Auction 105 Technical Guide

1 Introduction

This technical guide details the bidding procedures for Auction 105 as described in the *Auction 105 Procedures Public Notice*.[1] The clock auction design for Auction 105 differs in two respects from previous Commission clock auctions.

First, the auction will not include an assignment phase to assign frequency-specific licenses, as in previous clock auctions, because the Commission has determined that Priority Access Licensees will not be assigned frequency-specific licenses, but will be authorized to use frequencies associated with their PALs as dynamically assigned by Spectrum Access Systems. Thus, Auction 105 will consist solely of clock rounds.

Second, the bidding activity rules that were used in prior Commission clock auctions are modified to provide a safeguard against a bidder losing bidding eligibility under certain circumstances. Specifically, a bidder is allowed to submit bids with associated bidding activity greater than its current bidding eligibility, up to a certain limit. However, as in other Commission clock auctions, the bidder's activity as applied by the bidding system during bid processing would never exceed the bidder's current bidding eligibility.

Section 2 of this guide describes the bids and the bidding rules. Section 3 describes the calculations for the bidding information shown to bidders, including bidding information related to the modification to the activity rule. Section 4 describes how bids are processed after a round. Section 5 describes the stopping rule. Section 6 describes how the system sets up the next round if the stopping rule is not met at the end of a round. This includes calculating the bidder's eligibility for the following round and calculating prices for the following round. Section 7 describes how final payments and per-license prices are calculated at the conclusion of the auction.

2 Bidding

The auction consists of a series of timed bidding rounds. A bidder in the auction indicates in each round its demand for blocks in each county at the current prices. When submitting a bid, the bidder specifies a quantity and a price. Bids are processed after each round to determine the quantity of a bidder's requested demand that is applied (the *processed demand*) and the *posted price* of each county for that round. If, after the bids are processed, there is no excess demand for blocks in any county, then the auction ends and the *final price* for each county is equal to the posted price of the last round. Otherwise, the auction continues with a new round.

In Round 1, each bidder indicates the number of blocks that it demands at the minimum opening bid amounts. For Round 1, the processed demands of a bidder are simply the quantities that it bid for in the round, and the posted price of a county is the minimum opening bid price for that county.

In each round after Round 1, a range of prices is associated with each county. The *start-of-round price* is the lowest price in the range, and the *clock price* is the highest price in the range. The start-of-round price for a county is equal to the posted price of the previous round for that county.

[1] See *Auction of Priority Access Licenses for the 3550-3650 MHz Band; Notice and Filing Requirements, Minimum Opening Bids, Upfront Payments, and Other Procedures for Auction 105; Bidding in Auction 105 Scheduled to Begin June 25, 2020*, AU Docket No. 19-244, Public Notice, FCC 20-18 (March 2, 2020) (*Auction 105 Procedures Public Notice*).

2.1 Bid Definition for Rounds After Round 1

Bid to maintain demand. A bid to maintain a quantity equal to the bidder's processed demand for a county r at the round's clock price indicates that the bidder is willing to buy a quantity equal to the previous round's processed demand at all prices in this round up to and including this round's clock price. Intra-round bids to maintain demand are not permitted.[2]

Bid to reduce demand. A bid requesting to reduce demand to a quantity q for a county r at price p in a round indicates that:

(1) At all prices above p and less than or equal to the clock price (or the next price at which the bidder submitted a bid, if the bidder submitted multiple bids for the county), the bidder is willing to buy an exact quantity equal to q; and

(2) At price p, the bidder is willing to buy any quantity between q and its previous demand for county r.[3]

If the bidder has submitted a single bid to reduce demand for county *r* in the round, the bidder is willing to buy a quantity equal to its processed demand at all prices greater than or equal to the start-of-round price and less than that bid price. More generally, the bidder is willing to buy a quantity equal to its processed demand at all prices greater than or equal to the start-of-round price and less than the lowest bid price among all of the bidder's bids to reduce demand for county r in the round.

Bid to increase demand. By submitting one (or more) bid(s) requesting to increase demand for a county *r* at one (or more) price(s) in a round, the bidder indicates that at all prices associated with this round (*i.e.*, prices that are greater than or equal to the start-of-round price and less than or equal to the clock price) it is willing to buy any quantity that is greater than or equal to its processed demand and less than or equal to the maximum quantity that it specifies in a bid for county r.[4]

<u>Example 1</u>: Bid Requesting to Reduce Demand to 2 Blocks at $5,500

Suppose that after the bids of the previous round are processed, the bidder's processed demand for a county is 4 blocks and the posted price is $5,000. In the current round, the clock price is $6,000, and the bidder submits a single bid for the county requesting to reduce its demand to 2 blocks at price $5,500.

To the bidding system, this bid means the following:

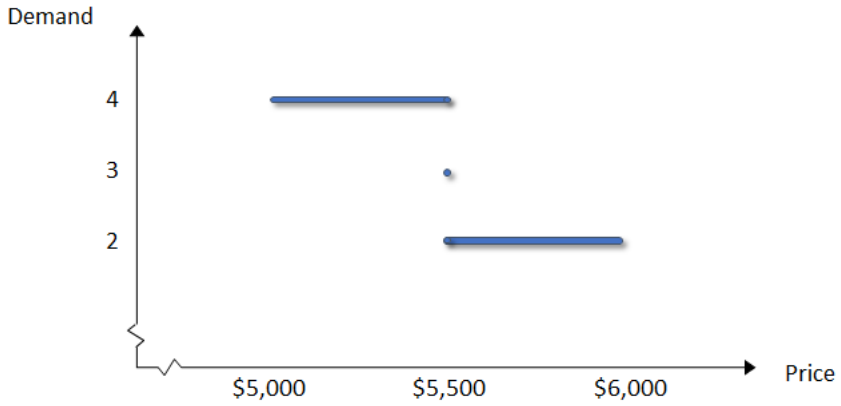
- If the price is below $5,500, the bidder is willing to purchase 4 blocks.
- If the price is exactly $5,500, the bidder is willing to purchase 2, 3, or 4 blocks.
- If the price is above $5,500, the bidder is willing to purchase only 2 blocks.

[2] A bidder cannot submit a bid to maintain its demand at a price below the round's clock price. Bids made at intra-round prices are used to indicate the price at which the bidder's requested demand changes from its processed demand from the previous round, or if the bidder requested a change at a lower intra-round price in the round, from its requested demand at the next lowest price.

[3] The bidder's previous demand for county r is either equal to its processed demand from the previous round or, if the bidder has submitted a bid at a price below p for county r, the quantity in the bid for county r with the highest price below p.

[4] The bidding system will not process the requested increase until bid processing reaches the price at which the bid was made, but depending upon demand for the county relative to its supply and depending upon which bids to reduce demand for the county are applied, the posted price for the current round may be above or below the bid price of the requested increase. The posted price may be lower if, for example, applying the increase allows another bidder's requested decrease at a lower price to be applied.

The graph below illustrates how the bidding system interprets this bid:



If a bid is partially applied, then the processed demand of the bidder is a quantity that is strictly between the bidder's processed demand before the bid was applied and the quantity that the bidder specified in the bid.

When the bidding system processes the bids at price $5,500, the bid will be applied fully, partially, or not at all depending on the level of excess demand at that point in the bid processing.[5]

(a) If aggregate demand exceeds supply by more than 2 blocks, the bid is fully applied. The bidder will have processed demand of 2 blocks.

(b) If aggregate demand exceeds supply by exactly 2 blocks, the bid is also fully applied. The bidder will have processed demand of 2 blocks.

(c) If aggregate demand exceeds supply by only 1 block, the bid is partially applied. The bidder will have processed demand of 3 blocks.

(d) If aggregate demand does not exceed supply, the bid is not applied. The bidder will continue to have processed demand of 4 blocks.

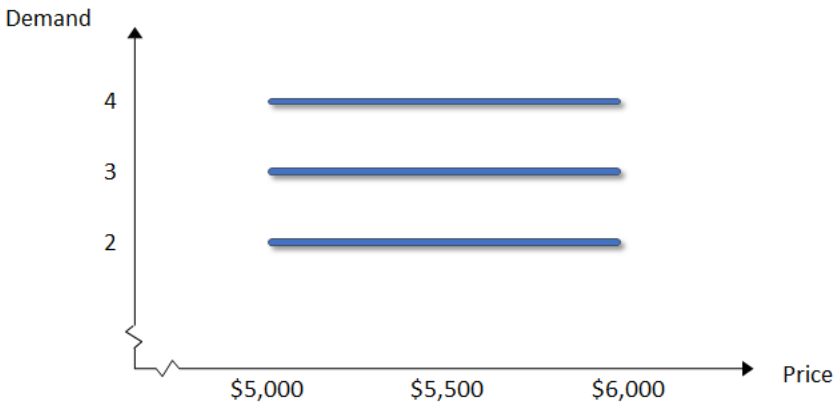
Using the same bid, if no other bidder has submitted a bid requesting to change its demand for this county, then:

- In case (a), the posted price will be equal to $6,000.
- In cases (b) and (c), the posted price will be equal to $5,500.
- In case (d), the posted price will be equal to $5,000.

Example 2: Bid Requesting to Increase Demand to 4 Blocks at $5,500

Suppose that, after the bids of the previous round are processed, the bidder's processed demand for a county is 2 blocks and the posted price is $5,000. In the current round, the clock price is $6,000, and the bidder submits a single bid for the county requesting to increase its demand to 4 blocks at price $5,500. This means that for all prices p such that $\$5{,}000 \leq p \leq \$6{,}000$, the bidder is willing to buy 2, 3, or 4 blocks in the county. The corresponding demand graph is shown in the following figure:

[5] Details on bid processing are provided in Section 4.



2.2 Bidding Rules

In every round, a bidder may only bid for a quantity that is greater than or equal to 0 and less than or equal to 4 for a county.

In Round 1, a bidder will *not* be allowed to submit a bid or a collection of bids if the bidder's activity for the round would exceed the bidder's eligibility for the round. In any round after Round 1, a bidder will *not* be allowed to submit a bid or collection of bids if the bidder's activity for the round would exceed the bidder's *activity upper limit* for the round. The bidder's activity upper limit for the round is equal to the activity limit percentage for the round times the bidder's eligibility for the round, rounded up to the nearest integer (see Section 3.3). This implies that, if a bidder's eligibility for the round is equal to 0, then the bidder will not be able to submit any bids.

A bidder may *not* submit two different bids for the same county at the same price. For example, the bidder cannot submit a bid for 2 blocks of county A and a bid for 0 blocks of county A both at the same price.

In any round after Round 1, a bidder can either bid to maintain its demand at the round's clock price or bid to change (*i.e.*, reduce or increase) its demand at any price associated with the round.

A bidder can submit multiple bids to increase demand or to reduce demand in a county, as long as all the bids are one-directional in terms of price. That is, if all of the bids submitted by a bidder in a round for a county are put in ascending order by price, the corresponding quantities must all either increase or decrease starting from the bidder's processed demand from the previous round.

The following algorithm illustrates how one can check one-directionality with respect to a given county r.

Algorithm for One-Directionality

Let A_r denote the set of bids that the bidder has just requested to submit that involve county r, and assume that A_r contains at least two bids.[6] The algorithm ranks these in price order, then checks the direction of the change and validates that all bids at higher prices maintain the same direction.

- Each element of A_r is represented by the pair (price, quantity for county r).
- Let S denote the union of A_r and the following element: (start-of-round price for county r, the bidder's processed demand from previous round for county r)

[6] When a bidder submits bids that include bids for a given county during a round, the bidding system will replace any bids for that county that the bidder submitted previously during that round.

- Rank all elements of S in ascending order of price, and let q be the corresponding vector of quantities. That is, $q(1)$ is the processed demand from the previous round, $q(2)$ is the quantity associated with the lowest-price bid for county r in A_r, etc. Let N be the number of elements in q.
- Check whether one of the following conditions holds:

  (i) $q(k) > q(k-1)$ for $k = 2, 3, \ldots, N$; or

  (ii) $q(k) < q(k-1)$ for $k = 2, 3, \ldots, N$.

  If either (i) or (ii) is satisfied, then the bids in A_r are one-directional with the bidder's processed demand from the previous round for county r. In that case, the system allows the bidder to submit the bids in A_r. Otherwise, the bids in A_r cannot be submitted.

Example 3: Suppose that the bidder's processed demand for county r from the previous round is 4, the start-of-round price is \$5,000, and the clock price is \$6,000. The bidder is now trying to submit the bids $A_r = \{(\$5{,}100, 3), (\$5{,}200, 1), (\$5{,}300, 2), (\$5{,}400, 0)\}$ for county r. Then,

$$S = \{(\$5{,}000, 4), (\$5{,}100, 3), (\$5{,}200, 1), (\$5{,}300, 2), (\$5{,}400, 0)\}$$

The following table shows the prices and quantities of the elements of S, ranked in order of price:

k	Price	$q(k)$
1	\$5,000	4
2	\$5,100	3
3	\$5,200	1
4	\$5,300	2
5	\$5,400	0

Observe that $q(2) < q(1)$ but q(4) $> q(3)$. Thus, the bidder will not be allowed to submit the bids in A_r.

3 Calculations for Bidding Information

In the following sections, R denotes the set of all counties.

3.1 Activity

When a round is open for bidding, the *activity* of a bidder is calculated as the total number of bidding units associated with the demand the bidder indicates it is willing to accept at the clock price, given all bids that the bidder has submitted.[7] In other words, the activity of bidder i in round t is:

$$\sum_{r \in R} q_{t,i,r} \cdot b_r$$

[7] The bidding system provides the activity calculation, as described here, during the bidding round. Processed activity and processed demand cannot be determined until after the round's bids have been processed, and therefore will be made available to bidders after the round.

Where:

- $q_{t,i,r}$ denotes the requested demand of bidder i for county r at the clock price of round t, given all bids that bidder i has submitted so far in this round. In particular, if all the bids that are submitted by bidder i for county r are applied during bid processing, then its processed demand will be $q_{t,i,r}$.
- b_r denotes the number of bidding units associated with county r.

At the beginning of a round, *i.e.*, before the bidder has submitted any bids in this round, the bidder's activity is equal to 0.

Example 4: County A has 10 bidding units per block and county B has 8 bidding units per block. For county A, the start-of-round price is $5,000 and the clock price is $6,000. For county B, the start-of-round price is $4,000 and the clock price is $4,800. Suppose that bidder i has submitted the following bids in the current bidding round:

- County A: a bid for 3 blocks at price $5,500, and a bid for 2 blocks at price $5,700.
- County B: a bid for 2 blocks at price $4,500.

After the bidder has submitted these three bids, its activity is: $(2 \cdot 10) + (2 \cdot 8) = 36$ bidding units.

3.2 Required Activity

A bidder's *required activity* in round t is the minimum total number of bidding units associated with the bidder's processed demand that the bidder should have after the bid processing of round t in order to maintain the same eligibility in round $t + 1$.

The required activity of bidder i in round t is calculated by multiplying the activity requirement percentage for round t with the eligibility of bidder i in round t. The result is rounded down to the nearest integer. The activity requirement percentage will be set within a range of 90% and 100% inclusive and may change from round to round.[8]

3.3 Activity Upper Limit

A bidder's *activity upper limit* for a round represents the maximum activity that the bidder can submit for the round. For Round 1, the activity upper limit of bidder i is equal to the bidder's initial eligibility.

For any round $t > 1$, the activity upper limit of bidder i is calculated by multiplying the activity limit percentage for round t with the eligibility of bidder i for round t. The result is rounded up to the nearest integer. The activity limit percentage will be set with a range of 100% and 140% inclusive and may change from round to round.[9]

For example, consider a round $t > 1$. If the activity limit percentage for round t is 120% and the eligibility of bidder i for round t is 156 bidding units, then the bidder's activity upper limit for round t is calculated as 120% of 156, which after rounding up to the nearest integer yields 188. That is, the bidder can submit bids with activity of up to 188.

[8] The initial activity requirement percentage for Auction 105 will be set at 95%. *Auction 105 Procedures Public Notice* at page 54, para. 178.

[9] The initial activity limit percentage for Auction 105 will be set at 120%. *Auction 105 Procedures Public Notice* at page 56, para. 184.

The bidding system, however, will not apply bids that would result in the bidder having processed activity that exceeds its eligibility.[10]

3.4 Payment Information Available While the Round is Open for Bidding

For the convenience of bidders, the bidding system will provide information about the financial exposure created by bids during the course of the auction.

The following notation is used in this section:

- $q_{t,i,r}$ denotes the requested demand of bidder i for county r at the clock price of round t, given all bids that bidder i has submitted so far in this round. In particular, if all the bids that are submitted by bidder i for county r are applied during bid processing, then its processed demand will be $q_{t,i,r}$.
- $P_{t,r}$ denotes the clock price in round t for county r.
- BC_i denotes the bidding credit percentage of bidder i.
- R denotes the set of all counties.
- S denotes the set of all *small markets* (*i.e.*, counties subject to the small market bidding credit cap).
- $RC_{t,i}$ denotes the requested commitment of bidder i in round t.

3.4.1 Requested Commitment

A bidder's *requested commitment* during a round t is the total gross bid amount calculated at the round's clock prices, given the bids that the bidder has submitted so far in round t. During the round, bids for the round have not yet been processed, so the requested commitment is an estimate of a bidder's commitment, and this estimate is updated as bids are submitted. The requested commitment of bidder i in a round t is calculated according to the following formula:

$$RC_{t,i} = \sum_{r \in R} q_{t,i,r} \cdot P_{t,r}$$

At the beginning of a round, *i.e.*, before the bidder has submitted any bids in this round, the bidder's requested commitment is equal to 0.

Example 5: For county A, the start-of-round price is $5,000 and the clock price is $6,000. For county B, the start-of-round price is $4,000 and the clock price is $4,800. Suppose that bidder i has submitted the following bids in the current bidding round:

- County A: a bid for 3 blocks at price $5,500, and a bid for 2 blocks at price $5,700.
- County B: a bid for 2 blocks at price $4,500

[10] See Example 6. Note also that the price point associated with a bid determines the order in which the bid will be processed. Therefore, a bidder submitting bids with activity that exceeds its eligibility—that is, bids not all of which can be applied—should indicate price points that reflect its preferences for the order in which it wishes its bids to be processed by the system. See Section 4.2, Price Points.

By submitting these bids, the bidder indicates that it is willing to buy 2 blocks of county A up to and including the clock price of $6,000 per block, and 2 blocks of county B up to and including the clock price of $4,800 per block. After submitting these three bids, the bidder's requested commitment is:

$$(2 \cdot \$6{,}000) + (2 \cdot \$4{,}800) = \$21{,}600$$

3.4.2 Bidding Credit Discounts on Requested Commitment

This section describes the calculations for requested commitment bidding credit discounts in a round t. All bidding credit discounts are rounded to the nearest dollar. Rounding is only done at the very end of a given calculation, that is, after performing any summations and/or minimizations in a formula.

Rural Service Provider Bidding Credit. If bidder i qualifies for the rural service provider bidding credit,[11] then in round t,

Its *uncapped requested commitment discount* is:

$$BC_i \cdot RC_{t,i}$$

Its *requested commitment discount* is:

$$min\{\$10 \text{ million}, BC_i \cdot RC_{t,i}\}$$

This is equal to the bidder's requested commitment multiplied by its bidding credit percentage and then capped at $10 million.

Small Business Bidding Credit. If bidder i qualifies for the small business bidding credit, then in a round t,

Its *uncapped requested commitment discount in small markets* is:

$$BC_i \cdot \sum_{r \in S} q_{t,i,r} \cdot P_{t,r}$$

Note that the summation is across all counties subject to the small market bidding credit cap. The uncapped requested commitment discount in small markets is calculated by multiplying the bidder's requested commitment in small markets by its bidding credit percentage.

Its *uncapped requested commitment discount* (across all markets) is:

$$BC_i \cdot RC_{t,i}$$

Its *requested commitment discount* (across all markets) is:

$$min\left\{\$25 \text{ million}, BC_i \cdot \sum_{r \in R \setminus S} q_{t,i,r} \cdot P_{t,r} + min\left\{\$10 \text{ million}, BC_i \cdot \sum_{r \in S} q_{t,i,r} \cdot P_{t,r}\right\}\right\}$$

This calculation first caps the bidder's discount in small markets at $10 million, then adds the bidder's discount from all other counties (*i.e.*, counties that are not subject to the small market bidding cap) and caps the sum at $25 million.

[11] A bidder will not finally be deemed qualified for a bidding credit until after its qualifications have been approved in the long-form application process. Here, we refer to a bidder that "qualifies for a bidding credit" as a bidder that claimed eligibility for a bidding credit at the short-form stage and whose short-form application qualified the bidder to participate in the auction.

3.4.3 Requested Net Commitment

A bidder's *requested net commitment* is equal to its requested commitment minus its requested commitment discount.

3.5 Payment Information Available After the Round has been Processed

After bid processing for a round, the bidding system will then provide payment information based on the processed demands and the posted prices for the round. The calculations are similar to the corresponding calculations for requested commitment that are conducted during a round (as described in Section 3.4), except that the bidder's processed demand ($d_{t,i,r}$) is used instead of the bidder's requested demand at the clock price ($q_{t,i,r}$), and a county's posted price ($p_{t,r}$) is used instead of the county's clock price ($P_{t,r}$).

In addition to the notation of Section 3.4, the following notation is used in this section:

- $d_{t,i,r}$ denotes the processed demand of bidder i for county r after round t.
- $p_{t,r}$ denotes the posted price of county r after round t.
- $C_{t,i}$ denotes the commitment of bidder i after round t.

3.5.1 Commitment

The bidder's *commitment* from the previous round is a dollar value that is calculated from the bidder's processed demand and the posted prices after the bid processing of the previous round.

The commitment of bidder i after round t is given by the following formula:

$$C_{t,i} = \sum_{r \in R} d_{t,i,r} \cdot p_{t,r}$$

3.5.2 Bidding Credit Discounts on Commitment

This section describes the calculations for bidding credit discounts on a bidder's commitment after round t. All bidding credit discounts are rounded to the nearest dollar. Rounding is only done at the very end of a given calculation, that is, after performing any summations and/or minimizations in a formula.

Rural Service Provider Bidding Credit. If bidder i qualifies for the rural service provider bidding credit, then after round t,

Its *uncapped commitment discount* is:

$$BC_i \cdot C_{t,i}$$

Its *commitment discount* is:

$$min\{\$10 \text{ million}, BC_i \cdot C_{t,i}\}$$

Small Business Bidding Credit. If bidder i qualifies for the small business bidding credit, then after round t,

Its *uncapped commitment discount in small markets* is:

$$BC_i \cdot \sum_{r \in S} d_{t,i,r} \cdot p_{t,r}$$

Its *uncapped commitment discount* (across all markets) is:

$$BC_i \cdot C_{t,i}$$

Its *commitment discount* (across all markets) is:

$$min\left\{\$25 \text{ million}, BC_i \cdot \sum_{r \in R \setminus S} d_{t,i,r} \cdot p_{t,r} + min\left\{\$10 \text{ million}, BC_i \cdot \sum_{r \in S} d_{t,i,r} \cdot p_{t,r}\right\}\right\}$$

3.5.3 Net Commitment

A bidder's *net commitment* is equal to its commitment minus its commitment discount.

4 Bid Processing

This section describes bid processing. The purpose of bid processing is to determine, at the conclusion of a round of bidding, the processed demands for all bidders and the posted prices for all the counties.

4.1 Missing Bids

For each county for which the bidder had positive processed demand in the previous round, if the bidder did not submit a bid for that county during the current round, it will be deemed to have a bid for that county with a quantity of 0 at a price equal to the start-of-round price. For example, if the start-of-round price for a particular county is $6,000 and a bidder does not submit a bid in this round for that county, it will be deemed to have bid a quantity of 0 at $6,000. Note that this does not necessarily mean that a bidder will receive 0 blocks at $6,000. The missing bid will be processed just as if the bidder submitted a bid for 0 blocks at $6,000.

4.2 Price Points

Prices points are used to prioritize bids during bid processing.

The price point of a bid is calculated as the following ratio:

$$\text{price point} = \frac{\text{bid price} - \text{start-of-round price}}{\text{clock price} - \text{start-of-round price}}$$

The result of the calculation is rounded to 10 decimal places.

For example, the 0% price point refers to the start-of-round price, the 100% price point refers to the clock price, and the 50% price point refers to the average of the start-of-round price and the clock price. As another example, if the start-of-round price is $5,000 and the clock price is $6,000, the price $5,100 corresponds to the 10% price point.

4.3 Processed Demands

Bids to maintain demand are always applied during bid processing, whereas bids to change demand are applied to the maximum extent possible.

Bids to change demand are prioritized for processing in the following order: price point (from lowest to highest) across all bids, and then a bid-specific pseudorandom number (from lowest to highest). The priority ordering of bids remains the same throughout the bid processing of a round (that is, only one pseudorandom number is associated with a given bid in a round).

The bid processing algorithm maintains a queue of all bids to change demand from the round that have not been applied in their entirety, and, whenever a bid is applied either partially or in its entirety, the queue is re-tested to determine whether any bids in the queue can be applied.

A bid to increase demand is applied to the maximum extent possible while ensuring that the bidder's processed activity does not exceed its eligibility for the round.

A bid to reduce demand is applied to the maximum extent possible while ensuring that it does not create (or further increase) excess supply in the county.

Whenever a bid is applied either partially or in its entirety, the queue is re-tested to determine whether any bids in the queue can be applied. When a bid has been applied in its entirety, it is removed from the queue; otherwise, it is kept in the queue so that the remaining part may be applied later. The re-testing of the queue is iterated until no bids remaining in the queue can be further applied. Then the next bid from the round is processed until (1) all bids from the round have been processed, and (2) no bids in the queue can be further applied. At that point, all bids remaining in the queue are discarded.

The demands of a bidder following the processing of the bids for the round are referred to as its processed demands.

4.4 Posted Prices

Once processed demands have been determined, the posted price for a county is set based on the aggregate demand for the county. The aggregate demand is evaluated using the processed demands.

The posted price of each county is determined as follows:

- If aggregate demand exceeds supply, the posted price equals the clock price for the round.
- If aggregate demand equals supply and at least one bid to reduce demand for the county was applied, the posted price equals the highest bid price among all bids to reduce demand for the county that were applied (either entirely or partially). That is, the posted price is the price at which a reduction caused demand to equal supply.
- In all other cases, the posted price equals the start-of-round price (*i.e.*, the posted price of the previous round).

These rules ensure that the posted price of a county will not be higher than the price of any bid that requested a reduction for that county but was not applied (either entirely or in part) *and* will not be lower than the price of any bid that requested a reduction for that county and was applied.

5 Stopping Rule

After the bids of a round have been processed, the stopping rule is met if, for every county, aggregate demand is less than or equal to 7 (*i.e.*, the supply). If the stopping rule is met and the aggregate reserve requirement has been satisfied, the auction concludes.[12] If the stopping rule is not met, the auction proceeds with a new round. If the stopping rule is met but the aggregate reserve requirement has not been satisfied, the auction will end, and no licenses will be assigned.

6 Setting Up the Next Round

If the bidding system determines that there is excess demand for at least one county, then the system sets up the next round. The system must calculate each bidder's eligibility for the next round based on the

[12] See *Auction 105 Procedures Public Notice* at page 58, para. 192. The Public Reporting System will indicate when the aggregate reserve has been met.

activity associated with the bidder's processed bids in the previous round. The clock prices for the new round must also be calculated. This section provides the details of these calculations.

6.1 Processed Activity and Next Round Eligibility

A bidder's *processed activity* for a round is equal to the total number of bidding units associated with the bidder's processed demand after the bid processing of the round. Specifically, the processed activity of bidder i after round t is calculated as:

$$\sum_{r \in R} d_{t,i,r} \cdot b_r$$

Where:

- R denotes the set of all counties.
- $d_{t,i,r}$ denotes the processed demand of bidder i for county r after round t.
- b_r denotes the number of bidding units associated with county r.

An activity rule is used to require bidders to participate in each round of the auction. A bidder's *eligibility* in Round 1 of the auction is determined by the bidding units associated with its upfront payment.

A bidder's eligibility in subsequent rounds is calculated based on its eligibility in the previous round, its required activity (see Section 3.2), its processed activity, and the activity requirement percentage.

If the processed activity of bidder i after round t is greater than or equal to its required activity, then bidder i maintains its eligibility in the following round, that is, the bidder's eligibility for round $t+1$ will equal the bidder's eligibility for round t.

Otherwise, the eligibility of bidder i for the next round $t+1$ is reduced and is set to be equal to the ratio of the bidder's processed activity for round t over the activity requirement percentage. The result is rounded up to the nearest integer.

Example 6: In a given round $t > 1$, the activity requirement percentage is 95% and the activity limit percentage is 120%. Consider a bidder with eligibility of 10,000 bidding units in the round. The following table shows the bidding units, start-of-round prices, and clock prices for counties A, B, C, and D as well as the bidder's processed demands after the previous round and its submitted bids in this round.

County	Bidding Units	Previous Round Processed Demand	Start-of-Round Price	Clock Price	Submitted Bids Quantity@Price (Price Point)
A	7,000	1	$80,000	$90,000	0 @ $81,000 (10%)
B	2,800	1	$30,000	$35,000	0 @ $31,000 (20%)
C	10,000	0	$90,000	$100,000	1 @ $93,000 (30%)
D	2,000	0	$20,000	$24,000	1 @ $22,000 (50%)

That is, the bidder had one unit of processed demand in counties A and B in the previous round. In this round, the bidder has submitted bids to reduce its demand in counties A and B to zero, and to increase its demand in counties C and D by one unit. The bid to increase demand in county C, because it was submitted at a lower price point, has higher priority than the bid to increase demand in county D.

The bidder's processed activity in the previous round is 7,000 + 2,800 = 9,800. The bidder's submitted activity in the round is 10,000 + 2,000 = 12,000. The bidder is allowed to submit these bids because the submitted activity does not exceed its activity upper limit for the round which is 12,000, that is, 120% of 10,000.

Bids to change demand are processed in increasing order of price point. This example assumes that no other bidder submitted a bid to change its demand in A, B, C, or D. The example considers two scenarios:

Scenario 1: There is excess demand in county A and in county B so that both of the bidder's bids to reduce demand are applied. The bid to reduce demand in A is considered first and is applied, because this scenario assumes that there is excess demand in A. As a result, the activity associated with the demand held by the bidder is 2,800. The bid to reduce demand in B is considered next and is applied, because this scenario assumes that there is excess demand in B. As a result, the activity associated with the demand held by the bidder is now 0. The bid processing algorithm will then consider the bid to increase demand in C (because it has a lower price point than the bid to increase demand in D). The bid to increase demand in C is applied, because that does not cause the bidder's processed activity to exceed its eligibility. As a result, the activity associated with the demand held by the bidder is now 10,000. The bid to increase demand in D is considered next but is not applied, because applying the bid would cause the bidder's processed activity to exceed its eligibility. Thus, the bidder's processed activity after the round is equal to 10,000. This means that the bidder maintains its eligibility at 10,000.

Scenario 2: There is excess demand in county B but not in county A so that the bid to reduce demand in B is applied but the bid to reduce demand in A is not. The bid to reduce demand in A is considered first but it is not applied, because this scenario assumes that there no excess demand in A; thus, the bid is placed in the queue, and the activity associated with the demand held by the bidder continues to be 7,000 + 2,800 = 9,800. The bid to reduce demand in B is considered next and is applied, because this scenario assumes that there is excess demand in B. As a result, the activity associated with the demand held by the bidder is now 7,000. The bid processing algorithm will then consider the bid to increase demand in C (because it has a lower price point than the bid to increase demand in D). The bid to increase demand in C is not applied, because applying it would cause the bidder's processed activity to becomes 10,000 + 7,000 = 17,000, which would exceed the bidder's eligibility of 10,000. The bid to increase demand in D is considered next and is applied, because that does not cause the bidder's processed activity to exceed its eligibility (7,000 + 2,000 < 10,000). Then, the bidder's processed activity after the round is equal to 9,000 (less than its required activity of 9,500) and the bidder's eligibility in the next round is 9,474 bidding units (that is, 9,000/0.95 rounded up to the nearest integer).

6.2 Clock Prices for Next Round

A county's clock price in the next round is calculated as the county's posted price from the previous round multiplied by an increment percentage.

Specifically, the clock price $P_{t,r}$ for county r in round t is calculated as:

$$P_{t,r} = \left(1 + y_{t,r}\right) \cdot p_{t-1,r}$$

Where:

- y_t denotes the increment percentage for round t. The increment percentage will be set within a range of 5% to 20% inclusive.[13]
- $p_{t-1,r}$ denotes the posted price of county r for round $t-1$.

[13] The initial increment percentage will be set at 10%. *Auction 105 Procedures Public Notice* at page 59, para. 195.

Results above $10,000 will be rounded up to the nearest $1,000; results below $10,000 but above $1,000 will be rounded up to the nearest $100; and results below $1,000 will be rounded up to the nearest $10.

Finally, the clock price $P_{t,r}$ will be capped at $p_{t-1,r}$ plus the *increment cap*, so that the difference between the clock price and the start-of-round price for a county in a round does not exceed the increment cap.[14]

Note that this calculation applies to every product, irrespective of whether the product is in excess demand.

7 Final Payments and Per-License Prices

Bidders that are still expressing demand for a quantity of blocks in a county at the time the stopping rule is met will become the winning bidders of licenses corresponding to that number of blocks. The *final price* for a generic block in a county is equal to the posted price for the final round, and the *final payment* of a winning bidder is equal to the net commitment of that bidder after the final round. See Section 3.5 for the definitions of commitment, commitment discount, and net commitment after a round.

Because the discount and the final payment for a winning bidder with a bidding credit apply on an aggregate basis, rather than for individual licenses, the bidding system will also calculate a net per-license price for each license won. Such individual prices may be needed in the event that a licensee subsequently incurs license-specific obligations, such as unjust enrichment payments.

For a license won by a bidder that does not qualify for a bidding credit, the net price is simply equal to the final price of the license.

To describe the net price calculation for a bidder that qualifies for a bidding credit, we use the following notation:

- $p_{T,r}$ denotes the final price for a block in county r.
- $d_{T,i,r}$ denotes the processed demand of bidder i in county r after the final round (*i.e.*, the bidder's winnings in that county).
- $C_{T,i}$ denotes the commitment of bidder i after the final round.
- If bidder i qualifies for the small business bidding credit discount, $C_{T,i}^{SM}$ denotes the commitment of bidder i in small markets after the final round. That is, $C_{T,i}^{SM} = \sum_{r \in S} d_{T,i,r} \cdot p_{T,r}$, where S is the set of counties subject to the small market bidding credit cap.
- $D_{T,i}$ denotes the commitment discount of bidder i after the final round.

A bidder i that qualifies for the small business bidding credit is considered to have exceeded the small market bidding credit cap if $BC_i \cdot C_{T,i}^{SM}$ rounded to the nearest integer is greater than $10 million.

If bidder i qualifies for the rural service provider bidding credit *or* if the bidder qualifies for the small business bidding credit and did not exceed the small market bidding credit cap, then the net per-license price of a license in county r won by bidder i is determined by the following formula:

$$p_{T,r} - \frac{p_{T,r}}{C_{T,i}} \cdot D_{T,i}$$

That is, the bidding system calculates net prices by apportioning the bidder's discount to licenses in proportion to the final prices of the licenses that the bidder won.

[14] This increment cap will be set initially at $10 million. *Auction 105 Procedures Public Notice* at page 59, para. 194.

Each license calculation is rounded down to the nearest dollar and then the slack due to rounding down is distributed to licenses (one dollar at a time) based on descending order of final prices. Ties are broken based on ascending lexicographic order of license ID. License ID is defined as the FIPS ID for the county followed by a number representing the block (*i.e.*, the suffix "-1", "-2", …, or "-7").

If bidder i qualifies for the small business bidding credit and it exceeded the small market bidding credit cap, then the $10 million discount that applies to small markets is apportioned to licenses won by the bidder in counties subject to the small market bidding credit cap proportionally to the final prices of those licenses. The remaining discount (*i.e.*, $D_{T,i} - \$10 \text{ million}$) is apportioned among the licenses in counties not subject to the small market bidding credit cap proportionally to the final prices of those licenses.

- The net per-license price of a license in county r that is subject to the small market bidding credit cap is determined by the following formula:

$$p_{T,r} - \frac{p_{T,r}}{C_{T,i}^{SM}} \cdot (\$10 \text{ million})$$

- The net per-license price of a license in county r that is not subject to the small market bidding credit cap is determined by the following formula:

$$p_{T,r} - \frac{p_{T,r}}{C_{T,i} - C_{T,i}^{SM}} \cdot (D_{T,i} - \$10 \text{ million})$$

For each license, the calculation is rounded down to the nearest dollar. The slack due to rounding down is then distributed (one dollar at a time) to licenses based on descending order of final prices. Ties are broken based on ascending lexicographic order of license ID.

In the case of a small business that exceeded the small market bidding credit cap, the apportioning of discounts and the distribution of any slack is done separately for the small markets and for the non-small markets.