TAN45 PROCEDURE

The New York Control Area Installed Capacity Requirements for the Period May 2006 through April 2007 utilizes a *probabilistic* approach for determining the NYCA IRM requirements. GE-MARS is the primary analytical tool used for this probabilistic analysis. The 2006 IRM Requirement Study applied two new study methodologies, the *Unified Method* and the *IRM Anchoring Method.* Both methodologies were developed jointly by the NYSRC and NYISO staff and adopted by the NYSRC Executive Committee in 2005.

Briefly, under the Unified Method capacity is removed from zones west of the Central-East interface that have excess capacity when compared to their forecast peaks until a study point IRM is reached. At this point, capacity is either shifted from Zones J and K into same zones as above or vice versa until the 0.1 LOLE criterion is violated. Doing this at various IRM points yields a curve, whereby all points on the curve meet the NYSRC 0.1 days/year LOLE criterion. Furthermore, all LCR "point pairs" for NYC and LI curves along the IRM axis represent a 0.1 LOLE solution for NYCA.

The IRM Anchoring Method identifies the NYCA IRM Requirements and related MLCR from IRM/LCR curves established by the Unified Method. The *anchor point* on the curve is selected by applying a tangent of 45 degrees ("Tan 45") analysis at the bend (or "knee") of the curve. Points on the curve on either side of the "Tan 45" point may create disproportionate changes in LCR and IRM, since small changes in LCR can introduce larger changes in IRM Requirements and vice versa.

As part of "Lessons Learned" a regression analysis software was utilized to best fit the IRM/LCR curves and determine the TAN45 point, rather than a visual inspection of the curves as was utilized in this analysis. DataFit curve fitting software was utilized for this analysis.

The IRM/LCR curve apparently consists of two sections – a linear portion of the curve beginning somewhere at 18% IRM and a log/exponential portion of the curve between 16% and 18%. Two different methodologies were utilized for curve fitting. The first methodology considered all points between 16% and 20%. The resulting best curve fit is a sixth order polynomial with an equation Y = a*x^6+b*x^5+c*x^4+d*x^3+e*x^2+f*x+g and R^2 of 0.9977 for Zone J and 0.9981 for Zone K, which indicates a slight deviation from a "perfect" fit. Because there are only two data points between 18% and 20% the regression analysis produced a large sinusoidal swing between those points. The swing will disappear once more data points are inserted. The second method looked at the portion of the curve between 16% and 18% only. The best curve fit results are the fifth order inverse polynomial with an equation Y = a+b/x+c/x^2+d/x^3+e/x^4+f/x^5 and fifth order polynomial with an equation Y = a*x^5+b*x^4+c*x^3+d*x^2+e*x+f. Both curve fits produce an R^2 of 1.

Taking a first derivative of the curve fit equation and solving it for Y=-1 will result in a mathematical TAN45 value.

The following table summarizes the mathematical TAN45 results:

Function	Range of IRM Data	Calculated IRM at TAN45	Calculated LCR at TAN45	Calculated LCR at IRM = 118%	R^2
Sixth Order Polynomial Y=a+b*x+c*x^2+d*x^3+e*x^4+f*x^5+g*x^6	16%-20%	17.8	80.1	79.8	0.9977
Fifth Order Inverse Polynomial Y=a+b/x+c/x^2+d/x^3+e/x^4+f/x^5	16%-18%	17.6	80.2	79.7	1
Fifth Order Polynomial Y=a+b*x+c*x^2+d*x^3+e*x^4+f*x^5	16%-18%	17.6	80.2	79.7	1
Second Order Polynomial (Quadratic) Additional data to be prvided by NYISO					

ZONE K

Function	Range of IRM Data	Calculated IRM at TAN45	Calculated LCR at TAN45	Calculated LCR at IRM = 118%	R^2
Sixth Order Polynomial Y=a+b*x+c*x^2+d*x^3+e*x^4+f*x^5+g*x^6	16%-20%	18.1	99.0	99.2	0.9981
Fifth Order Inverse Polynomial Y=a+b/x+c/x^2+d/x^3+e/x^4+f/x^5	16%-18%	17.8	99.6	99.1	1
Fifth Order Polynomial Y=a+b*x+c*x^2+d*x^3+e*x^4+f*x^5	16%-18%	17.8	99.6	99.1	1
Second Order Polynomial (Quadratic) Additional data to be prvided by NYISO					

It was observed that the curve fit oscillations resulting in the fifth and sixth order polynomials occurred on the linear portion of the curve. Additional data points on that portion of the curve should eliminate this phenomenon. It is important to note that if a third order or higher polynomial is used, the first derivative would be a second order or higher polynomial. This means that the first derivative or the slope would have more than one answer. In other words, there would be more than one TAN45 point. That is why a quadratic curve fit is preferred, with the first derivative as linear equation which results in a single solution point. In order to get a good fit with one equation for the full range from 16% to 20% IRM, there should also be the same number of data points between 16% and 18% IRM as between 18% and 20% IRM.

To further test the TAN45 procedure it is recommended that the ISO provide data points between 18% and 20% in 0.25% increment. The following methodology will be applied to determine the TAN45 point:

1. Plot uniform data point distribution between 16% and 20% IRM (0.25% increment).
2. Using curve fitting software determine the linear and quadratic sections of the curve.
3. Take first derivative of the quadratic equation to determine the TAN45 inflection point.

ALTERNATE APPROACH

The complex relationship between LCRs and IRM is defined primarily by transmission limitations. When transmission limits are dynamically modeled, and constraints becomes binding, the amount of upstream capacity needed to serve downstream load will vary. For example, if we assume the transmission system is unconstrained, then1 MW of energy generated anywhere can reliably serve 1 MW of load anywhere. Essentially, the LOLE value of 1 MW of capacity is the same everywhere on the system (ignoring the impact of reserve sharing). However, as transmission limits vary due to the probabilistic nature of generation or transmission elements themselves, the import capability into constrained load areas will vary. When modeling dynamic transmission constraints over the course of thousands of computer simulations, not all capacity under the IRM will be deliverable for some hours of the year to a constrained zone.

For example, based on the 2006-2007 IRM Study at 18% IRM, 1 MW of locational capacity in a constrained area is equal, in terms of LOLE benefit, to 3.4 MW of ROS capacity. Therefore, it takes, on average, 3.4 MWs of ROS capacity to serve 1 MW of constrained load.

The mathematical meaning of TAN 45 is defined as 1 unit of change in the Y-axis is equal to 1 unit of change in the X-axis – a 1:1 relationship. However, a 1:1 LCR/IRM relationship measured in percent would equal to approximately 1:3 rate of change measured in MW. An alternate approach might be determining TAN 45 based on MW relationship between LCR and IRM.

This approach, however, assumes an unconstrained system. The Resource Adequacy rules state that *"...In order to meet the annual statewide ICR established by the NYSRC, the NYISO establishes installed capacity ("ICAP") requirements for the load serving entities ("LSEs"), including locational ICAP requirements,* ***recognizing internal and external transmission constraints.***"

Once the transmission constraints are taken into account, the results should be similar to those using the TAN 45 procedure described in the beginning of this document. The following table represents the relationship between NYCA Installed Capacity Requirement and total downstate locational capacity requirement.

IRM (% of NYCA Peak)	NYCA Installed Capacity Requirement (MW)	Delta (NYCA ICAP)	NYC LCR (MW)	LI LCR (MW)	Total Locational Capacity Requirements (NYC and LI) (MW)	Delta (Locational ICAP)	When is change in locational ICAP equal to opposite change in NYCA ICAP?
16.50%	38,789		10,362	5,765	16,127		
17.00%	38,955	166	9,525	5,455	14,980	-1,148	-6.9
17.25%	39,038	83	9,420	5,412	14,832	-147	-1.8
17.50%	39,122	83	9,339	5,364	14,703	-130	-1.6
17.75%	39,205	83	9,316	5,332	14,648	-55	-0.7
18.00%	39,288	83	9,269	5,300	14,569	-79	-0.9
19.00%	39,621	333	9,141	5,236	14,377	-192	-0.6
20.00%	39,954	333	9,048	5,166	14,214	-163	-0.5

The TAN 45 point (the change in locational ICAP vs. the change in NYCA ICAP) on the 1:1 MW rate is approximately 18%.