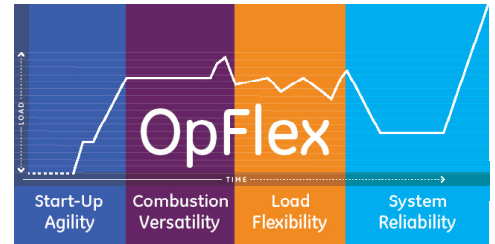




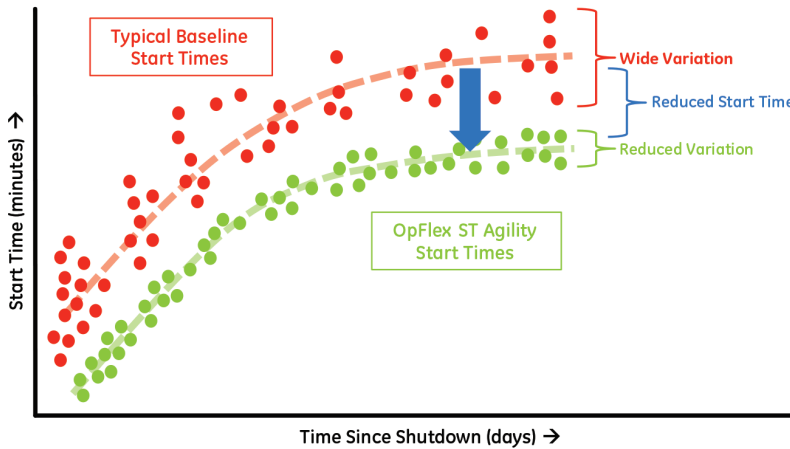
OpFlex* Steam Turbine Agility

Advanced Start-Up for Combined Cycle Plants

Steam turbine start-up can be a significant contributor to overall combined cycle start time and variability due to complex processes with multiple operator touch points and conservative operating limits. A well integrated plant level control approach with the proper level of automation provides enhanced combined cycle start times, reduced variability, and reduced fuel consumption.



OpFlex Steam Turbine Agility vs. Baseline Start Times and Variation



OpFlex Steam Turbine Agility is a comprehensive system solution to improve start times of combined cycle plants using GE gas and steam turbines. It includes a combination of controls upgrades with expert plant-level operational analysis and recommendations to deliver significant improvements in combined cycle start performance.

Technology. An enhanced Automatic Turbine Start-Up (ATS) routine provides a fully automated steam turbine start-up from ready to start conditions with the push of a single button. The improved rotor stress control uses Model-Based Control (MBC) technology during loading and steam temperature ramping phases to improve start times. Temperature references from the steam turbine are integrated with the gas turbine controller to provide a fully automated temperature ramping solution.

Expertise. GE experts in plant control and operability will perform a detailed analysis in collaboration with plant personnel to understand site specific start-up practices. A custom engineered solution for your combined cycle plant will be developed, including a detailed analysis of post-installation start-up data.

Benefits

- Up to a 50% reduction in steam turbine start time
- Reduced start-up fuel costs and emissions
- More predictable and repeatable combined cycle start times
- Reduced potential for missed dispatch commitments
- Reduced performance degradation rate
- Improved automation/control feedback
- Reduced operator touch points
- Improved balance between start time and steam turbine rotor life

Experience. GE has more than half-a-million hours of experience with combined cycle start-up automation, utilizing data from more than 10,000 starts across the over 200-unit GE fleet from the last decade.

OpFlex Steam Turbine Agility contains many control features and settings updates that work together as a system to maximize start time benefit potential. This product is applicable to most A-series and D-series steam turbines with Mark V* or newer controls. The following table lists the main features, benefits, and applicable controls technology.

OpFlex* Steam Turbine Agility features and benefit include:

Feature	Benefit	Mark V* Control System	Mark VI* and Newer Control Systems
One Button Start ¹	<ul style="list-style-type: none"> Automates steam turbine start-up from ready to start conditions Provides repeatable and predictable starts Reduces operator touch points 		✓
Enhanced Rotor Stress Control	<ul style="list-style-type: none"> Reduces steam turbine start time by reliably controlling closer to stress limits 		✓
New Rotor Stress Limits	<ul style="list-style-type: none"> Revises rotor stress limits to improve the balance between combined cycle start time and steam turbine rotor life consumption 	✓	✓
Automatic Temperature Ramping ¹	<ul style="list-style-type: none"> Automates and integrates the temperature ramping function within the gas and steam turbine controllers Manages rotor stress more effectively Reduces operator touch points 	✓ ²	✓
Modified Reverse Flow ³	<ul style="list-style-type: none"> Enhances the turbine's ability to avoid radial rub induced vibration during cold starts Improves ability to maintain performance by reducing risk of deteriorating packing condition 	✓	✓
Inlet Pressure Control (IPC) Setpoint Tracking ⁴	<ul style="list-style-type: none"> Automatically adjusts the IPC setpoint to eliminate unnecessary valve throttling Improves long-term valve reliability Increases power output Enhances response capabilities to a GT/HRSO trip in a 2X1 or 3X1 configuration 	✓	✓
Flexible Hot Start ⁵	<ul style="list-style-type: none"> Allows the gas turbine to be loaded to minimum emissions compliance prior to (or in parallel with) starting the steam turbine Reduces combined cycle hot start times by enabling the steam turbine to quickly accept all steam that is produced 		✓
Improved Acceleration for Low Steam Production	<ul style="list-style-type: none"> Enhances capability for low steam production starts, often encountered at large 2x1 or 3x1 multi-shaft combined cycle plants operating with one gas turbine 		✓
Improved Water Detection ¹	<ul style="list-style-type: none"> Improves detection of water induction events through advanced pattern detection 		✓

1. Pre-existing on HEAT* and newer D series units

2. Sufficient input/output signals required

3. Applicable to D series and A10 units

4. Applicable to 2X1 and 3X1 configurations

5. Requires key control integration and HRSO system configuration and may not be applicable in all plants

*Trademark of General Electric Company

To learn more about this offering, contact your GE sales representative or visit powergen.gepower.com.