New Start-Up Cost Calculation Education

Tom Hauske

MIC Special Session

March 13, 2023

Change Summary

- For units without a soak process (combustion turbines, reciprocating engines), Start-Up Cost include costs from PJM notification to first breaker close and from last breaker open to shutdown (Status Quo).
- For units with a soak process (steam, combined cycle, nuclear) Start-Up Cost include costs from PJM notification to dispatchable output and from last breaker open to shutdown.
- Effective June 1, 2023

M15 Section 2.4.1 Start-Up Cost Equation

$$Start-upCost\ (\$/Start) =$$

$$[StartFuel\ (MMBtu/(Start))*TotalFuelRelatedCost(\$/MMBtu)*PerformanceFactor]$$

$$+[StationService(MWh)*StationServiceRate(\$/MWh)] + StartMaintenanceAdder(\$/Start)\ \cdot$$

Where

$$TotalFuelRelatedCosts =$$

$$FuelCosts + SO_2\,AllowanceCost + CO_2\,AllowanceCost + NO_x\,AllowanceCost + MaintenanceAdder + OperatingCostAdder$$

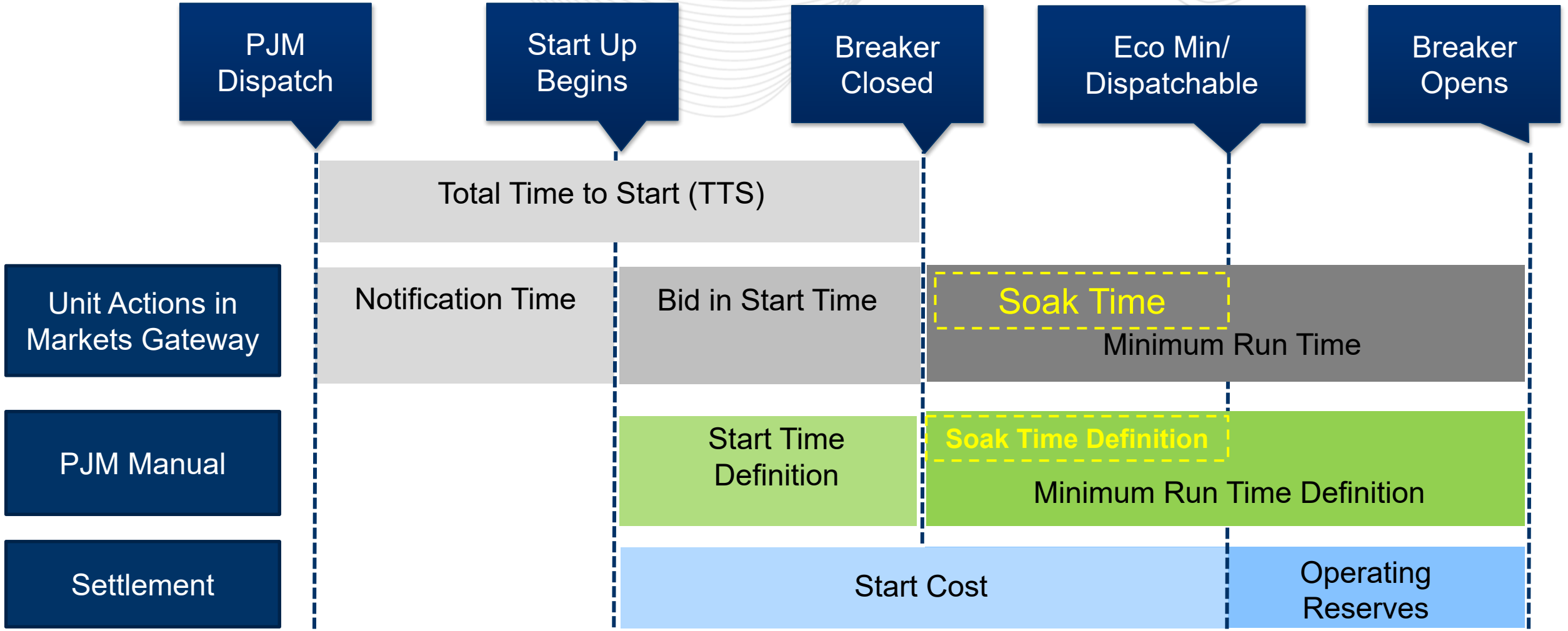
Units without a Soak Process

- Start-Up Cost calculations are basically status quo
- No changes other than removal of additional labor cost are required to existing hot, intermediate, and cold Start-Up calculations.
- Time range for calculation of Start Fuel & station service cannot exceed unit specific hot, intermediate, or cold Start Times.

Units with a Soak Process

- Removal of additional labor cost are required to existing hot, intermediate, and cold Start-Up calculations.
- Start Fuel includes fuel from first fire to dispatchable output plus fuel from last breaker open to shutdown
- Station service includes station service (above normal needs) from the beginning of the start sequence to first breaker closure minus net generation to dispatchable plus station service (above normal needs) from last breaker open to shutdown.
- Time range for calculation of Start Fuel & station service cannot exceed unit specific hot, intermediate, or cold Start Times plus the unit specific hot, intermediate, or cold Soak Time.
- Start-Up Cost cannot be less than zero.
- No operating reserves credits during Soak Time

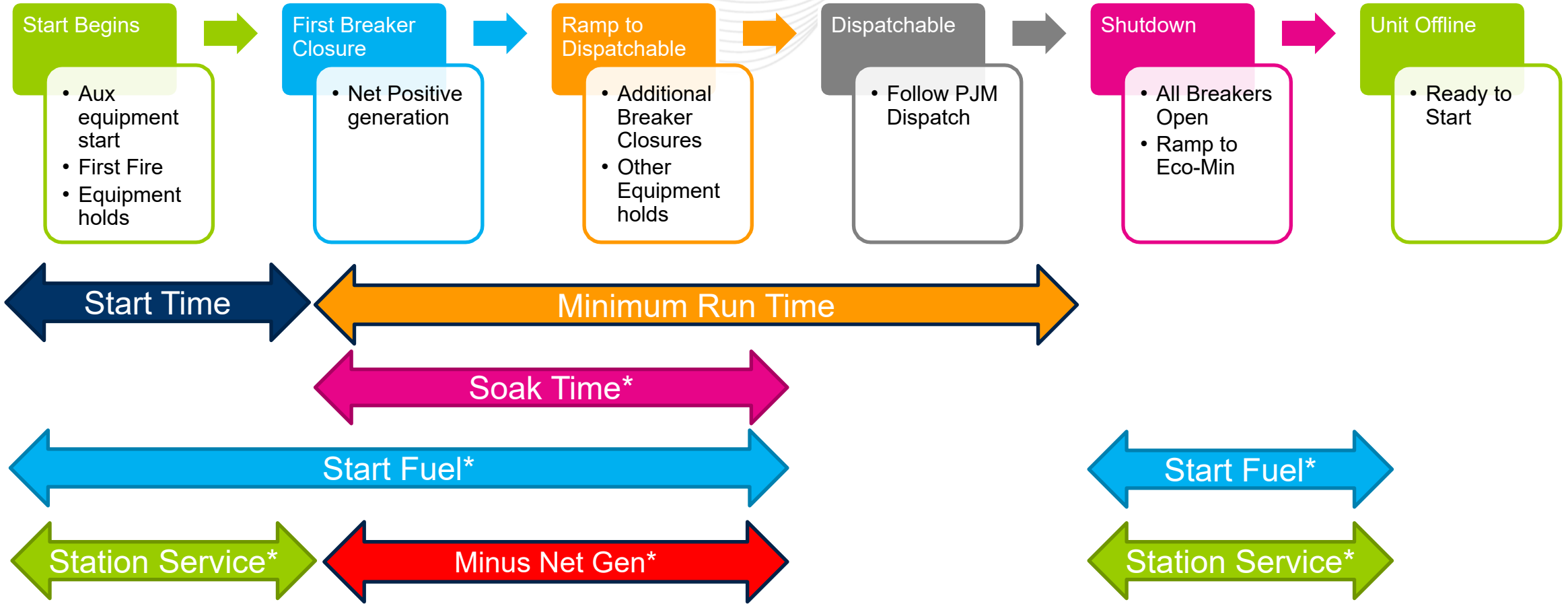
Operating Parameter Relationship



Unit Specific Soak Times

- Soak Time is currently included in a unit's Minimum Run Time parameter. Some generators submitted Unit Specific Soak Times as part of a Minimum Run Time adjustment request.
- Market Sellers can use either the unit's PJM approved unit specific hot, intermediate, and cold Soak Times or the defaults below:
  - Cold Soak Time = 0.71 * unit specific Minimum run Time
  - Intermediate Soak Time = 0.61 * unit specific Minimum Run Time
  - Hot Soak Time = 0.43 * unit specific Minimum Run Time

Generic Unit with Soak Process

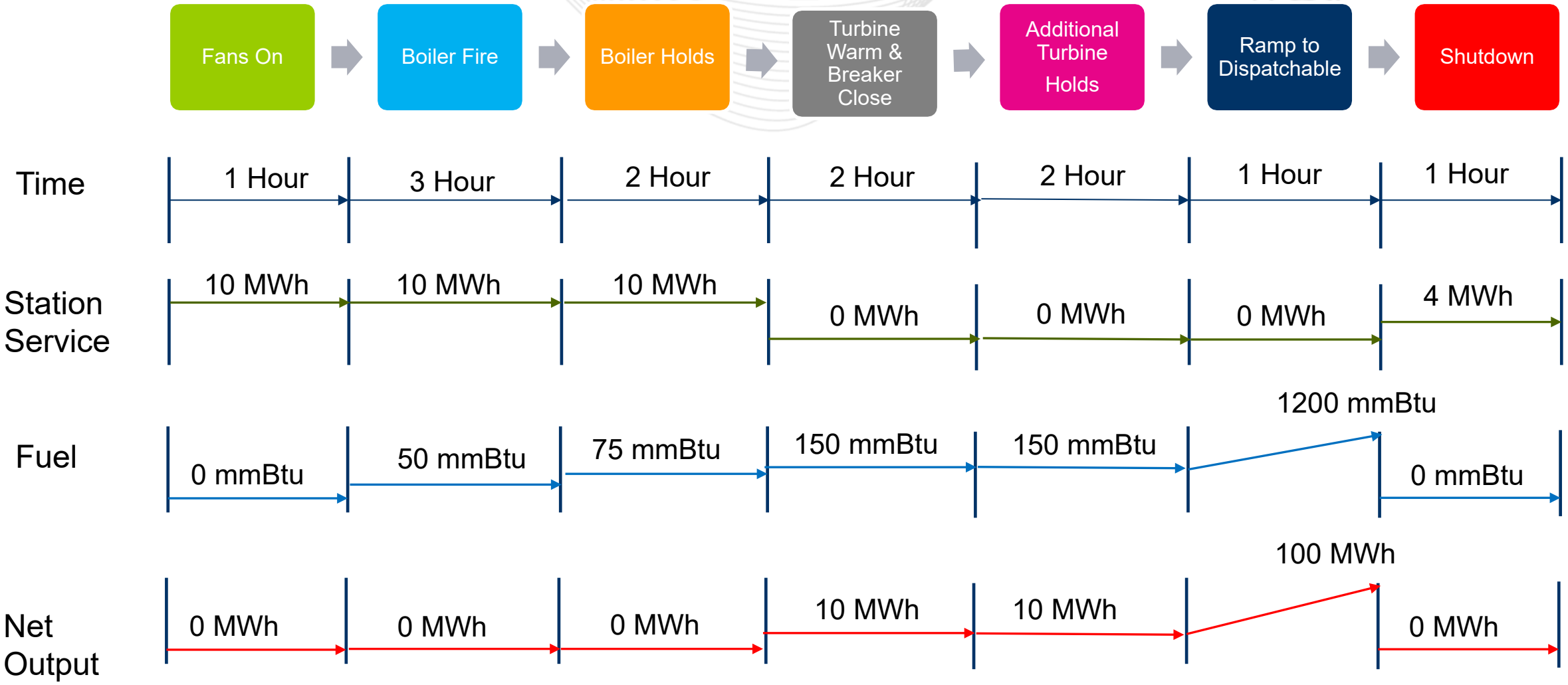


* Duration limited to unit specific start and soak time or M15 defaults

Steam Unit Start-Up Example

- 100 MW Steam Unit
- Fuel Cost = $4/mmBtu
- Performance Factor = 1.02
- Allowance Cost = $0.10/mmBtu
- Maintenance Adder = $0.25/mmBtu
- Operating Cost Adder = $0.05/mmBtu
- Station Service Rate = $55.84
- Unit Specific Start Time = 8 Hour
- Unit Specific Soak Time = 3 Hour

Steam Unit Start-Up Example



Steam Unit Start-Up Example

- Total Fuel Related Cost = $4/mmBtu + $0.10/mmBtu + $0.25/mmBtu + $0.05/mmBtu = $4.40/mmBtu

- Start Fuel = (50mmBtu/hr * 3 hr) + (75mmBtu/hr * 2 hr) + (150mmBtu/hr * 2 hr) + (150mmBtu/hr * 2 hr) + (1200mmBtu/hr * 1 hr) + (0mmBtu/hr * 1 hr) = 2,100mmBtu

- Station Service = (10 MWh * 1 hr) + (10MWh * 3 hr) + (10MWh * 2 hr) - (10MWh * 2 hr) - (10MWh * 2 hr) - (100MWh * 1 hr) + (4MWh * 1 hr) = -76 MWh

Steam Unit Start-Up Example

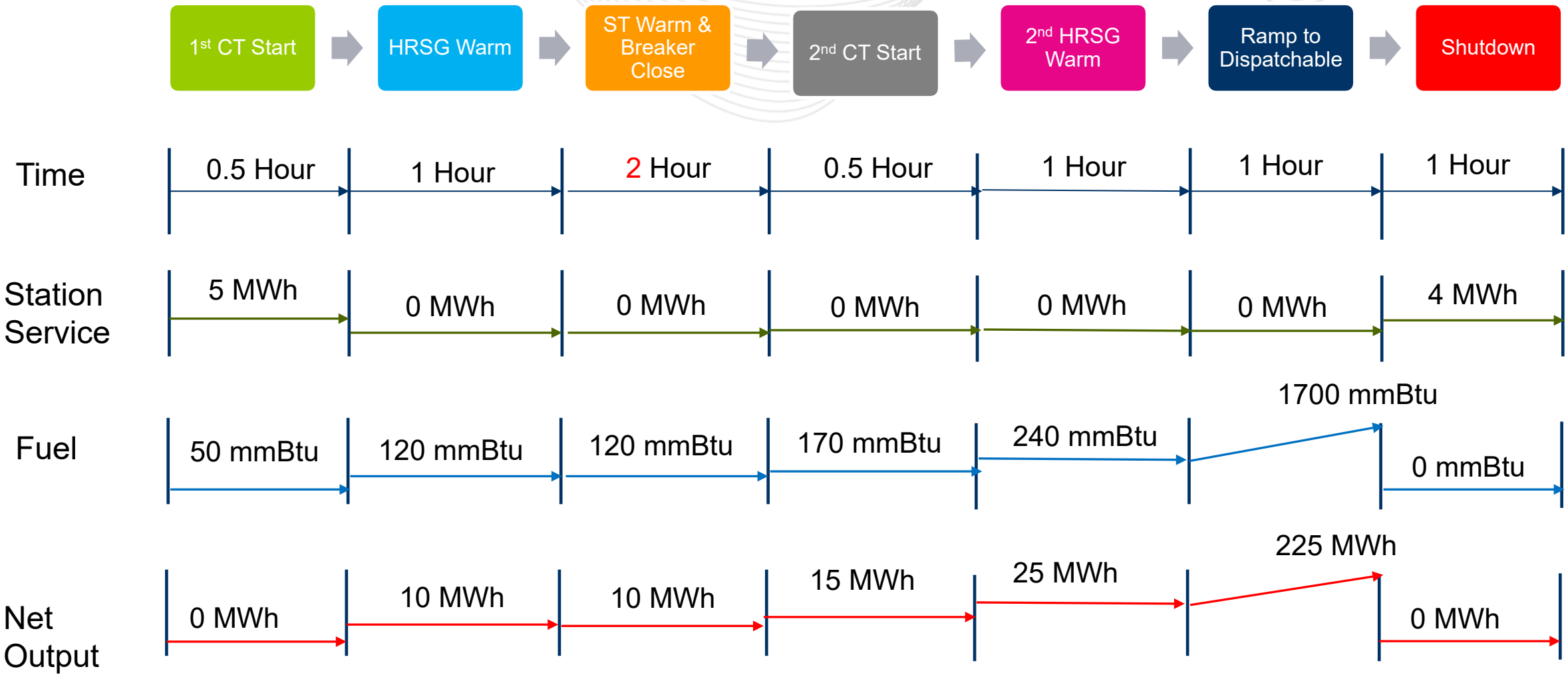
$$Start-upCost\ (\$/Start) =$$
$$[StartFuel\ (MMBtu/(Start))*TotalFuelRelatedCost(\$/MMBtu)*PerformanceFactor]$$
$$+[StationService(MWh)*StationServiceRate(\$/MWh)] + StartMaintenanceAdder(\$/Start)\ .$$

- Start-Up Cost = (2,100mmBtu * $4.40/mmBtu * 1.02)
  + (-76 MWh * $55.84/MWh)
  + $0/Start
  = $5,180.96/Start

Combined Cycle Unit Start-Up Example

- 2 X1 Combined Cycle
- (2) 100 MW CTs
- 100 MW ST
- Fuel Cost = $4.00
- Performance Factor = 1.20
- Allowance Cost = $0.10/mmBtu
- Maintenance Adder = $2000/CT/Start
- Station Service Rate = $55.84
- Unit Specific Start Time = 0.5 Hour
- Unit Specific Soak Time = 4.5 Hours

Combined Cycle Unit Start-Up Example



Combined Cycle Unit Start-Up Example

- Total Fuel Related Cost = $4/mmBtu + $0.10/mmBtu
  = $4.10/mmBtu

- Start Fuel = (50mmBtu/hr * 0.5 hr) + (120mmBtu/hr * 1 hr) + (120mmBtu/hr * 1 hr) + (170mmBtu/hr * 0.5 hr) + (240mmBtu/hr * 1 hr) + (1700mmBtu/hr * 1 hr) + (0mmBtu/hr * 1 hr)
  = 2,290mmBtu

- Station Service = (5 MWh * 0.5 hr) - (10MWh * 1 hr) - (10MWh * 1 hr) - (15MWh * 0.5 hr) - (25MWh * 2 hr) - (225MWh * 1 hr) + (4MWh * 1 hr) = -271 MWh

Combined Cycle Unit Start-Up Example

$$Start-upCost\ (\$/Start) =$$
$$[StartFuel\ (MMBtu/(Start))*TotalFuelRelatedCost(\$/MMBtu)*PerformanceFactor]$$
$$+[StationService(MWh)*StationServiceRate(\$/MWh)] + StartMaintenanceAdder(\$/Start)\ .$$

- Start-Up Cost = (2,290mmBtu * $4.10/mmBtu * 1.02)
  + (-271 MWh * $55.84/MWh)
  + ($2000/Start * 2 Starts)
  = $-1,555.86/Start

  Since Start-Up Cost cannot be less than zero

  = $0/Start

Related Documents

- Open Access Transmission Tariff –
  - Definitions
  - Attachment K Appendix Section 6.4
- Operating Agreement
  - Definitions
  - Schedule 1 Section 6.4
  - Schedule 2
- Manual 15 Cost Development Guidelines
- Manual 28 Operating Agreement Accounting

Manual 15 Revisions

- The new Start-Up Cost calculations are effective June 1, 2023 and an updated M15 revision including these revisions will be published on pjm.com on June 1,2023. Prior to that date Market Sellers can access a red line version of M15 changes via the link below.
- http://www.pjm.com/-/media/committees-groups/committees/mc/2022/20220727/consent-agenda-b---3-manual-15-revisions---redline.ashx

Contact

CDS Chair :
Nicole Scott ,
Nicole.Scott@pjm.com

CDS Secretary:
Heather Reiter,
Heather.Reiter@pjm.com

Presenter/SME:
Thomas Hauske,
Thomas.Hauske@pjm.com

Member Hotline

(610) 666 – 8980

(866) 400 – 8980

custsvc@pjm.com

PROTECT THE POWER GRID

THINK BEFORE YOU CLICK!

pjm

Be alert to malicious phishing emails.

Report suspicious email activity to PJM.

(610) 666-2244 / it_ops_ctr_shift@pjm.com

Appendix

OA Start Additional Labor Cost

- OA Schedule 2 Section 1.3 (a)

(a) For Start-up Costs
Fuel cost
Emission allowances/adders
Maintenance Adders
Operating Costs
Station service
~~Labor costs~~

OATT and OA Star Additional Labor Cost

- OATT Attachment K Appendix and OA Schedule 1 Section 6.4.3A (a)

Start-Up Cost component shall be evaluated for whether it exceeds the reasonably expected costs for that resource by applying the following formula:

Start-Up Cost ($) = [[(Performance Factor) x (Start Fuel) x (Fuel Cost)] + Start Maintenance Adder ~~+ Additional Start Labor~~ + Station Service Cost] x (1 +A)

OATT, OA, & M15 PJM/IMM Package
Proposed Start Cost Definition

Start-Up Costs:

"Start-Up Costs" shall consist primarily of the cost of fuel, as determined by the unit's start heat input (adjusted by the performance factor) times the fuel cost. It also includes operating costs, Maintenance Adders, emissions allowances/adders, and station service cost. Start-Up Costs can vary with the unit offline time being categorized in three unit temperature conditions: hot, intermediate and cold.

For units with soak process (nuclear, steam, and combined cycle), "Start Fuel" is fuel consumed from first fire of start process (initial reactor criticality for nuclear units): Start-Up Cost shall mean the net unit costs from PJM's notification to the level at which the unit can follow PJM's dispatch, and from last breaker open to shutdown.

For units without soak process (engines, combustion turbines, Intermittent Resources, and Energy Storage Resources): Start Cost shall mean the unit costs from PJM's notification to first breaker close and from last breaker open to shutdown.

OATT, OA & M15 PJM/IMM Package
Start Fuel Definition for All Units

Start Fuel:

For units without a soak process, "Start Fuel" shall consist of fuel consumed from first fire of the start process to first breaker closing, plus any fuel expended from last breaker opening to shutdown.

For units with a soak process, "Start Fuel" is fuel consumed from first fire of the start process (initial reactor criticality for nuclear units) to the level at which the unit can follow PJM's dispatch (including auxiliary boiler fuel), plus any fuel expended from last breaker opening to shutdown, excluding normal plant heating/auxiliary equipment fuel requirements. Start Fuel included for each temperature state from breaker closure to the level at which the unit can follow PJM's dispatch shall not exceed the unit specific soak time period reviewed and approved as part of the unit-specific parameter process detailed in Tariff, Attachment K-Appendix, section 6.6(c) or the defaults below:

- Cold Soak Time = 0.73 * unit specific Minimum Run Time (in hours)
- Intermediate Soak Time = 0.61 * unit specific Minimum Run Time (in hours)
- Hot Soak Time = 0.43 * unit specific Minimum Run Time (in hours)

M15 PJM/IMM Package Station Service for All Units

- **Station Service –**
  - **For units without soak process –** Station service consumed from PJM's notification to first breaker close and electricity consumed after last breaker open to shutdown above normal base station use. Normal base station service is the consumption prior to PJM's notification.
  - **For units with soak process –** Station service consumed from PJM's notification to first breaker close and electricity consumed after last breaker open to shutdown above normal base station use minus net generation produced from first breaker close to the level at which the unit can follow PJM's dispatch. Normal base station service is the consumption prior to PJM's notification.

Proposed Operating Parameter Relationship