Technical innovation, quality products, and excellent customer service have always been important trademarks at HFC. We are committed to supplying you with proven, reliable control systems designed in accordance with your needs and specifications, delivered on time at competitive prices.

We look forward to working with you to fulfill your process control and automation needs.

HFC-6000 Safety Control System
Product Line Overview

- USNRC Safety Evaluation (SE) Report
- TUV SIL-3 Certificate
- Korea KINS Qualified

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HFC-6000 Safety Control System

The HFC-6000 Safety Control System represents the culmination of over 30 years of control system research and development efforts. It is designed for control and monitoring of the most critical applications, the system is capable of functional operation, even in the most intense physical, electrical, and seismic environments. The overall system architecture, coupled with rugged, robust system components, reduces installation, maintenance, and spare parts costs, while assuring a long operation life. The flexibility and scalability in overall system design provides a customizable solution capable of meeting the most rigorous safety control system requirements. Based on these features, the HFC-6000 becomes the optimal choice for the functions being performed.

The HFC-6000 architecture is based on a field-proven design which can be found in hundreds of fossil and nuclear power plant installations worldwide. The system design is based on a thorough understanding of critical plant conditions, the ongoing events that trigger them, and the prompt resolution of such conditions. The architectural features of this platform for control and safety systems provide significant economic advantages during commercial operation while maintaining the reliability and flexibility standards in the overall system design. By utilizing in-house application software algorithms and communication protocols common to HFC control systems, the HFC-6000 is compatible with legacy control systems and is also capable of future upgrades, maximizing system longevity and return on investment. This emphasis on equipment and the preservation of future upgrade ability avoids the cost associated with system obsolescence and new product development.

Capable of being implemented in a Redundant or Triple Module Redundant (TMR) configuration for safety control applications, the HFC-6000 platform architecture eliminates single point of failure for maximum fault-tolerant operation. HFC can structure the system to incorporate redundancy specific to certain critical areas, and the segregation of functions provides a multitude of operational and maintenance benefits, reducing overall operating costs. The system architecture virtually precludes propagation of failure modes indication, the advanced, system-wide diagnostics continuously monitor system hardware, software, and communication parameters in real-time; and the resulting status data enable isolation of system anomalies all the way down to a single I/O channel.

Enhanced operator and maintenance functions are facilitated by a variety of Control Room strategies ranging from a traditional discrete Man-Machine Interface (MMI) to high-resolution, digital flat panel displays with touch screen capability. A dedicated safety flat panel display is available for environmental and seismic sensitive applications. The HFC-6000 has the flexibility to present high-level process displays for an overall system status overview, or more detailed displays which are particular to a specific process operation, increasing operational and maintenance benefits.

Features
- Dual-channel configuration with secondary loopback function
- High-speed data transfer rate
- Deterministic masterslave polling protocol
- Connection of up to 32 I/O modules on one physical link
- Local or remote I/O accessible
- Dedicated HFC-6000 HUB and Fiber-optic Transmitter
- Continuous error checking to prevent system degradation or data loss
- Local communication error isolation to prevent propagation to the whole system
- Multiple layers for different media to be located on separate layers
- Only proprietary communication protocols used in safety networks
- Safety channel gateway controls are independent per cabinet
- Proprietary software in Firewall to secure remote access
- Ground fault detection reported on rack basis
- Local communication error isolation to prevent propagation to the whole system
- Multiple layers for different media to be located on separate layers
- Only proprietary communication protocols used in safety networks
- Safety channel gateway controls are independent per cabinet
- Proprietary software in Firewall to secure remote access
- Ground fault detection reported on rack basis

Nuclear Special Input/Output Modules

- Motor Operating Valve (MOV) Starter Control
- Electrically Operated Breaker (EOB) Control

Other HFC-6000 Dedicated Components

- I/O Termination Boards and Cables
- Thermalcouples Input
- High pressure Power Supply, Plug-in type
- Control Switch Modules (CM)
- Manual/Auto (M/A) Station
- Flat-Panel Display (FPD)

HFC-6000 Technical Specification

- Controller: Intel Embedded Pentium
- System Redundancy: Controller, Communications, Power Supply
- I/O Modules Support: Discrete Input/Output
- Analog Input/Output
- Thermocouple Input
- R/T Input
- Pulse Input
- Special functions/nuclear Control Switch Module
- Manual/Auto Station
- Safety Features: Loop Integrity
- Coil Continuity
- Single channel ADC (14 B)
- 20 ms response time/loop
- Ground Fault detection

Nuclear & Manufacturing Facility

HFC has 40,000 sq. ft. nuclear & manufacturing facility located in Cullman, Texas (about 15 minutes driving distance from DFW international airport). It is operated under NQA-1 quality procedures and working instructions.

Commercial Grade Dedication

The Commercial Grade Dedication (CGD) and evaluation work has been performed in HFC’s Carrollton facility. All components and assemblies used for nuclear class 1E are required to be evaluated and tested according to CGD procedures.
**HFC Nuclear Plant Experience**

<table>
<thead>
<tr>
<th>Year</th>
<th>Plant</th>
<th>Safety</th>
<th>Application/Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011-2012</td>
<td>All 2+ korea Nuclear Power Plants</td>
<td>Safety Trip System</td>
<td>Automatic Speed Trip System (ASSM)</td>
</tr>
<tr>
<td>2009-2010</td>
<td>Shin Wolsong NPP unit 1 &amp; 2</td>
<td>Class I &amp; Non-I</td>
<td>1000 MW*2 HFC-6000 NPP Plant wide Control System</td>
</tr>
<tr>
<td>2008-2009</td>
<td>Shin Kori NPP unit 1 &amp; 2</td>
<td>Class I &amp; Non-I</td>
<td>1000 MW*2 HFC-6000 NPP Plant wide Control System</td>
</tr>
<tr>
<td>2008-2009</td>
<td>Ulchin NPP unit 1 &amp; 2</td>
<td>Class I &amp; Non-I</td>
<td>Alternate AC Diesel Generator Control</td>
</tr>
<tr>
<td>2008-2009</td>
<td>Yonggwang NPP unit 1 &amp; 2</td>
<td>Class I &amp; Non-I</td>
<td>Alternate AC Diesel Generator Control</td>
</tr>
<tr>
<td>2005</td>
<td>Doosan R&amp;D Center</td>
<td>Non-safety</td>
<td>Control Red Control System (CRCS)</td>
</tr>
<tr>
<td>2005</td>
<td>ACO NPP Spain Unit 1, 2</td>
<td>Non-safety</td>
<td>XCMS Display and Monitoring System</td>
</tr>
<tr>
<td>2004-2005</td>
<td>Kori NPP unit 1, 2, 3 &amp; 4</td>
<td>Class I &amp; Non-I</td>
<td>Alternate AC Diesel Generator Control</td>
</tr>
<tr>
<td>2003</td>
<td>KEDO NPP unit 1 &amp; 2</td>
<td>Class I &amp; Non-I</td>
<td>1000 MW*2 HFC-6000 NPP Plant wide Control System</td>
</tr>
<tr>
<td>2002-2004</td>
<td>Ulchin NPP unit 5 &amp; 6</td>
<td>Class I &amp; Non-I</td>
<td>1000 MW*2 HFC-6000 NPP Plant wide Control System</td>
</tr>
<tr>
<td>2001</td>
<td>Kori NPP unit 1, 2, 3 &amp; 4</td>
<td>Class I</td>
<td>Emergency Diesel Generator Control (Relay)</td>
</tr>
<tr>
<td>1992-1994</td>
<td>Yonggwang NPP</td>
<td>Class I &amp; Non-I</td>
<td>Alternate AC Diesel Generator Control</td>
</tr>
<tr>
<td>1992-1994</td>
<td>Yonggwang NPP</td>
<td>Class I &amp; Non-I</td>
<td>Alternate AC Diesel Generator Control</td>
</tr>
</tbody>
</table>

**Note:**

Plant wide Control System (PCS) controls up to 80% of Nuclear Power Plant (NPP) equipment and includes Control Room equipment, Balance of Plant, Load Sequencer, Engineering Safety Features Actuation System (ESFAS), Feeder and Chiller Control, HVAC Control, Diesel Generator and Alternate AC Diesel Generator Control, Turbine Monitoring, Emergency Shut Down System, and Redundant Control and Monitoring.

**Fact:**

Since the commission of the first set of plant wide digital control system in Yonggwang NPP 1992, HFC delivered and installed near 10,000 microprocessor based controllers in NPP successfully. The long operation history of field-proven nuclear safety control systems is the solid base of HFC’s nuclear I&C technology.

HFC is not only a manufacturer of high-quality control systems, but also an engineering firm capable of providing a variety of custom solutions through the use of advanced hardware and software solutions. HFC has a demonstrated record of supplying high integrity control system solutions in partnership with our end users. HFC can confidently and realistically address the pressing concerns of the plant by providing long-term support without risk of system obsolescence resulting in a lower cost of ownership over the operational life of a control system.
**HFC-6000 Safety Control System**

**Benefits & Features**

The HFC-6000 Safety Grade Control System overcomes the deficiencies associated with traditional analog systems through the provision of the following features and benefits:

- **Increased System Performance**
  - Controller computations and logic execution is performed utilizing a high-speed, dedicated Intel Pentium® processor (64-bit), which provides extremely fast system response times. Communication functions are conducted through separate, dedicated processor (32-bit) for increased data throughput. The high performance processors and high-speed communication reduces the required amount of equipment, simplifying overall system design. The system provides reliability, flexibility, and technology not available in traditional analog systems.

- **Field-Proven Architecture**
  - The high-integrity system architecture is found in many fossil and nuclear power installations worldwide. The simplification of the hardware and software design decreases system complexity, reducing maintenance and testing costs and minimizing the probability of system errors.

- **Unparalleled System Longevity**
  - The system architecture permits future upgrades with minimal modifications as well as backwards compatibility to legacy HFC control systems. Unsurpassed system operating life provides an exceptional return on investment.

- **Improved Maintenance and Testing Facilities**
  - A wide breadth of configuration, diagnostic, and maintenance tools and personnel are available in the definition and prompt resolution of system abnormalities. Corrective maintenance is also facilitated through the ability of 'hot swapping' failed modules without the disrupting other ongoing, critical processes.

- **Real-time System Tests and Diagnostics**
  - Continuous and concurrent monitoring and system status parameters. System alarms can be generated upon detection of any kind of process/system anomaly.
  - Maintenance personnel are able to observe detailed system status displays and perform various system tests through the Maintenance Subsystem.

- **Increased Reliability & Flexibility**
  - The utilization of field-proven hardware and system-wide redundancy results in improved fault-tolerant operation. The system architecture effectively eliminates single points of failure and is designed to any failure from compromising other system components. In its full, redundant form, a 99.999% system reliability rating can be achieved.

- **System Flexibility**
  - System flexibility is exhibited by providing redundancy specific to critical areas where it is required and by the wide variety of Man-Machine Interface configurations and displays that are available.

- **Comprehensive Debugging & Simulation Capability**
  - The system provides a diagnostic and debugging problems quickly. The operator can view any object on any page, set break points, single-step through control logic, and perform wiring and installation testing all in the comfort of one workstation. Forcing internal and external coils, contacts, and analog floating point values simplifies design and troubleshooting. Simulation capability provides instant feedback features enabling an entire process. Applications can be simulated on a PC, reducing your development time and providing operators with an easy-to-use training aid.

**HFC-6000 High Integrity Controllers**

The redundant HFC-SBC06 controllers provide reliable, fail-safe, and field-proven industrial process control technology. Redundancy is performed through Dual-Ported Memory (DPM) modules which allow a simultaneous controller imaging by both controllers.

**All dynamic data transfer from the primary controller to the secondary controller on a user configurable periodical basis. (Digital) or event base (Analog). A maintenance failover mechanism allows routine checking of the integrity of both controllers and ensures bumpless transfer from the primary controller to the secondary controller.**

**HFC-6000 High Integrity Input/Output Modules**

HFC provides a complete library of I/O cards to handle both Digital and Analog signals, all of which feature built-in self-diagnostics, hot-swappable capability, and a automatic address scheme. The extensive I/O library includes standard inputs/outputs and a series of special function cards. The I/O module conventions are defined as follows:

**HFC-30(I)O(c)ld**

- **Digital**: A – Analog, C – Combination
- **Input**: D, O – Output, C – Combination
- **Number of points**: 8, 16 or 32
- **Voltage**: 120Vac, 24Vdc, 48Vdc
- **Function**: 1 to 16 outputs, 0 to 16 inputs
- **Current**: 1 to 16 outputs, 0 to 16 inputs
- **Type**: Analog, Digital, or Combination
- **Components**: Thermocouple, RTD 100ohms, 48vdc SOE
- **Additional**: 36: 8 channels 4 to 20ma, 35: 12 channels, 48vdc inputs
- **Ports**: 32: 120vac outputs, 32: 120vac outputs, 48: 120vac inputs, 36: 12 channels 4 to 20ma, 36: 12 channels 4 to 20ma, 48: 12 channels 4 to 20ma
- **Inputs**: 32: 12 channels 0 to 10v inputs, 32: 12 channels 0 to 10v inputs
- **Outputs**: 4 channels 0 to 10v, 4 channels 0 to 10v
- **Technical**: Pentium Process Controller
  - Multiple (3) microprocessor controller
  - Intel-based architecture
  - 64-bit Pentium® processor for logic control
  - 32-bit 80386EX for LAN and IO control
  - Ethernet and RS-323/485 Communications
  - 8MB flash memory
  - 16MB volatile RAM memory
  - Redundant or Triple Redundant configuration
  - Redundant I/O module
  - HFC standard control algorithms
  - Modem PPGA technology

**HFC-30A4A Safety Loop Controller**

- **Digital**: A – Analog, C – Combination
- **Input**: D, O – Output, C – Combination
- **Number of points**: 8, 16 or 32
- **Voltage**: 120Vac, 24Vdc, 48Vdc
- **Function**: 1 to 16 outputs, 0 to 16 inputs
- **Current**: 1 to 16 outputs, 0 to 16 inputs
- **Type**: Analog, Digital, or Combination
- **Components**: Thermocouple, RTD 100ohms, 48vdc SOE
- **Additional**: 36: 8 channels 4 to 20ma, 35: 12 channels, 48vdc inputs
- **Ports**: 32: 120vac outputs, 32: 120vac outputs, 48: 120vac inputs, 36: 12 channels 4 to 20ma, 36: 12 channels 4 to 20ma, 48: 12 channels 4 to 20ma
- **Inputs**: 32: 12 channels 0 to 10v inputs, 32: 12 channels 0 to 10v inputs
- **Outputs**: 4 channels 0 to 10v, 4 channels 0 to 10v
- **Technical**: Pentium Process Controller
  - Multiple (3) microprocessor controller
  - Intel-based architecture
  - 64-bit Pentium® processor for logic control
  - 32-bit 80386EX for LAN and IO control
  - Ethernet and RS-323/485 Communications
  - 8MB flash memory
  - 16MB volatile RAM memory
  - Redundant or Triple Redundant configuration
  - Redundant I/O module
  - HFC standard control algorithms

The last letter D is DSP processor based.
Quality Assurance

HF Controls is very proud of its solid Quality Assurance Program. All of the different departments within the company work closely to achieve the goal of a continuously improving level of product quality. The solid Quality Assurance Program enables HF Controls to accommodate both large and small systems. Segregation of functions provides enhanced security. The solid Quality Assurance Program represents the culmination of over 30 years of control system research and development efforts. The platform was specifically designed for control and monitoring of the most critical applications, and built to survive the most intense physical electrical and seismic environments.

The HFC-6000 Safety Control System represents the culmination of over 30 years of control system research and development efforts. The platform was specifically designed for control and monitoring of the most critical applications, and built to survive the most intense physical electrical and seismic environments. The field-proven architecture, coupled with rugged, robust system components combine to reduce installation, maintenance, and spare parts costs, while assuring a long operational life. The highly modular and scalable design can accommodate both large and small systems. Segregation of functions provides enhanced maintenance and operational benefits with a choice of traditional, discrete Man-Machine Interfaces (MMI), and high resolution, digital flat panel displays.

- HFC-6000 is an effective approach to safety critical I&C
  - Single board controllers for single loop and multiple loop control
  - Wide selection of I/O modules
  - Flat panel displays
  - Dedicated Control Switch Modules and M/A stations for manual control of outputs
- One product for all safety critical applications
- Modular design for easier installation
- Redundant and Triple Modular Redundant architectures
- Single board Controller design based on a long operating history
  - Key product for HFC fossil projects
  - Used in Boiler Control and Safety Systems
  - USA installations
  - Wide spread applications worldwide
- Technology Approved by USNRC, TUV, Korea KINS for Nuclear Class IIE and functional safety applications

Obsolescence Management

- Control of hardware manufacturing and development
- Compatibility with past systems
- Upgrades supported
- System changes and additions can be made without our involvement
- Focus on client service
- Expected to last 40 years.

Quality Management Systems

- ISO 9001:2000
- 10 CFR 50 Appendix B
- IEEE 603
- EPRI TR 107330
- NFP
- TUV Certified
- Successful licensed nuclear safety systems in Korea
- US licensing topical report under review
- Expected to last 40 years.

Control strategies

- 1 millisecond SOE (without special modules)
- 20-100 millisecond system response time
- I/O point not tethered to specific controller

Maintenance

- Direct connection to termination board for I/O modules
- Hot swap of components
- Quality tagging (Non-nuclear)
- Quality tags propagate throughout calculated points and graphics
- Tracking and display of point quality
- Supports special treatment of quality data

Alarming

- Multiple levels, types, priorities of alarms, routing
- Intelligent alarming

Historian

- Native and third party historical archiving software

Advanced, open system

- Standard switched Ethernet TCP/IP network
- “Plug and go”
- Third party accommodation

Advanced system design

- ONE STEP configuration
- Self documenting
- System configuration can be managed by SQL database
- Data elements easily uploaded via TCP/IP

Software V&V Process

- RFP Customer request for proposal
- SRS Software Requirements Specification; IEEE 830-1998
- SwVP Software Verification and Validation Plan
- SWP Software Integration Plan; IEEE 1074-1997
- SAR Software Safety Analysis Report
- SvVR Software Verification and Validation Report; IEEE 1012-1998
- Project Post-Mortem Report
- Post-project evaluation report; IEEE 1490-1998
HFC-6000 Unique Design Features

HFC is a qualified nuclear I&C vendor capable of providing digital control systems for modernized nuclear power plants and any other mission-critical control environment. The HFC-6000 is HFC’s platform for safety-critical control system applications. The following list of HFC platform for safety control environment.

1. HFC’s nuclear class 1E auto-documentation tool provides the single source for:
   A. Engineering Logic Diagram in CAD format
   B. I/O configuration
   C. Database allocation
   D. Operator/IF graphics with dynamic status display

   “The drawings the engineer designed are the same graphics that operators monitor in plant operation.”

2. The modernized HFC-6000 safety control system provides:
   A. Faster response time from input, logic execution to output
   B. Total isolated and independent HSM (High Speed Interface Module) for critical points between trains/divisions
   C. Thorough system online diagnostic software capable of monitoring every bit in a system from controller to I/O cards
   D. Modular system configuration provides scalability from single loop/multi-loops to DC for entire plant control
   E. High reliability and maintainability design includes:
      1. Full Redundant or Triple Modular Redundant hardware configuration
      2. Dedicated CSM, M/A and FPO Interface per loop
      3. Maintenance failover enable/disable
      4. Unique Loop-Back I/O communication path
      5. Redundant I/O capability
      6. Nuclear special function boards with fail/circuit and seal-in function
      7. Ground fault detection and reporting by dack
      8. Open/short field wiring detection
      9. Hot-swappable power supplies and P.C. Boards
      10. Four-channel protection system with four uni-direction high speed communication channels

HFC’s Equipment Qualification

HFC has a long history of providing nuclear class 1E and non-class 1E equipment to nuclear power plants. The equipment development, qualification, and manufacturing are performed in accordance with requirements of NQA-1. The proposed HFC’s HFC-6000 product line has been qualified as nuclear class 1E on several Korean units. The following table provides a summary of recent qualification tests that have been completed.

<table>
<thead>
<tr>
<th>Year &amp; System</th>
<th>Safety Control Projects</th>
<th>Testing Facility</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003, SBC-14N System (Single Loop Model of HFC-6000)</td>
<td>UCN unit 566 Nuclear Power Plant Control System (PCS)</td>
<td>Wyle Laboratory Alabama, USA</td>
</tr>
<tr>
<td>2003, HFC-6000 System</td>
<td>USNRC Topical Report</td>
<td>Wyle Laboratory Alabama, USA</td>
</tr>
<tr>
<td>2005, HFC-6000 System</td>
<td>KORI unit 1-4 Nuclear Power Plant</td>
<td>Qualification and Analysis at HFC</td>
</tr>
<tr>
<td>2006, HFC-6000 System</td>
<td>90% unit 16.2, 98% unit 162 Nuclear Power Plant Control System (PCS)</td>
<td>Wyle Laboratory Alabama, USA</td>
</tr>
<tr>
<td>2007, HFC-6000 System</td>
<td>YGN unit 162, UCN unit162 Nuclear Power Plant, Alternate Diesel Generator</td>
<td>Qualification and Analysis at HFC</td>
</tr>
<tr>
<td>2007, E.S MUX System</td>
<td>Spat Focal Power Plant, India</td>
<td>TUV branch USA</td>
</tr>
<tr>
<td>2009, HFC-6000 System with SBC/D controller</td>
<td>SIL3 application on Triple Modular Redundant (TMR) control</td>
<td>TUV branch USA</td>
</tr>
<tr>
<td>2012, HFC-6000 system with FPC08 controller</td>
<td>SIL3 application on Triple Modular Redundant (TMR) control</td>
<td>TUV Germany</td>
</tr>
</tbody>
</table>

Ownership of HFC’s safety control system

HFC owns the entire Intellectual Property for this safety control system technology and has extensive capability and experience needed to provide safety control systems.