2.6 Variable Operating and Maintenance Cost

Variable Maintenance cost is the parts and labor expenses of maintaining equipment and facilities in satisfactory operating condition.

$$TotalMaintenanceCost_{NextYear} =$$

$$\left(AnnualMaintenanceCost * \frac{EscalationIndex_{NextYear}}{EscalationIndex_{CurrentYear}}\right) +$$

$$\left(AnnualMaintenanceCost * \frac{EscalationIndex_{NextYear}}{EscalationIndex_{LastYear}}\right) +$$

$$\left(AnnualMaintenanceCost * \frac{EscalationIndex_{NextYear}}{EscalationIndex_{LastYear\ -\ 1}}\right) +$$

$$\ldots + \left(AnnualMaintenanceCost * \frac{EscalationFactor_{NextYear}}{EscalationIndex_{LastYear\ -\ (Maintenance\ Period\ -\ 1)}}\right)$$

There are three components in Variable Operating & Maintenance costs: major maintenance, minor maintenance and Operating Costs. These costs must be submitted to PJM/IMM for review and approval prior to the inclusion of such adder (or prior to the expiration of a previously approved adder) in cost-based offers. Notwithstanding, Market Sellers may elect to utilize the default minor maintenance adder and/or default operating costs adder.

- Major Maintenance: The Market Seller must submit major maintenance costs (see 2.6.1.1) to PJM/IMM for review and approval when new major maintenance costs added or previous costs rolled off maintenance history. Major maintenance must be approved before they can be included in the cost-based energy offer.
- Minor Maintenance: The Market Seller may use the default adder specified in OA, Schedule 2 (see 2.6.11) for unit's technology type if available. The default minor maintenance adder is calculated to represent the minor maintenance costs (see 2.6.1.2). In the alternative, the Market Seller may submit unit-specific minor maintenance to PJM/IMM for review if default adder is not available for unit's technology type or the Market Seller elects not to use the default minor maintenance adder. Minor maintenance other than default adder must be approved before they can be included in the cost-based energy offer.
- Operating Costs: The Market Seller may use the default adder specified in OA, Schedule 2 (see 2.6.11) for unit's technology type if available. Otherwise, the Market Seller may submit Operating Costs (see 2.6.8) to PJM/IMM annually for review. Operating Costs other than default adder must be approved before they can be included in the cost-based energy offer.

The Maintenance Adder is based on the actual maintenance expense history of the unit for the defined Maintenance Period (See 2.6.~~3~~4) and must be justified with supporting documentation. The Market Seller shall ~~retain and make available to PJM and/or the Market Monitor when requested such~~ submit supporting documentation (see 2.6.9) for all costs that are included in the unit's historical Maintenance Period. Only expenses incurred as a result of electric production based on operating hours, starts, or a combination of operating hours and starts qualify for inclusion. Fixed costs cannot be included. ~~The Maintenance Adder should be~~

~~reviewed (and updated if changed) at least annually.~~ Maintenance Adders may be included as part of the start cost, no load, or incremental energy offer. Maintenance Adders may be specified as $/Start, $/Hour, $/MMBtu, $/Equivalent Service Hour (ESH), and/or $/MWh. Multiple Maintenance Adders cannot be used unless multiple variable maintenance payment criteria (specified in both starts and hours or starts/hours ratios, etc.) specified in LTSA (see 2.6.10). If multiple Maintenance Adders are used for the same unit(s), the total maintenance costs must be split into multiple Maintenance Adders to prevent double counting.

The Market Seller can use one Maintenance Adder for multiple units at the same generating plant only when units are the same technology type, such as aero-derivative CT. And the Market Seller must include total operating history for all units (for example, total operating hours for unit 1 plus total operating hours for unit 2 plus total operating hours for unit 3).

A Market Seller who elects to use a default minor maintenance adder specified in OA, Schedule 2 (see 2.6.11) may only submit unit-specific major maintenance costs for review. The major maintenance costs shall be submitted when major maintenance costs are added to or removed from the maintenance period. Regardless of when the maintenance is completed, the major maintenance adder shall include a minimum of 10 years of operating history. PJM will specify an expiration date upon approval of the major maintenance adder. Market Sellers that are using the default minor maintenance adder for black start service units shall not use 1% of the total maintenance dollars as part of their black start service annual revenue requirement.

A Market Seller may submit a unit-specific minor maintenance if the unit does not have a default minor maintenance adder available for its technology type or the Market Seller elects not to use the default minor maintenance adder. A Market Seller with tolling agreement must use zero for the default minor maintenance adder, but may include the variable tolling fees in the Maintenance Adder. The default minor maintenance adder may be included in the cost-based energy offer.

The Maintenance Adder ~~must~~ may be submitted to PJM and the MMU for review annually, in accordance with Operating Agreement Schedule 2 Section 4. Market Sellers may only use the PJM-approved unit-specific Maintenance Adder in their unit's cost-based offer. ~~Approved Maintenance adders expire December 31 of the year following acceptance.~~ PJM will specify an expiration date upon approval of the Maintenance Adder. Upon the transfer of ownership to a new Market Seller, the new Market Seller must submit a new Maintenance Adder for PJM review if a non-zero major m~~M~~aintenance a~~A~~dder and/or unit-specific minor maintenance adder is desired.

A Market Seller may include a default operating costs adder (see 2.6.11) in the cost-based energy offer and shall not be required to submit Operating Costs for review. If the Market Seller elects not to use the default operating costs adder, or the unit does not have a default operating costs adder available for its technology type, the Market Seller may submit t~~T~~he Operating Costs ~~must be submitted~~ to PJM and the MMU for review annually, in accordance with Operating Agreement Schedule 2 Section 4. Market Sellers may only use the PJM-approved unit-specific Operating Costs in their unit's cost-based offer. ~~Approved Operating Costs expire December 31 of the year following acceptance.~~ PJM will provide the expiration date of a PJM-approved Operating Costs upon approval of the Operating Costs. Upon the transfer of ownership to a new Market Seller, the new Market Seller must submit a new Operating Costs for PJM review if a non-~~zero~~ default o~~O~~perating c~~C~~osts adder is desired.

Market Sellers may only change the format of the major m~~M~~aintenance ~~a~~Adder (i.e., $/MMBtu, $/MWh, $/Start, etc.) ~~during the annual review period~~once per calendar year. In addition, once the Maintenance adder is approved by PJM, the adder can only be included in the corresponding portions of the associated cost based energy offer components (i.e., No-Load Costs, Incremental Energy Costs, Start-Up Costs).

Market Sellers may only change the format of the Operating Costs (i.e., $/MMBtu, $/MWh) ~~during the annual review period~~once per calendar year. In addition, once the Operating Costs have been approved by PJM, the adder can only be included in the corresponding portions of the associated cost based energy offer components (i.e., No-Load Costs, Incremental Energy Costs, Start-Up Costs).

The Maintenance Adder or Operating Costs and corresponding supporting documentation shall be submitted to PJM/IMM by March 31 of the year that adder expires; PJM shall provide final approval decisions by December 31.

If a Market Seller feels that a unit modification or required change in operating procedures will affect the unit's Maintenance Adder, the revised Maintenance Adder must be submitted to PJM and the MMU for review and PJM-approval prior to use in cost-based offers.

2.6.1 Allowable Maintenance Expenses

Maintenance Costs are expenses incurred as a result of electric production. Allowable expenses can include repair, replacement, inspection, and overhaul expenses, including Long Term Service Agreements (LTSA), related to the following systems and/or their associated FERC accounts identified later in this manual – steam turbine, gas turbine, generator, boiler, Heat Recovery Steam Generators (HSRG), main steam, feed water, condensate, condenser, cooling towers, transformers, and fuel systems. Allowable expenses are maintenance costs that vary directly with the electric production, such as run hours or starts. The ~~major inspection and overhaul costs~~maintenance listed below ~~in sections (a)-(c)~~ are not exhaustive. A Market Seller may include capital costs or expense costs in cost-based offers if those costs are similar to the costs outlined in this provision, so long as they are variable costs that are directly attributable to the production of electricity.

2.6.1.1 Major Maintenance

Major maintenance are overhauls, repairs, or refurbishments that require disassembly to complete of boiler, reactor, heat recovery steam generator, steam turbine, gas turbine, hydro turbine, generator, or engine.~~(a)~~ Major ~~inspections and overhauls of gas turbine and steam turbine generators~~ maintenance include, but are not limited to, the following costs:

- turbine blade repair/replacement;
- turbine diaphragm repair;
- turbine casing repair/replacement;
- turbine bearing repair/refurbishment;
- turbine seal repair/replacement and generator refurbishment;
- ~~heat transfer replacement and cleaning;~~
- ~~cooling tower fan motor and gearbox inspection;~~
- ~~cooling tower fill and drift eliminators replacement;~~

- Selective Catalytic Reduction and CO Reduction Catalyst replacement;
- ~~Reverse Osmosis Cartridges replacement;~~
- ~~air filter replacement;~~
- ~~fuel and water pump inspection/replacement.~~

~~(b) Major maintenance of gas turbine generators directly related to electric production include, but are not limited to:~~

- compressor blade repair/replacement;
- hot gas path inspections, repairs, or replacements;~~.~~

~~(c) Major maintenance of steam turbine generators directly related to electric production include, but are not limited to:~~

- steam stop valve repairs;
- steam throttle valve repairs;
- steam nozzle block repairs;
- steam intercept valve repairs;
- ~~.~~generator stator or rotor rewind, refurbishment, or replacement;
- scrubber refurbishment;
- water wall panel replacement;
- pendant or super heater replacement;
- economizer replacement;
- diesel/reciprocating engine overhaul;
- reactor refueling;
- steam generator overhaul/replacement.

2.6.1.2 Minor Maintenance

Minor maintenance are repairs or refurbishments on equipment and components directly related to electric production, such as main steam, feed water, condensate, condenser, cooling towers, transformers, gas turbine inlet air and exhaust, and fuel systems. Minor maintenance include but are not limited to, the following costs associated with the aforementioned systems:

- heat transfer replacement and cleaning;
- cooling tower fan motor and gearbox inspection;
- cooling tower fill and drift eliminators replacement;
- air filter replacement;
- repair and replacement of valves & piping components, control equipment, pumps, motors, condenser components, transformers, cabling, breakers, motor control centers, switch gear, fuel & ash handling, SCR & Scrubber emission control equipment and

components, mills burners, boiler components, fan components, reactor recirculation compnents, hydraulic control rod drive system components and reactor components.

Minor Maintenance include repairs and replacements done as the result of component failure or prior to failure due to limited remaining life. They could include maintenance work done while the unit is operating or during unplanned or scheduled outages. Maintenance work during annual or otherwise time based outages could also be considered minor maintenance as long as the repairs and replacements are due to wear and tear from electrical production.

Minor Maintenance do not include preventative maintenance surveys done on a time basis such as oil sampling, vibration surveys, infrared surveys, or annual or time based oil or filter changes. However, any repair or replacements that are done as the result of the survey for wear and tear from electric production or limited remaining life are considered minor maintenance.

2.6.1.3 Unallowable Expenses

Maintenance Costs that cannot be included in a unit's cost-based offer are time-based~~,~~ or annual maintenance or preventative maintenance, ~~and~~or routine maintenance ~~-~~on any equipment~~systems.~~, Also unallowable are any maintenance costs that do not vary with ~~and any maintenance on systems not directly related to~~ electric production, such as ~~auxiliary equipment like~~ buildings, HVAC, compressed air, closed cooling water, heat tracing/freeze protection, control room equipment and software, reactor safety system and plant water treatment systems. Typically, if the system is needed to remain in-service when the unit is not in operation expenses related to it cannot be included in a unit's cost based offer.

Upgrades or replacement of existing equipment with capital upgrades/enhancements typically cannot be included in the calculation of a unit's maintenance adder. If the equipment is being upgraded because the original equipment is obsolete and can no longer be procured, this expense is considered a replacement and can be included.

Expenses for repairs and or replacements due to weather events also cannot be included in a unit's maintenance history, items that have failed, for example, due to a lighting strike or external weather corrosion are not directly related to electric production.

2.6.2 Labor Costs

Labor costs included in cost-based offers are limited to start-up costs for additional staffing requirements and do not include straight-time labor costs. Only staff overtime or contractor labor incurred for costs referenced in Section 2.6.1 of Manual 15 can be included in maintenance adder. Staff overtime or contractor labor to augment existing operations staff to run the unit cannot be included in the unit's cost-based offer.

2.6.3 Escalation Index

Escalation Index is the annual escalation index derived from the Handy - Whitman Index Table published at the PJM website link below:

https://www.pjm.com/committees-and-groups/subcommittees/cds/handy-whitman-index.aspx

These escalation indices could be used in the calculation of generating unit Maintenance Adders and Operating Costs.

2.6.4 Maintenance Period

A unit must choose a rolling historical period based on calendar year. A unit may choose a 10-year or 20-year period for maintenance cost, or all available actual maintenance history if a unit has less than 20 years of maintenance history. Once a unit has chosen the historical period length, the unit must stay with that period until a significant unit configuration change. Significant unit configuration change is defined as any change to the physical unit's system that significantly affects the maintenance cost for a period greater than 10 years. Examples of a significant unit configuration may include but are not limited to:

- Flue Gas Desulfurization (FGD or scrubber)
- Activated Carbon Injection (ACI)
- Selective Catalytic NOx Reduction (SCR)
- Selective Non-Catalytic NOx Reduction (SNCR)
- Low-NOx burners
- Bag House addition
- Long-term Fuel change (greater than 10 years)
- Water injection for NOx control
- Turbine Inlet Air Cooling

A maintenance period choice may also be given in circumstances of change in ownership necessitating a new Interconnection Service Agreement (ISA). Change of ownership within the same holding company is not eligible to change the historical maintenance period.

Note:
~~Total Maintenance Dollars must be calculated for the same historical period as Equivalent Service Hours.~~

2.6.5 Incremental Adjustment Parameter

Incremental Adjustment Parameter is defined as any variable cost incurred in the production of energy for PJM dispatch that is not included in the CDS guidelines for Total Fuel Related Costs or Maintenance Adder. This includes any variable cost that has been previously approved pursuant to Cost Methodology and Approval Process for inclusion. These records shall be made available to PJM and MMU upon request.

2.6.6 Equivalent Service Hours Maintenance Cost

- The Equivalent Service Hours Maintenance Cost. This is defined as total maintenance dollars divided by equivalent service hours.

$$EquivalentServiceHoursMaintenanceCost\ (\$/ESH) = \frac{TotalMaintenanceDollars}{EquivalentServiceHours}$$

/

- Estimated Year 2011 Total Maintenance Cost calculation example for a CT:

$$TotalMaintenanceCost_{2011} =$$
$$\left(AnnualMaintenanceCost_{2010} * \frac{EscalationIndex_{2011}}{EscalationIndex_{2010}}\right) +$$
$$\left(AnnualMaintenanceCost_{2009} * \frac{EscalationIndex_{2011}}{EscalationIndes_{2009}}\right) +$$
$$\left(AnnualMaintenanceCost_{2008} * \frac{EscalationIndex_{2011}}{EscalationIndex_{2008}}\right) +$$
$$\ldots + \left(AnnualMaintenanceCost_{2000} * \frac{EscalationIndex_{2011}}{EscalationIndex_{2000}}\right)$$

- ~~Estimated Year 2011~~ Equivalent Service Hours calculation example:

$$EquivalentServiceHours =$$
$$(CyclicStartingFactor * NumberOfStarts) + TotalOperatingHours +$$
$$(CyclicPeakingFactor * NumberOfHoursAboveBaseload)$$

Note:
Cyclic Starting Factors and Cyclic Peaking Factors can be used only when the maintenance adder is in $/ESH and the values can be supported by LTSA or OEM. They shall be consistently used for equivalent service hours and cost based offer calculations for simple cycle or combined cycle CT major maintenance costs only. Cyclic Fuel Factors can be used in the calculation of ESH if specified in the LTSA or OEM. Multiple cyclic peaking factors can be included in the calculation of ESH if specified in the LTSA or OEM. Cyclic Starting Factors and Cyclic Peaking Factors values shall be consistently used for equivalent service hours and cost based offer calculations for CC and CT Units. See cyclic starting factor and cyclic peaking factor in sections 5.6.3 & 6.6.3.

2.6.7 Immature Units: Maintenance Costs

Immature Units - Units with neither 10 years of operation nor 50,000 Operating Hours.

Immature Units should use actual available costs. Maintenance costs, operating costs and operating history must correspond to the number of years for which supporting documentation is available.

When a resource has less than one calendar year of operating history available, the Market Seller may use the default minor maintenance adder and default operating costs adder specified in OA, Schedule 2 (see 2.6.11) ~~Variable Operations and Maintenance default value for its resource class published by Monitoring Analytics in the latest Annual State of the Market Report. If the Market Seller elect to use such value, it can only be used as Operating Costs in the format of $/MWh;~~ the major maintenance adder must be 0.

Once a unit reaches either 10 years of operation or 50,000 Operating Hours, it is considered a mature unit. Once a unit is mature, it will use actual historical maintenance cost and the Market Seller will decide to use a 10 or 20 year history (See section 2.6.2). If a mature unit has less maintenance history than its elected historical period, the Market Seller will use all available history to calculate the Maintenance Adder. For mature units that transferred

ownership, the new owner should include maintenance and operating costs for which supporting documentation is available. Operating history must reflect at least 10 (up to 20) years.

2.6.8 Operating Costs

The Operating Costs can be represented by the default adder specified in OA, Schedule 2 (see 2.6.11) or submitted by the Market Seller to PJM/IMM to review.

The **Operating Costs** may be calculated based on a fixed or rolling average of values from one to five years in length, reviewed (and updated if changed) annually, or a rolling average from twelve to sixty months in length, reviewed (and updated if changed) monthly. Both the term and the frequency of the Operating Cost calculation shall be included in the Market Seller's Operating Costs ~~template~~.

- Allowable Operating Cost include lubricants, chemicals, Limestone, Trona, Ammonia, acids, caustics, water injection, ~~and~~ demineralizers, ash disposal, and waste disposal. Operating Cost also include variable Title V and other applicable emissions fees.
- Allowable Operating Costs must be directly related to electric production. They are incurred or used during startup, while operating producing MWs, or during shutdown. If any of the operating costs incurred have already been included in the start-up cost, such costs will not be allowed as operating costs.
- Market Sellers will be allowed to include additional operating costs via the Section 1.8 cost methodology and approval Process. Acceptable items will be added to M15 during the biennial revision.
- Operating Costs may be specified as $/MMBtu or $/MWh only.
- Escalation of previous year's Operating Costs dollar amounts is permitted when the term of calculation exceeds twelve months. When used, escalation indexes will be the same as those developed for calculation of incremental Maintenance Adders.
- Market Sellers that elect to use monthly rolling average shall submit the operating cost adder value to PJM and IMM via COA monthly if no cost items change; If cost items change, Market Sellers must also submit a new Operating Costs to PJM and IMM.

2.6.8.1 Leased Fuel Transportation Equipment

Leased Fuel Transportation Equipment Cost –Expenses incurred using leased equipment to transport fuel to the plant gate.

Only the leased equipment costs that vary with electric production can be included in the Operating Costs. If the costs are fixed, they must be excluded. If the costs are based on a charge for every unit of fuel delivered, such costs should be included in the fuel costs and not included in Operating Costs.

2.6.9 Supporting Documentations

The supporting documentations for the Maintenance Adder and Operating Costs may be in the format of maintenance management system records, general ledger data, accounting records or invoices. The maintenance expenses and operating costs and supporting documentation must be linked and traceable. The supporting documentation must clearly show how each cost item was calculated.

Supporting documentations for maintenance expenses shall include the work order and/or description of maintenance activities performed.

Supporting documentations for operating costs shall include the amount of each consumable used while in operation, and the cost per unit of each consumable.

2.6.10 Maintenance Adder with LTSA

When LTSA costs are included, the Market Seller shall use the format of adder consistent with the variable maintenance payment criteria (i.e. $/starts, $/hours, etc.) specified in LTSA.

The adder format shall be consistent with the maintenance expense and is a function of units starts or run hours. For example, if the maintenance expenses are a function of starts, the Maintenance Adder shall be in $/start.

Units that have LTSA or OEM documentation which specifies N-Ratio (i.e. run hours divided by number of starts) for maintenance payments will apply those in consistent manner in submitting Maintenance Adder. For example, a Market Seller allocates the dollars charged based on starts and divide by total starts to get a $/start adder; and allocates the other dollars charge based on hours and divide by total hours to get a $/hour adder.

2.6.11 Default Adders

A Market Seller may elect to utilize a default minor maintenance adder or submit unit-specific minor maintenance costs to the Office of Interconnection and the Market Monitoring Unit. All maintenance costs on a unit-specific basis must be submitted to the Office of Interconnection and the Market Monitoring Unit.

A Market Seller may include a default operating costs adder in the cost-based energy offer in lieu of submitting unit-specific operating costs for review and approval.

The default adders (calculated from 2020 data escalated for 2021) are as follows:

Technology Type	Default Minor Maintenance Adder ($/MWh)	Default Operating Costs Adder ($/MWh)
Combined Cycle	0.98	0.40
Combustion Turbine	3.59	0.75
Reciprocating Engine	4.03	1.62
Fossil Steam	1.71	2.87

The default adders shown above shall be escalated for use beginning with the 2024 calendar year and annually for the subsequent years utilizing the Handy Whitman Index and shall be posted annually by the Office of Interconnection.