ISO new england

memo

To: Markets Committee

From: Market Development

Date: March 5, 2013

Subject: Operating Reserve Deficiency Information – Historical Data

There are several subjects related to Operating Reserves that will be before the Markets Committee in 2013. To facilitate Committee discussions, the ISO has assembled an Excel-format data file with event-level information on operating reserve deficiencies and related system conditions from 2007 to the present. The data are posted with the March 2013 Markets Committee meeting materials at www.iso-ne.com/mc.

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.

Summary Information and Statistics

This section presents summary statistics on the following conditions:

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

First, some essential background on reserve requirements to 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.*, ten-minute spinning reserves, TMSR).

ISO New England Inc.
One Sullivan Road, Holyoke, MA 01040-2841
www.iso-ne.com **T** 413 535 4000

- 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 cost cap would be exceeded, the ISO's dispatch software will not redispatch the system to maintain the reserve requirement. When this occurs, the system 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 duration of the reserve deficiency.

B. Annual Frequency of Reserve Deficiencies and Evolution over Time

Since implementation of the current 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 and for the spinning reserve requirement 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 2012.

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 Dec. 2012 (7 months)			1.7, 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 (**) indicate 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 last row in Table 1 shows this condition occurred only 1.7 hours (on an annualized basis) after 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 last row of the table shows that after June 2012, this condition occurred only 0.3 hours (again, on an annualized basis).

Simulation Study Results. Although Table 1 shows fewer hours of RCPF activations under the current (higher) RCPF values in effect since June 2012, it is important to observe that these statistics do not control for other factors that may have changed over time. To provide a sense of the prevalence of reserve deficiency conditions 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.

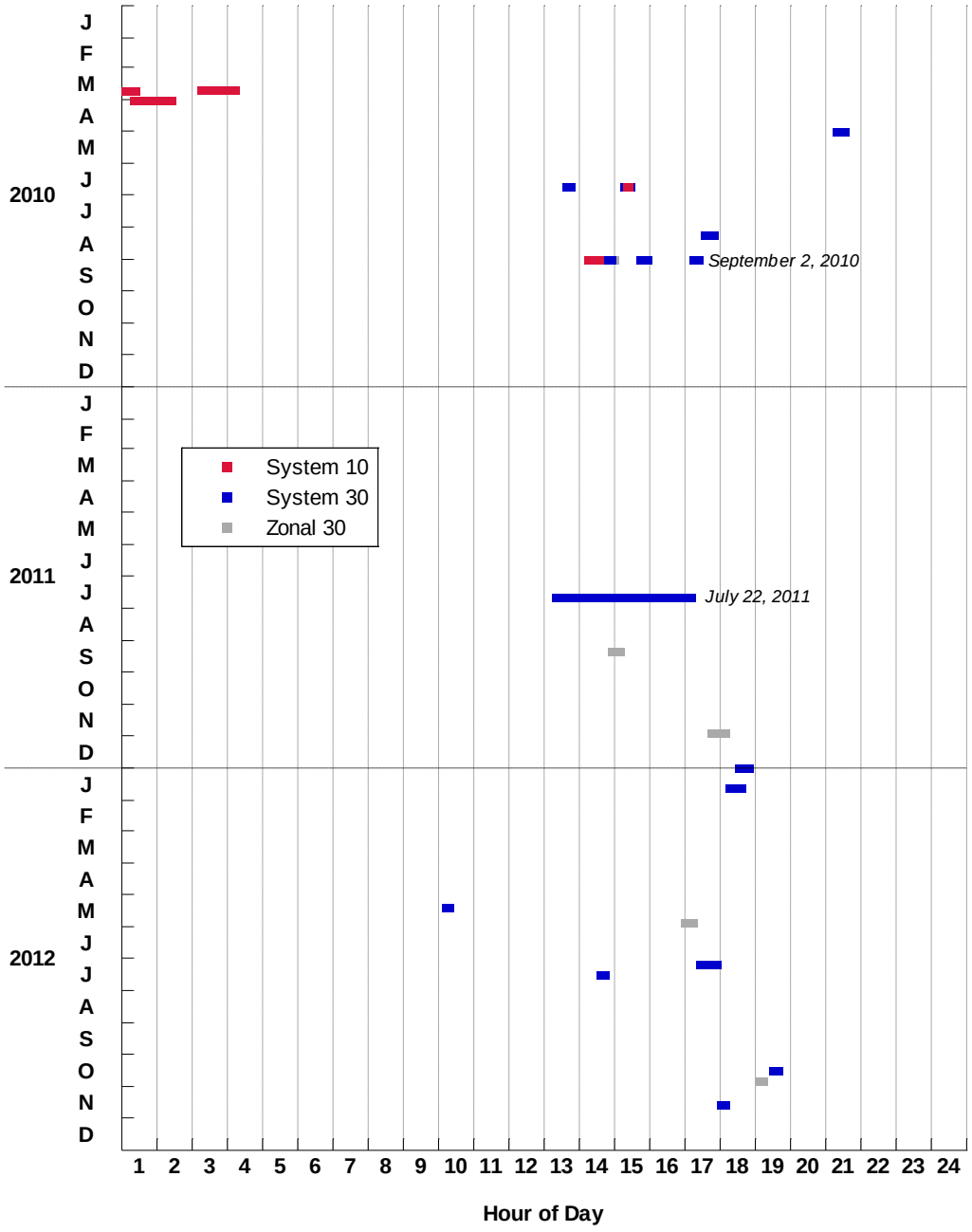
These results show that under current RCPF values, the frequency of system-level reserve deficiency conditions would have been low during the Jan. 2010 to May 2012 period (at 3.5 hours, on an annual basis), mirroring the ISO's actual operating experience during the period after June 2012 (at 1.7 hours, on an annual basis) when the new RCPFs have been in effect. Combining the actual and simulation study results with current RCPF values, the annual average over the full 2010-2012 period is 3.2 hours of RCPF activations (system-level).

Taken together, the actual and simulated data for the 2010-2012 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 2010-2012 With Today's RCPF Values

Figure 1 (*next page*) presents a visual representation of when RCPF activations occur. This figure covers a three-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 December 2012. These simulation study results are also provided, at the event-level, in the accompanying Excel data file.

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



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 12), and remained active for approximately 4 hours until shortly after 4 pm (Hour Ending 16).

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

1. **Reserve deficiencies are 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 three year period:

Table 2. RCPF Activations by Time of Day, 2010-2012.

	Time (hours)	Percent
Peak Hours (HE12 to HE18)	6.9	72 %
Other than Peak Hours	2.7	28 %
All Hours	9.6	100 %

Annually, nearly three-fourths (72%) of the total time the system-10 or system-30 RCPFs are activated occurred during the peak hours of noon to 6pm.

2. **Reserve deficiencies are 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, 2010-2012.

	Time (hours)	Percent
June through September	6.0	62 %
October through May	3.6	38 %
Totals	9.6	100 %

Annually, nearly two-thirds (62%) of the total time the system-10 or system-30 RCPFs are activated occurred during the summer months of June through September.

3. **The duration of RCPF activation events varies.** 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, 2010-2012.

Event Duration	Total Time (hours)	Percent
Less than 30 minutes	3.5	36 %
30 to 60 minutes	1.2	13 %
60 minutes or more	4.9	51 %
Totals	9.6	100 %

The first row indicates that, of the 9.6 hours of RCPF activations shown in Figure 1, a total of 3.5 hours (or 36%) occur during events that had durations of less than 30 minutes. Similarly, a total of 1.2 hours (13%) occur during events lasting between 30 and 60 minutes, and 4.9 hours (51%) occurred during events lasting 60 minutes or more.

The summary information in these tables point to a general observation about reserve deficiencies. Many RCPF activations arise quickly and are resolved within an hour. However, other reserve deficiencies are sustained events when total system capacity is insufficient to meet load and reserve requirements for hours at a time. These longer events tend to be precipitated by a confluence of factors, including: High load conditions, day-ahead under-forecasts of 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, here using the (simulated and actual) RCPF activation results for the 2010-2012 period obtained under current RCPF values (that is, for all events represented in Figure 1).

Table 3. Balancing Ratio Values during RCPF Activations, 2010-2012, Under Current RCPF Values.

Minimum	*Average*	*Maximum*
0.35	0.75	0.95

The lowest observed value of the balancing ratio, 0.35, occurred during a deficiency of total-10 minute reserves overnight on March 23, 2010. The highest observed value, 0.95, occurred during an extended

period of high loads on July 22, 2011. On an annual average basis, the (duration-weighted) balancing ratio for system-level RCPF activation events in these data is 0.75.

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.