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Load Forecasting Manual

1. OVERVIEW

1.1 PURPOSE AND SCOPE

This manual has three purposes.

The first is to explain the data reporting, weather-normalization methodology, and load forecasting methodology requirements that are prescribed in the NYISO Services Tariff Sections 5.10 and 5.11 and used in the calculation of the NYCA Unforced Capacity Requirement. The load forecasts used in the calculation of the NYCA Unforced Capacity requirement will be referred to herein as UCAP Load Forecasts.

The second is to explain the methodology that the NYISO uses to produce the load forecast used in the Comprehensive Reliability Planning Process (CRPP).

The third is to explain the load data submission requirements that the NYISO fulfills in its filings to NPCC, NERC, FERC, and other reliability and regulatory bodies.

(The requirements and procedures related to the load forecast data used in the daily system and market operations are covered in the **NYISO Manual for Day Ahead Scheduling**.)

2. DATA, WEATHER-NORMALIZATION, AND LOAD FORECASTING METHODOLOGY SUBMISSION REQUIREMENTS FOR THE NYCA UNFORCED CAPACITY LOAD FORECAST

This section describes:
1. Notification procedures to be followed by the NYISO
2. Data submission requirements for TOs and Municipal Electric Systems (MES)
3. The procedures the NYISO follows for
   - Evaluating the TO and MES submitted actual and weather-normalized loads at the time of the NYCA peak (and locality peaks)
   - Calculating NYCA Weather-Normalized Load + Losses (WNL+L) at the NYCA peak hour for the current capability year
   - Evaluating TO and MES Regional Load Growth Factors (RLGFs)

- Calculating the NYCA ICAP Peak Forecast and each TO and MES load at the time of the forecasted NYCA peak

2.1   <u>Notification Procedures to be followed by the NYISO</u>

The Capability Year Peak for purposes of this section of the Load Forecasting Manual is defined to be the highest hourly load that occurs from May 1 to August 31, inclusive.

Notifications will include:

1. **Capability Year Peak and Date and Hour of Occurrence:** The NYISO will provide information to the TOs and MESs by September 1.
2. **EDRP and SCR Impacts during the NYCA Peak Hour:** The NYSIO will provide information by September 15.
3. **UCAP Load Forecast Schedule:** The NYISO will release a schedule by August 31 of every year that will list the dates of when data submissions and analyses are to be completed.
4. **Evaluation of TO and MES Weather-Normalized Loads:** in November, as determined in the Schedule
5. **Evaluation of TO and MES RLGFs:** in September, as determined in the Schedule
6. **Preliminary UCAP Load Forecast:** in September, as determined by Schedule
7. **Final UCAP Load Forecast:** in October, as determined by Schedule.

2.2   <u>Data submission requirements for TOs and MESs</u>

TOs and MESs shall submit to the NYISO

1. Hourly loads for a quarter-year (first quarter is January – March, etc.) within 90 days of the quarter's end
2. Actual load at the time of the NYCA peak including a statement of whether or not transmission losses are included
3. The weather-normalized load at the time of the NYCA peak
4. The previous five years' values for 2. and 3. (except that weather-normalized data will not be required for years before 2003)
5. The MW impact of Emergency Operating Procedures (EOPs) and load modifiers operating at the time of the NYCA peak
6. For TOs with locational UCAP requirements, the actual and weather-normalized locality peak load
7. Regional Load Growth Factors

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The due dates for items 2. – 7. will be provided in the Schedule.

2.2.1 Hourly Loads

TO and MES hourly loads are necessary for verification of the load at the time of the NYCA peak and for other purposes as described in Section 3 of this manual. Data may be submitted in any common electronic format.

2.2.2 Actual Load at the Time of the NYCA Peak

TOs and MESs will provide

1. Their load in MW at the time of the NYCA peak for the current capability year together with a statement explaining whether or not this load includes transmission losses.

2.2.3 Weather-normalized Load at the Time of the NYCA Peak and Supporting Material

TOs and MESs will provide the weather-normalized load corresponding to their actual loads (provided pursuant to 2.2.2. TOs and MESs may calculate their weather-normalized load using their own procedures. However, the design criteria employed by each TO and MES shall be such that it at ensures, at a maximum, a 0.50 probability of occurrence on an annual basis.

The following supporting material will be provided:

1. A written description of the method used to derive the weather-normalized load from the actual load
2. If a statistical model is used, the model, its statistics and the data from which it was derived
3. A description and supporting data for the design conditions used in calculating the weather-normalized load

2.2.4 Actual and Weather-normalized Load at the Time of the NYCA Peak for the Five Preceding Years

Data prior to 2003 will not be required. For these years, TO and MES weather-normalized non-coincident peak load data that was previously submitted will be used. This data is used by the NYISO to evaluate RLGFs provided by TOs and MSEs. If required, supporting documentation will be made available.

2.2.5 MW Impact of EOPs and load modifiers operating at the Time of the NYCA Peak

TOs and MESs shall provide the MW reduction achieved by EOPs and load modifiers at the time of the NYCA peak. If none of these measures were in operation at that time, a statement to that fact will be provided instead. Supporting documentation will be made available if required by the NYISO.

2.2.6   Actual and Weather-normalized Locality Peaks

TOs and MESs may have locality peaks that occur at a different time than the NYCA peak hour. If that is the case, they shall also provide the data required by Sections 2.2.2 – 2.2.5 for the hour of their locality peak.

2.2.7   Regional Load Growth Factors (RLGFs)

TOs and MESs will provide the NYISO RLGFs. An RLGF is the ratio of the projected load at the time of the NYCA peak for the next capability year to the weather-normalized load at the time of the NYCA peak in the current capability year.

2.3 Procedures for Determining the NYISO UCAP Load Forecast

This section describes procedures the NYISO will follow to produce the UCAP Load Forecast for the next capability year. The following analyses will be performed.

1. Reconciliation of TD loads at NYCA Peak
2. Calculation of TO and MES Load Less Losses (LLL)
3. Evaluation of TO and MES Weather-normalized Load and Losses
4. Allocation of Weather-normalized Losses to TOs and MESs
5. Evaluation of TO and MES Regional Load Growth Factors
6. Forecast of TO/MSE loads at time of predicted NYCA Peak

1.   Reconciliation of TD load at NYCA Peak

TOs and MESs submit their load at the time of the NYCA peak in accordance with Section 2.2.2 of this manual. NYISO will calculate TD loads by adding TO and appropriate MES loads. These will be compared to TD billing loads from the NYISO Decision Support System (DSS). Adjustments will be made as necessary to account consistently for losses, load modifiers and other demand modifications. If the TD loads calculated from the TO and MES data does not match the DSS TD load, NYISO will discuss and try to resolve the difference with the TO and MES. If the unresolved difference is less than 1%, NYISO will accept the TO plus MES calculation. If the unresolved difference exceeds 1%, the

NYISO will determine the appropriate TD load and submit it for comment to the Load Forecasting Task Force and the ICAP Working Group.

2. **Calculation of TO and MES Load Less Losses (LLL)**

Losses will be obtained from the NYISO DSS for each TD. In cases where TOs reported their load inclusive of losses, the LLL will be calculated by deducting the NYISO DSS losses from the reported load. In cases where the TO reported load does not include losses, no loss deduction is necessary. MES loads are reported net of losses
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3. **Station Load**

Station Load may be deducted by TOs and MESs in calculating LLL. If so, the unit(s) for which the deduction and the amount of the deduction shall be reported to the NYISO.

4. **Evaluation of TO and MES Weather-normalized Load and Losses**

NYISO will produce its own estimate of the weather-normalized load for each TO and MES. These estimates will be produced using models and design criteria the NYISO develops. The NYISO will compare its own estimates with those submitted by the TOs and MESs in according to Section 2.2.3. using two comparisons:

If the adjustments to the actual load calculated by the NYISO and a TO or MES differ by 25% or less, the NYISO will accept the submitted estimate.

And

If the weather-normalized load calculated by the NYISO differs from that calculated by a TO or MES by 1% or less, the NYISO will accept the submitted estimate.

If both differences exceed their thresholds, the NYISO and TO will investigate and attempt to reconcile it.

If it is not possible to reconcile the difference, the NYISO will use its own estimate of the weather-normalized load for that TO. The TO may dispute the NYISO's decision to substitute its weather-normalized load for the TO's, pursuant to the Expedited Dispute Resolution Procedures specified in the NYISO Services Tariff Section 5.16.

If a MES does not submit a weather-normalized load, the NYISO will calculate one for it by applying the ratio of the weather-normalized to actual load of the TO in whose TD the MES is located to the MES actual load.

Losses will be weather-normalized for each TO using the same proportion of weather-normalized load to actual load as was determined for it.

5. Allocation of Weather-normalized Losses to TOs and MESs

The total of all TO and MES weather-normalized loads will be calculated. This is the NYCA weather-normalized peak load less losses (W/N LLL). The total of all weather-normalized losses will be calculated by adding all TO weather-normalized losses.

Total weather-normalized losses will be allocated to each TO and MES according to the ratio of its W/N LLL to the NYCA W/N LLL. The result will be the weather-normalized load plus losses (W/N L+L) for each TO and MES.

The sum of all TO and MES W/N L+Ls will be the NYCA weather-normalized peak load for the capability year.

Each TO and MES W/N L+L will be the basis to which its RLGF will be applied to calculate its forecasted load at the time of the NYCA peak in the forecasted capability year.

6. Evaluation of TO and MES Regional Load Growth Factors

NYISO will evaluate Capability Year RLGFs by comparing them to:

1. Recent Historical Load Growth - RLGFs should be within a range of historical year-to-year growth rates of Actual Adjusted Peak Load experienced in the previous five calendar years.

2. Relationship to Economic Indicators - The NYISO will clearly outline for all market participants the economic parameters it will use in developing these relationships no less than thirty days before date the TOs are required to submit RLGFs.

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    a. The ratio of the annual growth in TO/MES load at the time of NYCA peak, reflected in the RLGFs, to annual growth in economic indicators, as provided to the NYISO by its economic forecasting consultant, shall be calculated by the NYISO for each TO.

    b. The ratio of each predicted RLGF to the annual growth in economic indicators, as provided to the NYISO by its economic forecasting consultant, shall be calculated by the NYISO.

    c. The ratios calculated in 2.a.. should be consistent with the ratios calculated in 2.b. The selection of indicators and criteria for deciding consistency between 2.a. and 2.b. are to be determined by the LFTF.

3.   Projections performed by NYISO - NYISO will develop independent projections of RLGFs and use them in evaluating those submitted for Section 2.2.7. The NYISO will post on the NYISO website for all market participants the assumptions and methodologies used to develop its projected RLFGs for each Transmission District.

The NYISO will develop a range for each of the three criteria above. If the NYISO determines that a TO/MES forecast is not within the range provided for at least two of the three criteria above, the NYISO and TO/MES will attempt to reconcile and explain the difference. If the difference cannot be reconciled, the NYISO will inform the TO/MSE of that fact and that it intends to substitute its RLFG for the submitted one. The TO/MSE may dispute the NYISO's decision to substitute its RLGF, pursuant to the Expedited Dispute Resolution Procedures specified in the NYISO Services Tariff Section 5.16.

If, as a result of the deliberations between the NYISO and TO required under Section 5.16.1, the NYISO decides to accept a TO forecast that does not fall within the range provided for at least two out of three above criteria, any market participant may dispute that decision pursuant to the Expedited Dispute Resolution Procedures specified in the NYISO Services Tariff Section 5.16.

The only RLGFs, which may be disputed under the Expedited Dispute Resolution Procedures are those developed by the TO/MSE and the NYISO.

7. Forecast of TO/MSE Load at time of predicted NYCA Peak

The forecast of each TOs and MSEs load at the time of the NYCA peak for the upcoming capability year will be calculated by multiplying the W/N L+L for each, as determined in Section 2.3.4, by the appropriate RLFG, calculated in 2.3.5.

The sum of the TO and MSE loads at the time of the NYCA peak will be the NYCA peak forecast for the capability year.

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3.NYISO METHODOLOGY TO PRODUCE THE CRPP LOAD FORECAST

Load forecast data is used by the NYISO in its own analyses of the adequacy and reliability of the NYCA system in the CRPP. To meet these requirements, the NYISO produces ten-year forecasts of sendout and summer and winter peak for the NYCA and each of its eleven zones.

This section describes the process followed by the NYISO to produce these forecasts.

3.1 NYISO Annual Sendout Model

The NYISO develops statistical models that relate total NYCA sendout to economic, weather, and other variables. The current model is based on data for 1975 to 2005. The sendout model statistics and data are presented in Appendix B. The model is developed in log-log form.

The NYCA sendout model is used to predict annual energy requirements for the CRRP time ten-year frame .

3.2 NYISO Summer Peak Model

The model used to forecast the NYCA system peak is presented in Appendix C. It uses forecast sendout and other variables to predict peak demand. The modeled peak demand is then adjusted to the NYCA UCAP load forecast to account for consistency in planning criteria across all Transmission Districts.

3.3 NYISO Zonal Sendout and Peak Forecasts

Forecast energy sendout for each of the eleven NYCA zones is calculated by projecting the historical trends relative to measures of economic growth observed since 1993. Each Zone's energy forecast is then adjusted proportionately so that the total equals the forecast produced by the NYISO Annual Sendout Model.

Zonal peak demands are forecast in two steps. First, each zones coincident load at the time of the NYCA peak is calculated from historical data. Then each Zones peak is forecast by calculating the ratio of its coincident-to-non-coincident peak.

The sum of the zonal peaks is then calculated and overall NYCA coincident-to-non-coincident ratios are calculated. Zonal peaks will be adjusted if the ratio deviates from historical norms.

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Appendix A

Schedule for 2007 UCAP Load Forecast
(to be provided)

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Appendix B				
NYISO Annual Sendout Model				
Variable		**StdErr**	**T-Stat**	**P-Value**
	9.935	0.761	13.061	0.00%
Ln_2006.Output_R	0.135	0.072	1.874	7.64%
Ln_2006.ShrEdHl	0.398	0.061	6.490	0.00%
Ln_2006.ShrFin	0.335	0.070	4.803	0.01%
Ln_2006.IncMed_R	0.224	0.093	2.416	2.59%
Ln_2006.PrElecRes_R	-0.136	0.043	-3.185	0.49%
Ln_2006.CDD	0.047	0.010	4.762	0.01%
Ln_2006.HDD	0.072	0.030	2.371	2.85%
AR(1)	0.400	0.153	2.609	1.73%
Ln	Logarithmic transformation			
2006.Output_R	Real gross state output			
2006.ShrEdHl	Share of employment in education and health			
2006.ShrFin	Share of employment in finance			
2006.IncMed_R	Real median income			
2006.PrElecRes_R	Real residential electric price			
2006.CDD	Cooling degree days			
2006.HDD	Heating degree days			
Regression Statistics				
Iterations	19			
Adjusted Observations	30			
Deg. of Freedom for Error	21			
R-Squared	0.996			
Adjusted R-Squared	0.995			
Durbin-Watson Statistic	2.118			
Durbin-H Statistic	#NA			
AIC	-9.213			
BIC	-8.793			
F-Statistic	697.121			
Prob (F-Statistic)	0.0000			
Log-Likelihood	104.63			
Model Sum of Squares	0			
Sum of Squared Errors	0			
Mean Squared Error	0.00			
Std. Error of Regression	0.01			
Mean Abs. Dev. (MAD)	0.01			
Mean Abs. % Err. (MAPE)	0.05%			
Ljung-Box Statistic	1.88			
Prob (Ljung-Box)	0.8654			

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Appendix B (continued)							
NYISO Annual Sendout Model							
Year	AnnGWh	Output_R	ShrEdHI	ShrFin	IncMed_R	PrElecRes_R	CDD	HDD
1975	11.58	6.04	-2.23	-2.43	10.50	5.09	6.69	8.57
1976	11.61	6.03	-2.22	-2.44	10.48	5.05	6.59	8.68
1977	11.63	6.05	-2.21	-2.45	10.49	5.06	6.69	8.66
1978	11.65	6.09	-2.21	-2.47	10.50	5.03	6.65	8.72
1979	11.67	6.10	-2.19	-2.45	10.52	5.06	6.64	8.64
1980	11.68	6.11	-2.15	-2.42	10.45	5.08	6.88	8.68
1981	11.68	6.12	-2.13	-2.39	10.44	5.22	6.78	8.63
1982	11.67	6.13	-2.09	-2.37	10.43	5.21	6.42	8.61
1983	11.70	6.16	-2.08	-2.36	10.44	5.20	6.92	8.60
1984	11.72	6.23	-2.08	-2.37	10.46	5.12	6.68	8.60
1985	11.74	6.25	-2.07	-2.37	10.48	5.10	6.62	8.58
1986	11.76	6.28	-2.07	-2.34	10.50	5.03	6.61	8.59
1987	11.79	6.33	-2.05	-2.32	10.53	5.00	6.74	8.59
1988	11.84	6.38	-2.04	-2.32	10.58	4.96	6.86	8.65
1989	11.85	6.39	-2.02	-2.34	10.63	4.97	6.70	8.67
1990	11.85	6.39	-1.98	-2.35	10.60	4.98	6.81	8.45
1991	11.88	6.36	-1.91	-2.36	10.56	4.98	7.09	8.48
1992	11.86	6.38	-1.86	-2.37	10.51	4.99	6.45	8.63
1993	11.89	6.38	-1.84	-2.37	10.50	5.02	6.87	8.63
1994	11.89	6.40	-1.82	-2.37	10.49	5.03	6.82	8.61
1995	11.90	6.42	-1.80	-2.40	10.50	5.03	6.94	8.58
1996	11.90	6.46	-1.78	-2.41	10.55	5.02	6.64	8.66
1997	11.90	6.51	-1.78	-2.42	10.58	5.04	6.69	8.60
1998	11.92	6.55	-1.78	-2.42	10.61	5.00	6.86	8.44
1999	11.95	6.60	-1.78	-2.43	10.67	4.96	6.95	8.54
2000	11.95	6.65	-1.78	-2.45	10.68	5.00	6.65	8.63
2001	11.95	6.66	-1.74	-2.46	10.70	4.99	6.92	8.53
2002	11.97	6.66	-1.71	-2.49	10.68	4.99	7.04	8.55
2003	11.97	6.69	-1.68	-2.49	10.68	4.98	6.71	8.66
2004	11.98	6.74	-1.67	-2.49	10.71	4.98	6.68	8.61
2005	12.02	6.78	-1.66	-2.49	10.73	5.04	7.08	8.56
2006		6.81	-1.64	-2.50	10.73	4.97	6.78	8.61
2007		6.83	-1.63	-2.50	10.74	4.88	6.78	8.61
2008		6.86	-1.61	-2.51	10.75	4.84	6.78	8.61
2009		6.88	-1.60	-2.51	10.77	4.84	6.78	8.61
2010		6.91	-1.59	-2.51	10.78	4.84	6.78	8.61
2011		6.93	-1.58	-2.52	10.79	4.85	6.78	8.61
2012		6.95	-1.57	-2.52	10.80	4.87	6.78	8.61
2013		6.97	-1.56	-2.53	10.81	4.89	6.78	8.61
2014		6.99	-1.55	-2.53	10.82	4.89	6.78	8.61
2015		7.01	-1.54	-2.53	10.83	4.88	6.78	8.61
2016		7.03	-1.54	-2.53	10.84	4.88	6.78	8.61

Appendix C				
NYISO Summer Peak Model				
Variable		**StdErr**	**T-Stat**	**P-Value**
CONST	-8.962	1.878	-4.772	0.01%
Results_2006_Final.Ln_Energy	0.602	0.166	3.629	0.14%
Ln_2006.HH	1.278	0.422	3.027	0.60%
Ln_2006.CDD	0.107	0.035	3.042	0.58%
AR(1)	-0.350	0.182	-1.927	6.64%
Ln	Logarithmic transformation			
Results_2006_Final.Ln_Energy	Annual GWH			
2006.HH	Households			
2006.CDD	Cooling degree days			
Regression Statistics				
Iterations	5			
Adjusted Observations	30			
Deg. of Freedom for Error	25			
R-Squared	0.973			
Adjusted R-Squared	0.968			
Durbin-Watson Statistic	1.905			
Durbin-H Statistic	#NA			
AIC	-7.158			
BIC	-6.924			
F-Statistic	221.084			
Prob (F-Statistic)	0.0000			
Log-Likelihood	69.80			
Model Sum of Squares	1			
Sum of Squared Errors	0			
Mean Squared Error	0.00			
Std. Error of Regression	0.03			
Mean Abs. Dev. (MAD)	0.02			
Mean Abs. % Err. (MAPE)	0.19%			
Ljung-Box Statistic	4.27			
Prob (Ljung-Box)	0.5112			

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Appendix C (continued)				
NYISO Summer Peak Model				
Year	SummerMW	Ln Energy	HH	CDD
1975	9.90	11.58	8.73	6.69
1976	9.87	11.61	8.73	6.59
1977	9.96	11.63	8.74	6.69
1978	9.92	11.65	8.74	6.65
1979	9.92	11.67	8.75	6.64
1980	9.99	11.68	8.76	6.88
1981	9.97	11.68	8.76	6.78
1982	9.97	11.67	8.76	6.42
1983	9.99	11.70	8.77	6.92
1984	9.99	11.72	8.77	6.68
1985	10.04	11.74	8.78	6.62
1986	10.04	11.76	8.78	6.61
1987	10.10	11.79	8.79	6.74
1988	10.16	11.84	8.79	6.86
1989	10.14	11.85	8.80	6.70
1990	10.13	11.85	8.80	6.81
1991	10.20	11.88	8.81	7.09
1992	10.12	11.86	8.82	6.45
1993	10.21	11.89	8.82	6.87
1994	10.21	11.89	8.83	6.82
1995	10.21	11.90	8.83	6.94
1996	10.15	11.90	8.84	6.64
1997	10.26	11.90	8.84	6.69
1998	10.25	11.92	8.85	6.86
1999	10.32	11.95	8.86	6.95
2000	10.24	11.95	8.86	6.65
2001	10.34	11.95	8.87	6.92
2002	10.33	11.97	8.87	7.04
2003	10.32	11.97	8.87	6.71
2004	10.26	11.98	8.88	6.68
2005	10.38	12.02	8.88	7.08
2006		12.03	8.88	6.78
2007		12.04	8.88	6.78
2008		12.06	8.89	6.78
2009		12.07	8.89	6.78
2010		12.08	8.89	6.78
2011		12.09	8.90	6.78
2012		12.09	8.90	6.78
2013		12.10	8.90	6.78
2014		12.10	8.91	6.78
2015		12.11	8.91	6.78
2016		12.12	8.91	6.78