GE Energy

OC 6000e*

Distributed Control System

imagination at work

In today's competitive production environment, process industries demand a totally integrated control and optimization solution that can increase productivity, reliability, and quality while minimizing cost. These customers are driven to search for solutions to improve their competitive edge and to enhance their return on investment.

GE Energy's OC 6000e* Distributed Control System is designed to meet these customers' needs. The system and its advanced solutions deliver operating efficiency improvement, productivity gain, unit reliability and availability enhancement, and overall cost reduction. Its distributed architecture reduces impact from loss of system components and ensures production continuity. The component and network redundancy guarantees the operability of critical system and control functions.

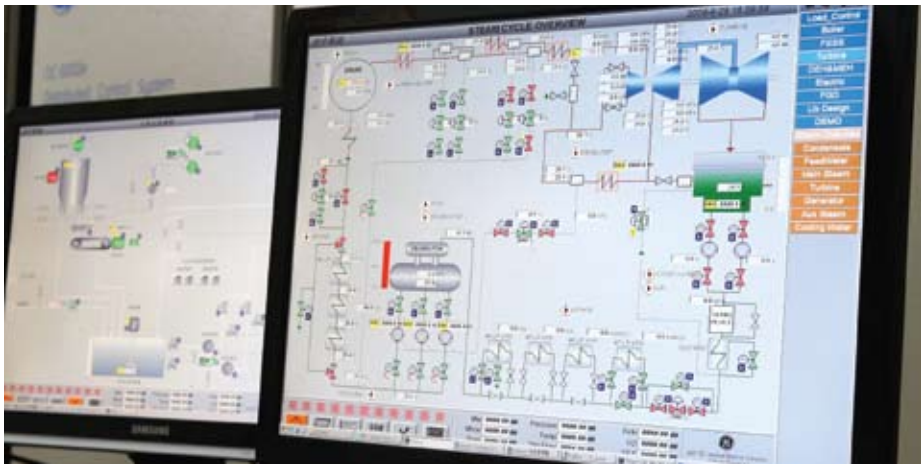
The OC 6000e DCS ensures operation safety and effectiveness. Seamless integration of its advanced control and optimization solutions further improves unit efficiency, reduces forced and unplanned outages, extends the maintenance cycle, increases unit reliability and availability, and minimizes operation cost.

System Architecture

Control system failure will likely result in the loss of production and equipment damage. This makes control system reliability an extremely important consideration when choosing a control system. The OC 6000e DCS has been engineered with special attention to diagnostic and redundancy features. The results are reduced downtime, improved system availability, enhanced control reliability, and uninterrupted system access.

Control, I/O, operator stations, engineer stations, data management, and gateway functions are distributed on a three-tiered Ethernet network to ensure system integrity and timely data transmission. Each node in the system is autonomous and yet closely integrated with its peers. The architecture distributes risk so the loss of any one component does not affect the rest of the system. For example, if a single controller fails, operation in other areas of the plant will be uninterrupted.

The distributed architecture also gives users greater flexibility in system installation and space utilization. Having the flexibility to distribute control, I/O, and HMI functions to different areas of the plant allows users to optimize available space. There is no need to allocate a large central area for the DCS installation.



System Network

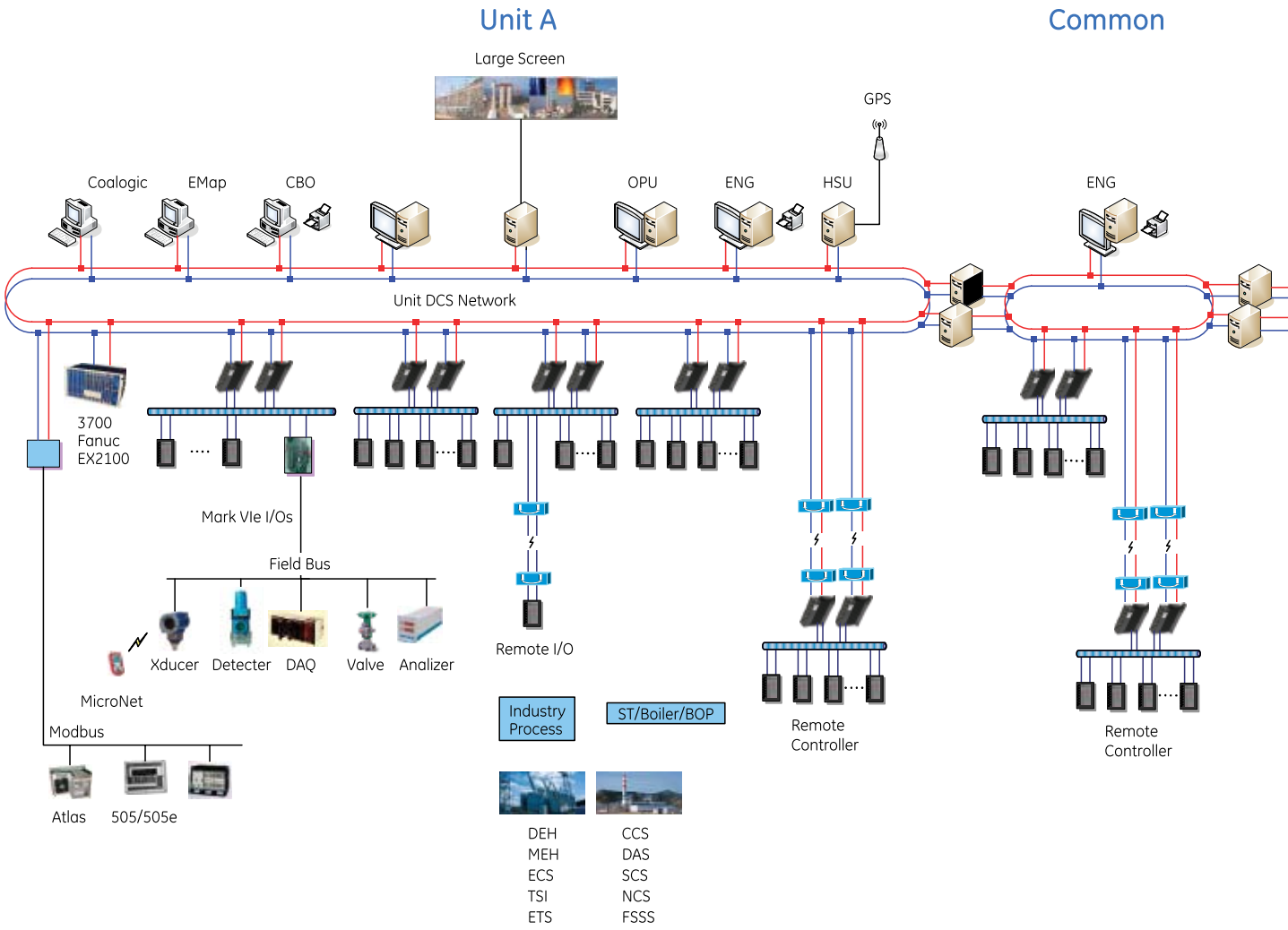
To minimize the probability of total communication failure, the OC 6000e DCS has a three level network; namely Plant Data Highway (PDH), Unit Data Highway (UDH), and I/O Network (I/ONet). Such network structure reduces extraneous network traffic, enhances network performance, and improves network reliability.

Plant Data Highway connects Operator Management stations for fast and effective data transfer of non-real-time files and print sharing. This improves overall network performance by offloading non-critical communication from Unit Data Highway.

Unit Data Highway connects the Operating and Control levels of the system. UDH provides superior reliability and availability between the operator and control layers through its double-ring high-speed Ethernet backbone, allowing uninterrupted access to real-time process information, alarms, and events.

The redundant Process I/O Network establishes a high-speed data transmission between DCS and Remote I/O stations over a distance of up to two kilometers. It uses a 100 MB Ethernet, is compatible with standard Ethernet devices per IEEE802.3, and supports IEEE1588 Precision Time Protocol. The media can be fiber or twisted pair.

OC 6000e DCS Typical Topology



Network redundancy can be implemented on two levels, depending on whether you install single or dual media. During normal operation in a single ring, the redundant switch-hub will continue to operate without interruptions during a single network fault so there is no impact on network operation. In the event of two simultaneous faults, the network is divided into two isolated parts and continues to operate in this capacity. When configured with redundant rings, the network can handle up to three faults simultaneously.

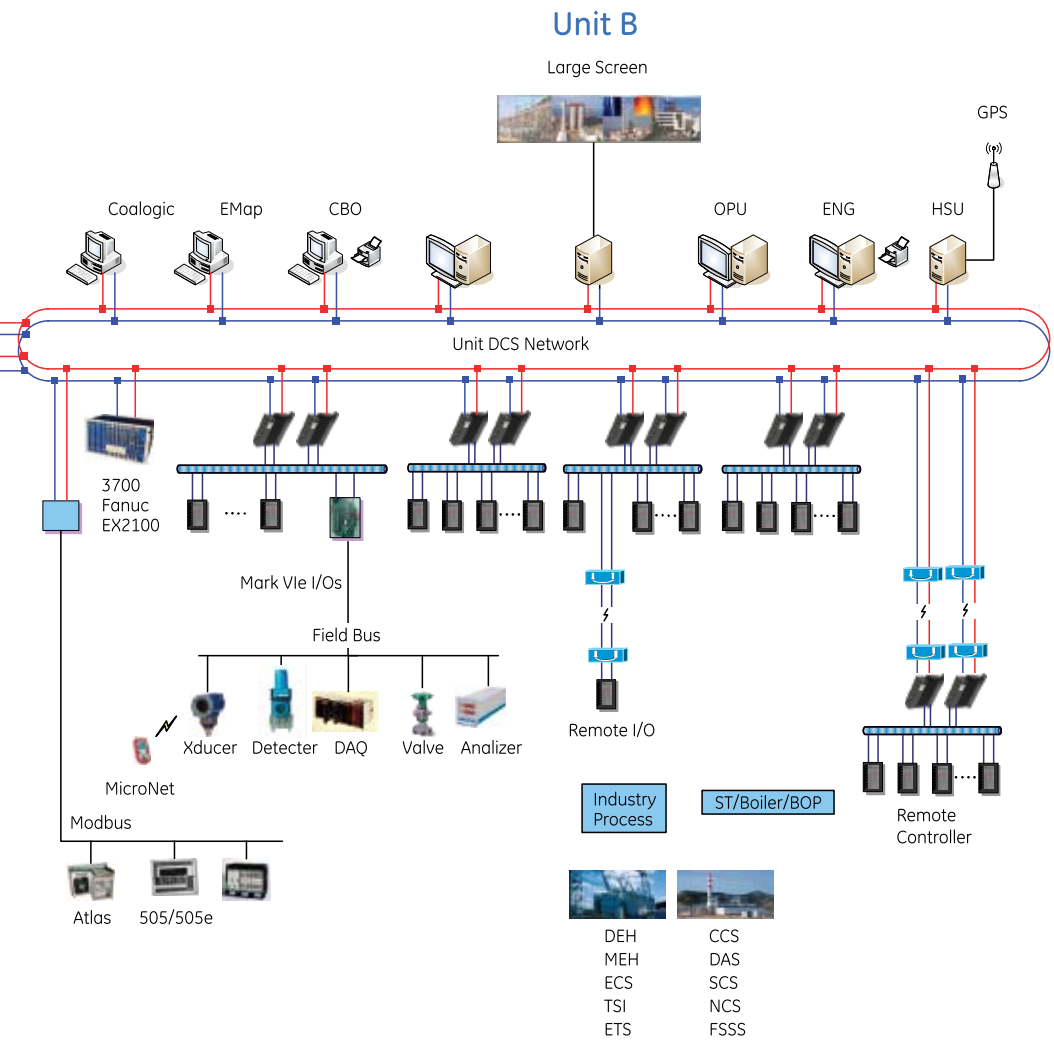
System Hardware

Operator Management Stations

During loss of an operator station, operation often encounters insufficient operator stations. OC 6000e stations support operation, engineering, and maintenance functions from a single workstation. Therefore, these stations are mutually redundant in function so the loss of any station will not impair proper operation and maintenance of the system.

Controller

Controllers in Distributed Processing Stations (DPS) provide the interface with process I/O. Control algorithms are configured by engineers through the engineering stations and executed in the controller. Controllers can be implemented in simplex or redundant configurations per user requirement.



World Class Products:

Network based I/O (Ethernet)
Support Field Bus
Simple/DMR/TMR
RTFN (Ring)
Powerful CPU
Compact cabinet
Qualified hardware (Test)
Safety cerifications
Integrated GE controls
- Mark VIe
- Fanuc
- 3500/3700/System 1
- Emap/Coalogic/CBO

The 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
- Sequence Control
- Advanced Control

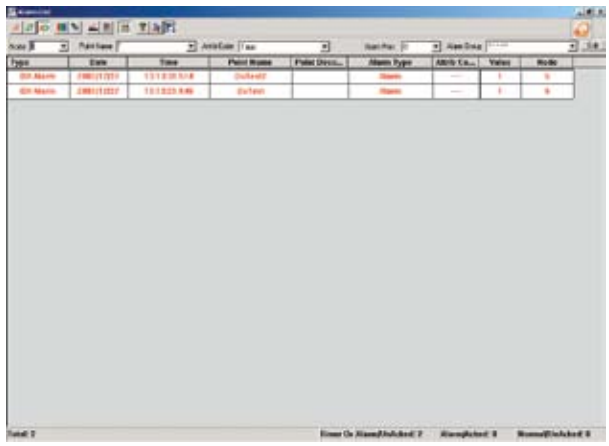
Both on-line and off-line configuration is supported.

I/O Module

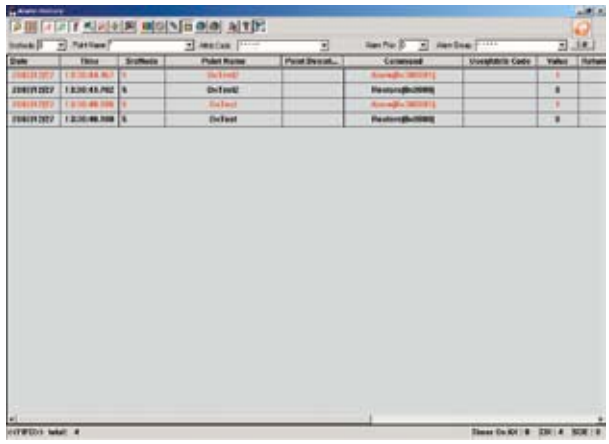
I/O modules are highly reliable and easy to maintain. Most I/O requirements are met using just four flexible module types (AI, AO, DI, DO). This simplifies I/O design and implementation, and minimizes the cost for spare parts. For example, the Analog Input module can be configured for mA or V, RTD or TC. All I/O modules support self-diagnostics to channel level and on-line maintenance.

The I/O subsystem can accommodate any size application. It is easily expandable and supports local, remote, indoor, and outdoor installations. I/Os can be distributed throughout the plant as individual modules or concentrated clusters to accommodate the distribution of field devices. I/O modules enclosed in industrial-hardened cabinets can also be located

I/O Module



Alarm List



Alarm History

Alarm Card

directly in the field close to operating devices, and then be connected to the OC 6000e network via the optic fiber or shielded twisted pair wire. This reduces field wiring runs and saves system installation expense.

Hot-swap capability and comprehensive diagnostics expedite maintenance and reduce downtime. Replacement of I/O modules can be performed under power and will not interrupt the operation of other modules. Modules are keyed to ensure they are always replaced with the correct module type.

I/O power supplies can be implemented with 1:1 redundancy. To further ensure continued operation, the user can program fail-safe modes for the I/O. For example, the user can program modules to hold a predetermined signal value, or hold the last good value on loss of communication with the Distributed Processing Stations.

System Functions

The OC 6000e DCS provides a suite of system functions to aid efficient unit operation, including:

- Engineering tools for graphics, database, control logic, reporting and guide
- Display for control, trends, alarm, points, group, etc.
- Data logging including various logs such as post trip, operator action, and alarm

System Security

System access control is central to plant safety and, therefore, is a core design feature of the OC 6000e DCS. Access to system functions are secured through four user authority levels: super

engineer, engineer, operator, and null. Each level has specific system operability access, with super engineer being the highest. User management allows *add*, *delete*, and *modify* for user accounts and passwords.

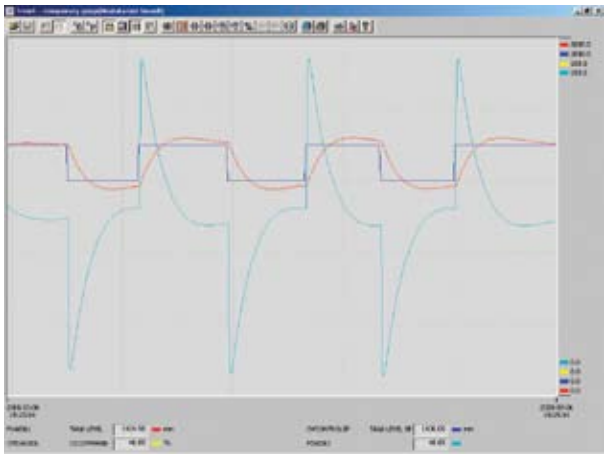
Data Acquisition and Management

The Operation Management subsystem provides a common interface for plant operators, engineers and maintenance personnel. The same HMI station presents each user class with critical information when and where it is needed. This includes real-time and historical process data, intuitive alarm indicators, Sequence of Events (SOE), and reports.

Versatile multifunction nodes in the Operation Management subsystem can also be configured to support historical data collection and storage, reporting, performance calculations, and third-party device integration (gateways). This flexibility simplifies system design and reduces hardware costs.

Operator Station and HMI

Each station supports control, monitoring, and configuration of the entire system. This allows a uniform graphical interface for all plant operations.



Trend Display

A set of standard system graphical displays are supplied with the system, including:

- Single point display for monitoring and control.
- Real-time and historical trend display.
- Alarm status and history display.
- Criteria-based point lists. Criteria such as signal type, controller assignment, SOE, alarm status, etc., can be used as filter criteria.

Custom-built dynamic displays can be created based on user standards and requirements.

A library of standard display elements, such as valves, pumps, and switches is supplied with the system.

Alarming

System and process alarms are essential to safe and efficient operation. The OC 6000e DCS has a flexible alarm-monitoring capability and is specifically designed to attract the operator's attention during operation upset and allows operators a clear view of unit operating condition. Alarms can be presented either in an alarm list or embedded in operator graphics. When embedded in operator graphics, dynamic action properties of the object can be configured to assist operator focus on distress areas. In addition to the alarm list and dynamic alarm graphics, a multimedia voice alarm can also be configured to alert operators.

Historical Services

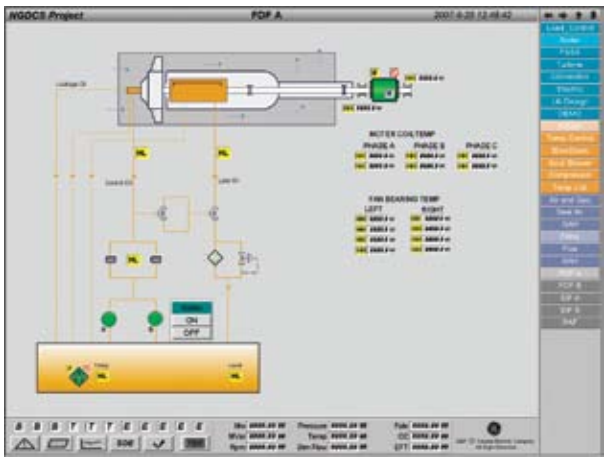
Process history is important to operation analysis, regulatory requirements, training, and root cause analysis. System Historical Services support the collection and storage of process history that includes process data, SOE and alarms. The collection sample rate is configurable, with 1 ms resolution for SOE. History capacity depends on availability of media capacity. History can be accessed through display, trend and periodic reports. This can also function as a log for operation records and configuration change management.

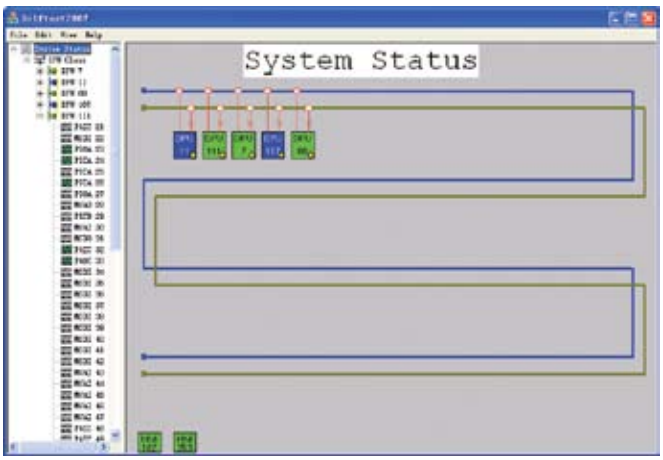
Redundant Historical Data Storage

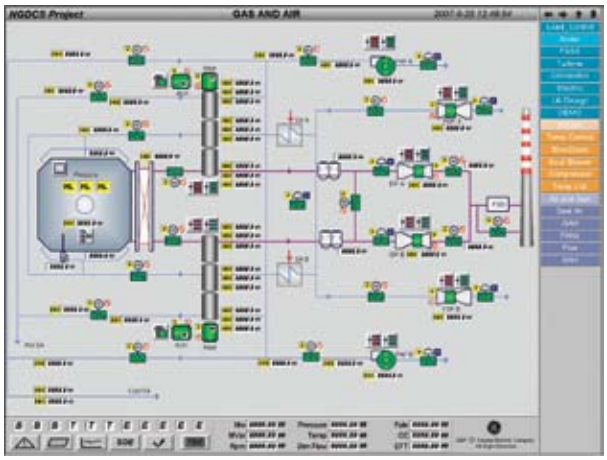
In some highly regulated processes, availability of process history is an absolute necessity by regulatory agencies. The OC 6000e offers a redundant historical data storage. This is accomplished by configuring historical data collection in two nodes, and then mapping the primary storage file of each node to the backup file in the other node.

Reporting

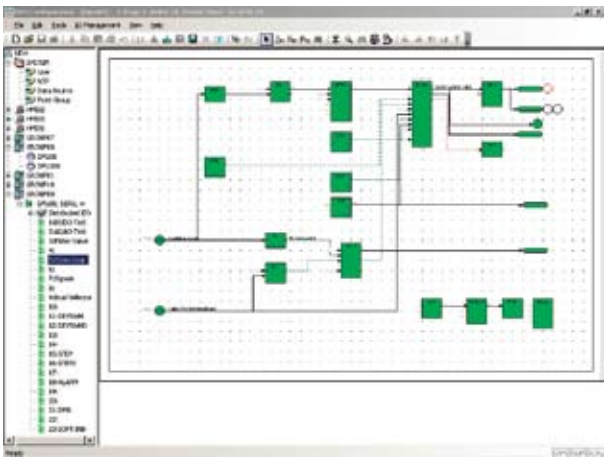
Reporting is critical to operation, productivity, and regulatory requirement. The Reporting function is provided through easily configurable report templates based on Microsoft® Excel®. Periodic



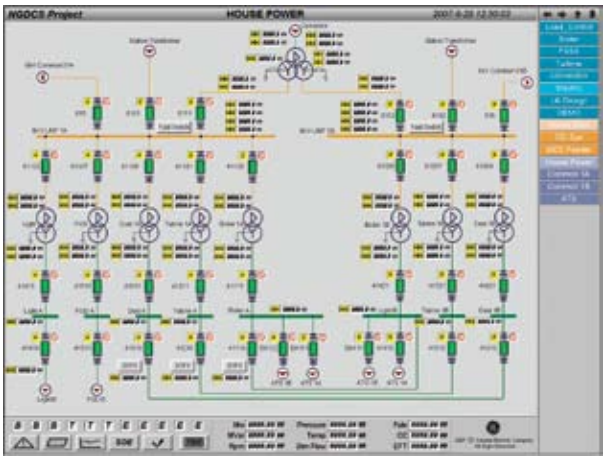




Diagnostics



Configurations



and event-triggered reports can be configured to query real-time and historical data. Periodic reports can be set up for hourly, shift, monthly, etc. Event-driven reports can be configured to record start/end time, duration, time-stamped max/min values, etc., and triggered by a digital point.

Fault Detection and Diagnostics

Fault detection and diagnostics is central to system stability and reliability. When a problem occurs in the system, the fault detection and diagnostic function of the OC 6000e can quickly analyze the cause of the failure by examining historical data and sequential SOE event records. This allows maintenance personnel to pinpoint the cause and location, and to determine a response.

The system detection and diagnostic software monitors the status on several levels:

- Network
- Network Node
- I/O Station
- I/O Module
- I/O Channel

Engineering Tools

Standard configuration tools allow quick and easy configuration of control, reports and displays. A standard set of engineering configuration tools is provided with the system. Tools consists of:

- Graphics builder
- Database builder
- Control logic builder
- Report builder
- System status display
- Electronic guide

State-of-the-Art Control Solutions

Proven control solutions allow precise control over the entire operating range and are the foundation of safe and efficient operation. The OC 6000e DCS provides a suite of integrated control solutions for safe and efficient unit operation. Solutions include plant-wide control, such as boiler control, turbine control, furnace safety supervision, sequential control, electrical control and balance of plant.

Modulating Control System (MCS)

MCS controls the operations and process parameters of each system such as fuel, air, gas, water, and steam. The MCS accomplishes this by applying a coordinated control scheme and advanced control strategy.

Coordinated Control System (CCS)

CCS is the main controller of the unit. Based on the dispatching demand, CCS adjusts thermal process to meet the demand. There are four modes of operation; namely coordinated control, turbine follow, boiler follow and manual operation. The unit can be

operated in either fixed pressure or variable pressure operation. CCS is an integrated control design that ensures safe and efficient coordinated unit operation.

Boiler Control System (BCS)

BCS provides automatic combustion control of the combustion process. Based on the steam load demand, BCS controls combustion by coordinating fuel, air, and furnace pressure. To accomplish optimal combustion control, BCS can coordinate single or multi-fuels, pulverizer and mills, FD/ID fans, and air/gas flow while maintaining a safe operation.

Furnace Safety Supervisory System (FSSS)

FSSS supports continuous monitoring of the combustion in the furnace—performing logic evaluations, dispatching operation instructions, and executing interlocking permissives in combustion control per procedures during normal boiler start-up and shut-down. When an abnormal situation or malfunction occurs, FSSS can respond quickly to stop fuel accumulation in the furnace, thus maintaining a safe operating environment by preventing accidents such as boiler explosion.

Turbine Control System (TCS)

TCS includes large steam turbine control, feed pump turbine control, the turbine bypass control system, the emergency trip system, and the turbine supervisory instrumentation system.

Balance of Plant (BOP)

BOP controls all plant equipment outside of the boiler, turbine and generator. As a part of the total integrated solution for the OC 6000e DCS, this goes beyond the scope of conventional BOP and includes:

- Circulating water pump system
- Fuel oil pump system
- Ash removal system
- Chemical water treatment system
- Dust removal system
- Coal conveying system

Sequential Control System (SCS)

SCS provides open-loop control for plant auxiliary equipment. This includes start/stop, interlocks, and protection functions. SCS is comprised of equipment level control, sub-group level control and group level control.

Electric Control System (ECS)

ECS provides monitoring and control for all electric equipment in the power plant on an integrated platform. Monitoring and control includes:

- Generator-transformer units
- Monitoring and control of the 6 kV Bus System
- Monitoring of the 380 V Bus System
- Monitoring and control of systems such as DC and UPS

ECS performs electric logic lock and interlock using various DCS logic functions, while completing the monitoring of the bus and generator-transformer. Those functions include, but are not limited to, standby automatic operation, safety power supply automatic operation, diesel generator automatic start, and interlock of breakers. The common system can be monitored and controlled by an individual ECS via gateway. Only an operator of one unit has the authority to operate the common system at any time.

ECS offers the following advantages over the traditional control systems:

- Standardized system configuration for convenient logic analysis
- User-friendly graphical interface with detailed instructions and help information
- Sequential control functions to prevent operator errors
- Grounding management interlocks to provide safe maintenance operation
- Highly visible and intuitive indicators for alarming

Advanced Solutions

Real-time Optimization

Efficient management of unit operation requires timely access and publication of process history and performance data to the management, operational and technical staff. Real-time Optimization supports automatic data acquisition, consistent storage and intuitive presentation of plant-wide information. The customized algorithms library serves as a knowledge base for various advanced analytical applications. The real-time supervisory information can also assist operational evaluation and decision. Configuration tools let you customize the graphical user interface display and algorithm logics on-line or off-line. Static and dynamic effects can easily be embedded in the display. Embedding complex algorithms in the display can be implemented by an easy drag-and-drop method. Real-time Optimization not only provides real-time and historical data interfaces to applications, but also provides secondary development interfaces to various local and remote applications. There are two basic functional groups.

Plant Level Information Supervisor

This is a real-time information monitoring and processing system. Plant management and technical personnel can access real-

time and historical operation data for all production systems. Data is presented in tabulated or graphical form. Data includes process data, plant-wide equipment conditions, critical operating parameters, and performance conditions.

Operation Performance Instructor

This is a set of performance analysis and support tools for plant operators:

- The operation performance analysis system delivers thermodynamic performance information for component, unit and plant.
- The plant level load optimization and dispatch system is designed to reduce overall plant heat rate and fuel cost. This system allocates and distributes unit loading among multiple units based on optimum unit efficiency.
- The operation performance guidance system analyzes and scores the overall operation performance for costs, safety and stability. This enhances plant operation performance.

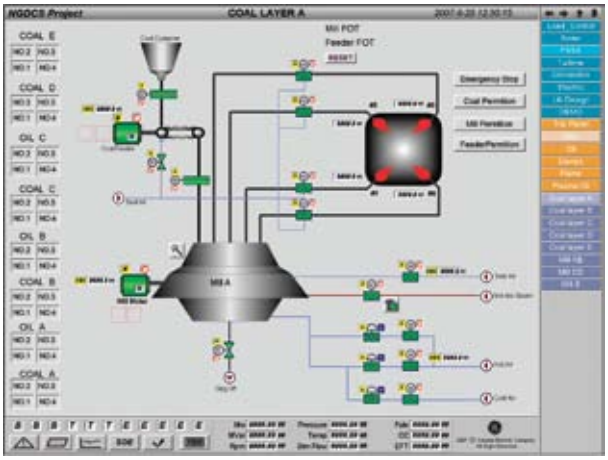
Process Simulation and Modeling

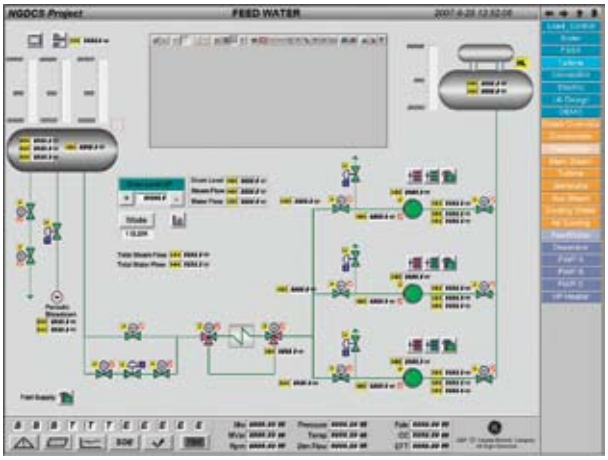
Process simulation and modeling can provide cost-effective operator training, effective control strategy validation, exhaustive system troubleshooting, and expeditious hardware fault diagnostics. Simulation provides a cost effective solution for:

- Operator training
- Control strategy validation
- On-line and off-line system troubleshooting

This simulator mirrors the structure and functionality of the actual DCS. All DCS upgrades are done concurrently on the simulator so there is exactly the same operating environment as the DCS and no version mismatch.

Historical operation data can be read into the simulation system. By replaying the production process history, plant engineers can expedite root cause analysis. Simulation can be used to conduct accident avoidance drills to improve the operating capability.





The simulator can support a miniature version of the DCS. This configuration can be used for system hardware troubleshooting. The Mini-DCS can be used for testing suspect I/O cards for fault diagnosis and spare parts.

The simulation system is portable and can be installed on a laptop. Troubleshooting can be done live at site.

Advanced Control and Optimization

Knowledge Cubed* (Kn^3)

Advanced control and optimization solutions are essential tools for today's competitive market. These tools improve reliability, efficiency, productivity, and cost. Kn^3 is a platform for modeling, optimization and control. Three unique technologies are used: namely, neural nets for predictors; optimization by genetic algorithms; and multi-variable control. Neural nets are extremely accurate at predicting, even for complex processes. Genetic algorithms use a mathematical model that emulates natural selection and delivers a strong optimal control solution. Multi-variable control is GE's advanced process control solution that can smoothly and safely adjust multiple operational setpoints based on optimization. Kn^3 is designed to be flexible and configurable so its application is economical and customizable. It can be applied on/off-line and in open/closed loop.

A suite of advanced applications has been developed to take advantage of this unique platform and technology.

System 1*

System 1 is GE Energy's patented software platform for real-time optimization of equipment and selected processes, condition monitoring, and event diagnostics. This platform provides the capability for the assets to drive the process. Asset-related decisions require detail analysis of data so impact to plant safety and operation is minimal. System 1 is intelligently designed to provide assistance for well-informed, high-confidence decisions.

CLOC*

CLOC is a supervisory controller that automatically determines optimal setpoints and passes these to the unit DCS. System safety is a core design feature. The optimal setpoints are constantly compared with unit operating limits, equipment constraints and emissions limits to insure safe unit operation.

Coalogic*

Coalogic allows dynamic blending of coal, real-time optimal coal usage matching market conditions, coal movement tracking, mix and flow modeling, and it also maps quality and inventory. This is designed to permit proper and accurate blending of coal, so the amount of fuel burnt matches the hourly operating and market

conditions. Coalogic can reduce fuel costs, help emissions control, increase fuel flexibility, and it also monitors fuel costs in real-time.

Coal Boiler Optimizer* (CBO)

CBO is an optimization application for coal-fired boilers. This on-line optimization can be applied either in open or closed loop. It is designed to improve combustion efficiency and reduce emissions. Three types of advanced technologies (neural nets, genetic algorithms and multi-variable control) are built into this application to ensure an optimal and stable solution.

System Scalability and Expandability

The OC 6000e DCS is scalable and customizable to provide a cost-effective solution for the user's current control requirements, and is easily expandable to meet the future needs as demanded by future growth. The sizing flexibility can be scaled for any operation with regard to the number of Operator Management stations and control points, and the amount of historical data to be stored.

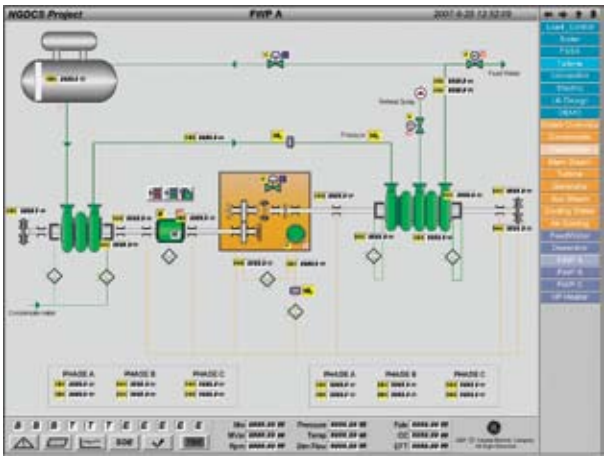
Third-Party Device Integration

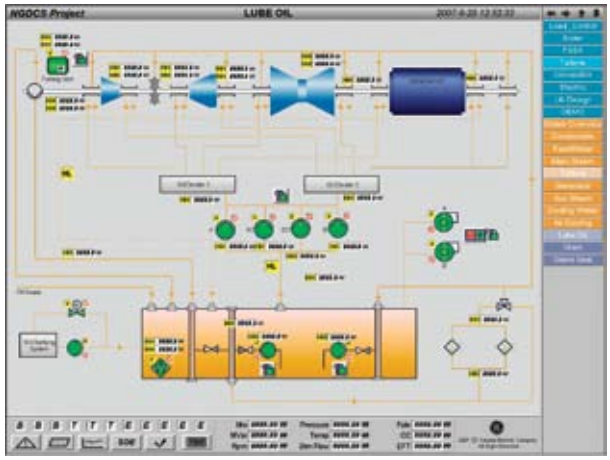
The OC 6000e DCS lets you integrate external devices through I/O drivers running on Distributed Processing Units, or gateway software running on Operator Management Stations. This capability helps you extend the life-cycle of your system on two levels:

- **Integrating existing systems.** You can integrate existing GE systems such as Turbine Control and Electrical Control Systems into the OC 6000e DCS. This lets you squeeze every bit of productivity from existing systems that continue to perform reliably.
- **Integrating new products.** You can integrate new off-the-shelf products to enhance your system with new technologies as they become available.

Protecting Your Investment

GE's OC 6000e DCS offers an integrated platform for distributed control, advanced control, optimization, and simulation that increases the customers' competitive advantage. The system provides a solution that is scalable to the customers' needs, impacts the bottom line, and increases return on investment.






DANGER

GE Energy
3800 North Wilson Avenue
Loveland, CO 80538 USA

+1-970-461-5201
800-835-5182

GE Energy
160 Wenjing Road
Shanghai, 200245, China

+86-21-24036666

energy.controlsolutions@ge.com
www.ge-energy.com/controlsystems

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