



SMARTSIGNAL CYCLEWATCH
EXTENDS PREDICTIVE-ANALYTIC
CAPABILITIES TO COMBUSTION
TURBINE STARTUPS

Whether combined-cycle or simple-cycle, whether intermediate-load or peaking, combustion turbine operations have several common characteristics: frequent cycling, cycling beyond the original design intent of the equipment, and the need to get units online whenever they are dispatched.

STARTUP PRESENTS UNIQUE CHALLENGES

Nearly everyone who operates combustion turbines has experienced the problems unique to startup. Startup places tremendous stress on combustion turbines. Frequent startups intensify the stress. And stress can lead to failed starts, trips, and forced outages. Even with OEM monitoring support, these events can happen several times/year.

This translates directly to added cost. A full-load trip can cost \$120,000 or more--just in accelerated maintenance. An average forced outage from CT problems can cost \$160,000 in lost generation. A missed dispatch obligation can lead to penalties and a need to purchase the power to fulfill obligations, often at a higher spot price. Note that these figures represent the cost for one trip or outage of one unit. If you multiply them by the number occurring across all your combustion turbines, the costs can be staggering.

Whether you operate a regulated or an unregulated utility, if you can't get the unit online reliably, it costs you. If it's a regulated utility, you end up starting more expensive units. If it's an unregulated utility, it directly hits your bottom line.

SMARTSIGNAL CYCLEWATCH™ INCREASES RELIABLE STARTS IN COMBUSTION TURBINES

SmartSignal CycleWatch is the *only* solution that can detect equipment and process problems that are revealed during CT startup cycles.

It analyzes the highly variable conditions of startup and detects subtle deviations from normal. It allows you to investigate deviations and perform necessary repairs before your next startup, ensuring units are reliable and ready when needed.

SmartSignal CycleWatch models the dynamic startup conditions that are not present during steady-state operation. It models the envelope of your "golden" starts at a fast 10-second rate--across hundreds of parameters and the entire CT startup cycle. It accounts for different startup conditions at every point in the cycle, removing all the startup variation and pointing you to impending problems.

Combustion turbine startup provides a unique window to detect developing problems because temperatures, pressures, flows, and vibrations have yet to stabilize. As just one example, CT trips often occur due to temperature spreads radially around the gas path. You can prevent a trip if you're able to repair faulty thermocouples before they cause the failure. SmartSignal CycleWatch provides the actionable insight to prevent this problem by noticing when these temperatures exhibit the slightest deviations from their expected profile.

HOW CYCLEWATCH WORKS

Inputs to SmartSignal CycleWatch are selected from those archived in the data historian. To deploy the solution, access to the historian and historical data is required.

CycleWatch watches all startup parameters for which it is programmed. It models through both the speed and load transients, starting from turning gear up through a significant fraction of the load transient. Dynamic SmartSignal CycleWatch models compare the parameters of every startup with expected behavior given the profile of your "golden starts" and in context of current conditions. It then reports its findings so maintenance can be scheduled or performed before the next scheduled start, if necessary.

SMARTSIGNAL CYCLEWATCH VS. SMARTSIGNAL EPI*CENTER

SmartSignal EPI*Center is a patented and proven Predictive Analytic solution for detecting problems when your plant is running. SmartSignal CycleWatch extends the value SmartSignal provides you beyond steady-state analysis to the dynamics of CT startup, which allows you to catch even more problems, even earlier. If your plant uses both solutions, you have complete coverage.

SmartSignal EPI*Center is based on Similarity-Based Modeling (SBM), which is the ideal solution for steady-state monitoring. Because CT systems are comparatively stable during steady state, the software's sample rate is typically set at 10 minutes.

SmartSignal CycleWatch is, necessarily, quite different than SmartSignal EPI*Center. Because of the dynamic nature of turbine startup, the SmartSignal CycleWatch scan rate is 10 seconds. This allows the software to capture rapidly changing parameters. Although different in algorithm, frequency, and approach, both technologies are ideal for their intended purposes.

SmartSignal CycleWatch uses a new patented modeling technology called Variable Similarity-Based Modeling (VBM). This is like putting the performance of your turbine under a microscope. VBM is what enables SmartSignal CycleWatch to track transient conditions so accurately.

PROBLEMS SMARTSIGNAL CYCLEWATCH CAN IDENTIFY EARLY

With SmartSignal CycleWatch, you can be on top of every aspect of CT behavior—what is functioning as expected, and what’s starting to deviate. SmartSignal CycleWatch monitors for a complete spectrum of issues by looking at specific CT subsystem and operational performance.

SmartSignal CycleWatch will indicate the low temps from contaminated fuel, preventing a flameout and failed start. When bleed valves begin to stick, SmartSignal CycleWatch will give you advance notice to make repairs and prevent a compressor stall. When vibration at critical frequencies increases, the insight from SmartSignal CycleWatch will let you address bearing, coupling, and casing issues during the next maintenance opportunity and prevent problems down the line.

CycleWatch provides early warning of all key equipment failure modes, including:

Early Warning of Key Equipment Failure Modes

CT STARTUP MONITORING	Performance	Process Deviations	Post-Startup Control Changes	Fuel System Diagnostics	Contaminated Fuel	Control Valves	Compressor Problems	Bearing Failures	Lube	Mechanical Damage/Wear	Fouling	Instrumentation
Compressor	X	X	X							X	X	X
Turbine Cooling		X	X			X						X
Mechanical		X	X					X	X	X		X
Combustion	X	X	X	X	X	X					X	X
Fuel System	X	X	X	X	X	X	X				X	X

SMARTSIGNAL CYCLEWATCH BENEFITS—INSIGHT, COST AVOIDANCE, AND CONTROL

Whether you operate combined-cycle or simple-cycle combustion turbines, no one is immune to the uncertainty and unpredictability that startups impose. SmartSignal CycleWatch is designed to even those odds by providing *insight* into CT startups that is not available from any other source. It provides insight into where to spend valuable maintenance resources during small windows of available time—and where not to. Instead of periodically replacing all sensors or all servo valves, for example, SmartSignal CycleWatch prevents this unnecessary and costly preventive maintenance. Rather, SmartSignal detects deviations before they become problems, allowing you to direct corrective work orders.

If you operate a power plant, you understand that the core issue is money. Uptime equals revenue; missed dispatch opportunities equal costs. Until now, many of the costs associated with startup issues were considered to be inevitable. But SmartSignal CycleWatch can help you *avoid costs* by enabling you to:

- Avoid failed or aborted starts
- Avoid trips at load
- Avoid excessive LTSA accruals
- Optimize maintenance resources

Finally, SmartSignal CycleWatch enables you to gain *control* by providing insight that isn’t available from any other source. SmartSignal CycleWatch spots problems earlier and pinpoints them more accurately. It provides you with the peace of mind that there is a solution automatically monitoring what even the best operators in the world cannot.

SMARTSIGNAL CYCLEWATCH VS. YOUR OEM

The OEM is responsible for overhauls and the overall integrity of the heavy pieces of the turbine. The OEM relies on the control system to govern the starts and protect the turbine from significant damage. The control system will trip the turbine on a hair trigger if it sees something it doesn’t like, since the OEM is responsible for preventing damage that it has to cover. Some of the classic damage is prevented by the control system. But, control-system trips can actually *cause* damage from the thermal shocks the trips introduce to the turbine. Also, sometimes these trips are caused by

failing sensors, plugged filters, or fuel issues rather than mechanical failures per se. SmartSignal CycleWatch is designed to detect such issues and give you the insight to avoid control system trips.

CONCLUSION

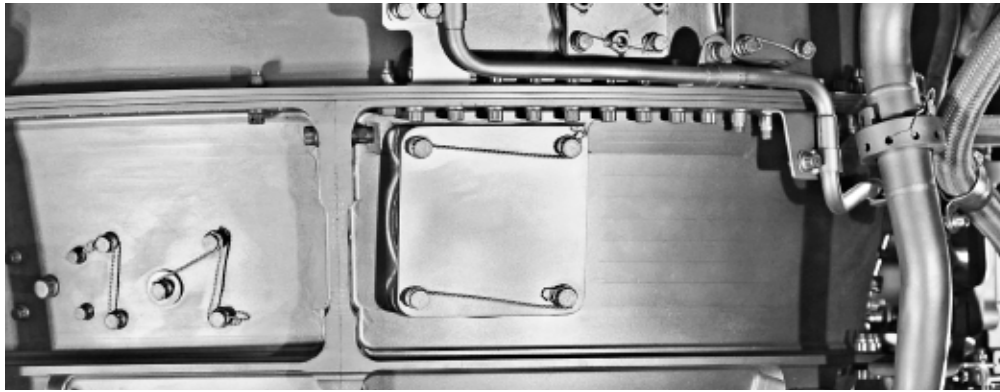
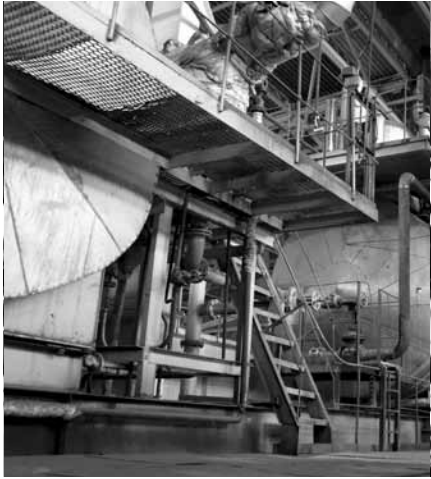
SmartSignal is the proven leader in detecting failures in your mountains of data. It brings

problems to your direct attention exceptionally early so you can do something about them. SmartSignal CycleWatch now extends the value of SmartSignal to the unique and dynamic conditions of CT startup—allowing you to catch even more issues even earlier.

Everyone who operates a fleet of combustion turbines understands the risks of startup: missed dispatch commitments, aborted starts, and trips. If these risks become reality several times a year, the costs can be tremendous.

SmartSignal CycleWatch provides the necessary insight and control to reduce the risks inherent in every start.

The predictive and proactive SmartSignal CycleWatch solution will help you prevent the trips and outages that still occur, even with your OEM services. With SmartSignal CycleWatch analyzing the indications from a startup, you will maximize your efforts during your valuable maintenance window. This actionable insight will put you in control—and ensure your next startup’s success.



ABOUT SMARTSIGNAL

SmartSignal is the leading provider of Predictive Diagnostic software and services used to anticipate and avoid surprise equipment failure. SmartSignal customers detect equipment problems with enough advanced timing to optimize maintenance resources, reduce risks, and eliminate failure. With over 40 patents and tens of thousands of prevented impending equipment failures and operational errors, SmartSignal technology has won over twenty-five awards for excellence, including an international *Wall Street Journal* Technology Innovation Award.

TO LEARN MORE ABOUT HOW SMARTSIGNAL CAN HELP YOU ELIMINATE EQUIPMENT FAILURE,
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