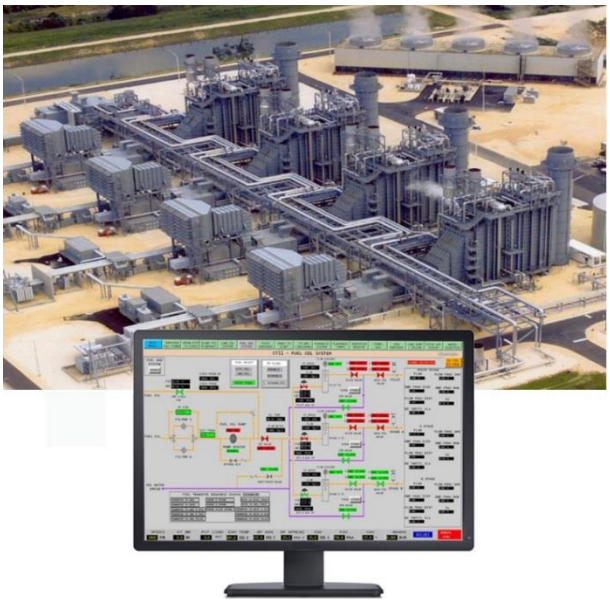
Emerson Solutions for Siemens/Westinghouse Gas Turbines

Features

- Fully engineered and field-proven retrofit for Siemens-Westinghouse gas turbines equipped with Emerson WDPF or Siemens Teleperm™ XP (TXP) control systems
- Ovation-based solution with powerful redundant processors specifically designed to meet the needs of DLN/ULN and non-DLN units
- User-friendly tools and direct access to turbine logic facilitates in-house maintenance
- Integrates governor, sequencer and safety functions with Ovation turbine control
- Incorporates control enhancements that enable
  - Better operator decision making
  - Improved unit operation, performance and starting reliability
  - Simplified troubleshooting and maintenance
- Comprehensive suite of integrated products and services that support cybersecurity programs and obligations
- Flexible architecture easily unifies turbine and balance-of-plant systems for comprehensive plant control
- Options available for generator excitation, vibration prediction, instrumentation upgrades, wireless monitoring and simulation



Emerson offers a fully engineered and field-proven packaged retrofit solution for upgrading Siemens Teleperm XP and Westinghouse WDPF controls on Siemens-Westinghouse gas turbines

Introduction

Emerson acquired the Westinghouse Turbine Control Group in 1997 and since then has continued to provide innovative upgrade solutions for W501 D-F-G turbines and mature Westinghouse W191-W251 fleets.

Over the decades, Emerson has combined former OEM expertise with advanced technology to modernize most of the W501 fleet to the state-of–the-art Ovation™ system.

Emerson's gas turbine control portfolio includes system upgrades that provide reliable and efficient control on hundreds of W501 model gas turbines, right up to G class.

Emerson's retrofit program for this fleet covers turbine control development, application enhancements, project specific content, installation and commissioning as well as W501 gas turbine application lifecycle support and updates.

To further enhance our market offering on these turbines, Emerson formed an alliance with Mitsubishi Hitachi Power Systems America (MHPSA) to provide a comprehensive solution covering controls, uprates, enhancements, long term agreements, parts and outage services. The combination of Emerson's Ovation controls and MHPSA's turbine technology delivers retrofit and modification solutions aimed at improving all aspects of your plant's performance.

Ovation W501 Gas Turbine Retrofit Application

Emerson's Ovation W501 gas turbine control retrofit replaces all the original TME/TXP/WDPF turbine control systems while incorporating new enhancements for reliable, flexible and safer turbine operation. The Ovation solution provides integrated governor, sequencer and protection control functions including:

- Turbine control and sequencing
- Turbine fuel control (governor)
- DLN/ULN control
- Turbine protection
- Fuel transfers
- Turbine monitoring
- Vibration monitoring
- Generator monitoring, control and protection
- Manual and automatic synchronizing
- Remote monitoring & communications

Native I/O modules directly interface the Ovation system to speed detectors, LVDT, servo-valves, RTD, thermocouples and other turbine instruments. Direct interface to turbine instruments avoids the use of external signal conditioners and provides full diagnostics down to I/O level. Ovation's direct interface to existing turbine instruments ensures fully integrated control of all turbine systems including:

- Variable guide vane actuators
- Fuel systems – diffusion and DLN
- Water injection systems
- Flame detection systems using sensors or temperature based algorithm
- Starter systems
- Lube and hydraulic oil systems
- Overspeed protection system
- Vibration monitoring
- Excitation
- Generator temperature monitoring
- Auxiliary systems

Panel retrofit example

Emerson maintains a version-controlled library of turbine specific control algorithms, developed based on years of turbine control implementation and field-proven in hundreds of gas turbine applications. This approach ensures a high degree of software standardization, eases software testing, improves revision control and reduces commissioning time. Ovation's turbine control permits all modes of operation that were provided with the original TXP / WDPF system.

TXP Panel Retrofit

The Ovation upgrade is packaged as a direct replacement for TXP control systems. The original TXP panels are retained while back panels, side panel mounted equipment and internal wiring are demolished and replaced with drop-in subpanels containing the Ovation equipment and plug-in wire harnesses that adapt to existing field terminal boards.

The Ovation solution completely replaces the Simadyn, Teleperm and S5-95F safety (if included) sub-systems, while retaining all existing field wiring and turbine instruments. Eliminating the entire set of TXP components ensures that no legacy control components are retained, thus mitigating potential

risks due to obsolescence issues. This solution also allows for full factory testing of the complete control assembly, both hardware and software, which reduces commissioning risks.

The measuring cabinet that houses the vibration monitor, overspeed protection and flame detection equipment may be retained or replaced as part of this upgrade.

WDPF Migration

Emerson has proven solutions to migrate legacy WDPF systems to Ovation that includes options for DPU-only and I/O replacements. Similar to the TXP replacement program, the vibration monitor, overspeed protection and flame detection equipment may be retained or replaced as part of this upgrade.

Benefit	Ovation System Enhancement
Enhanced operator decision making	▪ Unit operation maintenance summary automatically updates factored hours/starts ▪ Smart dashboard displays start and trip data as well as gross, net and auxiliary MWH for each run ▪ Automatic turbine trip reports are provided by the Ovation Process Historian ▪ Enhanced exhaust display with color-coded tabular views of combustion data ▪ Generator capability monitor shows capability curve with automatic alarming outside of generator limits
Improved unit operation and performance	▪ Unit start profile compares startup and coast-down times with a baseline to readily identify blade tip rub and other issues ▪ Gas turbine performance indicator includes megawatt capability predictions as well as real-time heat rate and efficiency calculations ▪ Easy-to-read combustion monitor helps to quickly identify hot/cold spots ▪ Rate of change algorithm for improved thermocouple rejection ▪ Automatic turning gear scheduling reduces disc wear and blade problems ▪ Manual synchronization from Ovation operator workstations ▪ Manual bias of water injection improves NOx control ▪ Automatic droop tests and frequency response ▪ Off-line wash IGV logic provides more effective compressor cleaning ▪ Part load exhaust temperature control optimization to increased steam production at part load in combined cycle operation
Simplified troubleshooting and maintenance	▪ Dedicated start permissives and trip displays enable fast problem identification ▪ High-speed trending to pinpoint event data ▪ Overspeed testing from the HMI ▪ Fuel valve calibration from the HMI ▪ Monitoring of 125 VDC battery voltage
Improved control and protection	▪ 2oo3 logic for speed sensor fault detection and rejection to ensure more reliable measurements and avoid trips ▪ Fuel oil ignition logic updates to improve unit starting reliability on fuel oil ▪ Improved water injection and flame out protection logic ▪ Combustion dynamic monitoring system to monitor combustion dynamics and protect from unsafe operation ▪ Updated fuel gas logic to avoid unwanted trips ▪ Fuel gas schedule improvements and starting reliability enhancements ▪ SIL3 rated overspeed protection using Emerson's CSI6300 system ▪ Improved vibration monitoring using Emerson's Ovation Machinery Health™ Monitor (an integrated vibration monitoring system) or Advanced Turbo Guard (ATG) monitoring system ▪ On-line machinery health prediction system

Emerson - MPHSA Alliance

To further enhance our 501-gas turbine market offering, Emerson has partnered with Mitsubishi Hitachi Power Systems America (MHPSA) to provide a comprehensive solution covering controls, uprates and enhancements, long term agreements, parts and outage services.

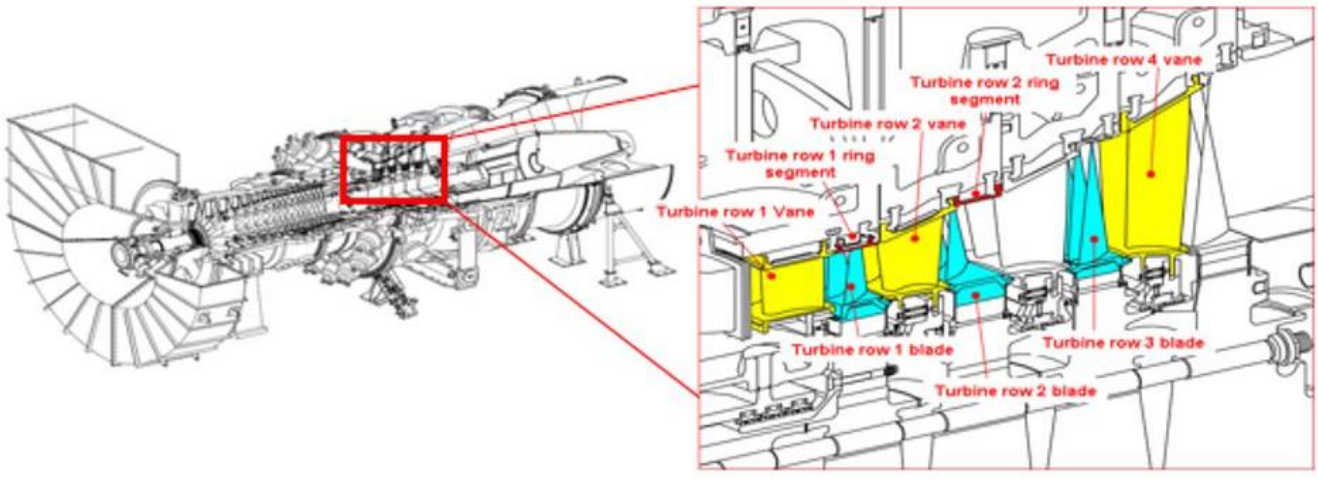
MHPSA was a Westinghouse licensee from the 1970's and participated in the design of the W501 product lines from the 1980's onward. MHPSA has continued to build upon their extensive OEM knowledge to develop advanced technology that is an integral component of the Siemens-Westinghouse 501 fleet upgrade program.

MPHSA solutions for W501 gas turbines feature improved reliability part upgrades to address existing fleet issues.

Examples of additional upgrades or modifications for improved gas turbine performance include:

- Flexible long-term service agreements
- Engineering studies and service bulletin implementation
- Improved parts to fix known issues and extend outage intervals; examples include:
  - Compressor hook fit and diaphragm repair and upgrades; weld repair or upgrade to new diaphragms
  - Compressor anti-rotation screw fix
  - Upgraded blades for row 1 and 2 to give extended parts life and reduced repair costs
  - Upgraded vanes for rows 1 – 4 based on MPHSA 501G technology
  - Row 4 blade root springs to minimize disc and blade root wear
  - Upgraded belly bands designed for quick replacement and high reliability
  - Upgraded exhaust cylinder for longer service life
- Turbine uprates including F4 uprate for 501F
  - Up to +5% megawatts
  - Up to -0.8% heat rate
- Part load exhaust temperature optimization for improved combined cycle efficiency
- Remote monitoring 24/7

The combination of Ovation control enhancements along with MHPSA parts upgrades outrival contemporaries in fuel efficiency, output, performance and service life.



MHPSA F4 upgrade for a 501F can produce 5% increased power output and 0.8% improvement on heat rate

Integrated Combined Cycle Control

Many gas turbines operate in combined cycle plants. The Ovation platform is perfectly suited for all combined cycle control applications, including steam turbine, heat recovery steam generator (HRSG), balance-of-plant (BOP) and auxiliary controls. Controlling the entire power block using a single unified automation platform not only helps enhance reliability, but also provides further opportunities for operational improvement such as increased plant efficiencies and megawatt production, and long-term operation and maintenance savings.

Ovation - Designed for Power

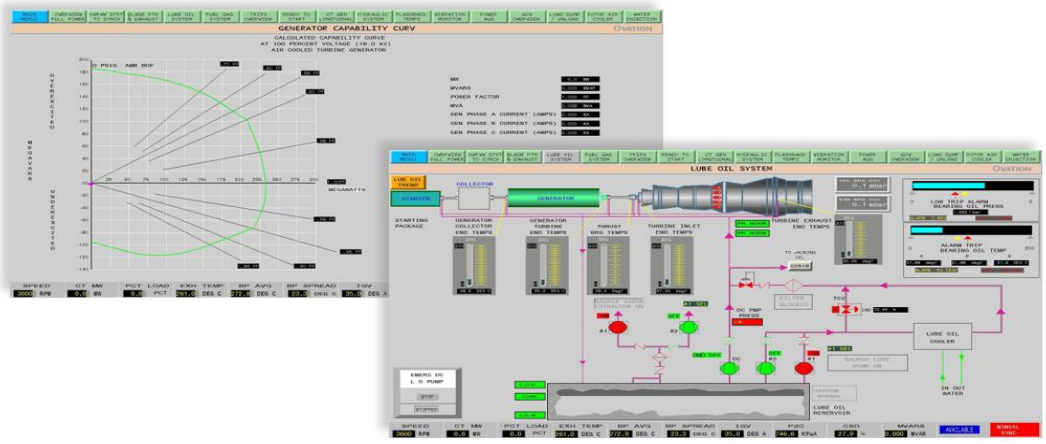
The foundation of Emerson's gas turbine control solution is Ovation technology. Ovation was designed to:

- **Eliminate obsolescence concerns** by using commercially available technology
- **Provide intuitive built-in diagnostics** that enables quick problem identification
- **Secure operations** with standard features that address cybersecurity concerns
- **Simplify configuration and maintenance** with integrated user-friendly engineering tools.

Summary

Emerson understands the changing dynamics of the power industry and stands ready to apply our expansive portfolio of solutions to help increase performance and reliability of W501 generating assets. Together, with our alliance partner MHPSA, Emerson can provide a highly qualified and comprehensive solution on these units.

The Ovation retrofit for Westinghouse mature models and 501D-F-G gas turbines was developed by Emerson's dedicated gas turbine solutions group that includes highly specialized experts with years of experience designing, implementing and supporting turbine controls dating back to original turbine design work at Westinghouse gas turbine. An integral part of every retrofit is Emerson's commitment to long-term product support and cost-effective migration paths that reduce lifecycle costs while keeping pace with technological advancements.



Ovation W501F graphic examples