

Rules for Standard Offer Service Auction

This document presents the rules for Eastern Utilities Associates' auction for standard offer service. Motivation for these rules is given in Cramton et al., "Auction Design for Standard Offer Service," August 11, 1997.

I. Overview of the Auction Design

This section provides a concise description of the auction design.

A. The Bid Process

To be auctioned are 100 shares of the load responsibility for each year. These shares are sold in a simultaneous ascending auction, in which the service obligation for each year is on the block at the same time. Suppliers bid for service over a series of rounds until no bidder is willing to improve a bid. This format is similar to the successful FCC auctions for radio frequency spectrum. Before the auction, bidders make a deposit, which determines the maximum number of shares they are eligible to bid on.

The auction is actually two auctions conducted in sequence. First, the full-term auction is held. Bids in the full-term auction are for a specified share of load responsibility across all years. At the conclusion of the full-term auction, the single-year auction is held. The single-year auction is for any remaining shares that did not sell in the full-term auction. If all 100 shares are sold in the full-term auction, then the single-year auction will not be held. In the single-year auction, bids are for shares in a specified year. The single-year auction begins (if necessary) immediately after the full-term auction. Each bidder's initial eligibility in the single-year auction is its initial eligibility in the full-term auction less its winnings in the full-term auction.

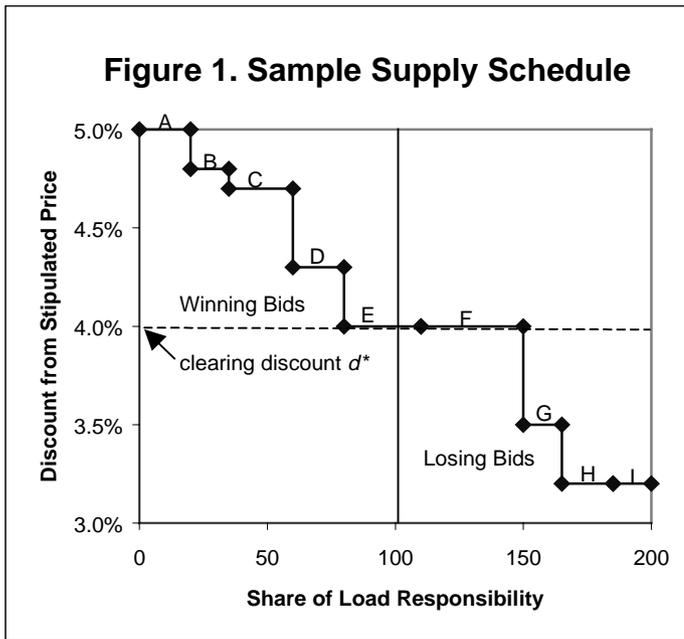
The rules for both the full-term and the single-year auction are nearly identical. We begin with a description of the full-term auction and then point out the differences in the single-year auction.

B. The Full-Term Auction

In each round, each bidder tenders a supply schedule as a group of bids. A bid is a pair (s, d) , where s is the number of shares and d is the discount (in percent). A winner of s shares at a discount d is obligated to serve $s\%$ of the standard offer service load in each year at a discount $d\%$. A bidder can submit as many bids as it likes, subject to its eligibility as initially determined by its deposit.

At the end of each round of bidding, the bids are ranked in descending order of discount, then in ascending order of time-stamp (earlier bids are ranked higher) to form the aggregate supply schedule. Starting with the largest discount, bids are designated as winning bids until the cumulative shares reaches 100. All other bids are designated losing bids. The lowest-winning bid defines the clearing discount d^* .¹ After the final round of bidding, all winning bids are awarded at the discount bid. The example in Figure 1 illustrates how the clearing discount is determined. A bid is also referred to as a "step," since each bid represents a step on the supply schedule.

¹ If the total shares bid is less than 100, then any nonnegative bid is accepted.



The following are the activity rules for the full-term auction:

Eligibility Rule: The bid deposit determines a bidder's maximum eligibility. A bidder must submit bids totaling 100% of its eligibility in the initial round, otherwise the bidder's eligibility in the full-term auction is reduced to the number of shares bid for in the initial round.

Opening Rule: A new step in the bid schedule can be submitted only in the first round.

Sorting Rule: In each round, the steps are sorted in decreasing order by discount, and then in increasing order by time-stamp. Steps are designated as winners, until the cumulative shares exceed 100. (If the total shares bid is less than or equal to 100, then all steps are designated as winners; no steps are rationed or rejected.) The next step is rationed as follows:

Rationing Rule: The first step that straddles 100 – that is, with cumulative shares greater than 100 – is split into two steps: a winning step with shares so that cumulative shares are exactly 100 and a losing step for the remaining shares of the step. All steps further down the schedule are losing steps.

Rejection Rule: A losing step from the prior round is rejected after the current round if its discount is not improved (i.e. its discount is not raised above the previous round's clearing discount by the minimum bid increment). Rejected steps are permanently removed from the bidder's bid schedule. All steps that are not rejected are automatically carried over to the next round.

Revision Rule: A step can be divided into two or more steps with total shares equal to the initial step. (This allows a bidder to raise its bid on only part of a step.) A step can be revised only by improving the previous clearing discount. That is, the revised step must bid a new discount that is more than the previous clearing discount by at least the specified minimum bid increment.

Closing Rule: The full-term auction stays open until a round goes by with no improvements.

C. The Single-Year Auction

If not all of the 100 shares are sold in the full-term auction, the remaining shares are sold in the single-year auction. The single-year auction will commence immediately on completion of the full-term auction. The rules are identical to the full-term auction with the following exceptions. In each round,

each bidder tenders a supply schedule for each year as a group of bids. A bid is a triple (y, s, d) , where y is the year, s is the number of shares, and d is the discount (in percent). A winner of s shares in year y at a discount d is obligated to serve $s\%$ of the standard offer service load in year y at a discount $d\%$. Rather than having a single supply schedule, as in the full-term auction, there is a separate schedule for each year.

The following are the activity rules that are specific to the single-year auction (i.e. all other rules provided above for the full-term auction apply, with these exceptions):

Eligibility Rule: A bidder's initial eligibility in the single-year auction is its initial eligibility in the full-term auction (determined by its bid deposit) less any shares won in the full-term auction. A bidder must submit bids totaling at least 25% of this initial eligibility in the first round, 50% in the second round, 75% in the third round, and 100% in the fourth round. Failure to maintain these activity levels results in a reduction in eligibility.

Opening Rule: A new step in the bid schedule can be submitted only in the first four rounds.

Closing Rule: All the yearly markets stay open until a round goes by with no improvements in any market. Hence, all markets close simultaneously.

II. Detailed Description of the Auction Rules

A. What is up for auction?

There are three dimensions to a bid: time, price, and quantity. Time is the year of standard offer service. The auction is to produce supply schedules for each year in the seven-year transition period. Price is the discount from the prices stipulated in the EUA settlement agreement. The stipulated prices are shown below:

Year	1	2	3	4	5	6	7
Calendar Year	1998	1999	2001	2002	2003	2004	2005
Price (cents/kWh)	3.2	3.5	3.8	3.8	4.2	4.7	5.1

Quantity is the number of shares of load responsibility for EUA's standard offer service. There are 100 shares of load responsibility up for auction in each transition year. A bid for 10 shares corresponds to a 10% share of the load responsibility.

To summarize, the auction is for 100 shares of load responsibility for each year. A bid in the full-term auction is a pair (s, d) , where s is the number of shares and d is the discount (in percent). The share s is an integer (e.g., 16 shares); the discount d is specified with two decimal places (e.g., 3.12%). A winner of s shares at a discount d is obligated to serve $s\%$ of the standard offer service load in each year at a discount $d\%$. A bidder can submit as many bids as it likes, subject to its eligibility as initially determined by its deposit. Bids in the single-year auction are identical except they also specify the year y .

A share of load responsibility is the specified percentage share of the retail Standard Offer load in the Distribution Company's territory, with all attendant obligations in the regional market for ensuring an adequate and reliable electricity supply. Suppliers' responsibilities will include, without limitation, i) installed and operable capacity sufficient to meet the Supplier's load under NEPOOL or successor rules; ii) operating reserves; iii) transmission arrangements and expenses not recovered in the Company's transmission cost adjustment provisions; and iv) transmission and distribution losses between the sources of supply and the ultimate retail customers' meters. The Company may provide certain load forecast information, but Suppliers will be responsible for estimating their capacity and energy requirements in upcoming periods.

Each Supplier will have complete responsibility for their fixed percentage share of the Company's real-time Standard Offer customer energy demand (minute by minute, hour by hour, day by day). The quantities of energy and capacity required (MWh and MW) will fluctuate with changes in customer demand resulting from factors including but not limited to seasonal factors, normal daily load patterns, increased usage by existing standard offer customers, demand side management activities, extremes in weather, etc., but Supplier percentage responsibilities will not vary within a calendar year.

B. Bid Deposit and Eligibility

The maximum quantity of shares that a bidder can bid on is determined from the bidder's bid deposit. The bid deposit is forfeited in the event a winning bidder fails to execute the Contract for Load Responsibility at the conclusion of the auction. A bid deposit of \$50,000 is required per share of eligibility. This is about \$0.001/kWh. The weighted-sum of shares of the bidder's bids cannot exceed its eligibility. The eligibility weights vary by year as follows, which is based on a linear attrition from standard offer service:

Year	1	2	3	4	5	6	7
Calendar Year	1998	1999	2000	2001	2002	2003	2004
Weight	1.00	0.86	0.71	0.57	0.43	0.29	0.14

Hence, to get one share of eligibility in year 7 requires only one seventh of the deposit required to get a share of eligibility in year 1. This reflects the fact that the load in year 7 will be less than the load in year 1, because of attrition from standard offer service. The weights above are not a prediction of likely attrition from standard offer service. Attrition must be estimated by the bidders.

Bid deposits are returned with interest shortly after the close of the auction. Winners in the auction must provide a performance bond at the time the Contract for Load Responsibility is executed. A performance bond of \$500,000 per share is required for the weighted-sum of shares won. This is about \$0.01 per kWh. The yearly weights are identical to the eligibility weights above. The performance bond can decline in amount as performance is met; that is, the performance bond in year 3 is just the weighted-sum of shares won in years 3 to 7.

In the event that the retail access date is postponed the weight for year 1 is adjusted appropriately. For example, if the retail access date were postponed to April 1, 1998, then the weight for year 1 would be 0.75.

C. Simultaneous Ascending Auction Design

The auction format is a simultaneous ascending auction. All shares of load responsibility for all years are bid on simultaneously. In the single-year auction, clearing prices are determined separately by year. Any non-rejected bid for any year can be improved in any round. The auction continues so long as there is bidding in any year.

D. Pay-Your-Bid Pricing

A primary goal of the auction is to determine competitive supply prices for standard offer service. Pay-your-bid pricing in an ascending bid auction best accomplishes this goal. Pay-your-bid pricing works as follows. With each round of bidding the bids are ranked in descending order of discount, and then ascending order of time-stamp, to form the aggregate supply schedule. For example, Figure 1 shows the supply schedule for a particular year based on the following table of bids:

Bidder	Bid Discount	Time-stamp	Shares	Cumulative	
				Shares	Status

3	A	5.0%	10/16/97 09:35:42	20	20	Winning
1	B	4.8%	10/18/97 12:14:25	15	35	Winning
2	C	4.7%	10/16/97 11:51:45	25	60	Winning
4	D	4.3%	10/17/97 14:21:52	20	80	Winning
4	E	4.0%	10/19/97 10:02:47	30	110	Rationed
2	F	4.0%	10/19/97 13:12:45	40	150	Losing
1	G	3.5%	10/19/97 13:47:20	15	165	Losing
3	H	3.2%	10/19/97 13:14:06	20	185	Losing
1	I	3.2%	10/19/97 13:36:42	15	200	Losing

Starting with the largest discount, bids are designated as winning bids until the cumulative shares reaches 100. All other bids are designated losing bids. The lowest-winning bid (bid E) defines the clearing discount d^* . After the final round of bidding, all winning bids are awarded at the discounts bid – that is, the winning bidders receive the share of the load they bid for at the discounts bid. The example in Figure 1 illustrates two details. First, ties are broken by the time-stamp of the bid. Bids E and F are tied in discount (4%); however, bid E has an earlier time-stamp and thus has higher priority.² Second, in the event the marginal bid crosses beyond the 100-share point, then the bid is only partially filled and is designated as a rationed bid. For example, bid E, the marginal bid, extends the cumulative shares to 110; hence, the bid is reduced by 10 (20 of the 30 shares are won). At most one bid is rationed.

E. Activity Rule Based on Revealed Preference

A basic element of the simultaneous ascending auction is the activity rule, which promotes sincere bidding. The rule is based on the principle of revealed preference: a bidder's refusal to improve a previous clearing price is presumptive evidence that it cannot do so profitably. This principle is represented here by the Rejection Rule, which permanently rejects a bid that fails to improve the previous clearing price.

1. An Illustration of the Activity Rules

In every round, each bidder tenders a bid schedule, which is a bundle of bids or steps. Each step consists of a discount for a specified quantity of shares of the load responsibility in a particular year. The table below gives the four bid schedules from our prior example. Bidder 1's bid schedule has three steps: a 4.8% discount for 15 shares, a 3.5% discount for 15 shares and a 3.2% discount for 15 shares. At the conclusion of each round, steps are designated as winning or losing, depending on whether the discount is above or below the clearing discount. Steps at the clearing discount are ordered by the time-stamp (earliest first) and are designated winning, so long as the cumulative shares is less than or equal to 100. The next step is rationed, unless the cumulative winning shares is exactly 100, in which case there is no rationed step. The rationed step (step E in our example) is split into two parts: a winning step (EW), which increases the cumulative total to exactly 100, and a losing step (EL). All remaining steps at the clearing price (step F) are designated losing.

Bidder	Bid	Discount	Time-stamp	Cumulative		Status
				Shares	Shares	
1	B	4.8%	10/18/97 12:14:25	15	35	Winning
1	G	3.5%	10/19/97 13:47:20	15	165	Losing
1	I	3.2%	10/19/97 13:36:42	15	200	Rejected

² Notice that the time-stamps occur over several days. This is because the bids were submitted over several rounds of bidding. When a bidder improves a bid on its bid schedule, only the time-stamp for the revised bid is updated. All other bids retain the original time-stamp.

2	C	4.7%	10/16/97 11:51:45	25	60	Winning
2	F	4.0%	10/19/97 13:12:45	40	150	Losing
3	A	5.0%	10/16/97 09:35:42	20	20	Winning
3	H	3.2%	10/19/97 13:14:06	20	185	Rejected
4	D	4.3%	10/17/97 14:21:52	20	80	Winning
4	E	4.0%	10/19/97 10:02:47	30	110	Rationed
Bid E is split as follows:						
4	EW	4.0%	10/19/97 10:02:47	20	100	Winning
4	EL	4.0%	10/19/97 10:02:47	10	110	Losing

The revision rule has four parts. In each round after the first, for each step of the bid schedule:

1. The discount cannot be decreased.
2. A step can be split into two or more steps with total shares equal to the original step.
3. The discount can be increased only if the new discount is more than the clearing discount in the previous round by at least the minimum bid increment. We say in this case that the new discount “improves” the previous clearing discount.
4. Steps designated as losing in the prior round that do not improve the previous clearing discount are rejected and can never be improved.

Part 1 is a fundamental requirement for a competitive auction. Part 2 gives bidders the flexibility to improve a portion of a step. Part 3's requirement that a discount change improves the clearing discount eliminates extraneous revisions. A minimum increment averts stalling the auction.

Part 4 is the key provision. To see how this works, suppose in our example that the clearing price in the prior round was 3.5% and that the minimum bid increment is 0.5%. Then since steps H and I were losing steps in the prior round and they were not improved, they are rejected. This means that they are permanently deleted from the bidders' schedules and so cannot be improved in any subsequent round. All other steps were either winning steps in the prior round or improved this round.

The motivation for Part 4 is as follows. In the current round, Bidder 3 failed to improve its losing step H. This is taken as *de facto* evidence that it cannot profitably improve the step with a 4% bid (0.5% above the prior clearing discount). Hence, the step is permanently rejected, since Part 1 assures that discounts can only increase.

The effect of Part 4 is to reject any part of a supplier's bid schedule for which there is presumptive evidence that its cost exceeds the clearing discount. Part 3 prevents a supplier from profiting by withholding supply until the final round.

2. Detailed Activity Rules

This subsection describes the complete set of procedural rules.

The activity rules apply separately for each step on the bid schedule. Each step is a binding bid that remains in force until it is improved or rejected. An improved step replaces the prior step. Except for those rejected or improved, all steps continue in force for the next round. At the close of the auction, those steps with discounts below the clearing discount are rejected, with ties at the clearing discount resolved by the Rationing Rule. The remaining steps are accepted, and each becomes automatically a binding contract for the bid share at the discount bid. This contract is an obligation for serving the

specified share of the standard offer load under the terms of a pre-defined and agreed upon power supply contract.

The Eligibility Rule specifies the deposit required for a desired level of eligibility.

Eligibility Rule: The bid deposit, due by the Final Qualification date, determines a bidder's maximum eligibility. A deposit of \$50,000 per share of eligibility is required. Shares are weighted by year as follows:

Year	1	2	3	4	5	6	7
Calendar Year	1998	1999	2000	2001	2002	2003	2004
Weight	1.00	0.86	0.71	0.57	0.43	0.29	0.14

The opening rule requires that all new bids must be received early in the auction. In the full-term auction, the bids must be received in the initial round. In the single-year auction, all new bids must be received in the first four rounds. This gives the bidders the flexibility to balance their activity across the years in response to the bids of the others. For example, during the fourth round, a bidder may place most of its new bids on year 2, because of a shortage of bids in that year. However, once bids are placed, the bidders cannot shift bids across years. This is to prevent a bidder from placing a large bid for year 1, say, and then shifting it to year 7 near the end of the auction, causing a large disturbance to prices.

Opening Rule: A new step in the bid schedule can be submitted only in the first round in the full-term auction, and in the first four rounds in the single-year auction.

In the single-year auction, a bidder must submit bids totaling at least 25% of eligibility in the first round, 50% in the second round, 75% in the third round, and 100% in the fourth round. Failure to maintain these activity levels results in a corresponding reduction in eligibility. For example, if a bidder has eligibility to bid on 100 shares, but only bids on 20 in the first round, then its eligibility is reduced 5 shares (25 – 20).

In each later round the only bids allowed are improvements of ones submitted in the first round of the full-term auction or the first four rounds of the single-year auction. This rule ensures that the maximum supply in each yearly market is revealed by the fifth round. This rule is essential for effective price discovery; otherwise a bidder could wait until the final round to submit its first bids.

Next we describe the Sorting, Rationing, Rejection, and Revision rules.

Sorting Rule: All steps that are not rejected are automatically carried over to the current round. The steps are sorted in decreasing order by discount, and then in increasing order by time-stamp (equivalent bids are taken on a first-come first-served basis). Steps are designated as winners, until the cumulative shares exceed 100. (If the total shares bid is less than or equal to 100, then all steps are designated as winners; no steps are rationed or rejected.) The next step is rationed as follows:

Rationing Rule: The first step with cumulative shares greater than 100 is split into two steps: a winning step with shares so that cumulative shares is exactly 100 and a losing step for the remaining shares of the step. All later steps are losing steps.

In each round after the first:

Rejection Rule: A losing step from the prior round is rejected after the current round if its discount is not improved (i.e. its discount is not raised above the previous round's clearing discount by the minimum bid increment). Rejected steps are permanently removed from the bidder's bid schedule.

The Rejection Rule is based on the inference that refusal to improve the previous clearing discount signals that the improved discount would not be profitable. The restriction that rejected steps cannot be improved is essential to reliable price discovery. Otherwise, a supplier could wait until the last round to

improve steps, and in the meantime other bidders would be getting no information about higher discounts the supplier might be willing to bid. Thus, each discount that is below the clearing discount in one round must be revised in the next round lest it thereafter be permanently rejected.

Revision Rule: A step can be divided into two or more steps with total shares equal to the initial step. A step can be revised only by improving the previous clearing discount. That is, the revised step must bid a new discount that is more than the previous clearing discount by at least the specified minimum bid increment.

Thus, a losing step for 25 shares can be revised by breaking it into two steps, say for 10 and 15 shares. Then, the bidder can improve the previous clearing discount on just one of the steps. In this case, the second step is rejected. Alternatively, the bidder can improve both steps at different discounts, in which case neither step is rejected.

Closing Rule: The full-term auction ends when a round goes by without any improvements. In the single-year auction, all the yearly markets stay open until a round goes by with no improvements in any market. Hence, all markets close simultaneously.

F. Minimum Initial Bids and Minimum Bid Increments

The minimum initial bid is 0%. The minimum bid increments are stated before each round of bidding. Different years may have different minimum bid increments in the single-year auction. Typically, the increments decrease later in the auction; however, it is unlikely that an increment would ever drop below ½% in any year. The auctioneer intends to use the following increments, but these may change at the discretion of the auctioneer:

Minimum Bid Increment	Full-Term	Years 1 and 2	Years 3 to 7
Early in the Auction	1%	1%	2%
Late in the Auction	½%	½%	1%