#	Design Components[1]	Status Quo	Governing Document Section	MMU
*	Implementation			
1	Tariff definitions of No Load Cost and Incremental Offer			
1a	Incremental Energy Offer	**OATT** **Incremental Energy Offer** shall mean offer segments comprised of a pairing of price (in dollars per MWh) and megawatt quantities, which must be a non-decreasing function and taken together produce all of the energy segments above a resource's Economic minimum. No load Costs are not included in the Incremental Energy Offer. Incremental Energy Cost Offer not defined. Manual 15 The incremental energy cost is the cost per MWh to produce all of the energy segments above the Economic Minimum level (minimum generation level with the unit available for economic dispatch). No-Load Costs are not included in the incremental costs. It is calculated by summing the cost of each segment of energy in the unit's incremental cost curve up to the generation level. This cost is a dollar per hour ($/MWh) rate. Incremental Energy Cost –The incremental heat or fuel required to produce an incremental MWh at a specific unit loading level multiplied by the applicable Performance Factor, multiplied by the fuel cost plus the appropriate maintenance cost.	OATT (Definitions) M-15, Section 1.7.4 M-15, Section 2.3.4	**OATT** **Incremental Energy Offer** shall mean offer segments comprised of a pairing of price (in dollars per MWh) and megawatt quantities. The Incremental Energy Offer~~, which~~ must be a non-decreasing function~~ and taken together produce all of the energy segments above a resource's Economic minimum. No load Costs are not included in the Incremental Energy Offer~~. ~~Incremental Energy Cost Offer not defined.~~ Manual 15 and OA Schedule 2 The incremental energy cost is the cost in dollars per MWh of providing an additional MWh from a synchronized unit.~~per MWh to produce all of the energy segments above the Economic Minimum level (minimum generation level with the unit available for economic dispatch). No-Load Costs are not included in the incremental costs. It is calculated by summing the cost of each segment of energy in the unit's incremental cost curve up to the generation level. This cost is a dollar per hour ($/MWh) rate.~~ It consists primarily of the cost of fuel, as determined by the unit's incremental heat rate times the fuel cost. It also includes costs of consumables for operation, maintenance, emissions allowances, taxes, tax credits, and energy market opportunity costs. ~~Incremental Energy Cost –The incremental heat or fuel required to produce an incremental MWh at a specific unit loading level multiplied by the applicable Performance Factor, multiplied by the fuel cost plus the appropriate maintenance cost.~~
1b	No Load Cost	**No load Cost** shall mean the hourly cost required to create the starting point of a monotonically increasing incremental offer curve for a generating unit.	OATT (Definitions) M-15, Section 1.7.3	OA Schedule 2, OATT and Manual 15 No Load Cost is the hourly energy cost required to theoretically operate a synchronized unit at zero MW. It consists primarily of the cost of fuel, as determined by the unit's no load heat times the fuel cost. It also includes costs of consumables for operation, maintenance and emissions allowances.

2	No Load equation definition	1) The initial estimate of a unit's No-Load Cost ($/Hr) is the No-Load fuel Cost multiplied by the Performance Factor, multiplied by the (Total Fuel-Related Cost (TFRC)) NoLoadCost($/Hour) = (NoLoadFuel*PerformanceFactor*TFRC) Alternative No Load Calculations: 2) NoLoadCost($/Hour) = (EconomicMinimumHeatInput*PerformanceFactor* (TFRC + VOM) − (EconomicMinimumIncrementalCost $/MW$h$ *EconomicMinimum MW)) 3) Note that if the unit of Variable Operations and Maintenance (VOM) cost is in terms of dollars per Equivalent Service Hours (ESH), the equation changes to: NoLoadCost($/Hour) = (EconomicMinimumHeadInput*PerformanceFactor*TFRC) + VOM −(EconomicMinimumIncrementalCost($/MW$h$)*EconomicMinimum(MW))	M-15, Section 2.5.3	$NL = H(0) \times (FC + VOM(0) + EC(0)) + VOM_{hour}$ where: *NL* is the no load cost in $/hour. *H*(0) is the no load heat input, the intercept of the heat input curve, in MMBtu. *FC* is the fuel cost at MW output of zero in $/MMBtu. For units that use a different starting fuel (e.g. coal units), the fuel in the no load cost calculation cannot be the fuel used during startup and synchronization, but must be the fuel used during normal operation. *VOM*(0) is the sum of the variable operating cost and maintenance adder at zero *MW* in $/MMBtu. VOM_{hour} is the sum of the variable operating cost and maintenance adder at zero *MW* in $/hour. *EC*(0) is the cost of emission credit allowances at zero *MW* in $/MMBtu.
2a	No Load rules for Slope Offers	Manual 15, Sec 2.5.3 When using the alternative incremental cost method to calculate No-Load Cost, the Market Seller must submit incremental cost and select "Use Offer Slope" when entering cost information into Markets Gateway.	M-15, Section 2.5.3	Remove. Require all sloped cost based offers to start at zero MW.
2b	No Load Rules for Block Offers	Manual 15, Sec 2.5.3 When using No-Load Fuel to calculate No-Load Cost, the Market Seller must submit block average cost and cannot select "Use Offer Slope" when entering cost information into Markets Gateway.	M-15, Section 2.5.3	Remove.
2c	No Load Rules for units using Average Heat Rates	Not defined in M15		Units that only operate block loaded (i.e. no dispatchable range) must be offered using an average heat rate and zero no load cost. All the hourly costs of operating the unit must be included in the incremental energy offer.

3	No Load Fuel (Heat) calculation method	All Market Sellers shall develop No-Load Costs for their units. The no-load heat input may be determined by collecting heat input values as a function of output and performing a regression analysis. The heat input values as a function of output may be either created from heat rate test data or the initial design heat input curve for an immature unit. The minimum number of points to develop a heat input curve shall be 2 points for a dispatchable unit with a variable output and 1 point for a unit with a fixed output. Sufficient documentation for each generating unit's no-load point in MMBtu's (or fuel) per hour shall consist of a single contact person and/or document to serve as a consistent basis for scheduling, operating and accounting applications PJM and the MMU can verify calculation methods used are in accordance with the currently approved Fuel Cost Policy and the elements of Attachment B.	M-15, Section 2.5.2	Remove. Replace with description of heat input curves: Heat input curves, also called input/output curves, represent the amount of fuel used to produce energy. Heat input curves are developed based on net energy production. Heat input curves can be developed using historical data, performance test data or Original Equipment Manufacturer (OEM) documentation. Observed fuel heat input and electric output data during normal operation or a performance test provide a direct measure of the heat input curve. A linear regression of the heat input on the energy output can provide an estimated polynomial curve. In the typical case, the heat input curve is a second order polynomial that applies to the entire operating output range of the unit. $$H(MW) = X_2 \times MW^2 + X_1 \times MW + X_0$$ where: *H*(*MW*) is the fuel input in MMBtu per hour required to generate power in MW over a defined period. *MW* is the output level of the unit. X_2, X_1 *and* X_0 are the polynomial coefficients to be estimated through a linear regression. When based on historical data, heat input curves must be developed using data points during times in which the resource was operating above its physical minimum level (e.g. do not include data points when the resource was in starting, soaking or shutdown mode).
4	Incremental Energy Cost			
4a	Incremental Offer equation	The incremental energy equation is not specified in M15		$$C'(MW) = H'(MW) \times \left[FC(MW) + VOM_{fuel}(MW) + EC(MW)\right] + VOM_{output}(MW) + OC(MW)$$ where: *C'*(*MW*) represents the short run marginal cost curve for the unit, varying with the *MW* output of the unit, in $/MWh. *H'*(*MW*) is the incremental heat rate curve at *MW* in MMBtu/MWh. *FC* is the fuel cost at *MW* in $/MMBtu.

				VOM(MW) is the sum of the variable operating cost and the maintenance adder at *MW* in $/MMBtu. VOM can be included either in $/MMBtu ($VOM_{fuel}$) or in $/MWh ($VOM_{output}$). *EC(MW)* is the cost of emission credit allowances at *MW* in $/MMBtu. *OC(MW)* is the opportunity cost at *MW* in $/MWh.
4b	Sloped Offer Rules	Not defined in M15		$$H'(MW) = 2 \times X_2 \times MW + X_1$$ where: *H'(MW)* is the incremental heat rate as a function of MW output level in MMBtu/MWh. *MW* is the output level of the unit. *X_2 and X_1* are the coefficients of the heat input curve. Appendix A contains a numerical example of a cost-based offer calculated using a sloped incremental heat rate curve.
4c	SteppedBlock Offer Rules	Not defined in M15		$$H'(MW_i) = \frac{H(MW_i) - H(MW_{i-1})}{MW_i - MW_{i-1}}$$ where: *H'(MW)* is the incremental heat rate as a function of MW output level in MMBtu/MWh. *MW_i* and *MW_{i-1}* are two output segment endpoints. *H(MW)* is the heat input as a function of MW output level in MMBtu.

4d	Use of Peaking factor in offers	The equivalent service hours shall be calculated based on history. Equivalent Service Hours = Cyclic Starting Factor*Number of Starts + Total Operating Hours at any load level + Cyclic Peaking Factor* Total Operating Hours above base load temperature limit CTs shall use OEM supplied values for cyclic starting factors and cyclic peaking factors even if the CT technology is no longer being built. Only OEM-specified cyclic starting and peaking factors can be applied to the Maintenance Adder of the unit's cost-based offer. If the OEM documentation does not specify a cyclic starting factor and/or cyclic peaking factor, then the cyclic starting factor and/or cyclic peaking factor shall be zero.	M-15, Section 5.6.3 (Combined Cycle Units) M-15, Section 6.6.3 (Combustion Turbine Units)	Remove equation. CTs shall use OEM supplied values for cyclic starting factors, ~~and~~ cyclic peaking factors and formulas even if the CT technology is no longer being built. Only OEM-specified cyclic starting and peaking factors can be applied to the Maintenance Adder of the unit's cost-based offer. If the OEM documentation does not specify a cyclic starting factor and/or cyclic peaking factor, then the cyclic starting factor and/or cyclic peaking factor shall be zero. Cyclic starting and cyclic peaking factors can only be used if such factors are used by the Market Seller in the calculation of maintenance schedule. For example, if the maintenance schedule of the unit is determined by the number of starts, only the cyclic starting factor should be used. If the Market Seller does not use these factors to determine its maintenance schedule, the factors cannot be used.
5	Heat Input	Heat Input equals a point on the heat input curve (in MMbtu/hr) describing the resource's operational characteristics for converting the applicable fuel input (MMBtu) into energy (MWh). Heat Input curves are typically obtained via plant performance testing or from the original equipment manufacturer.	M-15, Section 2.1	Remove. Heat input curve already defined. Heat Input equals a point on the heat input curve (in MMB~~b~~tu/hr) describing the resource's operational characteristics for converting the applicable fuel input (MMBtu) into energy (MWh). ~~Heat Input curves are typically obtained via plant performance testing or from the original equipment manufacturer.~~
5a	Heat Input Equation	Not defined in M15	M-15, Section 2.1.1	See 4a
5b	Performance Factors	Performance Factor is the calculated ratio of actual fuel burn to either theoretical fuel burn (design heat input) or other current tested heat input. Actual burn may vary from standard burn due to factors such as unit age or modification, changes in fuel properties, seasonal ambient conditions, etc.	M-15, Section 2.2	Status quo plus: Market Sellers can choose to update the heat input curve instead of using performance factors. When that choice is made the performance factor is set to one (1).
5d	Performance Factor data/period	The Performance Factor shall be calculated on either the total fuel consumed or a monthly spot check test basis. The Performance Factor for nuclear and steam units shall be reviewed (and updated if changed) at least once every twelve months. The Performance Factors for combustion turbine ("CT"), diesel units, and combined-cycle ("CC") units shall be updated at least once during: • Twelve months, or • The year in which a unit reaches 1,000 accumulated running hours since its last Performance Factor update, whichever represents a longer period, not to exceed five years. Requests for exemptions from these periods should be submitted to PJM and the MMU for evaluation pursuant to Section 2.3. The overall Performance Factor can be modified by a seasonal Performance Factor to reflect ambient conditions. The calculated performance factor may be superseded by estimates based on sound engineering judgment. If the period during which estimated performance factors are used exceeds three months, documentation concerning reasons for the override must be maintained and available for review.	M-15, Section 2.2, 2.2.1	Performance factors have to be calculated for the entire year, by month or by season (e.g. summer/winter). Performance factors cannot be applied inconsistently (i.e. applied during the summer months and not during the winter months).

5e	Performance Factor methods	There are three options available for use in determining a unit's performance factor: 1. Total Fuel 2. Separate 3. Fixed start approach	M-15, Section 2.2.3	Status quo
6	Heat Rate	Heat Rate equals the MMBtu content of the heat input divided by the MWh of power output. The smaller the heat rate value the greater the efficiency. The heat rate can also be referred to as the input-output function. Total Heat Rate=MMBtuMWh=Heat InputNet MW	M-15, Section 2.1	Heat Rate equals the MMBtu content of the heat input divided by the MWh of energypower output. The smaller the heat rate value the greater the efficiency. The heat rate can also be referred to as the input-output function. Total Heat Rate=MMBtuMWh=Heat InputNet MW
6a	Incremental heat rate equation	The Incremental heat rate is the relationship between an additional MW of output and the heat input necessary to produce it. Graphically, the incremental heat rate can be determined from the ratio of the change in fuel input to the change in unit MW output; which is the slope of the input/output curve. Mathematically, the incremental heat rate curve can be expressed as the first derivative of the heat rate curve (input heat versus MW output). Incremental Heat Rate = ∆ MMBtu/ ∆ MWh = (C$h$ange in Fuel Going in)/(C$h$ange in Energy Coming Out) = (dy/dx) Total Heat Rate	M-15, Section 2.1	Status quo plus: Units can have offers based on incremental heat rates using a sloped function, stepped function or block loaded. The sloped function is the continuous first derivative of the heat input function. Units offered using a sloped function must select the "use offer slope" option in Markets Gateway. Generators offered using a sloped function must start their incremental offer curve with a zero MW segment. The incremental heat rate at zero MW is the y axis intercept of the incremental heat rate function (the incremental heat rate when MW = 0.). The stepped incremental heat rate curve is derived from heat input curves, and direct measurements at different discrete output levels. Units offered using a stepped function must not select the "use offer slope" option in Markets Gateway. Generators offered using a stepped function should submit a nonzero first MW segment. The heat rate of a block loaded offer is equal to the total heat input needed to run the unit divided by the total output.
6b	Average heat rate equation	Not defined in M-15. Incremental heat rate curve where only the B coeffiecient is non-zero.		Covered in 6a
7	10% Adder on Cost Offer	Allowable under OA Schedule 2; Limitations referenced in OA Schedule 1 Sec 6.4.2; For offers > $1000, adder must be lesser of 10% or $100. For offers >$2000, adder is $0.	OA Schedule 2, 1.1(c); OA Schedule 1, Sec 6.4.2 ii	