, or around 100,000 schedules per year. It is difficult within our current analytical tool set to identify HSW pricing out of schedules other than the pricing schedules, however we investigated the occurrence of high (but not 'constraint violation penalty', CVP) prices in the current RTD schedules. The range considered prices in excess of $10,000/MWh, but less than $100,000/MWh, being the CVP for deficit CE instantaneous reserve. In the last four years, prices in this range resulted in the RTD schedules approximately 50 (± 20) times per year out of around 100,000 schedules total. This represents the upper range of occurrence of this level of prices in RTD as not all RTD schedules are dispatched (some are re-solved several times with adjusted inputs to obtain a 'good' dispatch solution).

The occurrence of HSWPS in final pricing is lower. In 2015, HSWPS occurred in 13 trading periods, in 2016, 7 trading periods.

2.2 TREATMENT OF HSWPS IN FINAL PRICING

In final pricing the Code provides for the Pricing Manager to manually intervene in the pricing calculation to test the impact of binding constraints on pricing. This intervention is to relax the binding constraint by 1 MW and re-solve the pricing case. This method of relaxation is designed to test the price impact of inaccuracy in the schedule inputs. It is unsuitable for application to the dispatch schedule during real time operations as transmission constraints reflect actual asset capability. Altering the limit of the constraint could cause adverse physical impacts (e.g. asset overload) and consequential impacts for the provision of power system security.

In previous discussions with the Authority we have focused discussions on trying to determine 'causation', to attempt to ensure the elevated prices are the result of the binding transmission constraint. In those discussions we raised the possibility of using the shadow price of binding transmission constraints instead of nodal prices to determine whether a HSWPS was occurring. Simplistically, the shadow price of the constraint reflects the change in system cost for a 1 MW change in the limit of the constraint. This is not 100% fit-for-purpose as the shadow price of a constraint does not align exactly with GXP prices. The GXP prices are the cost of supply of the next MW (also simplified). If the test for a HSWPS is determined by the effect on GXP prices then logically that must be part of the 'test'.

Subsequently, the more important aspect of any HSWPS test and or relaxation methodology under RTP is the juxtaposition of price and security outcomes; how do you relax a constraint for a (possible) pricing outcome when the original limit is providing the correct level of security? Obviously, you cannot within the current constraints of the RTP proposal (e.g. prices are derived directly from the dispatch schedule).

2.3 PROPOSED RESOLUTION FOR REAL TIME PRICING

Because of the potential negative impacts on the provision of security Transpower does not recommend considering any automated resolution of HSWPS involving constraint limit adjustment under RTP. Instead we recommend improving the co-ordinator situational awareness and toolset for managing constraint limits to reflect reality as closely as possible.

The market system applies constraints on the basis of modelled inputs and assumptions. In the RTD schedule these inputs include:

- the expected quantity of demand for the next five minute interval
- modelled estimates of reactive power flows as a function of actual power flow
- the offered transmission network configuration, modified by outages
- the assumption that generation output is compliant with dispatch (disregarding frequency keeping and governor action)
- ramp rates are linear over the five minute interval

If one or more of these inputs do not reflect actual system conditions, the modelled constraint limits and transmission flows will be inaccurate. In practice the degree of inaccuracy is small and generally suitable for the purposes of dispatching generation. However there are some instances where modelled inputs deviate from system conditions to such an extent that the constraint limit in the market can be manually adjusted.

System conditions are monitored using a real time contingency analysis tool (RTCA) which tests the "off-load time" for an asset, given the loss of another circuit and the current power flows over the remaining circuits. Circuit power flows after an event must not exceed a rating which is derived from the standard that the circuit is off-loaded (ie power system is re-dispatched) within 15 minutes. If the test indicates that the 15-minute standard is violated (off-load time would be lower than 15 minutes for a given event) then the RTCA tool alerts the coordinators of this result. The coordinators then adjust the constraint limit and redispatch the power system, which would lower power flow on the affected asset to an acceptable level. This process is illustrated in diagram 1.

Given that there are multiple elements determining whether constraints bind and spring washer pricing eventuates, we do not recommend applying automatic interventions to modify the dispatch schedule for pricing outcomes. Instead we propose that for RTP we augment the existing mechanisms for detecting when RTCA and RTD modelling diverges producing different results. There are many design options to consider when implementing this solution, including:

- improving alarms to the co-ordinators where action is required
- incorporating alarms based on pricing results where constraints are binding
- automating 'constraint activation' such that RTD constraints are 'disabled' until RTCA results indicate they are needed

We note that the current post-schedule check (PSC) tool already incorporates some elements of these options and we intend to leverage this capability in the RTP design.

It would be possible to replicate the current 'correlation' test in RTP, however as noted previously this is not an actual test for the presence of a HSWPS having been caused by a particular binding constraint. Furthermore, having identified a possible HSWPS it may not be possible to attempt to 'resolve' the HSWPS if the binding transmission constraint is correctly modelled to maintain security.

2.4 OTHER CONSIDERATIONS

The project has not considered the implications for the 'low' side of high spring washers, which can result in negative prices. This is a natural result of the calculation which sometimes occurs in final pricing. The project will consider what is an appropriate price outcome in these circumstances, including possibly allowing negative prices to persist. Price averaging will need to account for possible negative pricing. It is understood that implementation of default scarcity price bands will naturally limit the magnitude of both high-side and low-side prices.

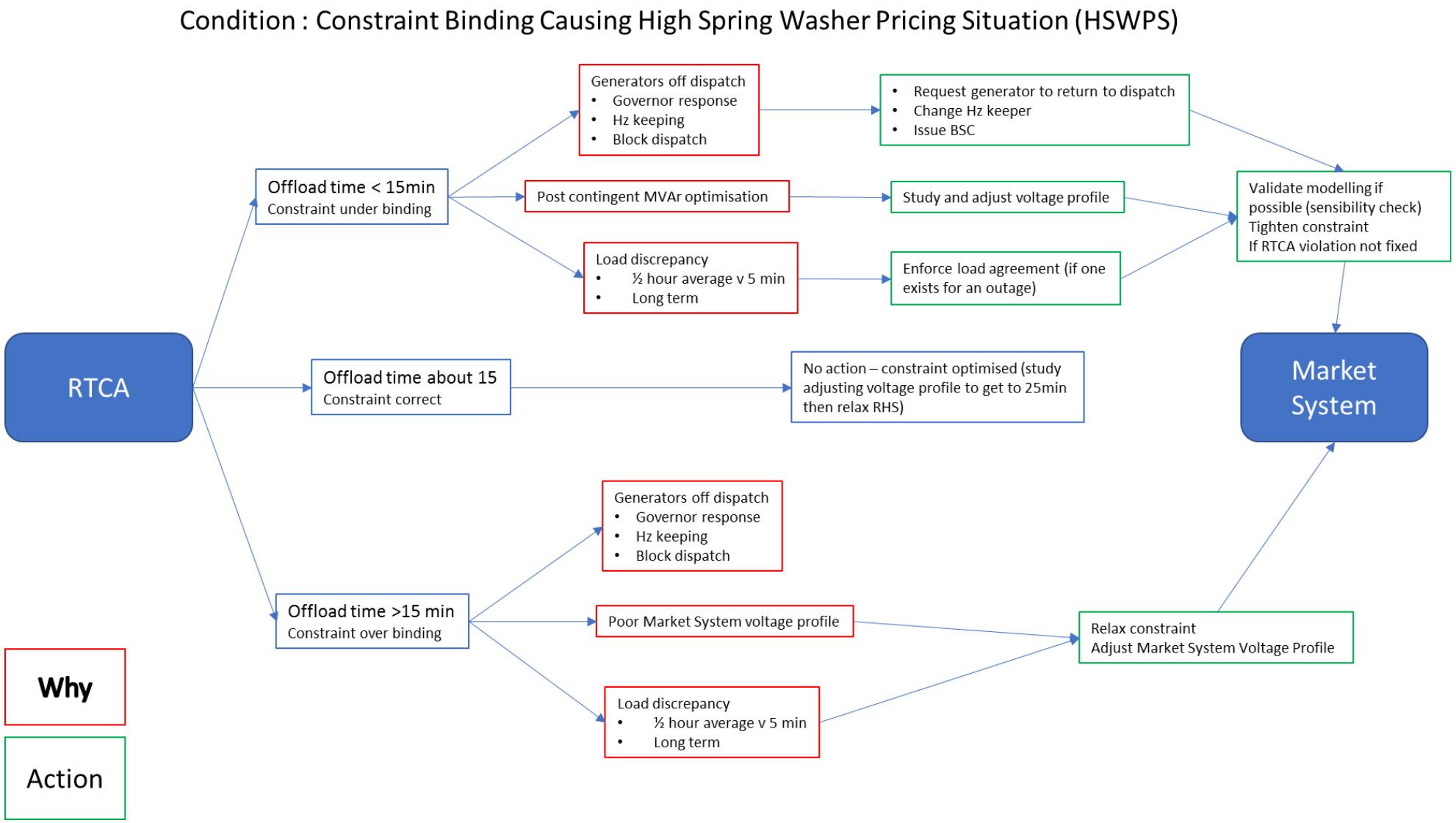

Diagram 1.