

Summary of Cost Development Subcommittee Start-Up Cost Packages

Nicole Scott
Tom Hauske
Market Implementation Committee
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Key Work Activities and Scope

Provide detailed guidance and updates as necessary in Manual 15 for:

- 1) Calculation of start-up cost based offers for steam units, combustion turbine units (CT), combined cycle units (CC), and diesel units including:
 - a. Allowable components in the start-up cost calculation,
 - b. Costs for multi-block combined cycle units including how to value CT generation if applicable,
 - c. Rules for aggregated combustion turbines or diesels,
 - d. And discussion of additional labor costs during start-up.
- 2) Discuss consistency of start-up cost parameters with start-up and notification times.
- 3) Review and confirm unit types currently in M15 limited to zero start-up costs.

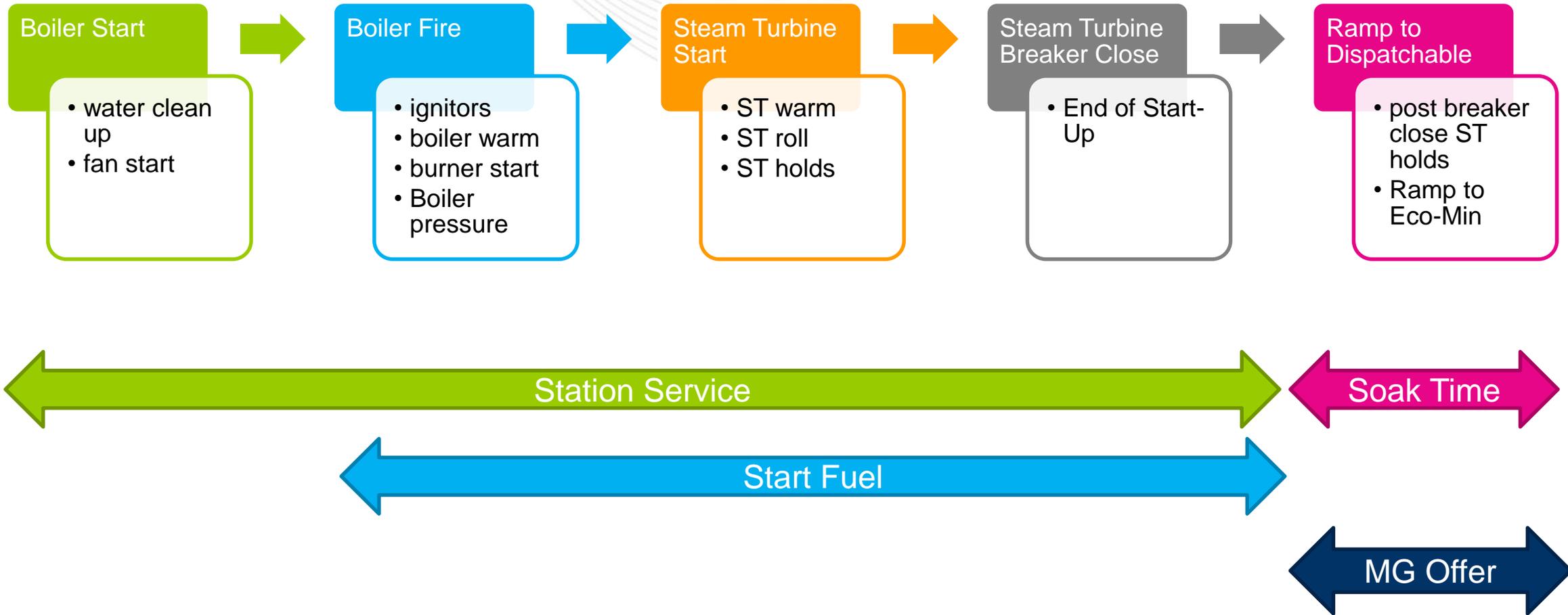
- CDS has developed two packages for consideration of the MIC
 - PJM/IMM Package
 - Clarification Package
- In general the two packages agree on a number of Start-Up Cost related changes to M15, however the packages deviate around:
 - Combined Cycle Start-Up Cost
 - Combined Cycle Start Fuel
 - Combined Cycle Station Service
 - Start Additional Labor Cost

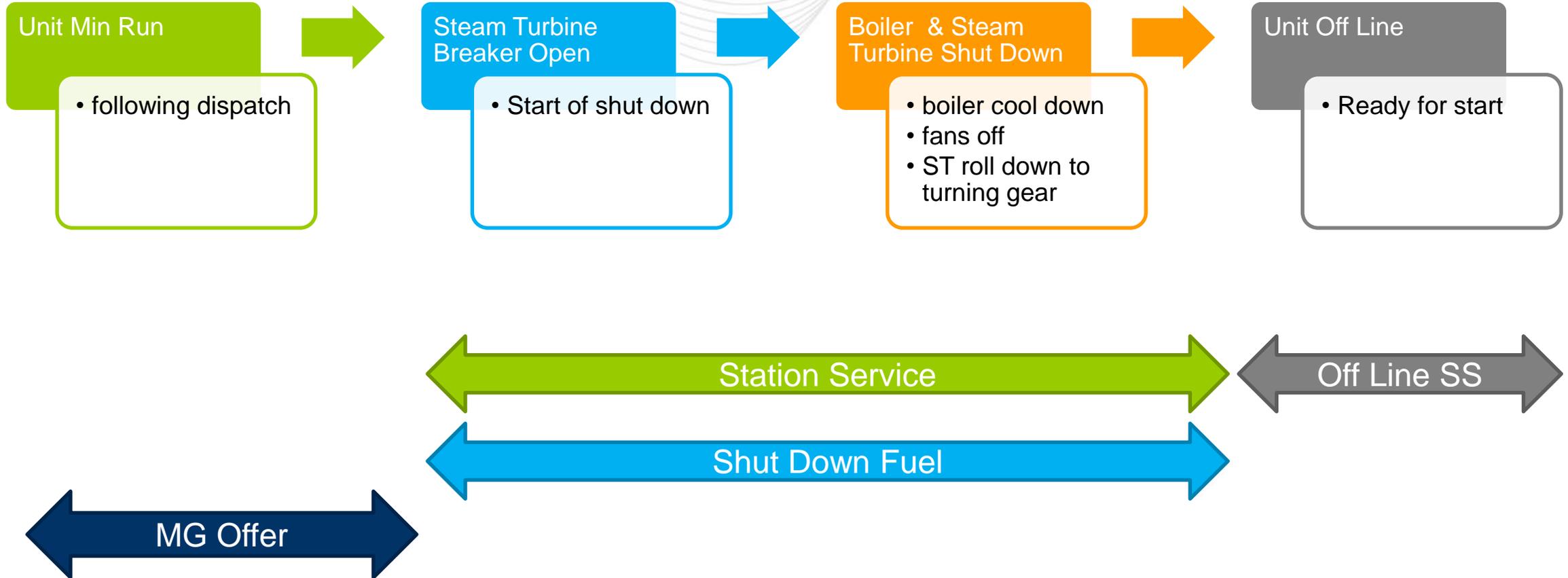


PJM/IMM Start-Up Cost Package

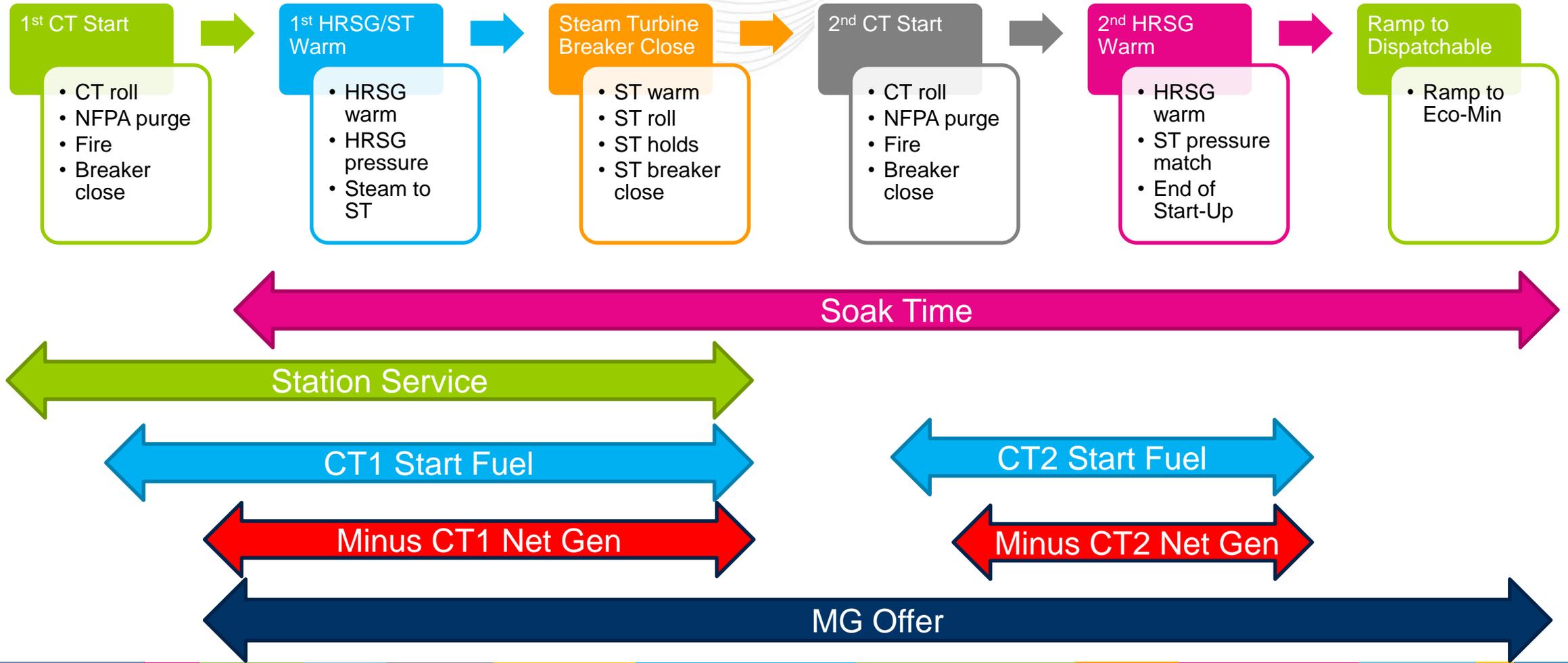
- The PJM/IMM Package proposes a number of changes to M15 to provide additional guidance and/or clarification on:
 - equation to calculate Start-Up Cost
 - station service for non-combined cycles
 - start maintenance adder
 - equivalent service hours definition
 - cyclic starting factor
 - Start costs for aggregated, pseudo-tied and cogeneration units
 - Unit types with zero start cost

- M15 currently allows combined cycle units to include fuel cost after generator breaker closure and synchronization to the grid in their calculation of Start-Up Costs that other unit types such as steam and nuclear cannot.

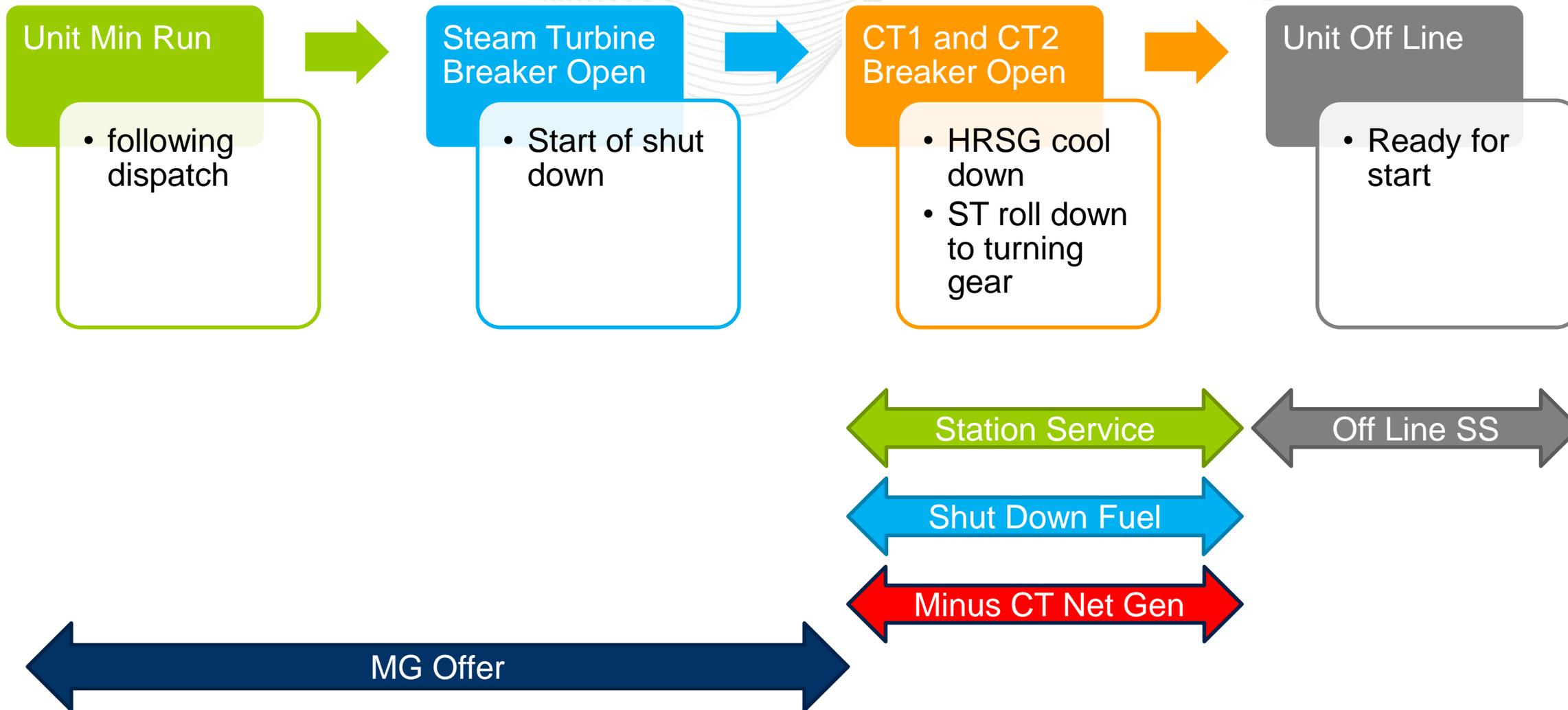




2x1 Combined Cycle Unit Start-Up



2x1 Combined Cycle Unit Shut Down





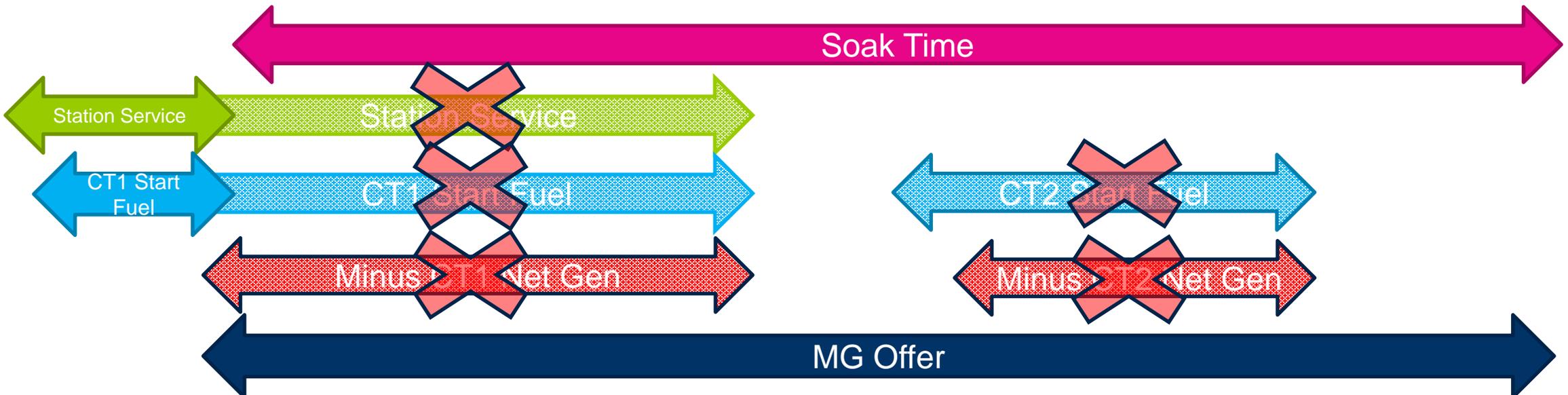
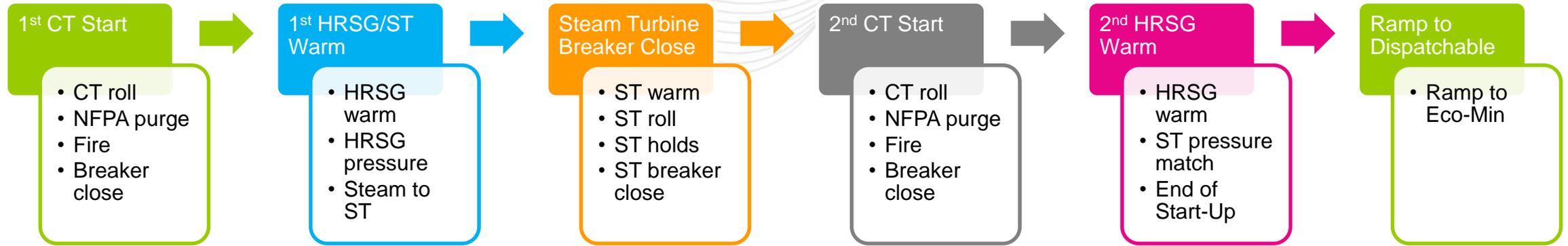
Calculation of Combined Cycle CT Net Generation Offset

		Heat Input Polynomial Coefficients				
Perf.Factor	a	b	c			
1.02000	0.007800000	4.516400	312.36			
Plant Supplied Data		as a function of HRSG temperature			Comments	
Step	Start-up Offer Heat Input Assumptions:	hot	intermediate	cold		
(A)	Heat Input from First Fire to ST breaker close (MBtu)	1,000.00	2,000.00	3,000.00	Assume CT First Fire to breaker close is 50 MBtu/CT.	
(B)	ST brk close to CT shutdown heat input (MBtu)	0	0	0	No shutdown fuel burn	
(C)	Station Service from initiation to ST brk.close(MWh)	5.0	10.0	15.0		
(D)	Generation from CT brk.close to ST brk.close (MWh)	18.75	31.25	43.75	average for each of the 2 CTs	
(E)	CT breaker close to STG breaker close (minutes)	45.00	75.00	105.00	average for each of the 2 CTs	
(F) = ((A)-100)/(E)	Average Heat Input level (MBtu/minute) soaking ST	20.00	25.33	27.62	note 100 MMBtu (50/CT) subtracted for ignition to brk.close burn	
(G) = (D)/(E)	Average Output level (MWh/minute) while soaking ST	0.42	0.42	0.42		
(H) = 60 x (G) x 2 CTs	Average CT generator output level (MW)	50.00	50.00	50.00	doubled because there are two CTs	
(I) = Poly. at (H) x (E)/60	Heat Input "GenOffset" (MBtu) applying polynomial	426.63	711.04	995.46	GenOffset	
Net of Offset = (A)+(B)-(I)	Net Heat Input after "GenOffset" is netted out(MBtu)	573	1,289	2,005		

- Use 995.46 MMBtu for CT1 & CT2 Net Generation Offset for the Cold Start-up Cost Calculation

- The PJM/IMM Package proposes to revise M15 calculations for Start-Up Cost, start fuel and station service to be consistent for all unit types and only include costs prior to first breaker closure and after last breaker opening.
- Generators are compensated for cost after breaker closure and synchronization via their Energy Offer.

PJM/IMM Proposal Combined Cycle Unit Start-Up



- Start Cost shall mean the unit costs to bring the boiler, turbine and generator from shutdown conditions to the point after breaker closure which is typically indicated by telemetered or aggregated state estimator megawatts greater than zero and is determined based on the cost of start fuel, total fuel-related cost, performance factor, electrical costs (station service), start maintenance adder, and additional labor cost if required above normal station manning. Start-up Costs can vary with the unit offline time being categorized in three unit temperature conditions: hot, intermediate and cold.

- Start Cost shall mean the unit costs from PJM's notification to first breaker close and from last breaker open to shutdown. It consists 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 and station service power cost. Start Costs can vary with the unit offline time being categorized in three unit temperature conditions: hot, intermediate and cold.

- Fuel consumed from first fire of start process (initial reactor criticality for nuclear units) to **first** breaker close (including auxiliary boiler fuel) plus 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~~ consumed from last breaker open to shutdown.

- ~~Station Service is included from initiation of start sequence to breaker closure of the steam turbine generator (total station use minus normal base station use priced at the Station Service Rate. Electricity 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.~~

- M15 Start-Up cost calculation allows generators to include additional labor cost in their Start-Up Cost.
- However, generators already get to include this cost in the unit's capacity offer via its Avoidable Cost Rate (ACR)
- The PJM/IMM Package proposes to eliminate this double counting by removing it from the M15 Start-Up Cost calculation.



Clarification Start-Up Cost Package

- The Clarification Package includes all of the proposed M15 guidance and clarification changes included in the PJM/IMM Package on Slide 5.
- However, the Clarification Package maintains the status quo (with some necessary updates) for
 - Start Cost Definition
 - CC start fuel definition
 - CC station service
 - Start additional labor cost

- “Start-Up Costs” shall mean the unit costs to bring the boiler, turbine and generator from shutdown conditions to the point after breaker closure which is typically indicated by telemetered or aggregated state estimator megawatts greater than zero and is determined based on the cost of start fuel, **shutdown fuel, total fuel-related cost**, performance factor, electrical costs (station service), start maintenance adders, **operating costs, emission allowances**, and additional labor cost if required above normal station manning. Start-Up Costs can vary with the unit offline time being categorized in three unit temperature conditions: hot, intermediate and cold. **Combined Cycle units include the costs for start fuel from CT fire to steam turbine generator clutching or breaker closing & pressure matching, shutdown fuel, station service and start maintenance adder, and additional labor cost if required above normal station manning. Credits for net generation during the startup and shutdown periods are debited in the combined cycle’s start fuel.**

- Start Fuel Consumed Cost is the cost of start fuel (basic fuel cost plus fuel handling ~~and other fuel related costs~~) from first CT fire to breaker closing for the steam turbine generator, as measured during a normal start sequence, and the cost of shutdown fuel from last breaker opening to fuel valve closure. Additionally, this includes the cost of start fuel from CT first fire to the point where heat recovery steam generator (HRSG) steam pressure matches steam turbine inlet pressure, for any CT unit/HRSG combinations started after synchronization of the steam turbine generator. **Net generation produced from CT synchronization to steam turbine generator synchronization, from CT synchronization to HRSG steam output at line pressure, and during the shutdown period is debited as the difference between the actual heat input during these periods and the heat input used in the combined cycle's energy offer.**

- Station Service is included from initiation of start sequence of initial CT to breaker closing of the steam turbine generator (total station use minus normal base station use) priced at the Station Service Rate.
 - Add to this (+) station service after breaker opening of the last component when finished operating as a CC unit, priced at the Station Service rate. (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.)
 - Net generation produced from CT synchronization to steam turbine generator synchronization, from CT synchronization to HRSG steam output at line pressure, and during the shutdown period is debited in the start fuel calculation.

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