memo

To: NEPOOL Market Participants

From: Market Development

Date: May 16, 2014 *(updated on May 21 to correct typo in table 4, page7)*

Subject: Operating Reserve Deficiency Information – Historical Data – *Updated*

In March 2013, as part of the *FCM Performance Incentives* subject at the NEPOOL Market Committee, the ISO provided historical data from 2007 to 2012 on real-time reserve deficiencies indicated by the ISO's dispatch and pricing system.

Recently a number of market participants have contacted the Internal Market Monitor ("IMM") requesting that the historical data be updated. These requests were made in the context of assessing the impact of the ISO's FCM *Pay for Performance* proposal on the formulation their De-list Bids or New Supply Offers in the FCM. In response to participant requests, this memorandum, and an accompanying data file, provides updated data through April 2014.

This memorandum offers a high-level summary of the main information contained in the data, and provides some key statistics on reserve deficiencies. The final portion of this memo offers guidance on using the Excel data file for participants interested in conducting additional analyses. The Excel-format data file contains detailed event-level information on real-time activations of reserve constraint penalty factors and related system conditions from 2007 to the present.

Summary Information and Statistics

This section presents summary statistics on the following conditions:

- The number of hours per year the ISO has experienced activations of Reserve Constraint Penalty Factors (RCPF) historically, under both current and prior RCPF values;
- When RCPF activation events have occurred, by time of day and by season;
- Duration of RCPF activation events, under current RCPF values;
- Values of the system *balancing ratio* during these events. This statistic is germane to the ISO's *FCM Performance Incentives* proposal.

First, some essential background on reserve requirements that may help interpret the data.

A. Reserve Types and RCPFs

In real-time operations, the ISO maintains four types of reserve requirements:

- A *system spinning reserves* requirement, which is satisfied with online incremental generation capability available in ten minutes or less (*i.e., T*en-Minute Spinning Reserves (TMSR).

- A *system 10-minute reserves* requirement (sometimes called the system's *contingency reserves* requirement). This is satisfied with either offline or online generation available in ten minutes or less (*i.e.*, with ten-minute non-spinning reserves, TMNSR, *or* with TMSR).

- A *system 30-minute reserves* requirement, which is satisfied with offline or online generation capability available in thirty minutes or less (*i.e.*, with thirty-minute operating reserves, TMOR, *or* with TMNSR, *or* with TMSR).

- Several *zonal 30-minute reserve* requirements (sometimes called *local 30-minute reserve* requirements).

Each type of reserve requirement has a different Reserve Constraint Penalty Factor (RCPF) value. A RCPF value sets a 'cap' on the incremental cost of redispatching the system to satisfy a specific reserve requirement. If the incremental cost cap would be exceeded, the ISO's dispatch software will not redispatch the system to maintain the reserve requirement. When this occurs, the dispatch system indicates it is *deficient reserves* and the associated RCPF value is "activated". When an RCPF is activated, the RCPF value determines the real-time price of reserves for the associated 5-minute price interval.

B. Annual Frequency of Reserve Deficiencies and Evolution over Time

Since implementation of the Ancillary Services Market design in late 2006, the ISO has changed two different RCPF values. The zonal 30-minute requirement RCPF was increased from $50 per MWh to $250 per MWh on January 1, 2010. The system total-30 requirement RCPF was increased from $100 per MWh to $500 per MWh on June 1, 2012. The RCPF for the system-10 requirement ($850 / MWh) and for the spinning reserve requirement ($50 / MWh) has not changed during these periods.

The New England power system experienced a different number of hours per year with reserve deficiencies following each RCPF increase. Table 1 presents the average annual number of hours of RCPF activations for three different time periods, from late 2006 through April 2014.

Table 1. Average Annual RCPF Activations, in Hours. Values are system, local.

	RCPF values in effect for 30-minute reserves		
Time Period	$100 System, $50 Zonal	$100 System, $250 Zonal	$500 System, $250 Zonal
Oct. 2006 to Dec. 2009 (38 months)	6.0, 18.7		
Jan. 2010 to May 2012 (29 months)		17.7, 0.5	3.5, 0.5 **
June 2012 to Apr. 2014 (23 months)			12.8, 0.1
Jan. 2010 to Apr. 2014 (52 months)			7.6, 0.3 **

Notes: System is total-10 or total-30. Zonal is 'zonal only', i.e, when a zonal RCPF is active but the system RCPFs are not. Data are actual historical values except starred (**) values that are based on simulation study results (see text).

Observe that there are two numbers in each entry in Table 1:

- The first number is the total hours per year during which *either* the system-10 *or* the system-30 RCPF was activated. For example, the value of 6.0 in the first row means there were 6.0 hours (as an annual average) during the Oct. 2006 to Dec 2009 period in which the RCPF was activated for either system-10 or system-30 reserves. The third row in Table 1 shows this condition occurred 12.8 hours (on an annualized basis) since June 2012.

- The second number in each entry is the total hours per year (again on an average annual basis) during which a zonal RCPF was activated but the system-10 and system-30 RCPFs were not activated. That is, the second number represents the duration of 'zonal-only' RCPF activations annually. For example, the number 18.7 in the first row of Table 1 indicates there were, on average, 18.7 hours per year with a 'zonal-only' RCPF activation prior to January 2010. The third row of the table shows that after June 2012, this condition occurred only 0.1 hours (again, on an annualized basis).

Simulation Study Results. To provide a sense of the prevalence of reserve constraint activations that would have occurred if the current RCPF values had been in place for several years, the ISO performed a simulation study. Specifically, the ISO undertook a simulation study to examine how many RCPF activations would have occurred if current RCPF values had been in place from January 2010 through May 2012. This simulation was conducted using the ISO's actual production-level unit dispatch system, by re-running the real-time dispatch that would have occurred (approximately every 5 minutes) during reserve deficiency periods. In Table 1, the first set of numbers in the second row show the actual hours of reserve deficiencies during this time period; the second set of numbers, appearing with 'starred' entries (in the second row and last column of Table 1), show the simulation study results.

These results show that under current RCPF values, the frequency of system-level reserve deficiency conditions would have been low during the Jan. 2010 to May 2012 period (at 3.5 hours, on an annual basis). The last row in Table 1 shows the results from combining the actual and simulation study

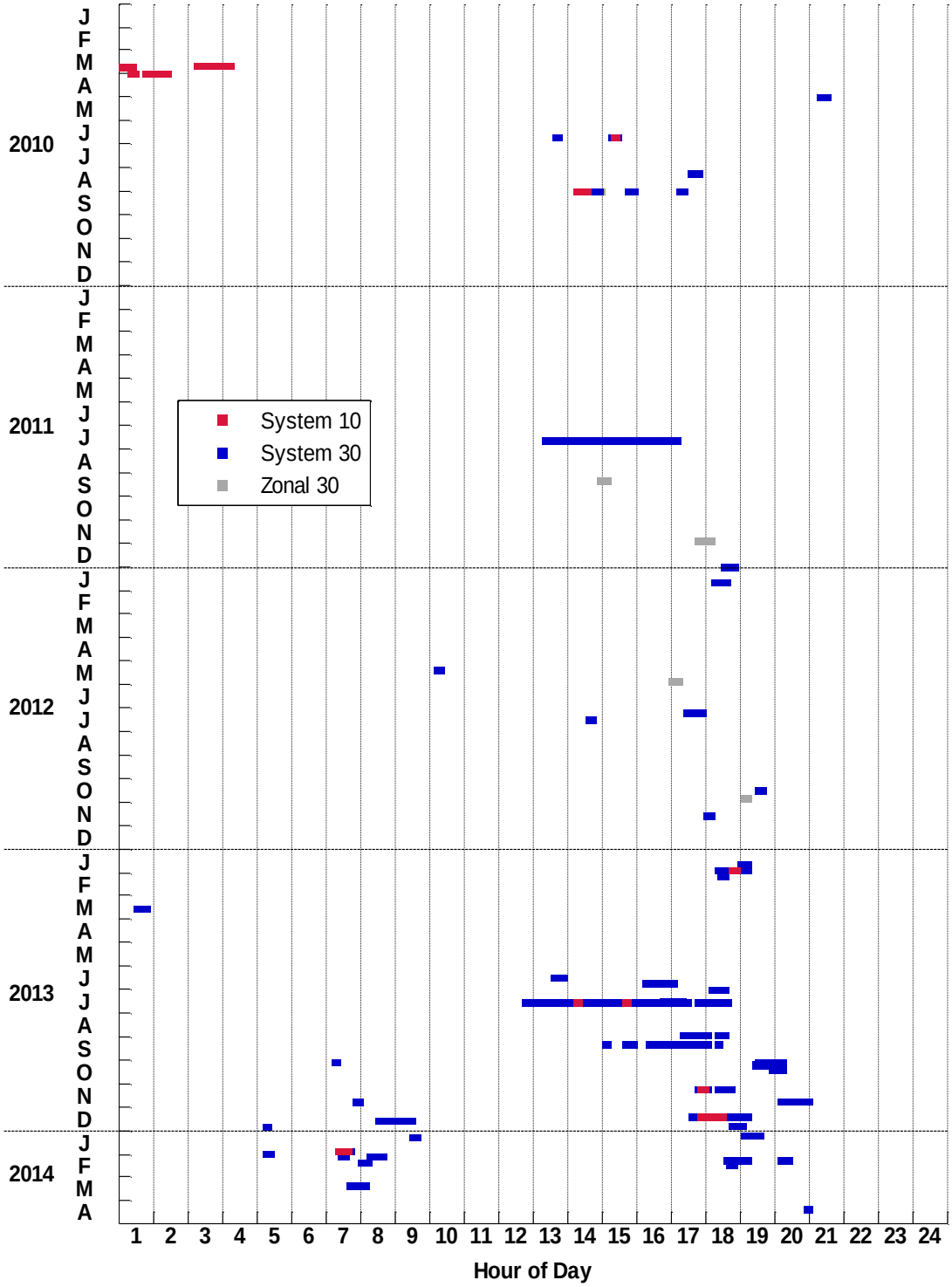
results with current RCPF values, and yields an annual average over the full 2010 – April 2014 period of 7.6 hours of RCPF activations (system-level).

Taken together, the actual and simulated data for the 2010 – April 2014 period using current RCPF values may provide the most relevant guide to assessing the prevalence and patterns of reserve deficiencies under current system conditions. We provide additional statistics based on these results further below.

C. Detailed Results for 2010 – April 2014 With Today's RCPF Values

Figure 1 (*next page*) presents a visual representation of when RCPF activations occur. This figure covers slightly more than a four-year span, from 2010 through 2012, and depicts the RCPF activation results obtained under today's RCPF values. To do so, Figure 1 shows the ISO's simulation study results for the Jan. 2010 to May 2012 period, and actual operating results from June 2012 to April 2014. These simulation study results are also provided, at the event-level, in the accompanying Excel data file.

Figure 1. RCPF Activations, 2010 to April 2014, by date and time of day, for current RCPF values. Data based on simulation study results for Jan. 2010 – May 2012 and actual operating outcomes June 2012 – April 2014.



In Figure 1, each solid horizontal bar shows a period of time when one or more RCPFs were activated, keyed by color. The horizontal axis shows the hour of day, vertical axis the date. For example, the blue horizontal bar corresponding to July 22, 2011 shows the system-30 RCPF was activated shortly after noon (Hour Ending 13), and remained active for approximately 4 hours until shortly after 4 pm (Hour Ending 17).

Figure 1 reveals several facts about reserve deficiencies during this three-year period. These are:

1. **Reserve deficiencies were most prevalent during the 'peak' hours of noon to 6 pm**. Based on the data in Figure 1, the table below shows the total amount of time (in hours) that system-10 or system-30 RCPFs were activated during this 52-month period:

Table 2. RCPF Activations by Time of Day, 2010 – April 2014.

	Time (hours)	Percent
Peak Hours (HE12 to HE18)	22.5	68 %
Other than Peak Hours	10.5	32 %
All Hours	33.1	100 %

Annually, slightly more than two-thirds (68%) of the total time the system-10 or system-30 RCPFs were activated occurred during the hours of noon to 6pm.

2. **Reserve deficiencies were more prevalent during June through September** than other months year. Based on the data in Figure 1, the table below shows the total amount of time (in hours) that system-10 or system-30 RCPFs were activated during this three year period:

Table 3. RCPF Activations by Season, 2010 – April 2014.

	Time (hours)	Percent
June through September	17.0	51 %
October through May	16.1	49 %
Totals	33.1	100 %

Annually, approximately one-half (51%) of the total time the system-10 or system-30 RCPFs were activated occurred during the summer months of June through September.

3. **The duration of RCPF activation events varied.** Based on the data in Figure 1, the following table shows how the cumulative duration of all system-10 or system-30 RCPF activations during this three-year period (9.6 hours) breaks down into events of various durations:

Table 4. Total RCPF Activation Time by Event Duration, 2010 – April 2014.

Event Duration	Total Time (hours)	Percent
Less than 30 minutes	10.6	32 %
30 to 60 minutes	8.5	26 %
60 minutes or more	14	42 %
Totals	33.1	100 %

The first row indicates that, of the 33.1 hours of RCPF activations shown in Figure 1, a total of 10.6 hours (or 32%) occured during events that had durations of less than 30 minutes. A total of 8.5 hours (26%) occured during events lasting between 30 and 60 minutes, and 14 hours (42%) occurred during events lasting 60 minutes or more.

The summary information in these tables points to a general observation about reserve deficiencies. Many RCPF activations arose quickly and were resolved within an hour. However, other reserve deficiencies were sustained events when total system capacity was insufficient to meet load and reserve requirements for hours at a time. These longer events tended to be precipitated by a confluence of factors, including: High load conditions, day-ahead forecasts are lower than real-time load, reductions in unit maximum generation capability occurring after the DA market and RAA processes (termed 'EcoMax reductions from Day-Ahead' in the detailed data file), and generation contingences occurring in real-time. The detailed event data in the accompanying Excel file provides quantitative information on these factors for each reserve deficiency from 2007 to present.

Balancing Ratio Values

The ISO's FCM Pay-for-Performance proposal indexes payments for performance during reserve deficiency conditions, in part, to a proportion of each resource's Capacity Supply Obligation (CSO). The proportion is determined by a statistic called the *balancing ratio*, which measures load plus reserve requirements relative to total CSO obligations.

In the attached Excel data file, we have provided the system-level balancing ratio for all events during which the system-10 or system-30 RCPF was activated. The table below summarizes this information, using the (simulated and actual) RCPF activation results for the 2010 – April 2014 period obtained under current RCPF values (that is, for all events represented in Figure 1). On an annual average basis, the (duration-weighted) balancing ratio for system-level RCPF activation events in these data is 0.76.

Table 5. Balancing Ratio Values during RCPF Activations, 2010 – April 2014, Under Current RCPF Values.

Minimum	*Average*	*Maximum*
0.33	0.76	0.99

Using the Detailed RCPF Activation Event Data in the Excel File

The Excel data file accompanying this memo contains more detailed information on RCPF activations from 2007 to present.

Organization. The data are organized into a series of tabs. Each tab corresponds to a specific time period during which the RCPF values where constant; these time periods effectively correspond to the rows shown in Table 1 of this memo. In addition, RCPF activations of system-level RCPFs (system-10 or system-30) are shown on different tabs from RCPF Activation of zonal RCPFs.

Most tabs show RCPF activations organized by events; an event may run from only a few minutes to several hours. A final set of tabs, prefaced by 'Interval_', provides further detail at the 5-minute (approximately) frequency for all events.

Information. In general, for each RCPF activation event, the data contain information on:

- The event date, start, and end times;
- The activated RCPF type (i.e., NEMA zonal-30, system-10, etc), and RCPF value;
- The average and maximum magnitude of the reserve deficiency, in MW, during the event;
- The reserve requirement during the event, in MW;
- System load during the event;
- Various statistics for calculating the (system-level) balancing ratio;
- Any OP-4 actions associated with the event;
- The MW of any contingency losses occurring during or prior to the event;
- The load forecast error from day-ahead during the event;
- The ISO's expected capacity margin during the RAA process;
- Total external interchange difference between real-time and day-ahead; and
- Total generation capability reductions from day-ahead prior to the event.

The README tab in the Excel data file provides additional information and precise definitions for all of the fields contained in the data set.

We hope this information proves useful to market participants.

Contact Information

If you have any specific questions in relation to this data please contact Customer Support at the ISO through Ask ISO, by calling (413) 540-4220 or by email at custserv@iso-ne.com.

If you have any questions with regard to the formulation of de-list bids or new supply offers under the ISO's Pay for Performance proposals please email the IMM at intmmufcm@iso-ne.com.