

Improve Duct-Firing Modeling – Update

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August 24, 2022

Agenda

- **Background**
- **Problem Statement**
- **Concepts discussed at prior MIWG meeting**
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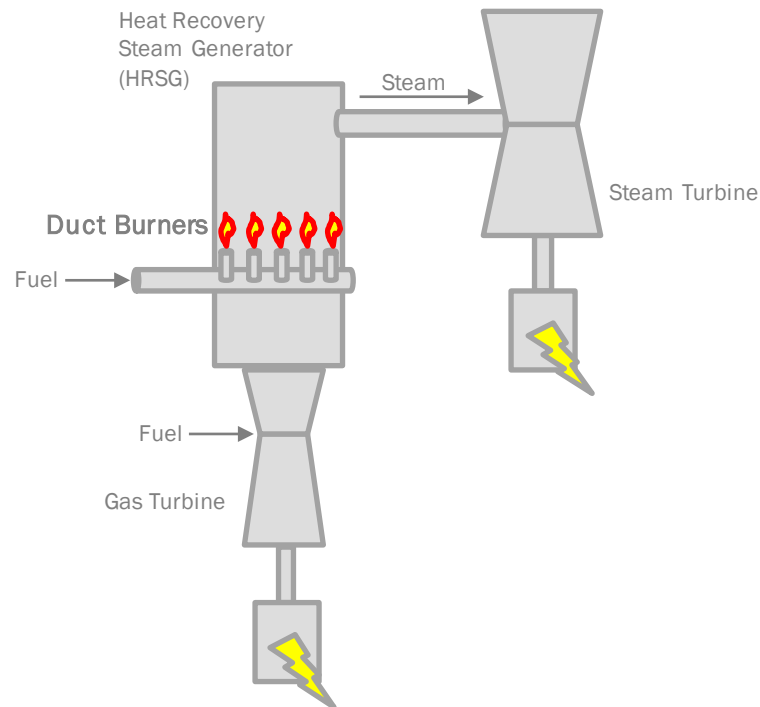
Background

Project Background

- **The Improve Duct-Firing Modeling Project seeks to enhance the Operating Reserves product to better accommodate combined-cycle gas turbine generators (“CCGTs”) equipped with duct-firing.**
- **We are targeting a 2022 Market Design Concept Proposed (MDCP).**

What is Duct-Firing?

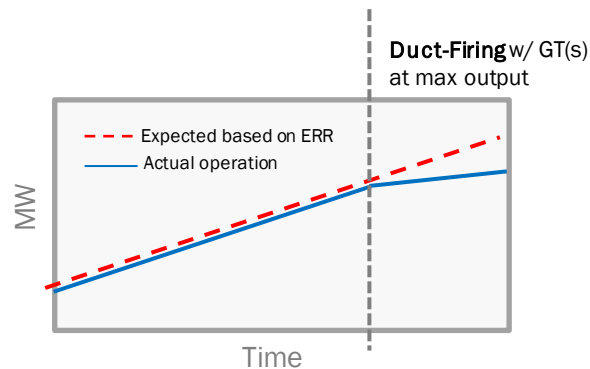
- In some combined-cycle power stations, the Heat Recovery Steam Generators (HRSGs) are equipped with duct burners, which add additional heat to the steam cycle by burning fuel directly in the exhaust duct.
 - The additional heat from the duct burners increases steam flow to the steam turbine, and results in power increase from the steam turbine only.
 - Typically, the operation of duct burners is limited to the last 1-10% of combined cycle output and requires the gas turbine to be near (or at) maximum output prior to use.



Problem Statement

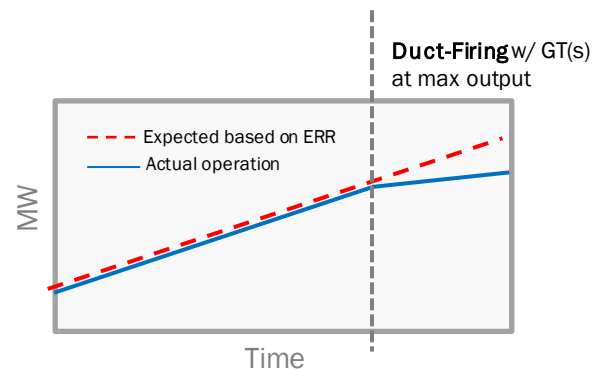
Problem Statement

- **For Energy market participation, up to three normal response rates (NRRs) may be used to characterize the MW/min ramp rate of a generator with respect to MW output.**
 - The NRR values and breakpoints can be tailored to best fit the specific generator's operating characteristics.
 - For example, reduced ramp rate capability in a certain range of operation (i.e., ramping on duct burners alone).
 - NRRs only apply to normal energy dispatch.
- **For Operating Reserves scheduling, the emergency response rate (ERR) is used.**
 - ERR is a single value required to be greater than or equal to all NRRs.
 - Thus, it does not appropriately capture the variable ramp rate over the complete operating range of some units.



Problem Statement (cont'd)

- It has been observed that CCGTs equipped with duct-firing systems may not be able to physically achieve their registered ERR when ramping through the region where duct burners are used.
- This project will explore changes to accommodate the operating capability of CCGTs when they are in the duct-firing region and called upon to provide reserves.



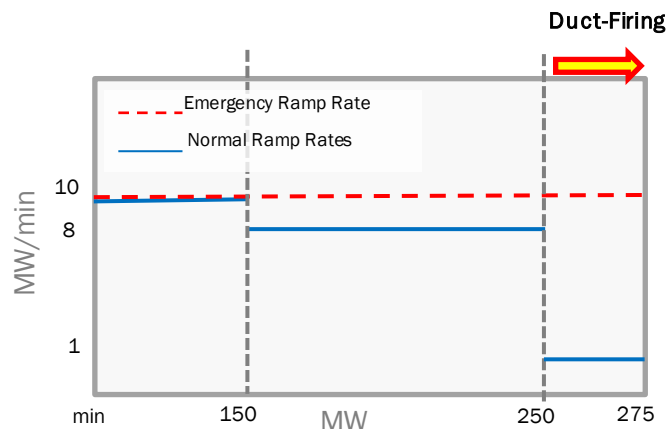
Concepts discussed at Prior MIWG meeting

Proposed Approaches

Option 1: Multiple ramp rates

Consistent with scheduling of energy today, leverage the concept of the normal ramp rate “segments” (instead of the single emergency rate) to schedule reserves.

- This offers the same flexibility as normal ramp rates to configure ramp rates and breakpoints.



*example values

Proposed Approaches (cont'd)

- **Option 2: Duct-firing as a separate “linked” unit**
 - In this approach, the duct-burner range is treated as a separate unit (with its own commitment parameters), that is linked in operation to the unit representing the lower range of operation.
- **Option 3: Limit participation**
 - No change to ramp rates, but limit participation of reserves to a lower limit that unit can respond to emergency rate.

Market Design Thought Process

Stakeholder Feedback/questions from previous MIWG

- Based on SOM 2021 report by MMU, certain units can not follow 5-minute signals in the duct firing region due to operating characteristics not properly recognized by the market scheduling and pricing logic.
- How is the transition time being accounted for in the multiple ramp rate solution?
- How would the multiple ramp rates solution address the issue where units are unable to ramp up or down within the duct burner region to contribute to reserves?
- Could the limiting participation option be combined with multiple ramp rates?
- Has the Linked unit approach been considered?

NYISO Appreciates Stakeholder Feedback

- Reviewed the stakeholder feedback.
- Reviewed the approaches of other ISOs/RTOs that are looking into for this issue.
- Reviewed the operation of CC plants with duct-firing to better understand their capabilities.

2022 Market Design Needs to Focus on Discrete Modeling Elements

- **Simpler designs can be tested more quickly and cost effectively than more complex modeling enhancements. Simpler designs include:**
 - (1) Testing response rates for each MW block and not the emergency rate for the entire output of the plant
 - (2) Allowing reserves to be provided for the full output of the plant without duct burners
- **Other ISO/RTOs are pursuing complex combined-cycle modeling enhancements, requiring 3-4 years to produce a new market design and a few more years for implementation**
 - More complex modeling enhancements like the linked unit approach could be pursued by NYISO, via project prioritization, but would require multiple years of work to achieve a Market Design Complete.
- **NYISO believes a combination of simpler elements, as discussed on subsequent slides, can capture many of the design features needed for more effective modeling of combined cycle facilities.**

Multiple Ramp Rates (MRR)

- **Multiple Ramp Rates will allow combined cycle resources to input a response rate for the duct-firing region that will more accurately characterize the physical responsiveness of the plant (e.g., lower ramp rate).**
 - Operating Reserve ramp rates are expected to be consistent with energy market ramp rates
- **Once in the duct firing range, this will allow dispatch signals to accurately reflect plant capabilities and enable plants to follow dispatch signals.**
- **The MRR option does not account for duct firing startup time.**
 - Participation limits, discussed on the following slide, ameliorate this concern.

Participation Limit with MRR

- **The Participation Limit option is proposed to be implemented with Multiple Ramp Rate solution.**
- **Participation limits can reflect the inability of a plant to provide certain products.**
 - For example, plants with duct-firing that require 10 minutes to start up cannot move from the top of the normal operating range into the duct range within 10 minutes, and therefore cannot provide 10-minute spinning or 10-minute non-spinning reserves in the duct-burner range.
- **Units could continue to offer MWs into the relevant reserve market up to the duct firing region.**
- **The MRR will be used instead of the Emergency Response Rate.**
- **The NYISO believes the combination of MRR and participation limits is likely to enable the energy market optimization to effectively model combined-cycle duct firing capability and enable appropriate provision of energy and reserve products.**
- **The combination of MRR and participation limits is expected to be prototyped and tested during the Market Design Complete phase of the project.**

Need for Prototype Testing

- **The NYISO pursued prototype testing at an early stage in this project.**
 - All modeling enhancements potentially introduce non-convexities in the optimization and are likely to result in a more complex optimization problem.
 - This can increase the level of difficulty in finding an optimal solution and/or increase the time needed to find a solution.
 - It is important to ensure optimal solutions can be found quickly and reliably to support Day-Ahead and real-time grid operations.

Linked Unit Approach

- **The NYISO has conducted internal and external outreach regarding more complex modeling approaches.**
- **An approach requiring similar efforts to the linked unit approach is being pursued by certain ISOs as a multi-year effort.**
 - The configuration mode approach gives one unit the opportunity to have several configurations, modeled as several units within the optimization program.
 - This approach is not the same as the linked unit approach, but the efforts required to pursue these approaches would be similar.
- **The NYISO similarly believes that implementing a more complex design like the linked-unit modeling would take multiple years.**
 - Given this, NYISO believes it is appropriate to focus the current project on discrete enhancements to duct-firing modeling and to prioritize other potential modeling enhancements in the project prioritization process.
 - These discrete enhancements would consist of the Participation Limit with MRR option as discussed on the prior slides.

Prototype & Testing Update

Prototype Update

■ Scope of Change

- Limited to changes required in the optimization model to demonstrate the concept of multiple ramp rates.
- The specific method is application of normal response rates to 10- and 30- minute spinning reserve schedules, on units configured with multiple normal response rates.
- The method of scheduling regulation capacity is unchanged.
- Software details of full implementation, including integration to the Market Information System, are not included.

■ Current Status

- Changes that cover 100% of the optimization model scope have been developed.
- Revised code is currently running on physical test hardware.
- Preliminary testing, by re-runs and input manipulation of SCUC and RTC/RTD save cases, has begun.

Testing Objectives

■ Accurate to design intent

- Verify that 10- and 30-minute spinning reserves are accurately scheduled across multiple ramp rates for units subject to new code (i.e., all units having more than one normal response rate).

■ No harm to other functions

- Verify no impact to other units not subject to new code,
- No impact to the existing scheduling of energy or regulation capacity for any unit, and
- With exception of different outcomes due to Energy & Reserves/Regulation co-optimization.

■ Performance measurement

- Produce a measure of solve time performance relative to current production code as baseline
- Conservatively estimate performance impact for a given number of multi-ramp units added.

Next Steps

Next Steps

- **Targeted for the End of September:**
 - Prototype Testing Results for Multiple Ramp Rates (ICAPWG/MIWG)
 - Detailed Impacts of the New Proposed Approach (ICAPWG/MIWG)
- **Targeted for the End of October:**
 - Market Design Concept Proposed (ICAPWG/MIWG)
 - Commence prototyping of Limiting Participation

Our Mission & Vision



Mission

Ensure power system reliability and competitive markets for New York in a clean energy future



Vision

Working together with stakeholders to build the cleanest, most reliable electric system in the nation