Date: April 1, 2014
To: Board of Directors
From: John Dumas, Director Wholesale Market Operations
Subject: Other Binding Document, Methodology for Implementing Operating Reserve Demand Curve (ORDC) to Calculate Real-Time Reserve Price Adder

Issue for the ERCOT Board of Directors

ERCOT Board of Directors Meeting Date: April 8, 2014
Agenda Item No.: 7.2

Issue:

Whether the ERCOT Board of Directors (Board) should approve revisions to the Methodology for Implementing Operating Reserve Demand Curve (ORDC) to Calculate Real-Time Reserve Price Adder consistent with ERCOT Staff's recommendation.

Background/History:

On February 12, 2014, ERCOT submitted Nodal Protocol Revision Request (NPRR) 598, Clarify Inputs to PRC and ORDC. As Attachment 1 to this NPRR submission, ERCOT proposed revisions to the Other Binding Document, Methodology for Implementing Operating Reserve Demand Curve (ORDC) to Calculate Real-Time Reserve Price Adder (Methodology). NPRR598 and the proposed revisions to the Methodology align the inputs to Physical Responsive Capability (PRC) and ORDC; stipulate the treatment of Off-Line capacity during scarcity conditions; remove STARTUP and SHUTDOWN status from PRC and ORDC calculations; set Real-Time Off-Line available reserves used in the ORDC calculation to zero when Security-Constrained Economic Dispatch (SCED) snapshot of the PRC becomes less than or equal to 2,300 MW, which is the PRC MW at which Energy Emergency Alert (EEA) Level 1 is initiated; and change the Load Resource Responsive Reserve (RRS) schedule used in ORDC.

At its February 27, 2014 meeting, the Technical Advisory Committee (TAC) unanimously voted to recommend approval of the Methodology as amended by the 2/25/14 ERCOT comments - Attachment 1. After additional sets of comments were submitted, TAC again considered the Methodology at its March 27, 2014 meeting and unanimously voted to file comments to endorse the 3/26/14 ERCOT Comments – Attachment 1.

Subsequent to TAC's endorsement of the 3/26/14 ERCOT Comments – Attachment 1, ERCOT discovered that the discount factor was incorrectly applied, and submitted the 3/31/14 ERCOT Comments – Attachment 1. Due to the timing of the 3/31/14 ERCOT comments – Attachment 1, TAC will not have an opportunity to review these comments prior to Board consideration. However, a Resource Adequacy Task Force (RATF) meeting is scheduled for April 4, 2014 to review the 3/31/14 ERCOT comments – Attachment 1. The full set of proposed revisions to the Methodology as recommended by ERCOT Staff are shown in redline in Attachment A hereto.

Key Factors Influencing Issue:

At its March 27, 2014 meeting, TAC unanimously voted to endorse the revisions to the Methodology set forth in the 3/26/14 ERCOT Comments – Attachment 1. The additional revisions proposed in the 3/31/14 ERCOT Comments – Attachment 1 correct the application of the discount factor consistent with the analysis previously presented to RATF.

Conclusion/Recommendation:

ERCOT Staff recommends that the Board approve revision of the Methodology for Implementing Operating Reserve Demand Curve (ORDC) to Calculate Real-Time Reserve Price Adder consistent with ERCOT Staff's recommendation as set forth in Attachment A.

ELECTRIC RELIABILITY COUNCIL OF TEXAS, INC.
BOARD OF DIRECTORS RESOLUTION

WHEREAS, after due consideration of the alternatives, the Board of Directors (Board) of Electric Reliability Council of Texas, Inc. (ERCOT) deems it desirable and in the best interest of ERCOT to modify the Methodology for Implementing Operating Reserve Demand Curve (ORDC) to Calculate Real-Time Reserve Price Adder;

THEREFORE, BE IT RESOLVED, that the Methodology for Implementing Operating Reserve Demand Curve (ORDC) to Calculate Real-Time Reserve Price Adder is hereby modified to reflect the changes set forth in Attachment A to this Resolution.

CORPORATE SECRETARY'S CERTIFICATE

I, Vickie G. Leady, Assistant Corporate Secretary of ERCOT, do hereby certify that, at its April 8, 2014 meeting, the ERCOT Board passed a motion approving the above Resolution by _____.

IN WITNESS WHEREOF, I have hereunto set my hand this ___ day of April, 2014.

_____
Vickie G. Leady
Assistant Corporate Secretary

NPRR Comments – Attachment 1

NPRR Number	598	NPRR Title	Clarify Inputs to PRC and ORDC – Attachment 1

Date	March 31, 2014

Submitter's Information	
Name	Resmi Surendran
E-mail Address	Resmi.Surendran@ercot.com
Company	ERCOT
Phone Number	512-248-3033
Cell Number	
Market Segment	Not applicable.

Comments

On 3/27/14, TAC endorsed the 3/26/14 Attachment 1 – ERCOT comments which clarified that the seasonal system wide discount factor will be used in the calculation of On-Line and Off-Line reserves. Subsequent to TAC endorsement, ERCOT discovered that the discount factor was incorrectly applied.

ERCOT submits these comments to provide the following clarification.

The discount factor was applied to ERCOT's original analysis in order to mirror the Physical Responsive Capability (PRC) number that is used by ERCOT Operations. The Resource Adequacy Task Force (RATF) requested that ERCOT also apply the discount factor to Settlements when calculating the reserve imbalance. ERCOT added this calculation to Settlements by applying the discount to the Day-Ahead obligation and the Real-Time reserve calculation so that a participant would not incorrectly receive an imbalance charge.

ERCOT believes RATF's Settlement request was correctly captured; however the logic was inadvertently added to the Real-Time ORDC which causes the ORDC to not mirror the PRC number. These comments make that correction.

There is a Resource Adequacy Task Force (RATF) meeting scheduled for April 4th to review these comments.

NPRR Comments – Attachment 1

Revised Other Binding Document Language

Methodology for Implementing Operating Reserve Demand Curve (ORDC) to Calculate Real-Time Reserve Price Adder

Effective upon implementation of Nodal Protocol Revision Request (NPRR) 568, Real-Time Reserve Price Adder Based on Operating Reserve Demand Curve

Version _0.6

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NPRR Comments – Attachment 1

Document Revisions

Date	Version	Description	Author(s)
09/19/2013	0.1	Initial draft	ERCOT Staff
10/11/2013	0.2	Second draft	ERCOT Staff
11/05/2013	0.3	Third draft	ERCOT Staff
11/06/2013	0.4	Fourth draft	ERCOT Staff
11/07/2013	0.5	Fifth draft	TAC
	0.6	Sixth draft	

NPRR Comments – Attachment 1

PROTOCOL DISCLAIMER

This document describes ERCOT systems and the response of these systems to Market Participant submissions incidental to the conduct of operations in the ERCOT Texas Nodal Market and is not intended to be a substitute for the ERCOT Protocols (available at http://www.ercot.com/mktrules/nprotocols/current), as amended from time to time. If any conflict exists between this document and the Protocols, the Protocols shall control in all respects.

NPRR Comments – Attachment 1

Table of Contents

NPRR Comments – Attachment 1

1. PURPOSE

Protocol Section 6.5.7.3, Security Constrained Economic Dispatch, requires the ERCOT Board to approve ERCOT's methodology for implementing the Operating Reserve Demand Curve (ORDC) to calculate the Real-Time reserve price adders. Additionally, the ERCOT Board must approve the parameters to be used in the methodology.

For each Security-Constrained Economic Dispatch (SCED) process, ERCOT calculates a Real-Time On-Line Reserve Price Adder (RTORPA) and a Real-Time Off-Line Reserve Price Adder (RTOFFPA) based on the On-Line and Off-Line available reserves in the ERCOT System and the ORDC. The On-Line Reserve Price Adder is added to the Real-Time Locational Marginal Prices (LMPs) to determine the Real-Time Settlement Point Prices. The price after the addition of RTORPA to LMPs approximates the pricing outcome of Real-Time energy and Ancillary Service co-optimization since RTORPA captures the value of the opportunity cost of reserves based on the defined ORDC. Additionally, the Real-Time Off-Line Reserve Capacity (RTOFFCAP) shall be administratively set to zero when the SCED snapshot of the Physical Responsive Capability (PRC) is less than or equal to the PRC MW at which Energy Emergency Alert (EEA) Level 1 is initiated. An Ancillary Service imbalance Settlement is done based on Protocol Section 6.7.4, Real-Time Ancillary Service Imbalance Payment or Charge, to make Resources indifferent to the utilization of their capacity for energy or Ancillary Service reserves.

Comment [ERCOT1]: 2300MW

This document describes:

- the ERCOT Board-approved methodology that ERCOT uses for determining the Real-Time reserve price adders based on ORDC.
- the ERCOT Board-approved parameters for determining the Real-Time reserve price adders and effective date.

2. METHODOLOGY FOR IMPLEMENTING ORDC

The maximum price on the PBPC would be set to SWCAP + 1. The Real-Time spot market clearing process uses the SCED application to dispatch Resources and set prices. For each execution of SCED, the System Lambda of the power balance constraint will be determined and the ORDC will be constructed as probability of reserves falling below the minimum contingency level (PBMCL) multiplied by the difference between Value of Lost Load (VOLL) and System Lambda. Since the System Lambda in this equation is not a fixed value and could vary for each SCED execution, the Real-Time ORDC could vary for each SCED execution as well. In short, this approach is needed with the current rules in order to ensure that power balance is given the highest priority. This approach, which uses a modified ORDC for each SCED execution, can result in a reserve price that is near zero and an energy price near SWCAP under scarcity conditions.

Determining the following values is a major part of implementing ORDC to calculate Real-Time Reserve Price Adder:

1. VOLL;
2. PBMCL, defined as the probability of reserves falling below the minimum contingency level; and

3. The Real-Time On-Line Reserve Price Adder (RTORPA) and Real-Time Off-Line Reserve Price Adder (RTOFFPA).

2.1. Determine VOLL

The VOLL is a parameter for implementing the ORDC and shall be approved by ERCOT Board.

2.2. Determine PBMCL

The key part of the concept is the determination of the probability of reserves falling below the minimum contingency level (PBMCL). PBMCL is derived from Loss of Load Probability curve (LOLP),which depends on many factors, including the probability of forced outages, probability of Load forecast error and probability of wind forecast error. It could also be different for different times of the day and for different months of the year. LOLP at a given reserve level can be interpreted as the probability of the occurrence of an event with a magnitude greater than that reserve level. A minimum contingency level (X) is chosen in order to send an appropriate scarcity price signal to maintain reliability and stability of the system. The PBMCL is constructed by shifting the curve to the right by the minimum contingency level (X) amount, since ERCOT is at a higher risk of shedding firm Load when reserves fall near or below the minimum contingency reserve level, and setting the value to one for reserve levels below the minimum contingency level (X). The PBMCL curve for a given reserve level (R) is given as follows:

$$\pi(R) = \begin{cases} LOLP(R - X), & R - X > 0 \\ 1 & , R - X \le 0 \end{cases}$$

LOLP is determined by analyzing historic events defined as the difference between the hour-ahead forecasted reserves with the reserves that were available in Real-Time during the Operating Hour. These events are split into twenty-four groups, comprising of four seasons and six time-of-day blocks per day. These groups are used to determine twenty-four distinct normal probability distributions of the events, which will determine the LOLP for the corresponding season and time block. The detailed logic for determining LOLP is described as below:

1) For each Operating Hour in the study period, calculate the system-wide Hour-Ahead (HA) reserve using the snapshot of last Hourly Reliability Unit Commitment (HRUC) for the Operating Hour (at the end of Adjustment Period):

   HA Reserve = RUC On-Line Gen COP HSL - (RUC Load Forecast + RUC DCTIE Load) + RUC Off-Line Gen COP OFFNS Responsibility + RUC On-Line Load COP Non-Spin Responsibility + RUC On-Line Load COP Reg-Up Responsibility + RUC On-Line Load COP RRS Responsibility + OFF10 from COP + OFF30 from COP

2) For each SCED interval in the study period, calculate the system-wide available SCED reserve using SCED telemetry and solution as:

SCED Reserve = SCED On-Line Gen HSL-SCED Gen Base Point + SCED Off-Line Gen OFFNS Schedule + SCED On-Line Load Telemetry RRS Schedule + SCED On-Line Load Telemetry Reg-Up Responsibility + SCED On-Line Load Telemetry Non-Spin Schedule + OFF10 + OFF30

3) For each Operating Hour in the study period, calculate the hourly average system-wide SCED reserve by averaging the interval SCED reserve in step 2).

4) For each Operating Hour in the study period, calculate the system wide Reserve Error as:

   Reserve Error = HA Reserve – SCED Reserve (Hourly Average)

5) For each Operating Hour in the study period, allocate it to the corresponding season and time block. All the hours will be split into 24 distribution groups developed for the analysis based on the Season and the time of day:

   - 4 Seasons of
     - Winter (Months 12,1, 2),
     - Spring (Months 3,4,5),
     - Summer (Months 6,7,8) and
     - Fall (Months 9,10,11)
   - 6 time-of-day blocks each consisting of 4 hours

6) Calculate the mean (μ) and standard deviation (σ) for each of the twenty-four distinct LOLP distributions using the calculated Reserve Error in step 4). The detail results for 2011 and 2012 are illustrated in Table 1. This hourly error is normally distributed and hence LOLP for a given value reserve level R can be calculated:

$$LOLP(\mu,\sigma,R) = 1 - CDF(\mu,\sigma,R)$$

   Where CDF is the Cumulative Distribution Function of the normal distribution with mean μ and standard deviation σ.

NPRR Comments – Attachment 1

Table 1 LOLP distributions by season and time-of-day block for 2011 and 2012

Season	For Hours	μ	σ
Winter (Month 12, 1, 2)	**1-2 and 23-24**	185.14	1217.89
	3-6	76.28	1253.93
	7-10	136.32	1434.64
	11-14	-218.26	1441.00
	15-18	-53.67	1349.52
	19-22	-183.00	1129.31
Spring (Month 3,4,5)	**1-2 and 23-24**	245.76	1174.61
	3-6	460.41	1313.46
	7-10	348.16	1292.36
	11-14	-491.91	1332.05
	15-18	-253.77	1382.60
	19-22	-436.09	1280.47
Summer (Month 6,7,8)	**1-2 and 23-24**	374.88	1503.97
	3-6	1044.81	1252.25
	7-10	339.01	1679.70
	11-14	-695.94	1251.05
	15-18	-270.54	1284.96
	19-22	-730.33	1331.49
Fall (Month 9, 10,11)	**1-2 and 23-24**	15.90	1044.88
	3-6	478.97	1014.02
	7-10	322.65	1036.07
	11-14	-473.16	1293.83
	15-18	-422.21	1246.49
	19-22	-177.76	1231.14

NPRR Comments – Attachment 1

2.2.1. Calculation of R_S and R_{SNS}

R_S is the reserves from Resources participating in SCED plus the Reg-Up and RRS from Load Resources and validated Real-Time telemetered OFF10 capacity. R_{SNS} is equal to R_S plus the reserves from Resources that are not currently available to SCED but could be available in 30 minutes.

1) R_S is calculated based on SCED telemetry and solution as:

$R_s = RTOLCAP = RTOLHSL – RTBP + RTCLRCAP + RTNCLRRRS - RTOLNSRS$
Where
$RTCLRCAP = RTCLRREG + RTCLRRRS$

[NPRR568: Replace paragraph (1) above with the following upon Phase 2 implementation:]

1) R_S is calculated based on SCED telemetry and solution as:

$R_s = RTOLCAP = RTOLHSL – RTBP + RTCLRCAP + RTNCLRRRS + RTOFF10 - RTOLNSRS$
Where
$RTCLRCAP = RTCLRREG + RTCLRRRS$

Where

- *RTOLCAP* is the system total Real-Time On-Line capacity of all On-Line Resources for the SCED interval.
- *RTOLHSL* is the system total Real-Time telemetered High Sustained Limits (HSLs) for all Generation Resources (excluding Intermittent Renewable Resources (IRRs) other than Wind-powered Generation Resources (WGRs), nuclear Resources, Resources with a telemetered ONTEST, STARTUP, or SHUTDOWN Resource Status, and Resources with telemetered net real power (in MW) less than 95% of their telemetered Low Sustained Limit (LSL)) available to SCED for the SCED interval discounted by the system wide seasonal discount factor. Resources with status ONRR HSL will not be discounted.
- *RTBP* is the system total SCED Base Points for all Generation Resources (excluding all IRRs other than WGRs, other than WGRs Resources with a telemetered ONTEST, STARTUP, or SHUTDOWN Resource Status, and Resources with telemetered net real power (in MW) less than 95% of their telemetered LSL) for the SCED interval.
- *RTCLRCAP* is the system total Real-Time capacity from Controllable Load Resources for the SCED interval. It is the sum of telemetered Real-Time Reg-Up and RRS Ancillary Service Schedules for all Controllable Load Resources.
- *RTNCLRRRS* is the system total validated Real-Time telemetered RRS Ancillary Service Schedule from Load Resources other than Controllable Load Resources for the SCED interval.

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<#>The telemetered OFF10 capacity shall be capped at the ERCOT-calculated maximum MW the Resource can provide in ten minutes based on the Resource asset registration information, COP and telemetry information.¶
<#>For an Off-Line Generation Resource providing OFF10 capacity other than a Combined Cycle Train, ERCOT shall verify the telemetered OFF10 capacity is viable in ten minutes based on the current warmth state and the corresponding start-up time of the Resource. For a Combined Cycle Train providing OFF10 capacity, ERCOT shall verify that the transition from the current configuration to the telemetered configuration providing OFF10 capacity is viable in ten minutes based on the transition times and transition matrix communicated via Resource asset registration information and the warmth state of the current configuration.¶

NPRR Comments – Attachment 1

[NPRR568: Insert the following upon Phase 2 implementation:]

- *RTOFF10* is the system total validated Real-Time reserve capacity available in ten minutes for all Resources for the SCED interval discounted by the system wide seasonal discount factor.
  - The telemetered OFF10 capacity shall be capped at the ERCOT-calculated maximum MW the Resource can provide in ten minutes based on the Resource asset registration information, COP and telemetry information.
  - For an Off-Line Generation Resource providing OFF10 capacity other than a Combined Cycle Train, ERCOT shall verify the telemetered OFF10 capacity is viable in ten minutes based on the current warmth state and the corresponding start-up time of the Resource. For a Combined Cycle Train providing OFF10 capacity, ERCOT shall verify that the transition from the current configuration to the telemetered configuration providing OFF10 capacity is viable in ten minutes based on the transition times and transition matrix communicated via Resource asset registration information and the warmth state of the current configuration.

- *RTOLNSRS* is the system total validated Real-Time telemetered On-Line Non-Spin Ancillary Service Schedule for all On-Line Generation Resources for the SCED interval.
- *RTCLRREG* is the system total validated Real-Time telemetered Reg-Up Ancillary Service Schedules from Controllable Load Resources for the SCED interval.
- *RTCLRRRS* is the system total validated Real-Time telemetered RRS Ancillary Service Schedules from Controllable Load Resources for the SCED interval.
- The seasonal system wide discount factor is calculated based on average seasonal temperature.

[NPRR568: Replace paragraph (1) above with the following upon system implementation of NPRR555:]

1) R_S is calculated based on SCED telemetry and solution as:

$R_s = RTOLCAP = RTOLHSL – RTBP + RTCLRCAP + RTNCLRRRS - RTOLNSRS$

Where
$RTCLRCAP = RTCLRBP – RTCLRLSL – RTCLRNS + RTCLRREG$

[NPRR568: Replace paragraph (1) above with the following upon Phase 2 implementation:]

1) R_S is calculated based on SCED telemetry and solution as:

$R_s = RTOLCAP = RTOLHSL – RTBP + RTCLRCAP + RTNCLRRRS + RTOFF10 - RTOLNSRS$

Where
$RTCLRCAP = RTCLRBP – RTCLRLSL – RTCLRNS + RTCLRREG$

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Where

- *RTOLCAP* is the system total Real-Time On-Line reserve capacity of all On-Line Resources for the SCED interval.
- *RTOLHSL* is the system total Real-Time telemetered High Sustained Limits (HSLs) for all Generation Resources (excluding non-Wind-powered Generation Resource (WGR) Intermittent Renewable Resources (IRRs), Nuclear Resources, Resources with a telemetered ONTEST, STARTUP, or SHUTDOWN Resource Status, and Resources with telemetered net real power (in MW) less than 95% of their telemetered LSL) available to SCED for the SCED interval discounted by the system wide seasonal discount factor. Resources with status ONRR HSL will not be discounted.
- *RTBP* is the system total SCED Base Points for all Generation Resources (excluding all IRRs other than WGRs, nuclear Resources, Resources with a telemetered ONTEST, STARTUP, or SHUTDOWN Resource Status, and Resources with telemetered net real power (in MW) less than 95% of their telemetered LSL) for the SCED interval.
- *RTCLRCAP* is the system total Real-Time capacity from Controllable Load Resources for the SCED interval. It is the sum of SCED Base Points less the telemetered CLR LSL and Non-Spin Schedule for all Controllable Load Resources.
- *RTNCLRRRS* is the system total validated Real-Time telemetered RRS Ancillary Service Schedule from Load Resources other than Controllable Load Resources for the SCED interval.

[NPRR568: Insert the following upon Phase 2 implementation:]

- *RTOFF10* is the system total validated Real-Time reserve capacity available in ten minutes for all Resources for the SCED interval discounted by the system wide seasonal discount factor.
  - The telemetered OFF10 capacity shall be capped at the ERCOT-calculated maximum MW the Resource can provide in ten minutes based on the Resource asset registration information, COP and telemetry information.
  - For an Off-Line Generation Resource providing OFF10 capacity other than a Combined Cycle Train, ERCOT shall verify the telemetered OFF10 capacity is viable in ten minutes based on the current warmth state and the corresponding start-up time of the Resource. For a Combined Cycle Train providing OFF10 capacity, ERCOT shall verify that the transition from the current configuration to the telemetered configuration providing OFF10 capacity is viable in ten minutes based on the transition times and transition matrix communicated via Resource asset registration information and the warmth state of the current configuration.

- *RTOLNSRS* is the system total Real-Time telemetered On-Line Non-Spin Ancillary Service Schedule for all On-Line Generation Resources for the SCED interval.
- *RTCLRBP* is the system total SCED Base Points from Controllable Load Resources for the SCED interval.
- *RTCLRLSL* is the system total Real-Time telemetered LSL from Controllable Load Resources for the SCED interval.

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- *RTCLRREG* is the system total validated capacity from Controllable Load Resources with Primary Frequency Response (not SCED qualified) Regulation-Up Schedule.
- *RTCLRNS* is the system total validated Real-Time telemetered Non-Spin Ancillary Service Schedules from Controllable Load Resources for the SCED interval.
- The seasonal system wide discount factor is calculated based on average seasonal temperature.

2) R_{SNS} is calculated based on SCED telemetry and solution as

R_{sns} = *RTOLCAP + RTOFFCAP*

RTOFFCAP = RTCST30HSL + RTOFFNSHSL + RTNCLRNS + RTCLRNS + RTOLNSRS

[NPRR568: Replace paragraph (2) above with the following upon Phase 2 implementation:]

2) R_{SNS} is calculated based on SCED telemetry and solution as

R_{sns} = *RTOLCAP + RTOFFCAP*

RTOFFCAP = RTOFF30 + RTNCLRNS + RTCLRNS + RTOLNSRS

Where

- *RTOLCAP* is the system total Real-Time On-Line reserve capacity of all On-Line Resources for the SCED interval.
- *RTOFFCAP* is the system total Real-Time Off-Line reserve capacity for the SCED interval.
- *RTCST30HSL* is the system total Real-Time telemetered HSLs of Generation Resources that have telemetered an OFF Resource Status and can be started from a cold temperature state in 30 minutes and discounted by the system wide seasonal discount factor.

[NPRR568: Replace the above bullet (RTCST30HSL) and sub-bullet with the following upon Phase 2 implementation:]

- *RTOFF30* is the system total validated Real-Time reserve capacity available in 30 minutes for all the Resources for the SCED interval discounted by the system wide seasonal discount factor.
  - The telemetered OFF30 capacity shall be capped at the ERCOT-calculated maximum MW the Resource can provide in 30 minutes based on the Resource asset registration information, COP and telemetry information.
  - For an Off-Line Generation Resource providing OFF30 capacity other than a Combined Cycle Train, ERCOT shall verify the telemetered OFF30 capacity is viable in 30 minutes based on the current warmth state and the corresponding start-up time of the Resource. For a Combined Cycle Train providing OFF30 capacity, ERCOT shall verify that the transition from the current configuration to the telemetered configuration providing OFF30 capacity is viable in 30 minutes based on the transition times and transition matrix communicated via the Resource asset

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<#>The telemetered OFF30 capacity shall be capped at the ERCOT-calculated maximum MW the Resource can provide in 30 minutes based on the Resource asset registration information, COP and telemetry information.¶
For an Off-Line Generation Resource providing OFF30 capacity other than a Combined Cycle Train, ERCOT shall verify the telemetered OFF30 capacity is viable in 30 minutes based on the current warmth state and the corresponding start-up time of the Resource. For a Combined Cycle Train providing OFF30 capacity, ERCOT shall verify that the transition from the current configuration to the telemetered configuration providing OFF30 capacity is viable in 30 minutes based on the transition times and transition matrix communicated via the Resource asset registration information and the warmth state of the current configuration.¶
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registration information and the warmth state of the current configuration.

- *RTNCLRNS* is the system total validated Real-Time telemetered Non-Spin Ancillary Service Schedules from Load Resources other than Controllable Load Resources for the SCED interval.
- *RTCLRNS* is the system total validated Real-Time telemetered Non-Spin Ancillary Service Schedules from Controllable Load Resources for the SCED interval.
- *RTOLNSRS* is the system total validated Real-Time telemetered On-Line Non-Spin Ancillary Service Schedule for all On-Line Generation Resources for the SCED interval.
- *RTOFFNSHSL* is the system total telemetered HSLs of Generation Resources that have telemetered an OFFNS Resource Status and discounted by the system wide seasonal discount factor.

[NPRR568: Delete the above bullet (RTOFFNSHLS) upon Phase 2 implementation:]

- The seasonal system wide discount factor is calculated based on average seasonal temperature.

[NPRR568: Replace paragraph (2) above with the following upon system implementation of NPRR555:]

2) R_{SNS} is calculated based on SCED telemetry and solution as:

$R_{sns} = RTOLCAP + RTOFFCAP$

$RTOFFCAP = RTCST30HSL + RTOFFNSHSL + RTCLRNS + RTOLNSRS$

[NPRR568: Replace paragraph (2) above with the following upon Phase 2 implementation:]

2) R_{SNS} is calculated based on SCED telemetry and solution as:

$R_{sns} = RTOLCAP + RTOFFCAP$

$RTOFFCAP = RTOFF30 + RTCLRNS + RTOLNSRS$

Where

- *RTOLCAP* is the system total Real-Time On-Line reserve capacity of all On-Line Resources for the SCED interval.
- *RTOFFCAP* is the system total Real-Time Off-Line reserve capacity for the SCED interval.

RTCST30HSL is the system total Real-Time telemetered HSLs of Generation Resources that have telemetered an OFF Resource Status and can be started from a cold temperature state in 30 minutes and discounted by the system wide seasonal discount factor.

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<#>For an Off-Line Generation Resource providing OFF30 capacity other than a Combined Cycle Train, ERCOT shall verify the telemetered OFF30 capacity is viable in 30 minutes based on the current warmth state and the corresponding start-up time of the Resource. For a Combined Cycle Train providing OFF30 capacity, ERCOT shall verify that the transition from the current configuration to the telemetered configuration providing OFF30 capacity is viable in 30 minutes based on the transition times and transition matrix communicated via the Resource asset registration information and the warmth state of the current configuration.¶

[NPRR568: Replace the above variable (RTCST30HSL) with the following upon Phase 2 implementation:]

- *RTOFF30* is the system total validated Real-Time reserve capacity available in 30 minutes for all the Resources for the SCED interval discounted by the system wide seasonal discount factor.
  - The telemetered OFF30 capacity shall be capped at the ERCOT-calculated maximum MW the Resource can provide in 30 minutes based on the Resource asset registration information, COP and telemetry information.
  - For an Off-Line Generation Resource providing OFF30 capacity other than a Combined Cycle Train, ERCOT shall verify the telemetered OFF30 capacity is viable in 30 minutes based on the current warmth state and the corresponding start-up time of the Resource. For a Combined Cycle Train providing OFF30 capacity, ERCOT shall verify that the transition from the current configuration to the telemetered configuration providing OFF30 capacity is viable in 30 minutes based on the transition times and transition matrix communicated via the Resource asset registration information and the warmth state of the current configuration.

- *RTCLRNS* is the system total validated Real-Time telemetered Non-Spin Ancillary Service Schedules from Controllable Load Resources for the SCED interval.
- *RTOLNSRS* is the system total validated Real-Time telemetered On-Line Non-Spin Ancillary Service Schedule for all On-Line Generation Resources for the SCED interval.
- *RTOFFNSHSL* is the system total telemetered HSLs of Generation Resources that have telemetered an OFFNS Resource Status and discounted by the system wide discount factor

[NPRR568: Remove the following variable RTOFFNSHSL upon Phase 2 implementation:]

- The seasonal system wide discount factor is calculated based on average seasonal temperature.

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Deleted: *RTOFFNSHSL* is the system total telemetered HSLs of Generation Resources that have telemetered an OFFNS Resource Status and discounted by the system wide discount factor.

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2.2.2. Calculation of $\pi_S(R_S)$ and $\pi_{NS}(R_{SNS})$

$\pi_S(R_S)$ and $\pi_{NS}(R_{SNS})$ are functions that describe the PBMCL at various reserve levels.

1) Calculation of Curve $\pi_S(R_S)$:

$\pi_S(R_S)$ is a function of the Real-Time reserves that should be available in the first 30 minutes of the hour and is intended to capture the PBMCL for that level of reserves. The general equation for $\pi_S(R_S)$ is:

$$\pi_S(R_S) = \begin{cases} LOLP_S(R_S - X), & R_S - X > 0 \\ 1, & R_S - X \le 0 \end{cases}$$

Where
- *X* in this equation is a minimum contingency level and represents a level of reserves at which ERCOT may need to begin to shed firm Load.
- $LOLP_S$ is the *LOLP* function for the spinning reserve.

$LOLP_S$ is different from the 60 minutes *LOLP* in Table 1, which is calculated based on the hourly error analysis. The reserves are classified into two categories; those that are being provided by Resources in SCED and Load Resources providing Reg-Up and RRS and those that are being provided by Resources that are not currently available to SCED but could be made available in 30 minutes. Since the first reserve type is available immediately, those reserves are the only ones considered to be available to respond to any event that happens in the first 30 minutes of the hour. All reserve types are then considered to be available to respond to events that happen in the second 30 minutes of the hour. From the hourly error analysis, a mean (μ) and standard deviation (σ) for the 60 minute *LOLP* are determined for each of the different seasons and time blocks. Because the error analysis is hourly, to capture the events within the first 30 minutes for $\pi_S(R_S)$, the μ and σ needs to be scaled to reflect the 30 minute timeframe, with $\delta = 0.5$ hour:

$$\mu' = \delta * \mu = 0.5\mu$$
$$\sigma' = \frac{\delta}{\sqrt{\delta^2 + (1-\delta)^2}} * \sigma = 0.707\sigma$$

So the $LOLP_S$ can be calculated based on the 60 minute *LOLP* as follows:

$$LOLP_S(\mu', \sigma', R) = LOLP(0.5\mu, 0.707\sigma, R) = 1 - CDF(0.5\mu, 0.707\sigma, R)$$

24 $\pi_S(R_S)$ curves are developed based on the season and the time of day.

2) Calculation of Curve $\pi_{NS}(R_{SNS})$:

$\pi_{NS}(R_{SNS})$ is a function of all the Real-Time reserves that can be expected to be available with the hour and is intended to capture the PBMCL for that level of reserves based on events that happen in an hour. The general equation for $\pi_{NS}(R_{SNS})$ is:

$$\pi_{NS}(R_{SNS}) = \begin{cases} LOLP(R_{SNS} - X), & R_{SNS} - X > 0 \\ 1 & , R_{SNS} - X \le 0 \end{cases}$$

This is similar to $\pi_S(R_S)$ but the key differences here are the types of reserves considered and the μ and σ that are used in calculating LOLP
- The total On-Line and Off-Line applies for the full change in net Load over the hour and there is no scaling adjustments needed for μ and σ in the $\pi_{NS}(R_{SNS})$ calculations
- Again, *X* in this equation is a minimum contingency level

Like $\pi_S(R_S)$, twenty-four individual curves are created for $\pi_{NS}(R_{SNS})$.

2.3. Determination of Price Adders (RTORPA and RTOFFPA)

Once PBMCL is determined, the Real-Time On-Line Reserve Price Adder (RTORPA) and Real-Time Off-Line Reserve Price Adder (RTOFFPA) for each SCED interval can be calculated. RTORPA (a.k.a. P_S) and RTOFFPA (a.k.a. P_{NS}) are functions of the PBMCL at various levels of Real-Time reserves, the net value of Load curtailment, and time duration during which the reserves are available. RTORPA and RTOFFPA are determined as follows:

$$RTORPA = P_S = v * 0.5 * \pi_S(R_S) + P_{NS}$$
$$RTOFFPA = P_{NS} = v * (1 - 0.5) * \pi_{NS}(R_{SNS})$$

where

$v = \max(0, VOLL - SystemLambda)$

$R_S = RTOLCAP$

$R_{SNS} = RTOLCAP + RTOFFCAP$

Where *v* represents the net value of Load curtailment and is calculated as the VOLL minus the SCED System Lambda. System Lambda is subtracted from VOLL to reflect the scarcity value of the marginal dispatch capacity and to ensure that the final cost of energy does not go above the VOLL. The Off-Line Available Reserves (RTOFFCAP) will be set to zero when the SCED snapshot of the PRC is equal to or below the PRC MW at which EEA Level 1 is initiated.

Comment [ERCOT2]: 2300MW

3. METHODOLOGY REVISION PROCESS

Revisions to this document shall be made according to the approval process as prescribed in Protocol Section 6.5.7.3, Security Constrained Economic Dispatch.

NPRR Comments – Attachment 1

4. APPENDIX 1: PARAMETERS FOR IMPLEMENTING ORDC

The definition and values of the parameters used in implementing ORDC are as follows:

Parameter	Definition	Unit	Value
VOLL	Value of Lost Load	$/MWh	9000
X	Minimum level at which ERCOT may need to begin shedding firm Load	MW	2000