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# Instructions for the Major Maintenance Template

## Overview

The Major Maintenance Template is a dynamic form for use in gathering the necessary data needed to calculate major maintenance adders. The form is dynamic in that when filled out in order from top to bottom and left to right, the form changes to be applicable to the equipment and maintenance items being entered.

The form is divided into four tables. The top table is for General Plant Information. This captures the specifics of the prime mover in adequate detail to modify the rest of the form, and enable comparisons of responses with similar technology for validation purposes. The second table, "Maintenance Cycles", is for specifying the operating parameters that drive the maintenance cycles, schedules or costs for each equipment group. The third table, "Scheduling Coordinator Estimates" enables values for maintenance adders to be provided directly by the Scheduling Coordinator, rather than calculated, subject to validation. The bottom table, "Maintenance Actions", captures the individual maintenance action items along with the cost and schedule associated with each.

## General Plant Information Table

General Plant Information (for validation purposes)		
	Response	Comments
Technology		
Primary Fuel		
Boiler Pressure		
Circulation Design		
Combustion System		
Manufacturer		
Model Series		
Operating Speed (RPM)		
Reciprocating Engine Design		
Model		
In Service Date		
Summer Dependable Capacity (MW)		

The General Plant Information table contains the following fields:

- "Technology" has a pull-down menu with the following choices:
  - Combustion\_Turbine\_and\_Combined\_Cycle
  - Conventional\_Steam\_Boiler
  - Nuclear
  - Hydro
  - Geothermal
  - Reciprocating\_Diesel\_or\_Other\_Fuel
  - Wind
  - Solar

- Other
- “Primary Fuel” has a pull-down menu with the following choices:
  - Coal
  - Gas
  - Oil
  - Nuclear
  - Wind
  - Solar
  - Water
  - Other
- “Boiler Pressure” only applies to the Conventional Steam Boiler technology, and can be either
  - Subcritical
  - Supercritical
- “Circulation Design” only applies to subcritical conventional steam boilers, and can be either
  - Natural circulation
  - Once-through: Boilers without steam drums
- “Combustion System” only applies to Coal units. It has a pull-down menu with the following choices:
  - Cyclone
  - Stoker
  - Pulverized coal
  - Fluidized bed reactor
  - Coal gasification
- “Manufacturer” only applies to Combustion Turbine and Combined Cycle units. It has a pull-down menu with the following choices:
  - General\_Electric\_Frame\_CTs
  - General\_Electric\_Aeroderivative
  - Siemens\_Westinghouse
  - Pratt\_Whitney
  - Dresser\_Rand
  - Alstom
  - Solar\_Turbines
  - Rolls-Royce
  - Hitachi
  - Other
- “Model Series” only applies to Combustion Turbine and Combined Cycle units and provides a pull-down menu that is specific to the manufacturer.
- “Operating Speed” only applies to the “Reciprocating Diesel or Other Fuel” technology. The speed in RPM (Revolutions per Minute) is to be provided in whole numbers.

- “Reciprocating Engine Design” only applies to the “Reciprocating Diesel or Other Fuel” technology, and can be either
  - 4-Stroke: Otto cycle or Diesel
  - 2-Stroke: Spark ignition or compression ignition
- Model is a free text field where the specific model number is to be entered.
- In Service Date is a date field where the in service date or commercial operation date is entered.
- Summer Dependable Capacity (MW) is a numeric field where the summer dependable capacity is entered in MW.

All the fields in this table are followed by a “Comments” field which allows the user to provide any information that they feel will be helpful.

### Maintenance Cycles Table

Maintenance Cycles			
Cycle	Equipment Group	Criteria	Primary Factor
A	Prime Mover	Blended influence of multiple parameters (eg. equivalent operating hour)	Operating Hours
B			
C			
D			
E			
F			
G			

Secondary Factor	Equivalence to Primary Factor	Equivalency Units	Third Factor	Equivalence to Primary Factor	Equivalency Units	Fourth factor	Equivalence to Primary Factor	Equivalency Units
Starts	20	Starts per Operating Hours	Production (MWhr)	5	Production (MWhr) per Operating Hours	Calendar Hours	8	Calendar Hours per Operating Hours

The Maintenance Cycles table contains the following fields:

- Equipment Group is a free text field where groups of components that share the same maintenance cycle are described. By default, Cycle “A” is for the Prime Mover which is described in the General Plant Information table. The Prime Mover is the portion of the power plant that consumes the fuel. Other equipment groups can be provided in subsequent rows as Cycles B through G.

- The "Criteria" field is used to describe how from one to four different factors (Operating Hours, Starts, Production (MWhr) and/or Calendar Hours) affect the timing of when the major maintenance costs are incurred for the equipment group. This field has a pull-down menu with the following choices:
  - Single parameter
  - Earlier of multiple parameters
  - Blended influence of multiple parameters (eg. equivalent operating hour)
  - Blended influence of multiple parameters (eg. equivalent operating hour) and Earlier of multiple parameters
- The "Primary Factor" is the primary determinate for the maintenance cycle. This field has a pull-down menu with the following choices:
  - Operating Hours
  - Starts
  - Production (MWhr)
  - Calendar Hours
- The Secondary Factor, Third Factor, and Fourth Factor allow for the selection of whatever factors were not already selected as a higher priority. Only populate fields that are highlighted in light green. These choices will not apply if the criteria "Single parameter" is selected.
- The "Equivalence to Primary Factor" fields apply to the blended influence of multiple factors and specify the quantity of non-primary factors that equate to a unit of primary factors. The quantity is to be specified in the units of shown in the "Equivalency Units" fields.
- The "Equivalency Units" fields provide the units for the Equivalence to Primary Factor.

## Scheduling Coordinator Estimates

The Scheduling Coordinator Estimates table contains the following fields:

- The \$ per Start and \$ per Run Hour allow the scheduling coordinator to propose values to be used as maintenance adders directly. The use of the proposed values will be subject to validation.
- The \$ per MWhr and \$ per Calendar Hr fields provide a place for the scheduling coordinator to report a broader range of expenses, but these values are not included in the maintenance adders. They are for information only. The first can be included in the energy component, and the second is considered fixed costs.
- The Cost Basis is the basis for the numbers that the scheduling coordinator provides. This field has a pull-down menu with the following choices:
  - Estimates from parts and service providers
  - Historical Costs (adjust to current year \$)
  - Maintenance Service Contract
  - Power Purchase Agreement
  - Other (explain)

- The last column, "References and Comments", provide a place to elaborate on the cost basis, and cite references to document(s) that describe basis of the maintenance cost provided. Also to be provided are affiliate relationships with service providers as applicable.

This table is organized in rows by "Cycle" as defined in the "Maintenance Cycles" table above. This serves two purposes:

1. Different equipment groups within the plant may be under different cost basis and have different schedules for major maintenance. For example, a combustion turbine at a combined cycle facility may be under a long term service agreement with the original equipment manufacturer, but the steam turbine may be from a different manufacturer and not under a maintenance agreement.
2. The detail of cycles enables the calculation of major maintenance adders for the various configurations of multi-stage generation resources.

## Maintenance Actions Table

Maintenance Actions					
Row	Cycle	Scheduled Maintenance Action	Description	Cost	Year Dollars
1	A	Beginning of Current Cycle			
2	A				
3					
4					
5					
6					
7					

Cycle Incremental Requirements									
Incremental Operating Hours	Row Reference	Incremental Starts	Row Reference	Incremental Production (MWhr)	Row Reference	Incremental Calendar Hours	Row Reference	Complete	Documentation Reference

The Maintenance Actions table contains the following fields:

- Cycle: Each row of Scheduled Maintenance Action must be preceded by a Cycle letter. The cycles refer to the Equipment Groups defined in the Maintenance Cycles table.
- Scheduled Maintenance Action: This field has a pull-down list that is specific to the technology type. Each list includes a "Beginning of Current Cycle" and an "End of Current Cycle" choice with one or more major maintenance actions between. The maintenance cycles for each equipment group must begin with a "Beginning of Current Cycle" record and end of an "End of Current Cycle" record. Records can be provided prior to the "Beginning of Current Cycle" record and following the "End of Current Cycle" record for informational purposes, but they will not be included in the major maintenance adder calculations. The expectation is that following the

"End of Current Cycle", the equipment is in a restored condition and subject to a new cycle of maintenance actions similar to the prior cycle.

- **Description:** Enter a description of the activities in the Scheduled Maintenance Action. For the "Beginning of Current Cycle" action include the date in the description field.
- **Cost:** Enter the cost of the Scheduled Maintenance Action. There is no cost associated with the "Beginning of Current Cycle" action, because it is merely a starting point from which to schedule Maintenance Actions.
- **Year Dollars:** Enter the year dollars of the values in the Costs field. For example, if the costs are discounted to the current year, enter the current year. If costs are forecasted for a future year, enter the future year.
- **Cycle Incremental Expenses:** A set of two fields is provided for each Factor specified in the Maintenance Cycles table.
  - **Incremental (factor):** The schedules for the maintenance actions are presented as an increment relative to a prior step specified by the "Row Reference".
  - **Row Reference:** The reference must be for a row within the same Cycle, and can be the "Beginning of Current Cycle" or any prior intermediate step in the cycle.
- **Complete:** Enter a "Y" or "N" to indicate if the action specified has been completed. For actions that are complete, it is expected that the costs reflect historical cost. For actions not complete, an estimate or forecast is expected. In some cases, the costs of the incomplete actions are predetermined through service agreements.
- **Documentation Reference:** Cite document(s) that describe this maintenance action, its cycle and cost. If the action is defined through a service agreement, also disclose any affiliate relationships between the power plant owner(s) and the service providers.