PJM Manual 15:

Cost Development Guidelines

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Prepared by:
Cost Development Subcommittee

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2.6.4 Equivalent Hourly Maintenance Cost

The hourly Maintenance Cost in dollars per hour. This is defined as total maintenance dollars divided by equivalent service hours or total fuel, depending on unit type.

\[
\text{Equivalent Hourly Maintenance Cost ($/Hour)} = \frac{\text{Total Maintenance Dollars}}{\text{Equivalent Service Hours}}
\]

Or

\[
\text{Equivalent Hourly Maintenance Cost ($/mmbtu)} = \frac{\text{Total Maintenance Dollars}}{\text{Total Fuel}}
\]

Estimated Year 2011 Total Maintenance Example for a Combustion Turbine

\[
\text{Total Maintenance Cost}_{2011} = \left( \text{Annual Maintenance Cost}_{2010} \times \frac{\text{Escalation Index}_{2011}}{\text{Escalation Index}_{2010}} \right) + \\
\left( \text{Annual Maintenance Cost}_{2009} \times \frac{\text{Escalation Index}_{2011}}{\text{Escalation Index}_{2009}} \right) + \\
\left( \text{Annual Maintenance Cost}_{2008} \times \frac{\text{Escalation Index}_{2011}}{\text{Escalation Index}_{2008}} \right) + \ldots + \\
\left( \text{Annual Maintenance Cost}_{2000} \times \frac{\text{Escalation Index}_{2011}}{\text{Escalation Index}_{2000}} \right)
\]

Estimated Year 2011 Equivalent Service Hours

\[
\text{Equivalent Service Hours} = (\text{Cyclic Starting Factor} \times \text{Number of Starts}) + \text{Total Operating Hours} + (\text{Cyclic Peaking Factor} \times \text{Number of Hours above Baseload})
\]

**Cyclic Starting Factors and Cyclic Peaking Factors values shall be consistently used for equivalent service hours and cost based offer calculations for Combined Cycle and Combustion turbine Units.** See cyclic starting factor and cyclic peaking factor in section 5.6.3 & 6.6.3.


Total Maintenance Dollars = \$406,236
Equivalent Service Hours = 118,348 Hours

\[
\text{Total Maintenance Dollars} \quad \frac{\text{Equivalent Service Hours}}{118,348 \text{ Hours}} = \$3.43/\text{Hour}
\]

*Exhibit 2: Example Calculation of Maintenance Adder for a CT using a 10 year Maintenance Period*

*Exhibit 6: Regulation Maximum Allowable Cost Adder Example*
Section 4: Fossil Steam Unit Cost Development

This section contains information pertaining to Fossil Steam Unit Cost development.

**Fossil Steam Turbine plants** use combusted fossil fuels to heat water and create steam that generates the dynamic pressure to turn the blades of a steam turbine generator.

Units that fire solid waste, biomass, or landfill gas solely or in conjunction with fossil fuels to heat water and create steam to drive a steam turbine generator are considered to be **Fossil Steam Turbine plants**.

4.1 Heat Rate

*Note:* The information in Section 2.1 contains basic Heat Rate information relevant for all unit types including fossil steam units.

4.2 Performance Factor

*Note:* The information in Section 2.2 contains basic Performance Factor information relevant for all unit types. The following information only pertains to fossil steam units.

Like units that can be used for calculation of performance factors are units having similar ratings, steam conditions, make or model and same site location.

4.3 Fuel Cost

*Note:* The information in Section 2.3 contains basic Fuel information relevant for all unit types. The following information only pertains to fossil steam units.

Fossil fuel cost adjustments compensating for previous estimate inaccuracies should not be considered when determining the basic fossil cost component of Total Fuel Related Cost.

**Fossil Other Fuel-Related Costs.** The dollars in FERC Account 501 Fuel plus incremental expenses for fuel treatment and pollution control (excluding SO\(_2\) and NO\(_X\) emission allowance costs) that were not included in Account 501; minus the fuel expenses from FERC Account 151 that were charged into Account 501, all divided by the fuel (heat content or quantity) shifted from Account 151 into Account 501.

4.3.1 Total Fuel Related Cost

Total Fuel Related Cost is the sum of the Basic Fuel Cost, applicable Other Fuel-Related Costs and the Maintenance Adder, CO\(_2\), SO\(_2\), and NO\(_X\) emission allowance costs.

\[
\text{Total Fuel Related Cost} \left( \$/\text{MBTU} \right) = \text{Fuel Cost} + \text{Other Fuel Related Cost} + \text{SO2 Allowance Cost} + \text{CO2 Allowance Cost} + \text{NOx Allowance Cost} + \text{Maintenance Adder}
\]
TFRC = Total Fuel Related Cost

4.4 Hot Start Cost, Intermediate Start Cost, and Cold Start Cost

**Note:** The information in Section 2.4 contains basic Start Cost information relevant for all unit types. The following information only pertains to fossil steam units.

- In some instances, a Steam Unit with a Start-up plus Notification time greater than 48 hours may enter a state called "Extended Cold Start" as described in the eMKT User Guide. Steam units in this state, calculate the Start Cost information associated with this state in accordance with the "Cold Start Cost" Section below and enter this value into the "Cold Start Cost" field in eMKT.

**Start Cost ($ / Start) =**

\[
\text{Start Cost} = \left( \text{Start Fuel Consumed (MBTU/Start)} \times \text{TFRC ($/MBTU)} \times \text{Performance Factor} \right) + \left( \text{Station Service (MWh)} \times \text{Station Service Rate ($/MWh)} \right) + \text{Start Maintenance Adder ($/Start)} + \text{Start Additional Labor Cost ($/Start)}
\]

**4.4.1 Hot Start Cost**

Hot start cost is the expected cost to start a steam unit, which is in the "hot" condition. Hot conditions vary unit by unit, but in general, a unit is hot after an overnight shutdown. Components of hot start cost include:

- **Total fuel-related cost** are the costs from first fire of start process to breaker closing (including auxiliary boiler fuel) priced at the cost of fuel currently in effect including shutdown fuel cost defined as the cost of fuel expended from breaker opening of the previous shutdown to initialization of the (hot) unit start-up, excluding normal plant heating/auxiliary equipment fuel requirements.

- **Station Service** from initiation of start sequence to breaker closing (total station use minus normal base station use) priced at the Station Service rate and station service after breaker opening during shutdown (station service during shutdown should be that associated with the normal unit auxiliary equipment operated during shutdown in excess of base unit use, this station service is not to include maintenance use or non-normal use) priced at the Station Service rate.

- **Additional labor costs** in excess of normal station manning requirements that are incurred when starting the unit.

- **Start Maintenance Adder** Section 2.6 contains information regarding calculation of Maintenance Adder.

**4.4.2 Intermediate Start Cost**

Intermediate start cost is the expected cost to start a steam unit during a period where neither hot nor cold conditions apply. Use of intermediate start cost is optional based on company policy and physical machine characteristics. The only restriction is that once an intermediate start cost is defined for a unit, the cost must be used consistently in scheduling and accounting. Components of intermediate start cost include:
Total fuel-related cost is the cost from first fire to breaker closing (including auxiliary boiler fuel) priced at the cost of fuel currently in effect, and shutdown fuel cost defined as the cost of fuel expended from breaker opening of the previous shutdown to initialization of the (intermediate) unit start-up, excluding normal plant heating/auxiliary equipment fuel requirements.

Station Service from initiation of start sequence to breaker closing (total station use minus normal base station use) priced at the Station Service rate and station service after breaker opening during shutdown (station service during shutdown should be that associated with the normal unit auxiliary equipment operated during shutdown in excess of base unit use, this station service is not to include maintenance use or non-normal use) priced at the Station Service rate.

Additional labor costs in excess of normal station manning requirements that are incurred when starting the unit.

Start Maintenance Adder Section 2.6 contains information for calculation of the Maintenance Adder.

4.4.3 Cold Start Cost

Cold start cost is the expected cost to start a steam unit that is in the "cold" condition. Cold conditions vary unit by unit, but in general, a unit is cold after a two or three-day shutdown. Components of cold start cost include:

Total fuel-related cost from first fire to breaker closing (including auxiliary boiler fuel) priced at the cost of fuel currently in effect, and shutdown fuel cost defined as the cost of fuel expended from breaker opening of the previous shutdown to shutdown of equipment needed for normal cool down of plant components, excluding normal plant heating/auxiliary equipment fuel requirements.

Station Service from initiation of start sequence to breaker closing (total station use minus normal base station use) priced at the Station Service rate and station service after breaker opening during shutdown (station service during shutdown should be that associated with the normal unit auxiliary equipment operated during shutdown in excess of base unit use, this station service is not to include maintenance use or non-normal uses) priced at the Station Service rate.

Additional labor costs in excess of normal station manning requirements that are incurred when starting the unit.

Start Maintenance Adder Section 2.6 contains information for calculation of the Maintenance Adder.
Section 5: Combined Cycle (CC) Cost Development

5.6 Maintenance Cost

Note: The information in Section 2.6 contains basic Maintenance Cost information relevant for all unit types. The following additional information only pertains to combined cycle units.

Combined Cycle Maintenance Adder – The dollars per unit of fuel (or heat) as derived from FERC Accounts 512, 513, and 553. If submitting as a simple cycle combustion turbine, use total dollars from FERC Account 553 divided by Equivalent Service Hours (ESH).

5.6.1 Combined Cycle / Combustion Turbine Long Term Service Contract Cost Recovery

A generation owner that has a currently in effect Long Term Service Contract (LTSA) with a third party vendor to provide overhaul and maintenance work on a Combustion Turbine (CT) either as part of a Combined Cycle (CC) plant or as a stand-alone CT, may file with the PJM MMU or PJM for inclusion of any variable long term maintenance costs in cost based offer bids pursuant to the Cost Methodology Approval Process, if the following conditions are met:

- The included variable long-term maintenance costs are consistent with the definition of such costs in the Cost Development Guidelines
- And the dollar value of each component of the variable long-term maintenance costs is set specifically in the LTSA.

5.6.2 Long Term Maintenance Expenses

Long Term Maintenance Expenses - Combined Cycle Plant major inspection and overhaul expenses, after being approved by the MMU, may be included until June 1, 2015 in variable maintenance expenses. Previously approved Long Term Maintenance Expenses will be removed from maintenance history as of June 1, 2015.

5.6.3 Equivalent service hours (ESH)

The estimated hours the unit will run based on history:

\[
\text{Equivalent Service Hours} = (\text{Cyclic Starting Factor} \times \text{Number of Starts}) + \text{Total Operating Hours at any load level} + (\text{Cyclic Peaking Factor} \times \text{Number of Hours above Base load temperature limit})
\]

Where Combined Cycle CTs shall use OEM supplied values for Cyclic Starting Factors and Cyclic peaking factors even if the CT technology is no longer being built. In situations where cyclic Starting factors or Cyclic Peaking factors are unknown or unavailable, Combined Cycle CTs shall use:

Cyclic starting factor = 5.0 for aircraft - type CTs and 10.0 for industrial - type CTs

And
**Cyclic peaking factor = 3.0 for all CTs.**

**Where**

**A Cyclic starting factor = 10.0 for an industrial – type CT for**

*For example, the incremental maintenance charged to one start on an industrial - type CT is equivalent to the incremental maintenance attributable to ten hours of base load operation.*

**And the Cyclic peaking factor = 3.0 for all CTs**

*This means that the additional incremental maintenance charged to the incremental energy between base and peak loads is equivalent to the incremental maintenance attributable to three hours of base load operation.*
Section 6: Combustion Turbine (CT) and Diesel Engine Costs

6.6 Maintenance Cost

**Note:** The information in Section 2.6 contains basic Maintenance Cost information relevant for all unit types. The following additional information only pertains to CT and diesel engine units.

**Combustion Turbine - Maintenance Adder** – The total dollars from FERC Account 553 divided by Equivalent Service Hours (ESH).

**Industrial Combustion Turbine** – This is a combustion turbine developed specifically for power generation.

**Aircraft - Type Combustion Turbine** – These are combustion turbines originally designed for aircraft and modified for power generation.

**Diesel - Maintenance Adder** – The total dollars from FERC Account 553 divided by total fuel burned (in MBTUs).

**Combustion Turbine Start** – For calculating combustion turbine maintenance cost, only the number of successful starts to synchronization shall be used. Successful starts should include those at the direction of PJM and for company tests.

**Long Term Maintenance Expenses** – Combustion Turbine Plant major inspection and overhaul expenses, after being approved by the MMU, may be included until June 1, 2015 in variable maintenance expenses. Previously approved Long Term Maintenance Expenses will be removed from maintenance history as of June 1, 2015.

**6.6.1 Combustion Turbine Maintenance Adder Example**

\[
\text{Equivalent Hour Maintenance Cost} = \frac{\text{Total Maintenance Dollars}}{\text{Equivalent Service Hours}} 
\]

(Industrial Unit)

Peak Hours = 200 Hrs

Service Hours = 2000 Hrs

No. of Starts = 300

Peak Pickup = 5 MW

Peak Hours are the hours run above base load temperature rating.

Total Maintenance Dollars = $100,000

(Actual historical maintenance data escalated to present value).

Cyclic Starting Factor = 10, Cyclic Peaking Factor = 3 (Note: Cyclic Starting Factor = 5 for aircraft engine CT's).
Equivalent Hourly Maintenance Cost (EHMC) = \( \frac{100,000}{(10 \times 300) + 2,000 + (3 \times 200)} \)

\[ \text{EHMC} = \$17.86/\text{Hr.} \]

Calculation of maintenance rates

Starting Maintenance Cost = Cyclic Starting Factor \times Equivalent Hourly Maintenance Cost

\[ = 10 \times \$17.86 = \$178.60 \text{ per start} \]

Hourly Maintenance Rate = Equivalent Hourly Maintenance Cost = \$17.86/\text{hour} \]

Peak Incremental Maintenance Rate \[ \frac{\text{Cyclic Starting Factor}}{\text{Peak Pickup}} \times \text{Equivalent Hourly Maintenance Cost} \]

\[ = \frac{3 \times \$17.86}{5} \]

\[ = \$10.72 \text{ per MWh} \]

*Exhibit 15: Combustion Turbine Maintenance Cost Adder Example*

6.6.2 Combustion Turbine Long Term Service Contract Cost Recovery

A generation owner that has a currently effective Long Term Service Contract (LTSA) with a third party vendor to provide overhaul and maintenance work on a Combustion Turbine (CT) may file a request for inclusion of any variable long term maintenance costs in cost based offer bids, pursuant to the Cost and Methodology Approval Process if the following conditions are met:

- The included variable long-term maintenance costs are consistent with the definition of such costs in the Cost Development Guidelines
- And the dollar value of each component of the variable long-term maintenance costs is set specifically in the LTSA.

6.6.3 Equivalent service hours (ESH)

The estimated hours the unit will run based on history.

Equivalent Service Hours = (Cyclic Starting Factor \times Number of Starts) + Total Operating Hours at any load level + (Cyclic Peaking Factor \times Number of Hours above Base load temperature limit)

Combustion turbines shall use OEM supplied values for Cyclic Starting Factors and Cyclic peaking Factors even if the CT technology is no longer being built. In situations where Cyclic
Starting Factors or cyclic Peaking factors are unknown or unavailable, Combustion Turbines shall use:

Cyclic starting factor = 5.0 for aircraft - type CTs and cyclic starting factor = 10.0 for industrial - type CTs

And

Cyclic Peaking factor = 3.0 for all CTs

Where:

A Cyclic starting factor = 5.0 for aircraft - type CTs and cyclic starting factor = 10.0 for an industrial - type CTs

For example, the incremental maintenance charged to one start on an industrial - type CT is equivalent to the incremental maintenance attributable to ten hours of base load operation.

And a Cyclic peaking factor = 3.0 for all CTs

This means that the additional incremental maintenance charged to the incremental energy between base and peak loads is equivalent to the incremental maintenance attributable to three hours of base load operation.

6.6.4 Diesel Incremental Maintenance Adder Calculation

The incremental Maintenance Adder for diesel units will be calculated and applied on a "per MBTU (or other unit of fuel)" basis. The calculation will be based on actual operation and escalated maintenance expenses for all available history in the Maintenance Period.