



Working to Perfect the Flow of Energy

PJM Manual 15:

Cost Development Guidelines

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Prepared by

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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

$$\begin{aligned} \text{Total Maintenance Cost}_{2011} = & \\ & \left(\text{Annual Maintenance Cost}_{2010} * \frac{\text{Escalation Index}^{2011}}{\text{Escalation Index}^{2010}} \right) + \\ & \left(\text{Annual Maintenance Cost}_{2009} * \frac{\text{Escalation Index}^{2011}}{\text{Escalation Index}^{2009}} \right) + \\ & \left(\text{Annual Maintenance Cost}_{2008} * \frac{\text{Escalation Index}^{2011}}{\text{Escalation Index}^{2008}} \right) + 0 \\ & \dots 0 \left(\text{Annual Maintenance Cost}_{2000} * \frac{\text{Escalation Index}^{2011}}{\text{Escalation Index}^{2000}} \right) \end{aligned}$$

Estimated Year 2011 Equivalent Service Hours

$$\begin{aligned} \text{Equivalent Service Hours} = & \\ & (\text{Cyclic Starting Factor} * \text{Number of Starts}) + \text{Total Operating Hours} + (\text{Cyclic Peaking Factor} \\ & * \text{Number of Hours above Baseload}) \end{aligned}$$

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

$$\text{Equivalent Hourly Maintenance Cost (\$/Hour)} =$$



$$\frac{\text{Total Maintenance Dollars}}{\text{Equivalent Service Hours}} = \frac{\$406,236}{118,348 \text{ Hours}} = \$3.43/\text{Hour}$$

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

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:

$$\begin{aligned} \text{Equivalent Service Hours} = & \\ & (\text{Cyclic Starting Factor} * \text{Number of Starts}) + \text{Total Operating Hours at any load level} \\ & + (\text{Cyclic Peaking Factor} * \text{Number of Hours above Base load temperature limit}) \end{aligned}$$

Combined Cycle CTs shall use OEM supplied values for Cyclic Starting Factor and Cyclic Peaking Factor 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 = ~~5.0 for aircraft-type CTs and~~ 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 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).

$$\begin{aligned}\text{Equivalent Hourly Maintenance Cost (EHMC)} &= \frac{\$100,000}{(10 * 300) + 2,000 + (3 * 200)} \\ &= \$17.86/\text{Hr.}\end{aligned}$$

Calculation of maintenance rates

$$\begin{aligned}\text{Starting Maintenance Cost} &= \text{Cyclic Starting Factor} * \text{Equivalent Hourly Maintenance Cost} \\ &= 10 * \$17.86 = \$178.60 \text{ per start}\end{aligned}$$

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

$$\begin{aligned}\text{Peak Incremental Maintenance Rate} \\ &= \frac{\text{Cyclic Starting Factor}}{\text{Peak Pickup}} * \text{Equivalent Hourly Maintenance Cost} \\ &= \frac{3 * \$17.86}{5} \\ &= \$10.72 \text{ per MWh}\end{aligned}$$

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.

$$\text{Equivalent Service Hours} =$$

(Cyclic Starting Factor * Number of Starts) + Total Operating Hours at any load level
+ (Cyclic Peaking Factor * Number of Hours above Base load temperature limit)

Combustion Turbines shall use OEM supplied values for Cyclic Starting Factor and Cyclic Peaking Factor 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 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.

