Wood Group GTS’s LM6000 experience is drawn from the company’s commitment to the overall LM6000 market, where it has provided solutions for the following:

- EPC: Greenfield and brownfield construction and relocation services.
- Accessory and component overhaul services.
- TransCanada Turbines: Wood Group and TransCanada Corp joint venture in operations and maintenance (O&M) and term maintenance services.
- Remote monitoring and diagnostic (M&D) services.
- Controls upgrades and support services.

Over the past five years, Wood Group GTS has executed more than 20 LM6000 controls upgrades on PA engines, PA-to-PC uprates, and on PC packages manufactured by Kvaerner, IHI, Stewart & Stevenson, and GE. The company has proven experience upgrading Woodward NetCon (with and without remote I/O), Woodward MicroNet, and GE Mark V-LM and Mark VI Millennium panels. Upgrades include gas and dual-fuel machines, units with and without IGVs, EPS, and Sprint/eSprint units.

It has completed upgrades where the scope is limited to the turbine control, as well as at sites with extended scope, including: voltage regulator, power-system stabilizer, vibration monitoring, all-electric fuel- and water-valve upgrades, local and remote HMI’s, and instrumentation. All Wood Group GTS LM6000 control upgrades have been executed as turnkey contracts, illustrating the company’s focus on providing a complete engineered solution that integrates seamlessly with the existing package.

Knowledge of both the engine and the package are critical in determining the correct product, scope, implementation, and field-conversion technique needed to ensure success and long-term supportability. With a focus on the end user, critical aspects of each upgrade conversion, such as documentation, are structured to improve the user’s ability to troubleshoot and support the system.

Wood Group GTS has executed over 650 turbomachinery control retrofit installations. Whether a customer is experiencing obsolescence, reliability/availability concerns, functionality and supportability anxiety, regulatory compliance challenges, or lifecycle management issues, the company uses its experience to provide a high-value, low-risk controls solution to suit each customer’s needs.

The company’s LM6000 open-platform solution, based on the Rockwell Automation PlantPAX platform, has been engineered as a direct replacement for the OEM control systems and easily accommodates various packaging arrangements. The typical solution installs within the existing control room cabinet lineup along with the MTTB and MGTB where applicable, with a complete control-panel replacement option available to customers with Mark V controls. Standard core software and pre-engineered “building blocks” are used to maintain consistency and quality while providing flexibility.

Wood Group GTS continues to invest in the LM6000 program, providing ongoing HMI and control-system functionality updates—such as infrared flame detection (option to eliminate on-engine flame detectors), purge credits, Sprint re-enable stall-margin improvement, and improved high-speed data capture. The last allows users to select a greater number of data points, record for longer periods, and more easily extract data into PI or MS Excel.

Each of our control upgrades includes all software licenses, allowing users the ability to be self-sufficient. Since turbine control is one “piece” of the overall unit control, we also provide engineered options to upgrade other aging electronic and mechanical components—such as vibration system, voltage regulator, power-system stabilizer, HMI, historian, flame scanners, valves and drivers, and BOP controls. The ultimate goal is to provide users a more seamlessly integrated system, one easy to support and maintain, while improving unit reliability and availability.

**Retrofit challenges**

Our solution has been engineered to directly replace the OEM’s control system. As such, the physical aspect of the control-system conversion is not abnormally difficult. Each conversion has its own specific set of challenges which are typically related more to scope and timing than the actual turbine control itself.

In addition to ensuring that the unique nuances of each site are addressed, a significant portion of our project team’s energy is spent focusing on each customer’s specific goals. These range from correcting performance or reliability problems to outage schedule and site execution to data management to spares strategy to life-cycle management to documentation and training. The challenge is more execution-oriented than it is product-oriented. Wood Group GTS’s ISO-certified processes and procedures are structured exclusively with an end-user focus to ensure consistency, quality, and success of the upgrade.

**Custom upgrades**

Wood Group GTS takes a unique approach to controls upgrades, basing each one on a problem-solving mentality because no single solution meets the needs of every site. Using problem statements, we first establish justification for the upgrade. This invariably answers the question: What “didn’t exist in the old” and “should be included with the new”?

The discussion starts by identifying problems that exist within the original system. It keeps both parties focused on what they are trying to accomplish through the capital expenditure and becomes the primary justification for the upgrade. Once the problematic sources are identified, a detailed review of the various options, along with pricing and outage duration, is conducted.

A new control system should have an expected lifecycle of more than 15 years, must conform to the performance criteria (recursion rate and throughput) required to control the LM6000, and leverage hardware and software technologies to ensure NERC
compliance. These are “minimum criteria” that must be considered to even qualify the solution.

After those criteria are met, the real work begins. We find that asking the appropriate questions is the key to determining what functions, features, and scope options should be included in the upgrade. Some of these questions include:

- What can be done to improve my competitive position in the market or optimize my contractual position to help justify the expenditure? Examples: Fast-start capability, water usage, AGC/dispatch, etc.
- What new regulatory requirements might I be facing now or in the future? Examples: NERC CIP, emissions, flexible reporting, etc.
- What are the major causes of forced outages at my plant and what improvements are necessary? Examples: Unreliability, failed start attempts, valve calibration, vent fan flow switch failures, etc.
- Where am I spending unnecessary maintenance time and/or costs? Examples: Stalls/borescoping, HMI/historian, CEMS computer maintenance, flame-detector failures, etc.
- What new functionality exists that can be leveraged? Examples: Infrared flame detection, purge credits, etc.

- If obsolescence is a major driver, as in most cases, what components besides the turbine control should be considered? Examples: Vibration monitoring, voltage regulation, power-system stabilizer, balance-of-plant control, etc.
- What is the cost of spares, and spares strategy, during and after warranty? Examples: In-house versus vendor stocking, hot versus cold spares, evolution, etc.

When a customer wants to perform this level of due diligence, Wood Group GTS takes a systematic approach to perform the necessary discovery before advocating a solution. Each upgrade is treated as if it were a unit we were responsible for operating and maintaining over its lifecycle. This creates a unique perspective and one we believe is a true differentiator in the market.

In addition to considering what should be included in the new system, one also must consider what the owner/operator wants to avoid. Some of these attributes may include:

- Systems which limit your ability to effectively troubleshoot and be self-sufficient.
- Documentation which is “piece meal” and potentially makes it more difficult to support rather than easier.
- A lifecycle of 10 years or less.
- Physical packaging that doesn’t truly fit within the existing footprint, making the new system extremely difficult to repair and support.
- Solution providers that do not fully understand the engine requirements and package configuration.
- Unproven hardware and software.
- Simple “box for box” replacements that only address basic equipment obsolescence issues.

### Field experience

With over 650 control-system upgrades, our field experience is best answered through the customers that we have served. Wood Group GTS supports customers in over 50 countries, and for over 25 years has built a reputation for delivering results through integrated solutions for all high-speed rotating equipment.

To view specific presentations and case studies outlining our controls history and performance, please visit our website at [www.woodgroupgts.com/products/pages/ge-lm6000.aspx](http://www.woodgroupgts.com/products/pages/ge-lm6000.aspx); or contact powerplantservices@woodgroup.com.