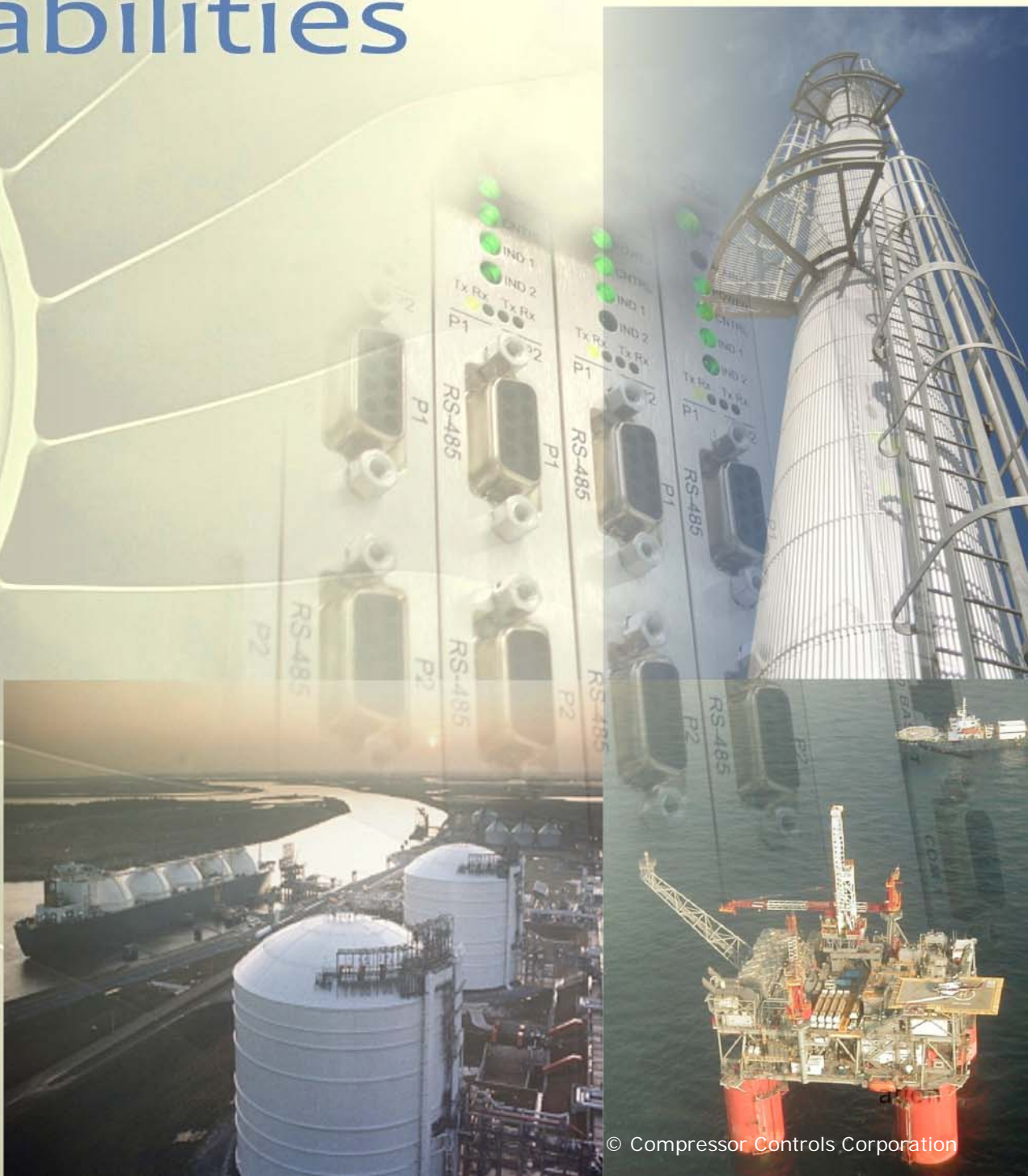


# Integrated Gas Turbine Control Capabilities





# CCC: A Leader in Gas Turbine Control

**Turbomachinery control is our only business** – and for more than 35 years we have been providing solutions for demanding applications. Since 1993, we have retrofitted over 1700 gas turbines. This, together with our installed base of over 8,000 compressor and steam turbine control systems, makes us a leader in every type of turbomachinery control solutions.

## Over 17 Years of Gas Turbine Successes:

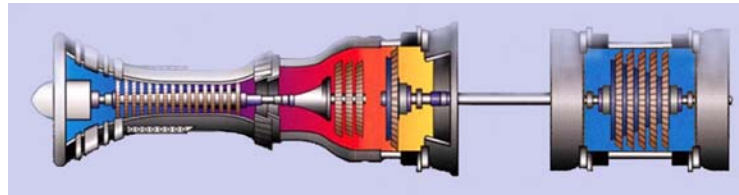
- Over 1700 gas turbines under control
- Over 30 types of gas turbines under control including most major manufacturers and models (reference lists available)
- Single-shaft and Multi-shaft Fuel Control
- Aeroderivative multi-shaft and heavy duty gas turbines used in both mechanical drive and electrical generator applications
- Gas, liquid and dual fueled units
- Nozzle and Variable Geometry Control
- Water and steam injection
- Startup & Shutdown Sequencing with IEC 61131-3 programming
- Integrated Machine Protection with Optional Duplex Architecture
- Purpose Built Platform with Integrated HMI
- Generator Control including Islanded Load Sharing
- CCC-designed & built Electric Fuel Control Valve specifically for gas turbine application
- Controlling gas turbines driving compressors, generators and pumps

## Auxiliary Control and Monitoring

Machine health and protection systems are a critical part of gas turbine operations. IEC 61131-3 logic-based programs are run on the same platform in a multitasking environment. Turning gear, starting motors, lube oil, vibration, rotor speeds and exhaust temperatures must all be measured and compared to alarm and shutdown thresholds.

The logic sequence will detect and alert the operator, abort the startup, or shut down the turbine in the event of excessive vibration or the failure of critical auxiliary systems.

First out detection, sequence-of-events recording, archiving and data presentation in a user-friendly format is a clear bonus for the customer. Time stamps are provided at loop time rates in the controller.

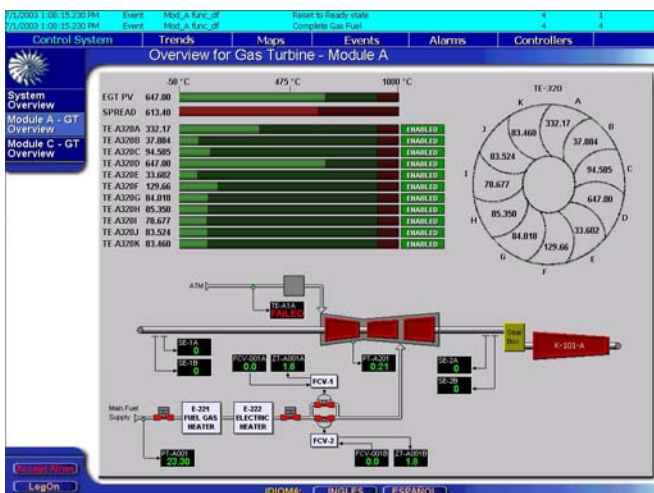


## CCC: Uniquely Qualified for Gas Turbine Control Solutions:

- Our unique “Readiness Screen” rapidly identifies all unfulfilled start permissives
- During startup, precise regulation of the fuel flow provides for consistent soft light-offs while limiting excessive temperature and acceleration, reducing wear and tear on your equipment
- Our pioneering trip-avoidance measures anticipate fast developing over-speed and over-temperature conditions to protect the turbine without unnecessarily restricting its operation. Operate at maximum power and at limits, without fear of tripping.
- Real-time compensation for variations in fuel pressure supply and temperature are provided as standard
- Combustion monitoring to assess hot spots and temperature spreads
- Data archiving
- Calculations for fuel and compressor efficiencies
- Predictive trending
- Integrated PDS (Predictive Diagnostic System) that helps identify turbomachinery problems before they affect your production. For example, when should operators wash the axial compressor? The PDS provides a simple and clear graphic presentation to answer this and many other questions.



CCC's all electric gas fuel valve



# CCC Integrated Turbomachinery Control Solutions



## Integration plus the Highest Quality of Control:

Integration of the gas turbine control with the driven compressor control reduces hardware, installation and commissioning costs. Integration, when combined with CCC's unsurpassed quality of control, provides true, lasting economic value. Our large base of gas turbine and compressor control retrofits have provided the experience to make us "best in class" for integrated gas turbine control solutions.

**Driver Challenges:** For the gas turbine, the challenge is to provide smooth and responsive power delivery to the shaft under variable loading conditions. Any load change on the compressor will have an affect on the shaft torque and hence, speed. Stable control requires precise speed control. In addition, start-up and shutdown must be handled in a precise, reliable and repeatable manner, in accordance with machine schedules and limits.

**Compressor Challenges:** The compressor is part of the process and not only affects – but is affected by – the process. For instance, a sudden drop in gas molecular weight can rapidly drive a centrifugal compressor into surge. This dynamic interaction between the compressor and the process creates control challenges, and the more dynamic the process - or when multiple machines share the load - the bigger the challenge. CCC has proven innovative strategies to solve complex compressor control problems.

**Control to the Limits:** To compound the inherent process and control instabilities, the compressors are tightly constrained by limits on all sides, some of which are very difficult to measure or model, yet operation outside of this envelope can be catastrophic.

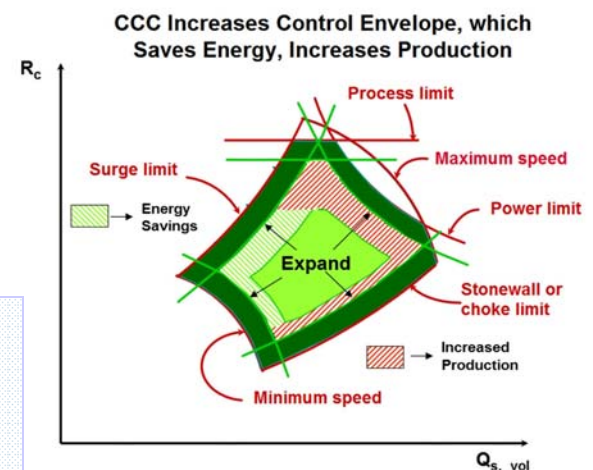
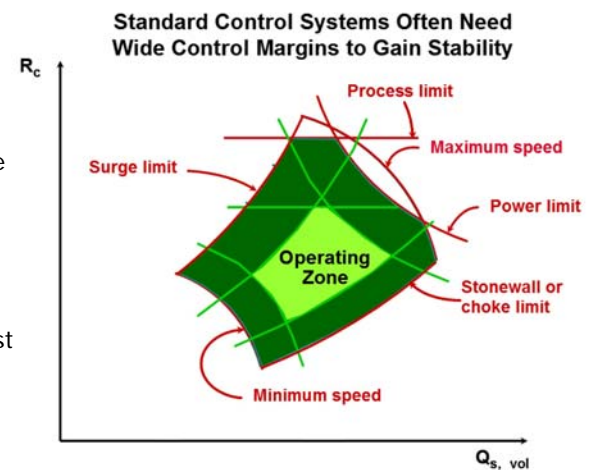
## Success Stories

**Offshore UAE:** Retrofit of three Rolls Royce Avon gas turbine driven compressors. Improved stability leading to significant reduction in flaring as well as significant production increases.

**Offshore Mexico:** Retrofit of two GE LM2500 compressor drives. Reduced trips, increased production, and the recycle valves are now closed.

**Offshore North Sea:** Retrofit of two Rolls Royce Avon gas turbine driven compressors. CCC algorithms enabled an increase EGT setpoint back to OEM levels providing a significant increase in production.

**Middle East:** Retrofit of ten GE Frame 5 compressor drives. System has resulted in exceptional availability, stability of control, reduced flaring and improved pressure control.



Our patented compressor and fuel control algorithms are proven to provide smooth and stable control closer to the control limits than any other system – maximizing your profits through increased production and reduced energy consumption. When the actions of the driver and driven equipment are coordinated, even narrower margins are possible, meaning even greater economic benefit.

## CCC Purpose Built Solutions

CCC develops, designs and builds its own control platform and HMI, dedicated for turbomachinery control, and provides all associated engineering services from conceptual design through commissioning. This provides significant advantages over PLC solutions:

**Built for Purpose:** CCC software & hardware are optimized for turbomachinery control. Our systems use field-proven application functions in highly flexible & configurable formats unlike adapted, individually programmed, often one-of-a-kind solutions implemented in PLC's. Our systems deliver decades of CCC institutional knowledge, resulting in consistent implementation, consistent support, consistent results.

**Longevity of Support:** CCC is not bound to the obsolescence and marketing plans of PLC's suppliers giving us a superior ability to control our hardware/software solution and ultimately provide the long-term support you expect.

**Support Excellence:** We are experts on the full solution, from R&D, to software development and through all phases of engineering, not reliant on third-party expertise, ensuring the fastest and highest quality of support. Over 70 field engineers in 11 strategic locations worldwide.

**Accountability:** We own the solution and are fully accountable for that solution, for the duration of the installation.

# CCC: Providing Tangible Economic Benefits for our Customers

CCC has a proven track record of improved availability and efficiency. Better turbomachinery controls provides major economic benefits. Paybacks within months are common:

- Fewer trips
- Improved process operations
- Increased production
- Reduced energy usage and CO2 emissions
- Reduced stress on operators and maintenance personnel

## Restoring Full Power Output from Your Gas Turbine:

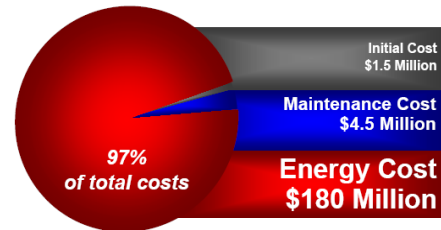
Many gas turbines operate well below their maximum allowed power outputs. Our unique setpoint suppression strategy allows restoration of EGT setpoints to OEM levels, without the fear of trips. The result is a significant boost in power output with corresponding increased production and profits. CCC also has a unique strategy to prevent flame out during compressor surge events, proven to prevent trips and keep the machines producing.

## Lowest Lifetime Cost of Ownership

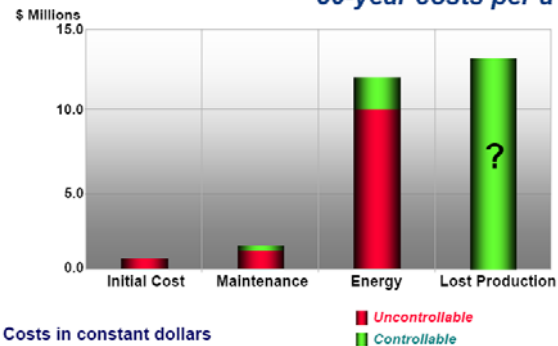
Is your evaluation based on capital costs alone, or do you factor in life cycle costs? CCC control systems provide the lowest lifetime costs - a key reason our customers keep coming back.

**The control system cost is a fraction of the lifetime costs, but the quality of that control significantly impacts lifetime costs.**

### 30-year life cycle costs for a 20,000 hp compressor



### 30-year costs per a 1,000 hp



*The data was from a study conducted by a major compressor user. Energy cost based on natural gas cost of \$3.50 per 1000 CF, or \$0.044 per kW-hr for electric motor drives. Initial and maintenance costs are for compressor only.*

**Lost production** has the biggest economic impact with paybacks in weeks or even days.  
**Energy savings** through improved efficiency provide paybacks in 2 to 12 months.

**CCC Turbomachinery Control Solutions have been providing enhanced profits for our customers for over 35 years.**

**Please contact a CCC office near you for more information on CCC gas turbine control solutions and other state-of-the-art products from the world leader in turbomachinery control.**



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