
Annex B Outline of CMRA auction rules

The CMRA auction proceeds in rounds, where each round is a time window set by the auctioneer for bidders to submit their bids for the round.

For each round the auctioneer sets a round price per lot for each lot category. Each bidder can then indicate the number of lots in each category it wishes to acquire at the prevailing round prices (subject to the activity rule). This defines the bidder's headline bid for the round, and establishes any applicable relative caps on other bids in accordance with the activity rules. In addition, the bidder can make additional bids for other packages, which cannot exceed the round price of the package and cannot be below 90% of the round price of the package (except for bids that determine the relative caps on other bids), and which must satisfy any applicable relative caps arising from the activity rules. Only one of the bids submitted by the bidder will become a winning bid – bids from the same bidder are mutually exclusive.

Each bidder may keep a list of 'eligible bids' for up to 50 packages. All of the bids submitted by a bidder which determine the relative caps on other bids will remain eligible. All other bids submitted by the bidder will continue to be eligible unless:

- they fall below 90% of prevailing round prices (as a result of price increments);
- they are discarded in order to allow the bidder to submit new bids for additional packages.

A bid can only be discarded if:

- it does not determine the relative caps on other bids;
- discarding the bid is necessary to keep the number of packages for which the bidder keeps eligible bids at 50; and
- is not an eligible bid for a package for which the bidder has submitted a headline bid in earlier rounds.

At the end of the round, the auctioneer considers all the possible combinations of eligible bids that include at most one bid from each bidder and which can be satisfied with the lots available. The value of any such combination of bids is calculated as the sum of bids in the combination plus the reserve price of lots that would remain unassigned if the bids in the combination were the winning bids.

If any of the combinations which achieves the highest possible value includes a bid from each bidder who has submitted a positive headline bid in the most recent round, then the auction ends, and one such combination will become the combination of winning bids (ties broken first to maximise the sum of eligibility points of lots

assigned, then at random). Otherwise, a further round is needed, with a higher price for lot categories in which the demand from bidders clashes.

Notice that the requirement that the winning combination has to include exactly one eligible bid from each bidder who is still making headline bids guarantees that bidders are not at risk of leaving the auction empty-handed, unless they stop making headline bids or unless they explicitly make a bid for an empty package.

Also notice that some bids at prevailing prices could be outbid by bids at lower prices if the latter allowed assigning a greater number of lots. Therefore, bidding could end even if there is excess demand at prevailing prices (i.e. across the headline bids in the latest round), if some bidders have made additional or earlier bids that are included in the winning combination. At the same time, bidding may continue even if it were feasible to accept all the headline bids submitted in the latest round, as the highest value of bids might be achieved when accepting some additional or earlier bids and leaving some of the headline bids in the latest round out.

Scheduling of rounds

The auctioneer schedules each round, announcing to bidders the start and end time for the round, and the round prices for the round. No other information about the bids received in any earlier rounds will be disclosed.

Each bidder will be given three extension rights, each of which will grant the bidder an additional 30 minutes to submit its bid if it has not done so by the scheduled end time of the round.

In any given round, the round price of a package is the sum of round prices of all the lots included in the package.

Bids

A bid is a price offer to acquire a package of lots indicated by the bidder.

There are two types of bids:

- headline bids; and
- additional bids.

A bid is only eligible to become a winning bid if:

- it is at least at the minimum offer for the corresponding package, calculated as set out below; and
 - if it has not been discarded in order for the bidder to make bids for additional packages, under the provisions set out below.
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We call such bids 'eligible bids'.

A headline bid must be placed at round prices. During a round, bidders can make a headline bid by indicating the number of lots they wish to acquire at the round prices, subject to not violating the spectrum cap or the activity rules (if applicable) outlined below.

In each round, each bidder may submit at most one headline bid. If in a given round a bidder does not make a headline bid, or specifies an empty package for its headline bid, then its headline bid for that round is a bid of zero for an empty package (a package containing no lots). Headline bids are particularly relevant for the application of the activity rules and the calculation of price increments in the event that a further round is needed.

Additional bids can be at or below round prices. Bidders can make multiple additional bids along with their headline bid, but are not required to do so. To make an additional bid, bidders need to specify the bid package, subject to not violating the spectrum cap, and the amount of the additional bid.

Additional bids must be at least the minimum offer for the bid package (calculated as set out below), but cannot exceed the round price of the bid package. Additional bids must also satisfy any constraints arising from the activity rules and the other bids made by the bidder. Bidders can make an additional bid for an empty package, which will make it possible for the second auction stage to end without the bidder winning any lots.

Minimum offer for a package

There is a minimum offer for each package in each round, which might differ across bidders depending on the relative caps that apply to the bidder in accordance with the activity rules set out below.

The minimum offer for a package for which the bidder has not already submitted a bid is 90% of the round price of the package.

The minimum offer for a package for which the bidder has submitted an eligibility-reducing bid, as defined in the context of the activity rules below, is the highest bid that the bidder has already made for the bid package.

The minimum offer for a package for which the bidder has *not* submitted an eligibility-reducing bid, but for which the bidder has submitted at least one other type of bid, is the greatest of the highest bid that the bidder has already made for the bid package and 90% of the round price of the package.

Maximum number of packages and discarding of bids

Bidders can bid for up to 50 packages in addition to the empty package (which contains zero lots). Once a bidder has reached this limit, then it may only be able to bid for additional packages, subject to a limit of ten additional packages each round, if it is possible to discard some of the bids it has made for some packages, so that the total number of packages for which the bidder has made bids that have not been discarded remains within the 50 limit. It is not possible to discard bids that:

- determine the relative cap on other bids; or
- are for a package for which the bidder has made one or more headline bids and are at least at the minimum offer for the package.

If any bids are discarded, then:

- all the bids for the package for which a bid is discarded will be discarded;
- the number of packages for which bids are discarded will not exceed the number of bids for new packages which the bidder makes in the round, which cannot exceed ten.

Subject to these requirements, the bidder can select the packages for which it wishes to discard bids.

A bidder may not withdraw or discard bids which it has already submitted and which remain eligible unless it needs to do so in order to be able to make bids for additional packages.

Assessment of bids at the end of the round

After each round, the auctioneer will evaluate the eligible bids in order to determine whether the auction can close or whether a further round is required.

Only bids which remain eligible to become a winning bid are considered.

A **feasible combination** is a combination of eligible bids which includes at most one bid (which may be a headline bid or an additional bid) from each bidder, and where the demand expressed in the bid packages of the bids in the combination can be met with the lots available.

A feasible combination is **inclusive** if it includes one bid from each bidder (which may be the zero bid if the bidder has submitted this bid, or has stopped making headline bids).

The **assignment** that corresponds to a feasible combination involves:

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- assigning to each bidder who has a bid included in the feasible combination (only) the lots in this bid's package; and
 - not assigning any lots to any bidders for who do not have a bid included in the feasible combination.

The **value** of a feasible combination is the sum of bids in the combination plus the sum of reserve price of any lots that would remain unassigned in the assignment corresponding to the feasible combination.

A feasible combination is **value-maximising** if it achieves the highest value across all feasible combinations.

The auction ends when a value-maximising feasible combination is inclusive. Otherwise, a further round is needed.

Setting of round prices

In the first round, the round price for each lot category will be equal to the reserve price for lots in that lot category.

If a further round is required, the auctioneer will determine for which lot categories round prices need to increase. As for the evaluation of bids, only bids which remain eligible to become a winning bid are considered.

The rationale for increasing prices is that if there is a conflict in the demand from different bidders, then it is necessary to establish whether the bidders with conflicting demand are willing to raise their bid in the following round, or switch or reduce their demand. Therefore, the first step to determine the lots that require a price increment is to identify which bidders are outbid in at least one value-maximising feasible combination that does not simply leave all of the lots that the bidder had included in a bid at reserve unassigned. We call these the 'omitted' bidders. Each of these bidders should face a price increase for the package they bid for in the most recent round.

However, because bids are for packages, it is possible that competition between omitted bidders may be focus on some specific lot categories, in which case it may not be necessary to increase the price for all of the lots included in that bidder's headline bid package. Therefore, we will try to identify individual lot categories for which there is a conflict, by isolating the headline bid demand from the bidder for each lot category in turn and then assess whether the demand from the bidder is still in conflict with that of other bidders. We do this for each of the omitted bidders in turn, but running through the following process:

- taking the headline bid from the bidder in the most recent round, we look at the lot categories for which the number of lots in the bid's package is greater than zero;
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- taking each of these categories in turn, we construct a hypothetical bid for a package that includes only the lots in this category that are included in the headline bid and no other lots (and with the bid amount being adjusted accordingly);
 - we then re-evaluate bids, replacing the headline bid from the omitted bidder under consideration with this hypothetical bid; if the bidder would still be an omitted bidder with this hypothetical bid, then we increase the price of this lot category;
 - if none of the lot categories considered for this headline bid has been found to require a price increment when considered individually, then we increase the price of all the lot categories included in the headline bid of this omitted bidder.

The auctioneer will determine the level of price increments.

Outcome of the auction

When the auction ends, one of the inclusive, value-maximising feasible combinations will become the combination of winning bids, applying if necessary the following tie-breaking criteria:

- if there are several inclusive, value-maximising feasible combinations, only those which maximise the sum of eligibility points of the lots that are assigned in their assignment will be considered;
- if several combinations remain for consideration, one of these will be selected at random.

Each bidder will then be assigned the lots included in the package of its winning bid, and will be required to this bid.

Activity rule

Each lot will be assigned a number of eligibility points.

The eligibility of a package is calculated as the sum of eligibility points of all lots included in the package.

The activity of a bidder in a round is equal to the eligibility of the package of its headline bid in that round.

Each bidder will be assigned an eligibility for each round.

The bidder will start with a given level eligibility for the first round, which might be set with reference to a bank guarantee, or to the maximum possible activity under the spectrum cap. In subsequent rounds, the bidder's eligibility will be equal to the smaller of its eligibility and its activity in the preceding round.

Therefore:

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- If in round r a bidder makes a headline bid with activity smaller than the bidder's eligibility, then the bidder's eligibility will be reduced going forward; specifically, in this case the bidder's eligibility in round $r+1$ will be set to its activity in round r .
 - If in round r a bidder makes a headline bid with activity no smaller than the bidder's eligibility, then the bidder's eligibility will be maintained for the following round; specifically, in this case the bidder's eligibility in round $r+1$ will be set to its eligibility in round r .

Given this, the submission of a headline bid with activity smaller than the bidder's eligibility at the start of the round will result in a reduction of the bidder's eligibility. We call such bids **eligibility-reducing bids**.

Eligibility-reducing bids establish some constraints on the bidder's bids for packages with eligibility between its previous and its new activity level for all future rounds. These constraints are called **relative caps**, and will constrain the bids that the bidder can make for packages with an eligibility that is:

- greater than the eligibility of the package of the eligibility-reducing bid; but
- not greater than the bidder's eligibility at the time of submitting the eligibility-reducing bid.

Any bid that is subject to a relative cap cannot exceed:

- the bidder's highest bid for the package of the eligibility-reducing bid (including bids submitted in previous rounds and any bids that the bidder may submit along with the bid subject to the cap); plus
- the difference in the round prices of the package of the bid subject to the cap and the package of the eligibility-reducing bid, in the round in which the bidder submitted the eligibility-reducing bid.

The cap is relative in that it constrains the bid amount that the bidder can submit for the constrained package relative to the highest bid that the bidder submits for the constraining package. This means that the bidder may be able to increase its bid for a package subject to a relative cap if it can (and does) increase the bid for the constraining package.

Example 1: Relative caps

Suppose that in round r a bidder has eligibility n and submits an eligibility-reducing bid for package X , with eligibility m .

Then this will create a relative cap on any bid that the bidder may submit for packages whose eligibility is greater than m , but not greater than n .

Suppose that package Y is one of these packages, then, from round $r+1$ onwards, any bid that the bidder makes for package Y will be constrained by this relative cap.

When calculating the value of the relative cap on Y , we need:

- the bidder's highest bid on X (the package of the eligibility-reducing bid that generated the cap) – denote this by B_X ; and
- the price difference between Y and X in the round in which the bidder made the eligibility-reducing bid (round r) – denote this as $P_Y - P_X$.

Then the relative cap requires that any bid for Y must not exceed $B_X + P_Y - P_X$.

Activity rules for the submission of headline bids

A bidder with zero eligibility will not be able actively to submit a headline bid that is not the zero bid.

Subject to not violating the spectrum cap, a bidder with eligibility greater than zero may submit a headline bid for:

- any package with eligibility not greater than its eligibility in the round; or
- a package with eligibility greater than its eligibility in the round (subject to not violating the spectrum cap), if this does not imply a violation of the relative caps.

Where relevant, the bidder may be able to submit additional bids alongside its headline bid in order to ensure compliance of with the relative caps (subject to such bids being permitted under the activity rules for the submission of additional bids).

Activity rules for the submission of additional bids

Subject to not violating the spectrum cap, a bidder may submit additional bids for any packages, subject to the following constraints:

- the bid cannot exceed the round price of the package;¹
- the bid cannot be lower than the minimum offer for the package;

¹ Note that a bidder may wish to bid for more than one package at round prices in any given round and may be able to do so. However, only one of these bids can be made as a headline bid. The selection of the headline bid may be relevant for the application of the activity rules, as the headline bid determines the bidder's activity and thus its eligibility going forward, and will be relevant for the calculation of relative caps if the headline bid is an eligibility-reducing bid.

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- the bid cannot be lower than any previous bid that the bidder may have already submitted for the same package; and
 - if the bid package has an eligibility greater than the bidder's eligibility in the round, then the bid must satisfy the relative cap.

Where relevant, the bidder may be able to submit further additional bids in order to ensure compliance with the relative cap, subject to such bids also being subject to the constraints above.
