



Nexus Controls

a Baker Hughes business

OnCore Control System for hydroelectric plants

A hydroelectric distributed control system to increase your up-time availability

Overview

Nexus Controls has extensive experience from our more than 62 years of delivering turbomachinery control systems upgrades and our Woodward Governor Hydro heritage of 150 plus years. We offer complete Hydro Power solutions that can include: control systems (Hydro turbine governor, Plant Controls, and EX2100e Generator Exciters), Cybersecurity solutions, and Mechanical components (Woodward mechanical kits and Flow control distributing valves). Our control systems increase equipment availability for rotating machines, offering a broad, specialized portfolio that includes critical cybersecurity features and diagnostic approach to the OEM system vendor.

The **OnCore** Control System for Hydroelectric plants integrates in the same hardware and software platform the following control functions:

- Governor for francis, pelton, kaplan, bulb and pump turbines
- Unit auxiliaries like:
 - Inlet gates
 - Air compressor
 - Cooling system
 - Generator monitor instrumentation
 - Turbine monitor instrumentation
 - Governor HPU
- Switch station common auxiliaries like:
 - MV and LV power distribution
 - Spillway gates
 - Generator and transformer protection interface
 - Excitation system interface

- Static frequency converter interface for pump units
- Substation interface
- Dispatch system interface

Integrated turbine and unit control

Historically, the turbine governor is a separated panel from the unit control system; but then, a failure on either one cabinet would trip the unit. Having the turbine governor integrated with a dual redundant unit control system increases the availability of the plant since it will not depend on two different control panels working simultaneously like in the conventional configuration. The controller has a powerful processor able to run both governor and unit control software functions on a 20-millisecond cycle. This also saves cabling and installation space in the powerhouse.

The **OnCore** Control System integrated turbine control functions include:

- Start and stop sequence integrated with unit auxiliaries activation like cooling water, creep detection, brakes, injection pumps, excitation and synchronization systems
- PID control loops for:
 - Offline and isochronous speed
 - Active power control with feedforward curve
 - Wicket gate opening control
 - Optional level or flow control
- Runner blade position (3D cam curve with net head as input)
- Pelton for 2, 4 or 6 nozzles with or w/o deflector control
- Maintenance functions like servo dry test, overspeed test, step tests

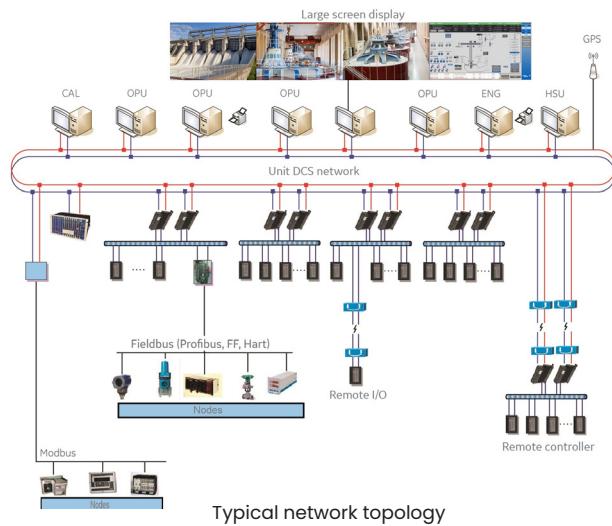
Nexus Controls knows that every hydroelectric power plant has something unique and specific to that installation and that the Nexus **OnCore** software platform and Nexus Controls engineering team is capable enough to implement the special functions as required.

All parameters or control constants are stored in non-volatile memory to guarantee that the latest adjustments will not be lost in the event of panel power supply, which is also redundant and prepared to be connected to any voltage between 90–264Vac 50/60Hz or 100–350Vcc.

Communication interfaces

OnCore Control System controller can communicate as master with other systems via the following protocols:

- MODBUS serial or ethernet
- Profibus DP
- IEC-60870-5-104



In today's competitive production environment, process industries demand control systems that increase productivity, reliability and quality while lowering cost. Nexus Controls' **OnCore** Control System is a **next generation DCS** that is an advanced, easy to learn, easy to use, fully configurable solution that improves overall unit reliability and availability while providing simplified expansion capabilities and reducing overall installation and training costs.

Designed and built using many decades of industry-proven control system expertise, the Nexus Controls' **OnCore** Control System provides seamless integration of advanced control and optimization solutions to further improve communication speed and reliability, reduce forced and unplanned outages, reduce the length of maintenance cycles, and decrease operations costs.

Benefits

- Logic configuration is completed online to avoid excess system outage or shutdown
- Redundant I/O communication and power enables independent replacement of modules without a complete system shutdown
- Three-level system network provides real-time performance with high-speed data exchange where needed the most—between the controller and HMI

- Non-critical information, such as data backups, is handled on a separate data highway
- Integrated HMI software package includes embedded historian and engineering tools.
 - The Historian can be expanded without additional equipment, saving cost and allowing for more analytical capability
- The redundant architecture provides enhanced control reliability and uninterrupted system access
- The rich function block library allows the user to customize the application and/or specific user defined sequencing, allowing for adaptability of plant configurations, both current and future
- Easily configured software allows for customization of HMI screens, reducing training time while improving the user experience

Industry challenges

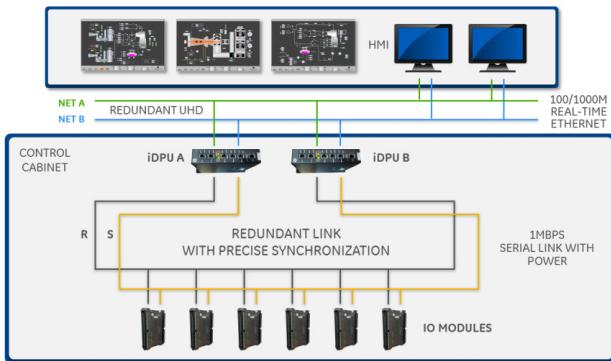
The hydro industry is looking for a long-term partnership and value-added solutions that reduce operating expenses. Nexus Controls' **OnCore** Control System not only provides that; but, also fills the lack of control system expertise and knowledge in the hydroelectric industrial segments with our extensive knowledge grown over many thousands of turbomachinery control systems installations.

About the solution

The **OnCore** Control System is the perfect solution to cover the hydroelectric industry's control system challenges. Nexus Controls' **OnCore** Control System is an easy to learn and use, flexible, scalable turbomachinery platform that provides customers with an inexpensive solution, regardless of their investment budget. Additionally, the **OnCore** Control System saves time during the project execution stage by providing dedicated turbomachinery I/O modules and libraries.

System architecture

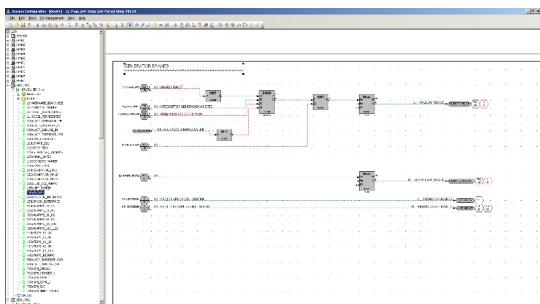
- **OnCore** Control System has been engineered with special attention to diagnostic and redundancy features. Its distributed architecture reduces impact from loss of system components and provides production continuity, guaranteeing the operability of critical system and control functions.
- Each node in the system is autonomous yet closely integrates with its peers. This architecture distributes risk so the loss of any one component does not affect the rest of the system. It also allows for optimization of available space by distributing control, I/O and HMI functions to different areas of a plant, eliminating the need to allocate a large, central area for installation.



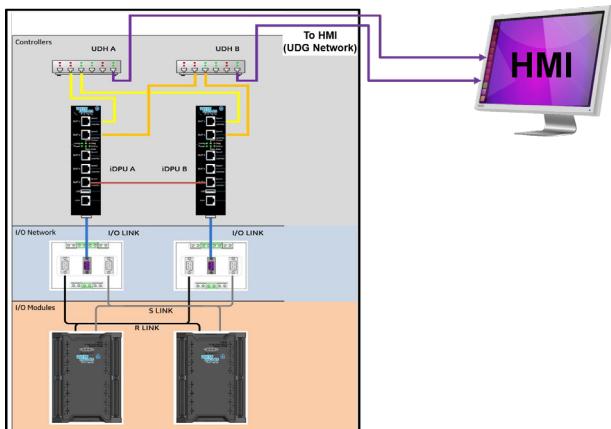
Typical **OnCore** Control System with redundant network

System software

- The **OnCore** Control System provides an integrated, easy to learn, easy to use and configure comprehensive software package (OptimumC) for plant operations.
- The **OnCore** Control System software allows for integration of displays, logs, graphics and alarms to give operators a comprehensive view of the plant and its assets – this provides a clear picture for data analytics and troubleshooting.
- The **OnCore** Control System software is intuitive and contains open source logic that users can configure to adjust to plant needs.



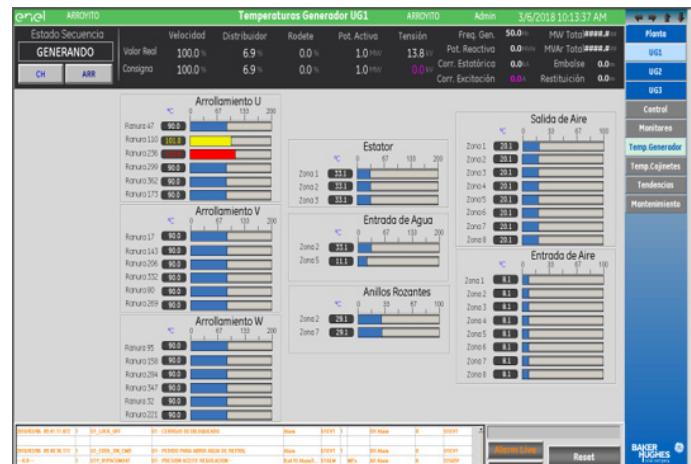
OptimumC – Programming environment



OnCore Control System cabinet system connection to HMI

Operator station and HMI

- Each operator station supports control, monitoring, and configuration of the entire system.
- Features of the operator station and HMI include:
 - Administrative control of user access levels
 - Single-point display for monitoring and control
 - Flexible alarm-monitoring capability (available in alarm list or embedded in operator graphics)
- Blue and gray scale color scheme aligned to ISA101 standards for high performance HMI. Yellow, red and magenta used to call the operator's attention to an abnormal condition. The temperature screen below is to emphasize this feature.



HMI Temperature screen

A library of standard display elements is supplied with the option of creating custom-built, dynamic displays based on user standards and requirements.

- Real-time and historical trend reports; both time-based and event-based options
- Configurable and redundant system historical data collection and storage

Fault detection-based historical data and SOE event records allow operators to pinpoint cause and determine response.



Hydroelectric turbine control screen

System hardware

Controllers

Central to the **OnCore** Control System is the iDPU controller. The iDPU is an integrated, stand-alone computer that runs the application code for industrial process control and data communication. It interfaces with process I/O modules and can be implemented in either a redundant or simplex configuration, depending on user requirements.

The OptimumC control software supports powerful control applications through straightforward configuration of function blocks. A wide range of process control capabilities include:

- Data acquisition
- Continuous control
- Logic control

Both real-time (online) and off-line configuration is supported.

Some of the system's hardware include:

- Controllers (iDPU)
- Some hydro-related I/O modules:
 - Speed measurement and protection module
 - Valve position control module
- Operator station and HMI



Typical **OnCore** Control System cabinet architecture