CCC AND YOKOGAWA R&D COOPERATION

Two companies combine capabilities to innovate DCS for compressor controls

WHITEPAPER SUMMARY

While searching for benefits of a simplified automation architecture to manage sensors, controllers, associated computers and other system components that are distributed throughout a facility, some end users have experienced problems related to simplistic self-made DCS-based compressor controls. Making complex standardized turbomachinery controls in cooperation between a DCS manufacturer and specialized expert turbomachinery controls company has proven to be more reliable and convenient as opposed to implementation by the user or an independent vendor. This paper will present a DCS-based compressor control system development model that resulted from close cooperation between a DCS manufacturer and a recognized expert in specialized turbomachinery during the system's R&D phase.

WHY DCS-BASED TURBOMACHINERY CONTROL?

There are a few reasons why some users want a DCS-based turbomachinery control system.

The first is to flatten automation architecture and reduce the number of automation platforms on site, making it easier to manage obsolescence and spare parts, train personnel, and to integrate with advanced process control and other supervisory systems.

The second is to increase operator confidence in the use and maintenance of turbomachinery controls, resulting in greater availability for qualified personnel to use the system, more flexibility in personnel selection, and easier troubleshooting. Managing the electronics within the compressor controls cabinet can also be easier when it is just another DSC cabinet, versus a dedicated system.

The third goal is to reduce integration efforts and costs by reducing interconnecting systems, protocols, and correlated testing activities. Recently, the cybersecurity alert has become one of the major considerations when choosing between purpose-built control systems that require integration into the overall cybersecurity infrastructure as opposed to including it in the DCS completely.

DCS-BASED TURBOMACHINERY CHALLENGES

Although experiments with DCS-based compressor controls were conducted decades ago, only recently have they gained industry-wide acceptance. This came after some DCS manufacturers were able to advance their system to a level that enabled them to perform high-speed turbomachinery control functions.

Today, there are several turbomachinery control vendors offering DCS-based solutions with various designs: different operating models, different engineering organizations, and different levels of complexity and efficiency of the control algorithms. Regardless of the systems available, many users still experience problems in turbomachinery controllability and in finding experienced resources that can support their control systems. These problems include unplanned trips, unstable control of primary control variables, excessive control margins leading to unnecessary recycle and energy consumption. There are additional problems related to manual operation of valves, speed set point, inlet guide vanes, and other control elements.

On an organizational level, some vendors are struggling to provide support to their customers globally due to lack of resources and an absence of local engineering capabilities. Another example of the challenges they are facing is incremental commissioning time, resulting from the need to make bespoke control algorithms on site when their standard software lacks some necessary functions. In rare yet not unheard-of situations, vendors are unable to even make the system work smoothly with the rest of process control. That eventually leads to systems being used in the manual operation mode.

GENERAL TECHNICAL REQUIREMENTS

Requirements for turbomachinery controls, when implemented using DCS, include high-quality, standardized, and proven control algorithms, high-speed controller and data recorder.

On the higher level of control architecture, several functional applications are required:

- Antisurge Control
- Performance Control
- Master Control
- Loadsharing
- Turbine Speed, Extraction and Expander Control

On the lower level, to fine-tune and optimize the interactions of control loops, several specialized algorithms are necessary: Loop Decoupling, Recycle Balancing along with more complex serial-parallel compressor operation algorithms. Going deeper, a high-quality compressor control system contains a lot of multi-layer protection schemes and fallback scenarios to mitigate even the smallest risk of unsafe operation or, on the opposite, of unnecessary false compressor trips. Not all of the functions may be necessary for every project, but they must be operable when needed to avoid additional on-site programming, leading to increasing commissioning time and associated risks for project schedules and budgets.

Technical requirements further include the availability of all operator-graphical objects relevant to the compressor controls: dynamos, faceplates, turbines, and compressor maps. And, before being put into service, the system must undergo thorough testing and validation from a specialized compressor controls company and DCS manufacturer.

Another key piece of the solution is the long-term global support provided by a compressor controls company and DCS manufacturer. It must be flexible to respond to all standard support requests locally and to all non-standard R&D support requests globally. Support resources must be readily available to provide help immediately, since every hour of the system downtime is associated with high costs to the user organization.

DCS-BASED COMPRESSOR CONTROL SYSTEM DEVELOPMENT

Engineers at CCC reasoned the answer to these challenges would require a partnership, which would exploit their capability as specialized expert in turbomachinery controls and a DCS manufacturer as an expert in process controls and provider of the right set of equipment, including controllers, network infrastructure, engineering tools, historian, and operator stations, etc. Using proven, well-known algorithms and engineering methodology combined with cutting edge technology control system from a global supplier would deliver better result and reduce risks at every stage, including technological and organizational aspects of the system lifecycle. This development model led to a concluded R&D partnership, commercial and marketing agreement for joint development and promotion of the CCC Inside solution for Yokogawa CENTUM VP control platform.

The partnership would enable several combined capabilities: integration of CCC's compressor control technology and Yokogawa's process control technology; shared products and created test beds for development, validation, and lifecycle support; rigorous validation processes by CCC and Yokogawa, combined engineering and field service capabilities. All that is to guarantee efficient implementation and timely support to end user operations.

Beyond being considered one of the most reliable DCS available, Yokogawa's CENTUM VP offered a number of advantages:

- N-IO greatly streamlines project execution by completely decoupling application engineering from field wiring and hardware installation
- Yokogawa's CENTUM VP technology and OpreX Agile Project Execution combine to streamline verification processes, binding, configuration, testing, and documentation for multiple field devices
- High-performance human machine interface (HMI) optimizes situational awareness and enables advanced decision support
- CENTUM VP supports standard interfaces, providing applications, compatibility, and interoperability throughout the entire enterprise
- Native compatibility across PLC, SCADA and SIS architectures
- Third party-certified defense-in-depth cyber security

YOKOGAWA AND CCC PARTNERSHIP YIELDS INVENTIVE TECHNOLOGY

As a result of their partnership, the companies developed several technological advancements.

A new function block was created by CCC and released by Yokogawa, by transpiling a control algorithm from a CCC purpose-built controller code into C programming language. By establishing the transpiling method, R&D group makes sure that the function block contains the same algorithm without manual corrections, which is very important to maintain consistency of the user's experience along with standardized engineering and commissioning methodology.

Advancements also included graphical objects that are native to the CENTUM VP Operator interface. There are faceplates to interact with the control applications, e.g., Antisurge Controller, Performance Controller etc. These are simple view faceplates along with detailed faceplates for access to control parameters. Another important piece of new graphics – Compressor Map – enables real-time observance of compressor performance: flow, polytropic head, compression ratio etc. Along with the new software, the solution uses some of the standard CCC specialized software to tune up the compressor control algorithms. Using the same CCC Configurator software enables CCC engineers to commission the compressor control loops using the same proven methodology they are using with the purpose-built controllers. The Fast Recorder trending and historizing software allows precise tuning by recording data with 100 millisecond resolution, which is a lot higher than standard DCS Historian. While not intended for

long-term data historizing, it substantially improves loop-tuning quality.

The two companies also developed a best practices controller and system commissioning chronology: The controller and system commissioning would be done by the local Yokogawa affiliate, as with a DCS. Compressor control loops commissioning would be done by the local CCC Field Engineering office, as with all other CCC systems. All expertise and support from both companies are to be enlisted to serve their other business in the region. This will ensure there are no special one-time solutions, no gaps, or exceptions, resulting in a solid, proven, reliable business process.

COMPRESSOR CONTROLS SYSTEM ADVANCEMENT UPGRADES THE USER EXPERIENCE

For users, the compressor control system advancements have yielded a number of benefits:

Notable and well-proven CCC control software contains all required functionality as standard and tested algorithms. Based on decades of experience, the software has been advanced to a level unprecedented in the industry. Every piece of the control logic serves to optimize, make safer, predict, and prevent any risk of failure. The experience and accumulated knowledge of generations of engineers is now available as a function block of Yokogawa CENTUM VP.

Operators have access to the turbo train parameters and system tuning parameters from the DCS screens, eliminating separate computers and screens and requiring no specialized knowledge to access information. Hardware maintenance is performed just as it would with the CENTUM VP – no special spares or expertise is required. Any form of the previous long-term service agreements with Yokogawa will be ready to support this new compressor control cabinet too. Users will also have access to intelligent devices and a complete range of field management devices is available for the DCS. Every time there is a planned new release of the CENTUM VP software, there will be a process of thorough validation of the compressor control software compatibility before the new CENTUM VP software release. Regional expert support and field engineering presence ensures instant support for controllers and algorithms.

CONCLUSION

In conclusion, it is important to remember that the best-in-class compressor control system is not just the most advanced technology. It is also the most advanced business process on every stage of product lifecycle – from the feasibility study to project design, delivery and commissioning and all the way to timely maintenance and support, providing enhancements and new features, eventually dealing with obsolescence and upgrades. Partnership between large, control system companies that have experience with thousands of projects ensures the business process will be most efficient at every stage, including post-installation system life. Buying the simplest solution is easy. Living with simplest solution is hard.

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