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# ERCOT Methodologies for Determining Ancillary Service Requirements

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## **Executive Summary**

### **Introduction**

ERCOT Protocol 3.16(2) requires that methodologies for determining the amounts of Ancillary Services to be required by ERCOT must be developed at least annually. Protocol 3.16(3) requires approval of this methodology by the ERCOT Board of Directors.

This document discusses the various Ancillary Services for which requirements are to be developed. Further, detailed methodologies for determining those requirements are ~~attached~~ included as part of this document.

The approach taken is ~~to summarize the details that are built into the operations systems purchased for the purpose of implementing the operations requirements of ERCOT Protocols and~~ to provide the individual procedures that ERCOT will use for those services whose quantity requirements are not determined within the operations systems.

### **Overview of ERCOT AS Methodology**

Methodologies are required for the determination of the quantities of Regulation Service (RGS) and Non Spinning Reserve Service (NSRS) that are required to maintain system reliability. Those procedures are discussed below.

The ERCOT Nodal Operating Guides establish a minimum requirement of 2300 MW of Responsive Reserve Service (RRS). This quantity will be increased for hour ending 0700 to hour ending 2200 by linking the amount of RRS to a day-ahead forecast of the Reserve Discount Factor (RDF) until it is determined that a change is appropriate. At that time, the changed methodology will be developed and presented to ERCOT TAC and the ERCOT Board for approval.

These procedures are only intended for determining AS requirements for the upcoming month and will be performed prior to the 20<sup>th</sup> of each month. For any additional months in which ERCOT is required to provide an AS requirement forecast, the forecasted requirement will be set to the historical requirement for the same month of the previous year.

### **Regulation Service (RGS) Requirement**

ERCOT has developed a procedure for determination of the base requirement for Regulation Service. The base requirement will be calculated as follows:

Calculate the 98.8 percentile of the 5 minute net load (load-wind) changes during the 30 days prior to the time of the study and for the same month of the previous year by hour. Also, calculate the 98.8 percentile of the up and down Regulation Service deployed during the 30 days prior to the time of study and for the same month of the previous year by hour. ~~Lastly, take the~~

~~Regulation Service requirements from the same month of the previous year and divide them by 2.~~ These results will be used to calculate the amount of Regulation Service required by hour to provide an adequate supply of Regulation Service capability 98.8% of the time.

ERCOT will calculate the increased amount of wind penetration each month and utilize tables provided by GE in their final report to ERCOT in the computation of Regulation Service requirements. The tables indicate additional MWs to add to the regulation requirements per 1000 MWs of increase in wind generation.

If it is determined that during the course of the 30 days prior to the time of the study that the ERCOT average CPS1 score was less than 100%, additional Regulation Up and Down will be procured for hours in which the CPS1 score was less than 100% ~~in the previous month.~~

Each month ERCOT will perform a back-cast of last month's actual exhaustion rate. If the exhaustion rate exceeded 1.2% in any given hour, ERCOT will determine the amount of increase necessary to achieve an exhaustion rate of 1.2 % for that hour.

### **Non-Spinning Reserve Service (NSRS) Requirements**

The GE final report to ERCOT indicated that wind generation could be treated as negative load. The report went on to describe Load minus wind generation as Net Load. The impact of Net Load on the system was the basis for the analysis performed by GE. Net Load cannot be forecasted but Load and wind generation can be forecasted independently and then combined. The combination of Load forecast uncertainty and Wind forecast uncertainty on the system, creates operational risks that have to be mitigated through ancillary services and/or manual instructions taken by the ERCOT operators. ERCOT will calculate the historical Net Load by subtracting the actual wind generation from the actual Load. The historical Net Load will then be compared to the Load and wind generation forecasts to determine the historical accuracy observed in forecasting. ERCOT will then compute the amount of NSRS that is required to ensure that the combination of NSRS procured plus the average amount of Regulation Up procured will result in a total capacity that is larger than or equal to 95 percent of the uncertainties observed in the Net Load accuracy evaluation. In the determination of the requirements, ERCOT will also consider the size of the largest unit. This is intended to cover exposure to the loss of the largest unit during periods of higher risk.

### **Responsive Reserve (RRS) Requirement**

Responsive Reserves are resources ERCOT maintains to restore the frequency of the ERCOT System within the first few minutes of an event that causes a significant deviation from the standard frequency. The ERCOT Operating Guides set the minimum RRS requirement at 2300 MW for all hours under normal conditions. The Operating Guides allow ERCOT to increase that requirement under extreme conditions.

## **Regulation Service (RGS) Requirement Details**

### **Introduction**

Regulation Service consists of resources that can be deployed by ERCOT in response to changes in ERCOT System frequency to maintain the target ERCOT System frequency within predetermined limits according to the Operating Guides. ERCOT is required to evaluate normal requirements for Regulation Service – Up (regulation up) and Regulation Service – Down (regulation down) on an annual basis. It is ERCOT's intent to use historical rates of Regulation Service usage to perform this evaluation. Regulation Service is deployed in order to correct actual frequency to scheduled frequency. This normal Regulation Service requirement may be increased by a multiple of two (2) during projected severe stress conditions such as forecasted extreme weather days.

### **Summary**

To evaluate Regulation Service requirements, ERCOT will collect historical ~~Regulation Service requirements, Resource Asset Registration Form (RARF) information, CPS1 data,~~ Regulation Service deployment data, aggregate wind output data, and ERCOT system load data. This data is used to calculate the Regulation Service requirements with the mathematical expectation that sufficient Regulation Service will be available 98.8% of all periods. This implies that 1.2% of every month ERCOT expects to exhaust available Regulation Service and will perform a back-cast of last month's actual exhaustion rate to determine if this expectation is being met. If the exhaustion rate exceeded 1.2% in any given hour, ERCOT will determine the amount of increase necessary to achieve an exhaustion rate of 1.2% for that hour.

### **Procedure**

Using archived data, ERCOT will calculate the 98.8 percentile of actual Regulation Up and Down Service deployed hourly for the 30 days prior to the time of the study and the same month of the previous year. Additionally, the 98.8 percentile of positive and negative 5 minute net load changes will be calculated for the 30 days prior to the time of the study and the same month of the previous year. ~~ERCOT will also look at the Regulation Service requirement for the same month of the previous year and divide the requirements by 2. The division by 2 is intended to account for the fact that Regulation Service is moving from a 10 minute product to a 5 minute product in the Nodal Market.~~ In order to consider the increased amount of wind penetration, ERCOT will calculate the increase in installed wind generation capacity and then, depending on the month of the year and the hour of the day, will add incremental MWs to the values determined using data from the previous year. The tables of Incremental MWs for Regulation Up and Down come from the Appendix of GE's final report to ERCOT and contain additional MWs for every 1000 MW increase in wind capacity. The increase in wind capacity will be calculated by taken the total nameplate capacity of wind resources in the ERCOT network model at the time of the procurement study and subtracting out the total nameplate capacity of wind resources in the ERCOT model at the end of the month being studied from the previous year.

For determining the base Regulation Up Service requirements, ERCOT will take the largest of the 98.8 percentile of the Regulation Up Service deployments over the last 30 days, the 98.8

~~percentile of the Regulation Up Service deployments for the same month of the previous year, the 98.8 percentile of the positive net load changes over the last 30 days, and the 98.8 percentile of the positive net load changes for the same month of the previous year, and half the requirement for the same month of the previous year.~~ For determining the base Regulation Down Service requirements, ERCOT will take the largest of the 98.8 percentile of the Regulation Down Service deployments over the last 30 days, the 98.8 percentile of the Regulation Down Service deployments for the same month of the previous year, the 98.8 percentile of the negative net load changes over the last 30 days, and the 98.8 percentile of the negative net load changes for the same month of the previous year,~~and half the requirement for the same month of the previous year.~~ In both cases, the calculation will be done separately for each hour. These Regulation Service requirements may be increased for hours in which the desired 1.2% exhaustion rate is exceeded.

~~It should be pointed out that for the first two months following the transition to the Nodal Market, Regulation Service deployments from the last 30 days will not be used in determining these requirements.~~

During the 0600 & 2200 time periods, large schedule changes typically occur, related to 16 hour block energy sale products. Because of these large energy swings, ERCOT often finds its maximum deployment rate of Regulation Service insufficient to control frequency<sup>1</sup>. During these times, ERCOT may see the need for extra Regulation Service to be available to cover the amount needed to respond to such large schedule changes. ERCOT may also include historic deployment of Responsive Reserve as a part of Regulation Service deployment in this analysis.

Additionally, if it is determined that during the course of the 30 days prior to the time of the study that the ERCOT average CPS1 score was less than 100%, ERCOT will procure an extra 10% of both Regulation Up and Down for hours of the day during the upcoming month in which the CPS1 score was less than 100%. This value will increase to 20% if the CPS1 score for the previous month falls below 90%. These additional reserves will assist ERCOT in ensuring that NERC requirements are met.

ERCOT will post these requirements as required by the Protocols.

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<sup>1</sup> The restrictions are specified in protocol section 8.1.1.4.1(1) which states “ERCOT shall limit the deployment of Regulation Service of each QSE for each LFC cycle equal to 125% of the total amount of Regulation Service in the ERCOT System divided by the number of control cycles in five minutes.”

**Incremental MW Adjustment to Prior-Year Up-Regulation Value, per 1000 MW of Incremental Wind Generation Capacity, to Account for Wind Capacity Growth**

Month	Hour Ending																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
<b>Jan.</b>	2.8	4.2	3.1	3.7	2.5	0.4	2.3	2.2	4.2	5.9	7.6	5.7	4.7	3.3	2.8	2.3	4.0	8.6	4.2	2.7	1.6	2.7	1.4	1.6
<b>Feb.</b>	3.6	4.0	2.9	2.9	1.5	1.8	5.2	3.5	4.9	6.0	5.1	5.2	5.3	4.2	4.3	3.5	3.8	8.6	5.5	1.9	1.4	3.1	1.9	2.2
<b>Mar.</b>	5.5	5.3	4.6	4.2	2.6	3.3	7.1	7.9	6.8	5.7	4.2	3.4	2.8	2.6	2.7	2.3	2.9	7.7	6.8	2.1	1.1	3.0	1.5	2.8
<b>Apr.</b>	3.1	3.6	5.0	4.0	2.4	2.5	8.5	11.6	10.0	5.6	4.2	3.4	3.2	2.5	2.1	2.1	3.5	9.2	8.2	4.1	1.0	0.8	0.0	1.4
<b>May</b>	3.6	3.3	4.3	4.3	4.2	3.3	8.7	8.8	8.1	5.7	6.0	4.4	3.6	3.8	3.9	4.2	4.7	11.6	5.9	0.6	0.0	1.0	1.4	2.5
<b>Jun.</b>	2.3	2.6	3.3	3.7	3.9	2.4	8.5	8.2	6.6	4.5	4.2	3.1	2.5	2.5	0.7	0.2	1.3	7.5	3.3	1.7	0.7	0.3	0.6	1.3
<b>Jul.</b>	1.0	2.8	4.4	3.7	3.0	3.2	11.2	10.2	6.5	5.3	3.3	2.2	1.4	0.4	-0.9	-1.3	0.3	3.4	0.9	1.1	0.1	0.0	1.0	1.2
<b>Aug.</b>	1.4	3.8	4.5	4.5	2.2	0.9	6.3	6.8	6.6	6.6	3.2	2.6	2.1	1.2	1.4	1.3	1.3	4.6	1.2	0.9	0.7	0.8	1.1	1.3
<b>Sep.</b>	3.2	4.0	3.7	3.5	1.8	1.9	6.9	7.7	8.3	6.9	3.5	4.8	3.8	2.3	1.6	1.2	3.0	9.2	3.1	0.9	0.1	0.4	0.8	1.9
<b>Oct.</b>	3.4	2.8	2.4	2.2	1.7	1.8	5.0	5.8	6.1	5.9	4.0	5.4	3.2	2.2	1.2	1.7	3.1	6.8	0.8	2.1	0.0	0.2	1.8	2.5
<b>Nov.</b>	2.7	3.2	3.6	3.0	2.2	2.3	4.6	5.3	6.9	6.8	5.1	5.6	4.1	3.7	1.8	1.7	5.8	12.8	4.8	3.8	1.0	1.6	2.2	1.4
<b>Dec.</b>	2.8	2.4	1.4	2.1	1.2	0.4	2.8	2.7	3.8	4.6	6.8	7.0	6.0	4.4	3.3	3.0	5.0	9.9	4.3	2.6	2.1	4.3	2.0	1.5

Incremental MW Adjustment to Prior-Year Down-Regulation Value, per 1000 MW of Incremental Wind Generation Capacity, to Account for Wind Capacity Growth																								
Hour Ending																								
Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
<b>Jan.</b>	1.2	1.7	2.2	2.9	2.5	1.0	0.8	2.5	-0.2	-0.5	-0.2	2.4	4.0	3.6	4.0	3.5	2.7	5.1	7.8	10.4	8.4	5.2	5.2	3.6
<b>Feb.</b>	2.7	3.6	3.8	4.4	3.3	1.7	0.5	2.5	2.0	2.3	2.1	2.3	2.8	3.7	3.7	2.6	2.3	6.9	7.2	10.0	11.0	7.3	7.1	4.7
<b>Mar.</b>	2.9	3.8	3.1	2.3	2.2	2.2	1.9	0.9	0.4	3.7	4.0	2.1	1.6	2.3	3.2	3.9	3.2	6.1	6.1	8.3	9.5	6.5	5.2	3.6
<b>Apr.</b>	4.3	4.5	3.4	3.0	4.1	2.8	2.4	1.3	0.6	2.9	4.5	3.3	1.4	2.5	4.1	4.5	4.5	7.3	7.3	10.7	9.5	7.4	5.1	3.0
<b>May</b>	3.0	1.6	2.3	1.7	0.4	-0.2	0.4	0.5	1.1	2.4	3.5	3.1	1.8	2.7	2.6	2.5	3.8	8.7	7.5	11.1	9.7	8.2	5.8	3.7
<b>Jun.</b>	1.4	0.1	1.7	2.0	0.5	-0.7	-1.2	-0.7	-0.2	0.0	0.7	0.9	1.9	2.8	2.9	2.8	3.6	11.0	8.4	7.7	6.5	5.8	4.2	2.7
<b>Jul.</b>	2.6	1.5	0.7	-0.3	-0.6	-0.7	-1.0	-0.5	-0.5	-0.7	0.0	0.7	1.7	2.3	2.7	3.1	2.7	8.0	9.2	8.7	6.1	5.5	4.7	2.6
<b>Aug.</b>	2.0	1.7	1.0	0.6	0.3	-0.9	0.0	0.3	-0.2	-0.1	0.7	1.0	1.5	1.9	2.7	4.1	3.6	4.7	5.6	7.2	5.0	5.4	5.1	2.7
<b>Sep.</b>	1.5	2.2	0.8	-0.4	-0.6	-1.4	-0.8	-0.4	-0.6	0.4	1.0	0.9	1.4	1.5	2.4	2.7	3.3	7.2	5.2	7.2	6.9	6.5	6.3	4.1
<b>Oct.</b>	2.4	4.0	2.0	0.6	0.1	-0.3	-0.2	0.3	0.0	1.5	2.6	2.4	2.6	2.0	2.3	3.0	4.3	9.0	6.8	8.6	6.8	4.6	4.2	2.3
<b>Nov.</b>	1.8	2.7	2.6	1.9	0.7	1.0	1.5	1.2	-0.6	1.5	2.1	2.0	2.2	1.5	1.8	3.5	4.7	6.8	10.4	14.1	9.5	5.7	4.1	1.7
<b>Dec.</b>	2.9	3.2	2.8	2.6	2.2	1.9	2.6	2.9	-0.8	-0.6	-0.4	1.3	1.8	1.4	2.6	3.5	3.2	3.1	7.9	11.8	7.9	4.2	3.9	3.4

## **Non-Spinning Reserve Service (NSRS) Requirement Details**

### **Introduction**

Non-Spinning Reserve Service (NSRS) consists of Generation Resources capable of being ramped to a specified output level within thirty (30) minutes or Load Resources that are capable of being interrupted within thirty (30) minutes and that are capable of running (or being interrupted) at a specified output level for at least one (1) hour. NSRS may be deployed to replace loss of generating capacity, to compensate for load forecast and/or wind forecast uncertainty on days in which large amounts of reserve are not available online or when there is a limited amount of capacity available for Security-Constrained Economic Dispatch (SCED).

### **Summary**

ERCOT will determine the 95<sup>th</sup> percentile of the observed hourly Net Load uncertainty from the previous 30 days from when the study is performed and from the same month of the previous year. Net Load is defined as the ERCOT load minus the estimated total output from WGRs. The estimated total output from WGRs considers what the total WGR output most likely would have been if the QSEs had not been given deployments to move their resources down. The forecast of Net Load is computed by subtracting the ~~aggregate WGR planned MWs in the Resource Plans or~~ aggregate WGR High Sustained Limits (HSLs) in the Current Operating Plans (COPs) from the Mid-term Load Forecast (MTLF). The COPs/~~Resource Plans~~ and MTLF used are the updated values as of ~~1600 in the day-ahead~~ midnight at the beginning of the Operating Day. The Net Load uncertainty is then defined as the difference between the Net Load and the forecasted Net Load. ERCOT will subtract the Regulation Up requirement from the calculated 95<sup>th</sup> percentile value to determine the amount NSRS to purchase during each hour of the day for the upcoming month.

ERCOT will purchase NSRS such that the combination of NSRS and Regulation Up Services cover 95% of the calculated uncertainties from the Net Load performance analysis. For on-peak hours (hours ending 7 through 22), ERCOT will also set a floor on the NSRS requirement equal to the largest unit.

### **Procedure**

The days that are used for analysis are the last 30 days prior to the study and the days from the same month in the previous year. For the purpose of determining the amount of NSRS to purchase for each hour of the day during the upcoming month, hours will be placed into four (4) hour blocks. The 95<sup>th</sup> percentile of the Net Load uncertainty for the analyzed days for all hours which are considered to be part of a four (4) hour block will be calculated. The same calculation will be done separately for each block. ERCOT will then calculate the average Regulation Up requirement for each four (4) block, separately, for the upcoming month. The NSRS requirement for the upcoming month for each block is calculated as the 95<sup>th</sup> percentile calculation for that block minus the average Regulation Up requirement during the same block of hours.



Additionally, the average uncertainty in the net load forecast will be calculated using the same days of study and four (4) hour blocks. If it is determined that the net load forecast on average over-forecast~~eds~~ the observed net load for a four (4) hour block, then that average uncertainty will be added back to the NSRS requirement value calculated using just the percentile method described in the paragraph above. The calculated average uncertainty value for each block will be adjusted such that the sum of the two values does not exceed 2000. ~~This and ERCOT~~ will place a cap of 2000 MW on the NSRS requirement. ~~The is same~~ adjusted average uncertainty value will not be set to a value less than 0 and will also be subtracted from the ERCOT load forecasts during the month for the sets of hours to which it applies.

After this analysis has been completed, ERCOT will apply a floor on the final NSRS requirement equal to the largest unit. This floor will only be applied to on-peak hours, which are hour ending 7 through 22.

ERCOT will post these requirements as required by the Protocols.

## Discussion

Historically, the need for NSRS has occurred during hot weather, during cold weather, during unexpected changes in weather, or during large unit trips when large amounts of spinning reserve have not been on line (spinning reserve in this document represents un-deployed online generation capacity). The increasing level of wind penetration has resulted in an increased level of operational risk. Wind output tends to be higher during off-peak hours when the system load is less and introduces a risk of decreasing output while the load demand is increasing. The periods when load is increasing and wind generation is decreasing requires other generation resources to increase output or come online quickly to compensate for the sudden Net Load increase. The risk of Net Load increases that are not forecasted exists for all hours of the day.

While Net Load analysis may cover reserves required for forecast uncertainty, it may not necessarily cover exposure to the loss of generation. Due to this risk, it may be necessary for ERCOT to have reserves available during high risk hours even if the forecast analysis does not indicate a need for NSRS to protect against forecast uncertainty.

Examples of circumstances when NSRS has been used are:

- Across peak hours during spring and fall months when hotter than expected weather with large amounts of capacity offline resulted in EE~~ACP~~ events~~;-~~
- Afternoons during Summer seasons when high loads and unit outages outstripped the capability of base load and normal cyclic units~~;-~~
- Cold weather events when early morning load pickup outpaced the ability of generation to follow~~;-~~
- Major unit trips when large amounts of spinning reserve were not online~~;- and-~~
- During periods when the wind generation ~~is~~ decreased~~ing~~ and load demand ~~is~~ increased~~ing~~.

### **Responsive Reserve Service (RRS) Requirement Details**

The ERCOT Operating Guides set the minimum RRS requirement at 2300 MW for all hours under normal conditions. The Operating Guides allow ERCOT to increase that requirement under extreme conditions. ERCOT will increase the amount of RRS purchased for Hour Ending 0700 through Hour Ending 2200 by linking the amount of RRS to a day-ahead forecast of the RDF. ERCOT will use the higher of the hourly forecast temperature for North Central or the Coastal weather zone to predict the amount of RDF to apply in real-time. For each hour in which the RDF is projected to be greater than 2%, ERCOT will adjust the Day-Ahead hourly RRS obligation upward by 100 MW per percentage point. ERCOT will not adjust the RRS requirement below the minimum RRS requirement set forth in the ERCOT Operating Guides nor greater than 500 MW more than the minimum RRS requirement in the ERCOT Operating Guides. The 2300 MW requirement was derived based on studies done in the past to determine the amount of Responsive Reserve that might be required to prevent the shedding of firm load upon the simultaneous loss of the two largest Generation Resources in the ERCOT Region.

One type of Responsive Reserve is Interruptible Responsive Reserve. Interruptible Responsive Reserve is provided by Load Resources that are automatically interrupted when system frequency decreases to 59.7 Hz. The total amount of the Resources procured for RRS during any given hour will be limited to 50% of the RRS requirement for that hour. The limit therefore will range between 1150 MW and 1400 MW. The ERCOT Protocols state, “[t]he amount of Resources on high-set under-frequency relays providing RRS will be limited to 50% of the total ERCOT RRS requirement. ERCOT may reduce this limit if it believes that this amount will have a negative impact on reliability or if this limit would require additional Regulation Service to be deployed.”

Self arranged RRS used to fulfill a QSE’s RRS requirement will be limited to 50% from Load Resources excluding Controllable Load Resources.

If the percentage level for Load Resources, excluding Controllable Load Resources, specified in the Protocols is changed, that change will be reflected in these requirements.