

# Analysis of Paradoxically Rejected Blocks

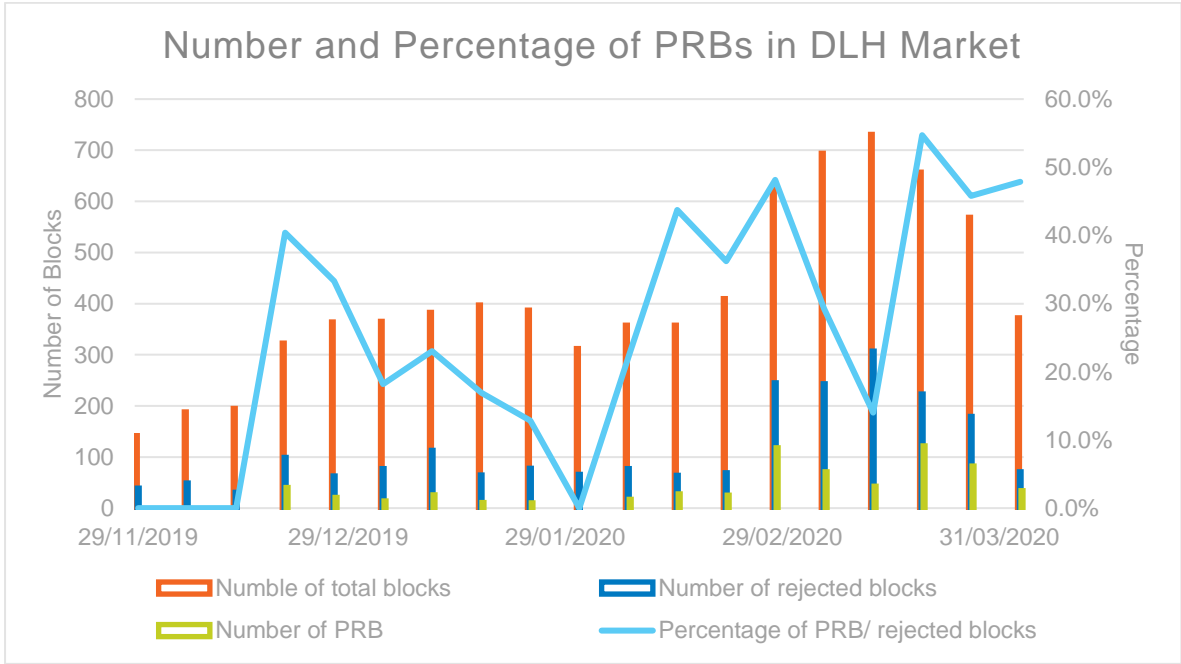
April 2020

nationalgridESO

### Introduction to this Document

In the Frequency Response Auction Trial, certain constraints on block order execution may cause some sell order blocks to be rejected, despite the price limit of these blocks being below the market clearing price. When this happens, the rejected blocks are called Paradoxically Rejected Blocks (PRBs).

The rate of occurrence of PRBs in the auction trial is increasing, as shown in the graph below. In recent auctions, one out of two rejected block orders has been rejected paradoxically in DLH market.



The occurrence of PRBs is not an anomaly of the auction but reflects the fact that rejecting some orders paradoxically is necessary to comply with the algorithm constraints (see next part).

This document outlines the clearing algorithm constraints which most commonly cause PRBs and illustrates these constraints with some case studies. The document also provides alternative approaches to forming sell order blocks to help reduce the number of PRBs.

### Most Common Causes of PRBs

PRBs are most commonly caused by the following constraints in the auction clearing algorithm:

- [1] The total volume of all accepted block orders in each EFA period cannot exceed the volume that NGENSO is willing to buy (i.e. currently 100 MW/h in each EFA period for the DLH market).
- [2] A C01 block order is non-curtable: it must satisfy the “fill-or-kill” property (i.e. it must be either fully accepted or fully rejected).

**[3]** A multi-period block order (i.e. an order defined across multiple EFA periods, with a single order ID and a single price) must be either accepted in all EFA periods or rejected in all EFA periods on which it is defined.

The impact of these constraints is best illustrated by case studies.

## Case Study 1 – Non-Curtailable Blocks

### Order 15262 (Auction of 20/03/2020, DLH market)

Order 15262 is a single-period C01 block order in EFA period 1, with a submitted volume of 20MW/h. Even though its offer price of £4.00/MW/h is lower than the market clearing price of £5.30/MW/h, it was rejected.

This situation can be graphically explained in the following diagram:

- NGESO buy order is represented as a green line
- Suppliers orders are represented by boxes. Red boxes stand for accepted orders and grey boxes are for rejected orders. All orders are ranked by increasing prices
- The market clearing price is represented by the blue line

In EFA period 1, orders totalling 93 MW/h, with selling prices below that of order 15262 (i.e. orders up to and including 15923 in the diagram below), were accepted by the clearing algorithm. Based on constraint **[1]**, a maximum additional 7 MW/h could be cleared in this EFA period.

The next order in merit is order 15262. With a volume of 20MW/h, this order is too big to be fully accepted. Additionally, because it is a C01 block, based on constraint **[2]**, it is non-curtailable and cannot be partially accepted. It was therefore rejected.



## Case Study 2 – Multi-Period Blocks

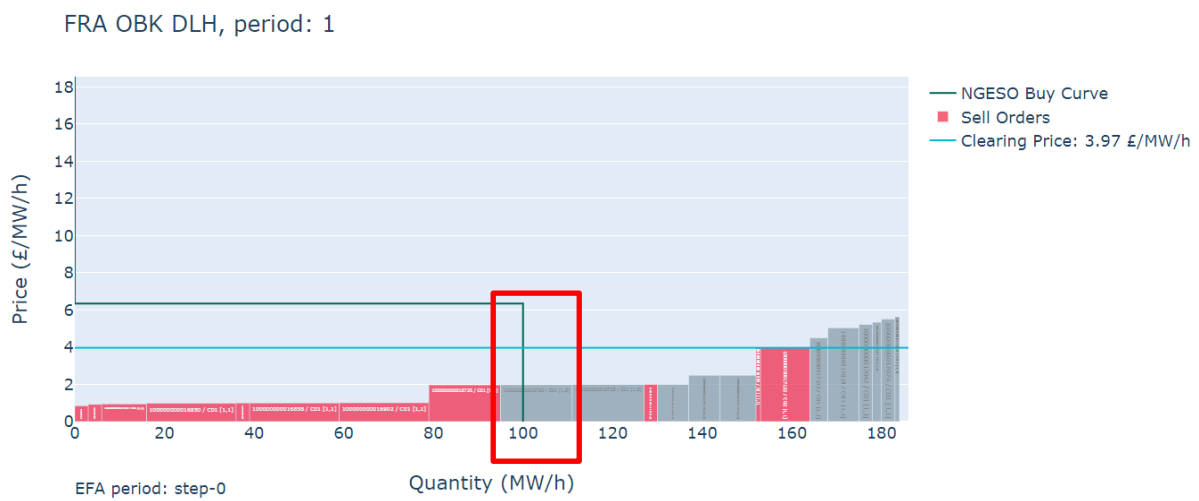
### Order 16730 (Auction of 27/03/2020, DLH market)

Order 16730 is a multi-period C01 block order spanning from EFA periods 1 to 6, with a submitted volume of 16MW/h. Despite its offer price being below the clearing price in all periods, it was rejected.

To understand the reason for this, let us focus on EFA period 1. In this period, orders totalling 95 MW/h, with selling prices below that of order 16730 (i.e. orders up to and including 16735 in the diagram below), were accepted by the clearing algorithm. Based on constraint [1], a maximum of an additional 5 MW/h maximum could be procured in this EFA period.

The next order in merit was order 16730 which offered a volume of 16MW/h. This is larger than the remaining volume requirement. Because this order is a C01 block, based on constraint [2], it cannot be partially accepted. As a result, it was rejected in this period.

Moreover, order 16730 is a multi-period block order across EFA periods 1 to 6. Because it was rejected in EFA period 1 and because multi-period blocks must be accepted in all periods in which they are defined, based on constraint [3], it was rejected in all EFA periods 1 to 6 despite being in merit in EFA periods 3 to 6.



Market Name	Order ID	Clearing Price	Price	Block Code PRM	EFA	Executed Volume	Volume
DLH	100000000016730	3.97	1.98	NA	1	0	-16
DLH	100000000016730	3.97	1.98	NA	2	0	-16
DLH	100000000016730	10.32	1.98	NA	3	0	-16
DLH	100000000016730	9.93	1.98	NA	4	0	-16
DLH	100000000016730	9.35	1.98	NA	5	0	-16
DLH	100000000016730	9.08	1.98	NA	6	0	-16

## Possible Mitigations for the Risk of PRBs

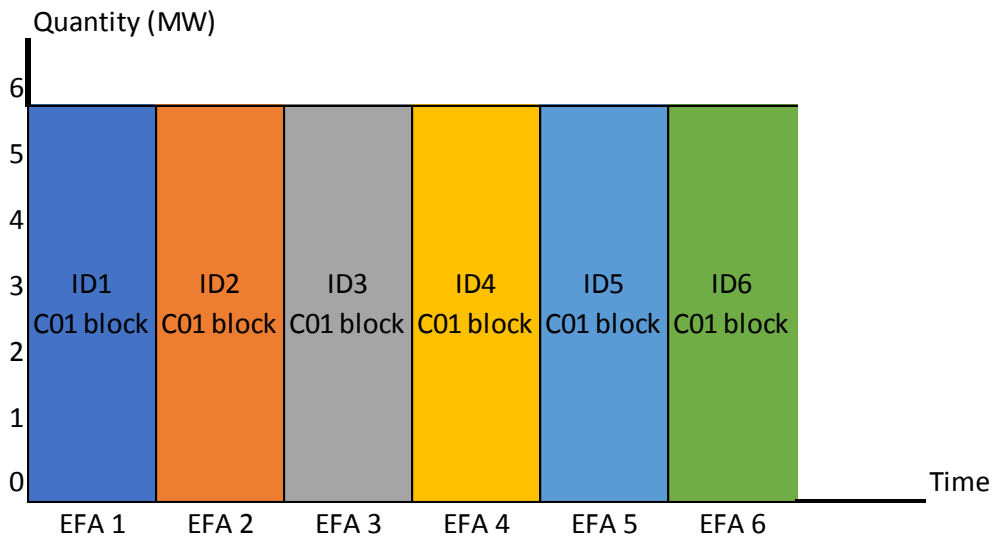
We provide below some examples of order formation which will reduce the likelihood of paradoxical rejection. Their suitability will depend the actual technical capabilities of the underlying unit as well as the commercial and risk management strategies of the supplier.

In the following examples, we assume that a supplier has one unit with a volume of 6 MW/h and would like to offer it on for all EFA periods 1 to 6 across a single EFA day. Furthermore, we assume that there are no technical constraints to prevent the unit providing frequency response for a volume as small as 1 MW/h nor a duration of delivery as short as a single EFA period.

**A. Use Single-Period Orders**

The supplier can create single-period C01 block order of 6 MW/h for each EFA period. In this case, the orders can be executed independently in each EFA period (i.e. they can be accepted in some periods in the EFA day and rejected in other periods). However, as C01 blocks, they are still “fill-or-kill”, and will be either executed for their entire offered volume or rejected.

Example:



How to fill in the sell order:

OrderId	BlockCode	BlockPRM	1	2	3	4	5	6
1	C01		-6					
2	C01			-6				
3	C01				-6			
4	C01					-6		
5	C01						-6	
6	C01							-6

Note that a multi-period block must be offered at a single price across all EFA periods, but each single period order may have its own offer price.

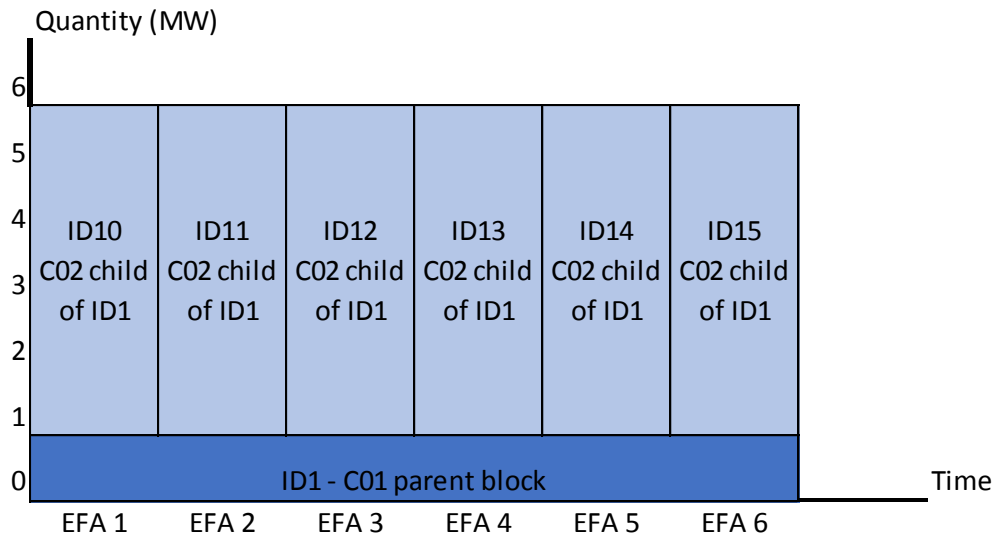
**B. Use Curtailable Orders**

To build a fully-curtailable, multi-period order, the supplier can, for example:

- Submit a multi-period “Parent” C01 order at the volume tick (1 MW/h); and
- Submit 6 “Child” C02 orders (max 1 per EFA period) linked to this C01 order.

With this order construction, the supplier now has 1 linked family with 7 block orders in total. A child C02 block can only be accepted if its parent is also accepted. Because the parent order (Order ID 1) is a multi-period order, it will be accepted or rejected for all EFA periods on which it is defined. If the parent order is rejected, then all child orders are rejected as well.

Example:



When completing the sell order, the supplier will need to update the “blockPRM” field with the ID of the parent block, as in the following example:

OrderId	BlockCode	BlockPRM	1	2	3	4	5	6
1	C01		-1	-1	-1	-1	-1	-1
10	C02	1	-5					
11	C02	1		-5				
12	C02	1			-5			
13	C02	1				-5		
14	C02	1					-5	
15	C02	1						-5

Note that C02 blocks cannot span over multiple EFA periods. In each EFA period, at most one C02 block can be defined for a given {unit, product}.

Example of an **incorrect** order:

OrderId	BlockCode	BlockPRM	1	2	3	4	5	6
1	C01		-1	-1	-1	-1	-1	-1
100	C02	1	-5	-5	-5	-5	-5	-5

As this order is curtailable, the accepted volume might be less than the total offered volume. The accepted volume in each EFA period might be different from one period to another (e.g., 4 MW/h accepted in EFA period 1, 3 MW/h in EFA period 2 etc.).

It is possible to create an order that is partially-curtailable rather than fully curtailable, by choosing a volume for the C01 block that reflects the part of the unit which the supplier doesn’t want curtailed. For example, if a supplier wanted to ensure that at least 2 MW/h were accepted in all EFA periods, they would choose a volume of 2 MW/h for the multi-period C01 block and the remaining volume in each period in the C02 blocks. In fact, a multi-period C01 block can have different volumes in each EFA period.

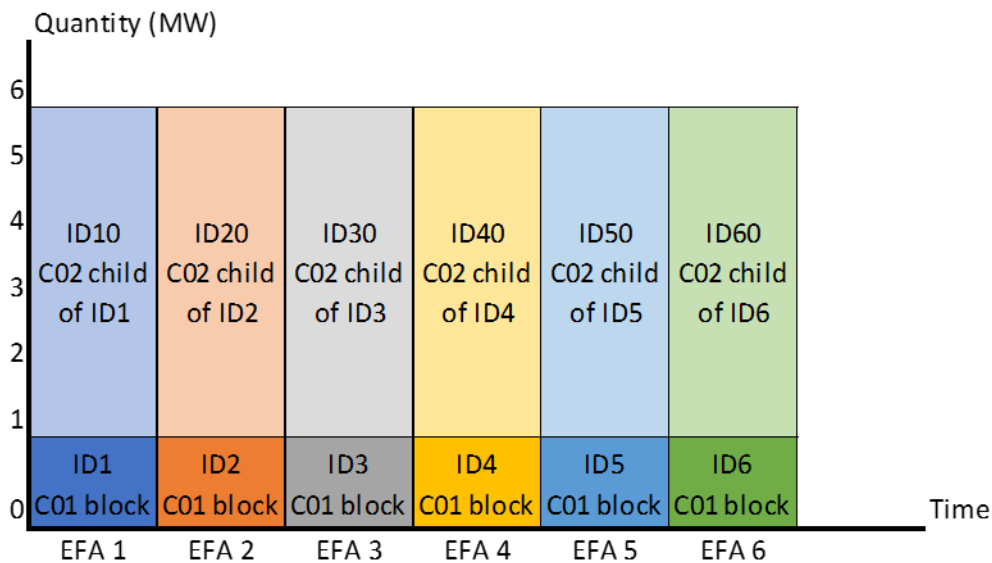
Also note that a multi-period block must be defined only on contiguous EFA periods within a single EFA day. Multi-period blocks cannot span over EFA periods from different EFA days. Additionally, A C02 block must be in the same EFA day as its parent block.

A multi-period C01 block is always defined with a single price for the block, applicable to all EFA periods on which it is defined. The C02 block orders can have different prices than the C01 block to which they are linked, and also different prices from each other.

**C. Use Curtailable and Single-Period Orders (A + B)**

The last option is to create, in each EFA period, a single-period parent order (C01) of 1 MW/h plus a child order (C02) of 5 MW/h. Like option B, it is possible to create an order that is partially-curtailable rather than fully curtailable, by choosing a volume for the C01 block that reflects the part of the unit which the supplier doesn't want curtailed. The supplier will have 12 block orders in total.

Example:



How to fill in sell order:

OrderId	BlockCode	BlockPRM	1	2	3	4	5	6
1	C01		-1					
10	C02	1	-5					
2	C01			-1				
20	C02	2		-5				
3	C01				-1			
30	C02	3			-5			
4	C01					-1		
40	C02	4				-5		
5	C01						-1	
50	C02	5					-5	
6	C01							-1
60	C02	6						-5

Each of these 12 blocks may be defined with a different price, if desired.