Foundation ä Fieldbus Project Specification

- **Full Redundancy in Class 1 Div 2 hazardous environment**
- **Full Redundancy in Safe Area**
- **Power Supply Redundancy in Safe Area**
- **No Redundancy**
- **Communication Networks**

Foundation ä Fieldbus Specification with full redundancy in Class 1 Div 2 area environment

9/16/2002

Foundation ä Fieldbus Specification with full redundancy and Intrinsic Safety Barriers for CL 1, Div 2 hazardous area environment 9/16/2002

INTEGRATED CONTROL SYSTEM

General

The ICS integrated control system is intended to handle all the monitoring, continuous and logical control and safety functions required to operate this plant and its remote facilities.

Summary of the ICS integrated control system

The ICS integrated control system will consist of:
Foundation™ Fieldbus – Linking Device Clusters with Full Redundancy and IS Barriers for CL1, Div 2 hazardous area environment. – SMAR DFI302 or equivalent.

- The Linking Device Clusters will use common Foundation™ Fieldbus HSE hardware, communications and technology as per the following FF-Linking Device Cluster diagram and be used for separate:
  - PCS - Process Control systems
  - SSS - Safety Shutdown Systems
  - FSG - Fire and Gas systems

- The quantity of clusters used for each of the three functions will be determined by the I/O requirements for each process and auxiliary unit and the geographic distribution of the field devices.

- Used for SSS and FSG these non-certified (TUV) Linking Device Clusters will be employed on the basis that HAZOP review will determine a SIL rating attainable by this alternate

- A redundant HSE fiber optic 100 Mbps high speed Ethernet Process Control network will interconnect all Linking Device Clusters (PCS,SSS and F&G) to:

  - all Workstations (Operator, Engineering, Application, Maintenance) regardless of their location

  - all modules performing specialized functions such as historian, report generator, matrix control, asset management, etc.

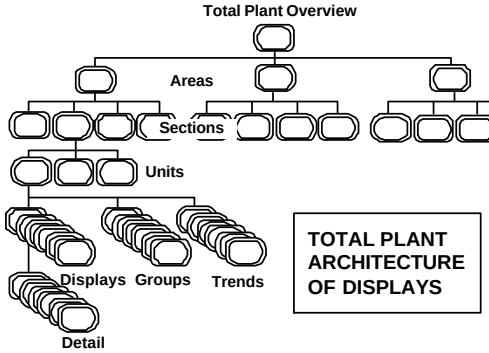
- A separate non-redundant HSE fiber optic 100 Mbps high speed Ethernet Plant network will be interfaced to the Process Control network and additionally interconnect:
  - The PABX system
  - The CCTV system
  - PC terminals in locations such as:
    - Administrative Building
    - Warehouse
    - Workshop
    - Security
    - Cafeteria
    - Senior Deluxe Rooms
    - Senior Staff Single Rooms
    - Central and remote Control Rooms
    - Motor Control Centers
    - Utility Buildings.

General

Workstations shall be based on the latest standard technology, running the Windows 2000 operating system. Workstation location and functionality will be as indicated on the following diagram.

Operator Workstations

Operator workstations shall provide graphical displays of the Plant. There shall be a total plant architecture of displays, displays of The total plant, the various areas, each unit, major grouping of equipment, details etc. with a logical approach to vertical and horizontal navigation. All displays should use common developed dynamic sub-pictures indicating all aspects of loop behavior. Alarm conditions should be indicated regardless of which display is being shown.



Characteristics of the Architecture, the Displays and the Navigation between displays should include:

- Panoramic Vision
- Progressive Exposure
- Pattern Recognition
- Intuitive Navigation
- Simplicity
- Alarm Management
- Operator Assistance

Judicious use of graphic and tabular representation should be made to best satisfy the needs of a given display.
Displays should take into account the requirements of all modes of operation including:

- Normal
- Process Upset
- Acknowledged Process Upset
- Recovery
- Shutdown

Engineering Workstations

Each engineering workstation shall provide the following functions:

- Configuration
- Database generation
- Graphics display generation and modification
- Control Strategy development
- Field device configuration and maintenance
- Function block configuration and linking
- Report generation and modification
- System Diagnostics
- Utility program access
- Assignment of specific plant area functions to a specific workstation
- The workstation hard drive should be a minimum of 40 GBs.
- Removable storage media provided at each engineering workstation including a CD-ROM Burner

Application Workstation

An application workstation will have access to the total plant integrated database.

Printers

At a minimum, one laser printer and one color ink jet printer should be supplied to support printing from the workstations, connected via a separate network bus between the printers and all workstations, engineering stations, and the Application station.

Foundation ä Fieldbus DEVICES

Any Foundation™ Fieldbus device used on this project should, at minimum:

- Be listed by Foundation™ and have Interoperability Test (ITK) 4.0 and higher certified
- If bus powered, have a maximum current consumption not exceeding 12 mA
- Have as many as 17 types of Function blocks including the 14 standard Foundation™ Fieldbus Function blocks
- Have instantiability, with the flexibility to choose one Function Block as many times as necessary - up to 20 Function Blocks per device. (i.e. 2 PID blocks to provide primary and cascade control in one Smart Valve positioner/controller.)
- Function blocks should include Flexible Function Block permitting implementation within each Foundation™ Fieldbus field device of functions such as and including:
  - Self tuning of control loop
  - Fuzzy logic
  - Model Predictive control
  - Matrix control
- Even though the PID function block could be used in any Foundation™ Fieldbus field device, both the primary PID and the secondary PID (cascade) function block should be in the control valve smart positioner/controller. The PID function block should provide information to the HMI that the control loop is normal mode of operation . There should be no extra charge for the inclusion of PID function blocks or Asset Management parameter access
- All regulatory control including cascade, feed forward, lead lag will be performed in the FF field devices.
- Have a total cycle time of less than 500ms even if device has two PID blocks
- True interoperability with Foundation™ Fieldbus approved device from any other manufacturer.

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PROCESS, SSS AND F&G CLUSTERS

- FF - LINKING DEVICE CLUSTER, FULLY REDUNDANT, with all field devices located in a CL1, Div 2 hazardous area environment will use FISCO (Fieldbus Intrinsically Safe Concept) Foundation™ Fieldbus intrinsic safety barriers (Linear Galvanic Isolator) Smar DFI302 or equivalent

    - Trunk and Spurs should be interconnected using #16 IEC1158 (ISA-SP50) type A shielded, armored, twisted-pair cable with suitable connectors.

    - Up to 4 barriers can be used per segment

    - The sum of the trunk length + all spur lengths for each H1 segment should not exceed 6000 feet (1900 meters)

    - Fieldbus junction box used to connect a spur to a trunk should permit connecting and removing a device without disturbing the entire bus

    - There should not be more than three devices per spur (intrinsic safety barrier) and 12 devices per segment. (4 X12 = 48 devices per linking device)

    - Point to Point wiring from the Micro PLCs located in safe areas (control room(s) or other buildings) shall be in conduit and meet explosion proof requirements.

    - Micro PLCs located in hazardous areas should be, with their power supplies, housed in explosion proof cabinets.

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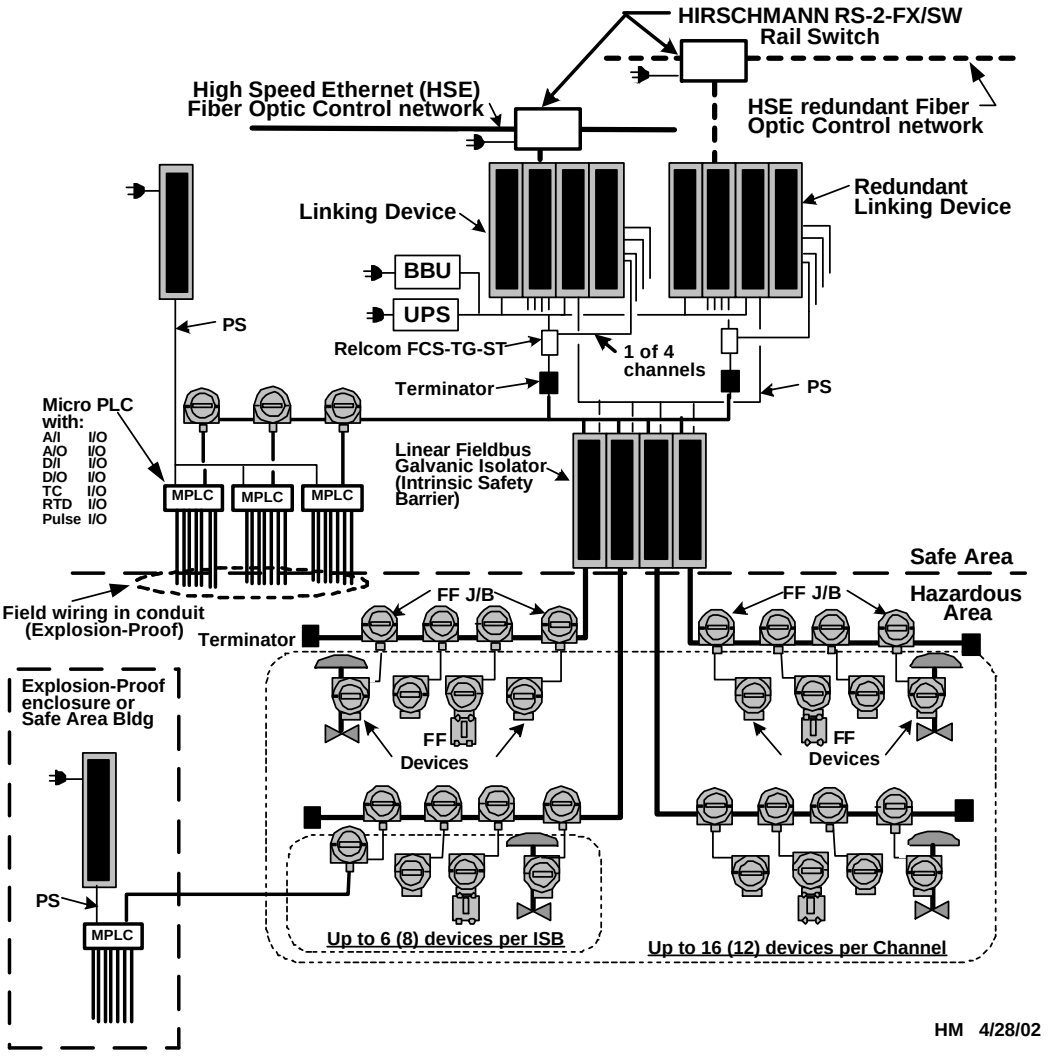
FF - Linking Device Cluster with Full Redundancy and IS Barriers for CL1, Div 2 hazardous area environment



Power Supply

The power available to the control system will be 24 VDC. Proposed controllers must include a calculation of power consumption. The power consumption estimate should include power consumption by the communication system, based on estimates of the communications polling cycle and message length, and by all field devices operable simultaneously. Power shall be supplied to redundant services from different sources.

Available Power

Power available will be 220 VAC, 60 Hz. A reliable power system should be designed including the following:

- Redundant UPS Systems to Power PCS and auxiliary equipment
- Redundant 24 VDC power supplies as required for specific equipment

The controllers and I/O subsystem are to operate from 24 VDC power and a 24 VDC redundant battery backup system shall be provided. The AC UPS will only be used to provide emergency power for operator workstations and auxiliary systems as required.

Backup control power must be guaranteed at least for 2 hours at full load.

Process Control System and Marshaling Cabinets

All indoor control system electronics should be housed in NEMA 12 industrial cabinets. Fused terminal strips must be provided between discrete input-output terminal blocks and field wiring. No direct connections to device I/O terminal blocks will be allowed. 20% installed and wired spare terminals should be provided above all future and present needs, including future cryogenic units and compressors. Analog inputs and outputs and discrete inputs and outputs should be located on separate terminal strips. High-voltage discrete AC inputs or outputs, if any, shall also be located on separate terminal strips. A grounded steel barrier is to separate the discrete, analog, and AC circuits

Lightning Protection.

All external wiring should pass through lightning protection barriers; this includes input/output signals, power supply connections, and communication links. Fiber optic links whose converters are mounted inside the cabinets are not included.

Install lightning rods and utilize good, safe grounding practices. See Grounding and Electrical specifications.

Communication networks within the Integrated Control System total network loading should be 30% or less at 100M Mbps. System expansion requirements shall be in accordance with this specification and with project procurement documents. System expansion shall be achievable without shutting down controllers not directly involved with expanding any specific part of the system.

Software Revisions

All software, exclusive of application software, shall be the most recent revision that is applicable to the system hardware, as agreed to in writing by the COMPANY or ENGINEER.

The system shall allow for upgrading of system operating software on all redundant modules of the system without the necessity of shutting down the process, without losing the operator interface, and without the loss of access to any control function.

Specially written application software shall not require modifications to be run under new releases of the system operating software. Any new release of system operating software shall be backward compatible with files created using the previous software releases.

Electrical Area Classification

Buildings containing ICS equipment will be rated as electrically unclassified.

Field mounted I/O modules or Foundation devices shall be suitable for installation in a Class I Division 2 area.

I/O Wiring, Terminal Blocks, I/O Cabling

I/O wiring and network communications cables (data highway, Foundation fieldbus or equivalent HSE and H1, ethernet, etc.) shall maintain a minimum separation of 75 mm from any AC power cables. Fiber optic cables are excluded from this requirement, but they must be kept away from sources of heat and potential trauma.

Vendor installed cables shall be designed and installed in such a way as to allow cable disconnection in order to service the equipment. Cables shall not interfere with circuit board removal.

It shall not be necessary to remove power or field wiring to replace a process control or input/output module.

Cabinet and Workstation Grounding

AC safety ground and instrumentation circuit ground shall conform to NEC, Article 250.

Further, good reasonable engineering practices for electronic noise suppression and lightning protection shall be followed. Active Transient Protectors shall be furnished for surge and lightning protection.

Inputs and Outputs

As may be Provided to/from the Process Controller and to/from the Safety Shutdown System

Discrete Inputs and Outputs

The system shall be capable of accepting the following discrete input types:

a. 24 VDC

b. 120 vac

c. 240 vac

The system shall be capable of providing the following discrete output types:

a. 24 VDC

b. 120 vac

c 240 vac

d. voltage-free relay or solid state outputs

Discrete output circuits shall be provided with protection for the switching of inductive loads.

All discrete I/O circuits shall be designed to ensure that accidental normal mode connection of up to 300 VAC or 300 VDC for an unlimited period of time shall not cause damage other than to the I/O module to which it is connected.

Analog Inputs and Outputs

to/from the PCS, SSS and F&G clusters.

The system shall be capable of accepting the following analog input types

a. 4-20 mA dc with concurrent smart transmitter (HART) protocol

b. 1-5 Vdc

c. Thermocouples. .

d. Platinum resistance temperature detectors (RTD)

The system shall be capable of providing the following analog output types:

a. 4-20 mA dc with concurrent (HART) protocol

Analog input modules shall be able to power 4-20 mA field instrumentation loops with a loop resistance of 600 ohms.

Pulse Inputs

The system shall be capable of accepting pulse inputs, for example from turbine flowmeters.

Alarm and Message Handling

ESD and Alarm System

Alarms and shutdown systems shall be designed and installed such that serious deviations from normal operating conditions, which, if not corrected, could endanger the plant, will shutdown either equipment experiencing the problem or the entire plant. All alarm switches shall be arranged to open in the alarm condition (fail-safe operation). ESD stations will be provided such

that manual shutdown of the plant will be possible from several locations within the plant.

Automatic shutdown and interlock systems shall perform a shutdown or prevent a start-up of equipment or portions of the plant when operations has determined that prevailing conditions would be a serious hazard. A pre-shutdown alarm prior to a shutdown is required with all automatic shutdown devices, where practical.

All alarms shall be displayed on the alarm/shutdown printer and Operator workstations. The PCS system shall have the capability to easily setup alarm suppression for multiple shutdowns (where the secondary alarms are spawned by the initial alarm and trip). Local alarm annunciating for plant sub-systems shall be repeated on the PCS workstations.

Audible alarms and visual beacons shall be installed at strategic points throughout the process plant area.

The alarm and shutdown system shall be a 24 VDC system.

Sequence of shutdown operation shall be shown on a shutdown logic diagram developed subsequent to Cause and Effect Diagrams.

The ESD System's logic provides an automatic response to abnormal process variables, loss of key utilities like instrument air and power, shutdown requests from operators, stand alone packaged systems, the PCS, Fire & Gas systems, etc. to insure that the plant, well cluster and flowlines operate in a safe manner. Final configuration of all the ESD inputs and outputs to the final elements will depend upon the Cause & Effect Diagrams generated after the HAZOP review by the detail design contractor.

General

Process alarms and designated system alarms shall be annunciated, displayed at workstations, and stored in the history files stored in the global database. Normal plant operator actions and events, and normal system actions and events shall not be alarmed. However, these events shall be stored in history files.

Alarms and messages shall be grouped to allow the user to readily identify and respond to alarms and conditions (e.g., in priority sequence) in his area of responsibility.

For any process alarm, it shall be possible, by no more than one mouse click or similar action, for an operator to access a display from which he may take corrective action.

All operator actions that affect process control parameters or alarms shall be stored in history files, including (but not limited to):

b. Alarm inhibit/enable
c. Controller mode change (auto/manual/etc.)
d. Controller setpoint change
e. Controller tuning parameter changes
f. Alarm limit changes

System Alarm Initiation

All devices connected to the PCS communications network shall be monitored for failures. A system alarm shall be generated for each failure detected.

Process and System Alarms History Retention

All alarms shall be stored in history files that can be archived to removable media. It shall be possible to recall alarms from these history files in on-screen display lists and in printed lists according to selectable filtering options. This system shall include an embedded OSI PI date historian.

Process and System Alarms Audible Annunciation

All alarms for a process area may be assigned to any workstation at configuration time. All alarms shall be displayed on the workstation(s) designated. The audible alarm shall be user configurable for different tones or patterns. The system shall have an adjustable volume control. It shall be possible to acknowledge process alarms only from a workstation configured for those alarms.

Process and System Alarms Visual Annunciation

Alarms shall cause visible display annunciation at, and only at, a workstation configured for those alarms. It shall be possible to acknowledge process alarms only from a Workstation configured for those alarms.

Active Process Alarms Summary

There shall be a summary display of active process alarms. Accessing this alarm summary display from any other screen shall require no more than one mouse click or similar action. This display shall show all process alarms currently in alarm condition. Display of any alarm shall not clear unless the alarm is acknowledged and the condition initiating the alarm has returned to normal condition.

System Diagnostics

On-line and off-line diagnostics shall be provided to assist in system maintenance and troubleshooting, for every major system component and peripheral. For peripheral devices that do not provide diagnostics (e.g., printers or terminals), the system must detect and provide an error indication for the failure of these devices.

Data Collection and Trending

A configurable, real time and historical data collection package shall be available to support process data trending, logging, and reporting.

On-line process data collection and storage shall not require any additional configuration.

Historical data must be available to remote desktop PC's, using standard, off-the-shelf viewing and analysis software, including Microsoft Excel and Access.

Trend Displays

Every operator and engineering workstation shall provide viewing of real-time and historical trend information. Data collected in any historian package shall be available to all workstations.

The system shall support user-defined sets of trends so that commonly viewed historical information can be defined as a trend once and can then be easily accessed by selecting a link on the screen. There should be no practical limit to the number of sets of trends that can be defined. Each trend set shall support up to 8 separate trends. Selection of points to be trended shall be menu driven.

Both historical and real-time trend information shall be integrated into a single trend within a trend window, with seamless movement between the two. If the trend window is scrolled to the left, then values from historical data files will be displayed. If the trend window is scrolled to the right past the most recent historical data, then current real-time data will be displayed as it is collected.

Zooming in or out and scrolling to the left or right within a trend shall be possible with no more than two mouse clicks or similar actions. A mechanism for selecting a point on a trend, such as a hairline cursor, and reading the digital values of the trend at that point, shall be provided.

Reports

A reporting utility shall be provided. It shall be possible to use any variable in the system or the history files in a report. It shall be possible for all reports to be displayed on a workstation screen as well as printed on a report printer. Hourly, daily, monthly, end-of-month, quarterly and yearly reports shall be supported. Reports shall be printed and/or saved to disk when designated process events occur. It shall be possible to activate a report in the following manner:

Upon demand (operator request)

Scheduled (shift, daily and monthly)

Upon event occurrence

It shall be possible to transfer data via standard off-the-shelf software tools to generic report writers.

The Integrated Control System should include Foundation Fieldbus **Online Asset Management** and provide at minimum the following:

- Viewing device configuration for intelligent field devices.
- Generating, maintaining, and viewing the device database for all current and historical device data.
- Perform device and database comparison and reconciliation.
- Provide a device audit trail.
- Provide device alert monitoring.
- Provide “as found” and “as left” calibration and test capability.
- Provide tag search for Foundation fieldbus or equivalent devices and database data.

- Provide support for Fieldbus, HART, and conventional device asset management.
- Provide online help.
- Provide security for device configuration.
- Provide database import/export capabilities.

Control System Services

Services offered with the Integrated Control System (ICS) shall include the following as a minimum:

- System configuration should be performed using the standard tools supplied with the system. Special care should be taken during the generation of the database to produce robust and well-designed templates and reuse them as much as possible across the configuration.
- A configuration tool shall be provided to generate or modify database and configuration data. The configuration tool shall employ fill-in-the-blanks or graphical block connecting format.
- The configuration tool shall allow drag-and-drop functionality to move or copy configuration data from one location to another.
- The user shall be able to view control strategies as defined in the configuration while they execute in real time, as well as view the real-time input and output values. When a tag is selected, the operator shall be able to press a single button to view the control strategy.
- Graphic screens should be generated using the system standard tools. Should the supplier decide to use a third-party application to generate process graphics, a licensed copy of the software shall be installed on the engineering workstation.

Historical database definition should be performed during system configuration via the embedded data historian. A set of standard trends and reports will be agreed upon during engineering development. The Historical database shall be sized to allow historization of all control valves.

Control System Availability

A single failure anywhere in the system shall not result in the loss of regulatory control to more control loops than those associated with a single process input/output/H1 module. Failure of any single device shall not affect the ability of the system to communicate with other devices in the system. Switchover from a failed system module to its backup shall not disrupt any system functions.

The loss of failure of any one controller, power supply, network card, network segment, switch, or hub shall not impair system operation.

Redundant equipment and software shall be continuously monitored for errors. All modules shall be diagnosed on-line. Errors shall be alarmed with an error message identifying the failed module.

External Interfaces

Serial Interface - Auxiliary Control Systems

The following capabilities shall be provided as required for communicating to auxiliary systems:

- RS-232C, RS-422, and RS-485 with full and half-duplex operation, and the following selectable baud rates: 9600, 19200, 38400, 57600, and 115200 baud as required for ancillary devices.
- IEEE 802.3 Fast Ethernet TCP/IP protocol at 100 MBPS, with RJ45 connector, over unshielded Category 5 twisted pair cabling within the Control Building.
- IEEE 802.3 Fast Ethernet TCP/IP Protocol, at 100 MBPS via type sm fiber optic cable in full duplex.
- Modbus over RS-485 serial link is to be configured in one of the Linking device cluster as the Master and gathering information from other Linking device or Modbus slaves,.

OPC Interface

The PCS shall be able to communicate bi-directionally with the ESD/F&G controller, PLCs, and remote building control systems using an OPC redundant server. The OPC interface shall be configured in a client-server relationship with the PCS as a client and the auxiliary system as the server.

There shall be no need to write any custom code to set up the OPC interface.

It shall be possible to remotely access the PCS or SSS from any connection on the control ethernet LANs using any standard off-the-shelf web browser such as Netscape's Navigator or Microsoft's Internet Explorer. Vendor shall list as an option all hardware and software needed to allow users to view process graphics and displays, events, and historic as well as real-time trends. All information viewed remotely shall update in real time.

All web browser access shall be secure. It shall be for viewing purposes only. It shall be possible to configure different security access privileges for different users.

TeleCommunicatIon SYSTEM

The telecommunication system is intended to allow remote operation of the remote facilities from the CCS as well as providing CCTV and PABX communication between building and the central control room.

The telecommunication system will have the following main subsystems as a minimum:

- Redundant digital controllers with Ethernet NIC's at well clusters for process control and monitoring

- Safety Shutdown System , including Redundant Controllers, hardwired to valves, safety system transmitters, and other devices.
- UHF radio telemetry backup communications.
- Radio links should be based on spread spectrum UHF or MicroWave radio modems. A preliminary engineering study to determine the radio system components should be issued. All the system components including antennas, masts, cables, power supplies, etc. should be included. The need for radio repeater stations should not be needed. Radio data transmission baud rate must be 9600 baud or higher, with an error rate lower than 1 in 10,000, 99.5% of the time.
- Control Network Data Transmission System, an IEEE 802.3 Fast Ethernet, 100 MBPS, 100BASE-FX, Full Duplex Backbone over Single Mode Fiber Optic cable, using Hirschmann RS-2-FX/SM Rail Switches in a Redundant Ring configuration in-plant and throughout the remote network to the Junction and at all Well Cluster sites.
- A second separate but similar network for the CCTV and PABX, except instead of the redundant ring topology, it shall be a linear bus. It shall also be full duplex over single mode fiber optic cable and shall utilize Hirschmann RS-2-FX/SM rail switches.
- A total of 6 fiber pairs connect remote buildings plus 4 spare fiber pair minimum for contingency.
- Closed Circuit TV (CCTV) and Communications

  CCTV and telephone communication shall be provided at each building and shall communicate with the Central Control Room CCTV Monitoring and Recording Console and with the PABX Panel via a dedicated IEEE 802.3 Fast Ethernet 100MBPS communications networks.

INSPECTION AND TESTING

This section describes the minimum requirements for inspection and testing and does not relieve CONTRACTOR of his obligation to carry out other inspection and testing as required by the codes and standards.

Introduction

The Testing Procedures applicable to all aspects of a control system have evolved over the years as dictated by the inherent characteristics of the control system. Major differences have resulted for

- Conventional analog single loop control systems
- DCS and PLC control systems.

Foundation™ Fieldbus control system testing.

Since, in Foundation™ Fieldbus control systems there are no all-inclusive, multi function, multiplexed systems as normally found in all DCS or PLC systems, and since the Foundation™ Fieldbus control system architecture and its components returns us to the fundamental advantages of single loop integrity, FAT and SAT tests normally provided for DCS or PLC systems are not applicable

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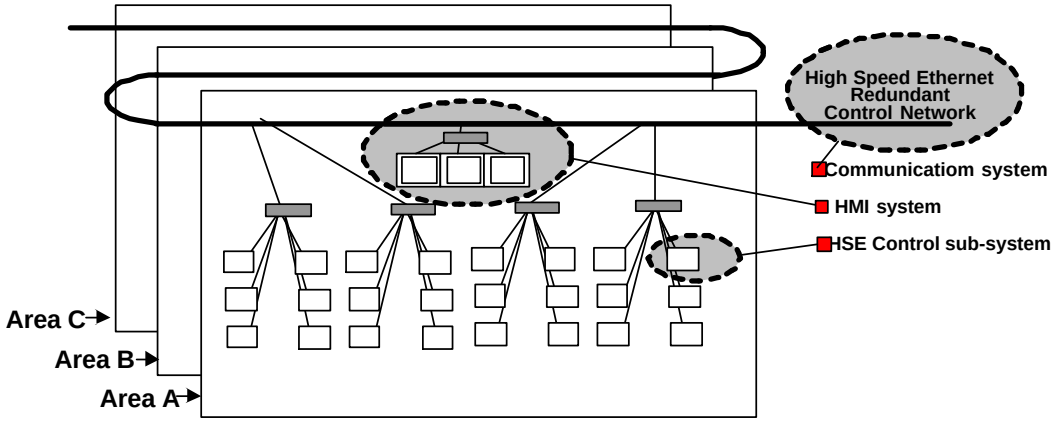
Recommended Foundation™ Fieldbus control system testing procedures follows:

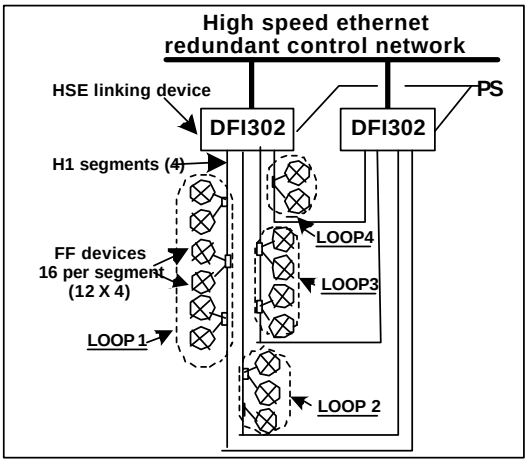
Total Plant Foundation ™ Fieldbus Control System Overview



Control System testing elements will be addressed as follows:

- HSE Control sub-systems
- Communication system
- HMI system

HSE Control sub-systems

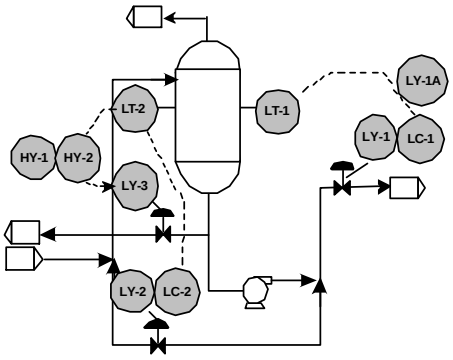


Engineering and documentation

Using Process Flow Diagrams (PFDs), Piping and Instrument Diagrams (P&IDs) (and modified PFDs showing the Foundation ™ Fieldbus control strategies and components) and using Engineering Workstation configuration capabilities

- Individual Control Strategies are developed to satisfy the process requirements. These show all function blocks within each device and the interaction between devices and blocks.

- Engineering Workstation will be used to produce the configuration and documentation necessary for:
- Full definition and configuration of the devices within the control strategy.
- The interconnections between the devices.
- Verification that the control strategies completely satisfy the

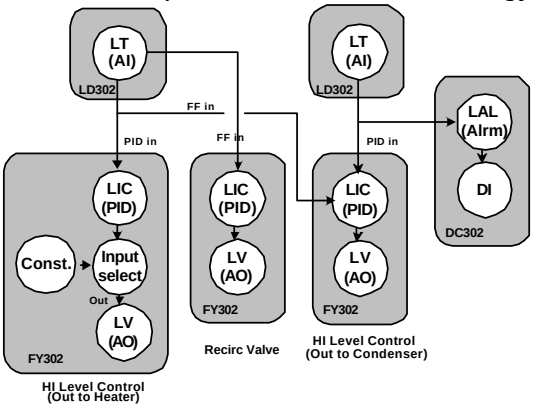


modified PFD

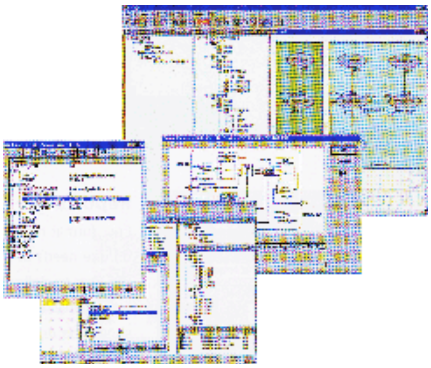
process control requirements.

- The actual configuration of each and every FF device.
- Serve as the basis for testing of each and every control strategy and its elements.

- Because of the commonality of the FF devices and control strategies, the most complex and all-inclusive control loop and strategy should first be developed as the reference control strategy for the project and be tested for interoperability. All other control loops and control strategies will then be depopulated versions of this representative control strategy.



Reference CONTROL STRATEGY



Workstation Configurator and DataBase Builder

Testing and commissioning

After completion of all loop control strategies and the definition of every device and every function block within that device, using the Workstation configurator, the entire control system will have been completed and verified, the database completed and system fully documented. Documentation prepared by the Workstation system will be available as electronic media or hard copy.

Reference System implementation

It is now time to implement a fully operational Reference system as developed in the engineering phase and incorporating at least one each devices that will be used within the total control system. The preferred location would be at the site as part of the training facility.

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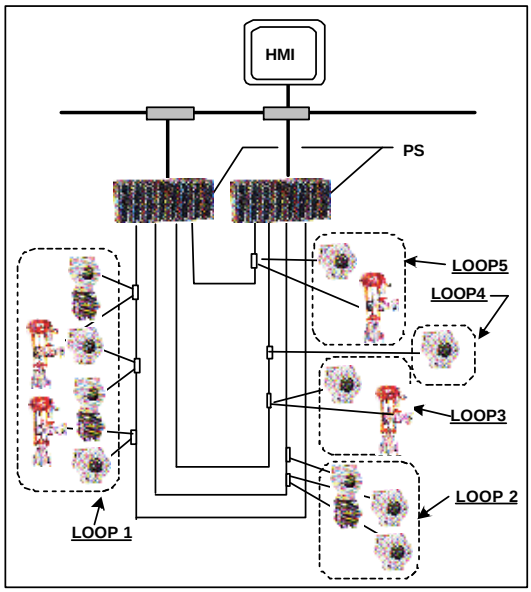
This will be used for a number of purposes.

- To fully verify the interoperability and operation of all the components to be used within the total plant control system.
- To verify all aspects of the reference control strategy. This ensures the proper operation of any depopulated version of the reference control strategy.
- To develop the control strategy, with the proper tags, and the proper devices for each of the indicating or control loops. The documentation generated will assist in the installation of all field devices and their interconnection.
- Once the installation complete, it will serve to configure each device and fully verify the loop operation. – this will essentially provide 100% verification and validation of the control system.

It will permit plant personnel to perform all aspects of testing with the presence and attendance of designated and qualified, manufacturer personnel



Reference system

Having the fully implemented reference system at the site training center will permit these courses to be provided at the site at the user's convenience as well customized courses for Casual and Intensive Users including:

- User's Overview Training for System Engineers, I&C Technicians and Operations Personnel
- System Maintenance Training Engineers and I&C Technicians
- Process Engineering

Conducting most courses at the site will ensure the maximum effectiveness by being fully specific to the actual Total Plant Control System and will ensure the Buyer taking full possession of the system.

Communication System Testing

Since the components used in the High Speed Ethernet (HSE)Redundant Fiber Optic Process Control Network will be off-the-shelf, testing will be limited to using switches, and other components incorporated as part of the reference control system and the linking to the Man Machine Interface and other systems.

HMI – Human Machine Interface System

In conjunction with the reference system at the site, display stations should communicate with the Foundation Fieldbus devices using the proper OPC (Ole for Process Control) drivers

A display following the above recommendations should be developed incorporating all devices and tags that make up the reference system. This will also serve for verification of the behavior of the dynamic sub-pictures.

TAGGING

Each panel shall be tagged with a permanently attached stainless steel identification tag, approximately 2-1/2" x 4". CONTRACTOR identification on any removable part of the panel is unacceptable.
In addition to the tag number, the nameplate shall also contain:

Company:	-
Project Name:	-
Equipment type:	-
Purchase Order Number:	-
Year Manufactured:	-

PREPARATION FOR SHIPMENT

After the completion of assembly, control panels and other assemblies shall be thoroughly cleaned of all grease and loose debris. All openings, machined surfaces, bulkhead and threaded connections shall be protected by coating with rust preventative or by having plugs installed. All bulkhead connections shall have tubing plugs installed.

CONTRACTOR

Shall be responsible for providing any bracing, clips and/or brackets necessary for temporary support during transportation. CONTRACTOR shall also provide the magnitude of temporary loads at the support points. Final details of temporary bracing, clips and brackets shall be subject to approval by COMPANY.

Completed units shall not ship until released by COMPANY.

SPARES

CONTRACTOR shall provide two (2) priced recommended spare parts lists for the systems specified herein. One list shall cover commissioning. The second list shall cover the first year of operation. CONTRACTOR shall provide both commissioning and

operating spare parts as specified on the lists subject to review and confirmation by COMPANY. COMPANY will place future orders for spare parts based on CONTRACTOR's submittals and recommendations.

All spare parts furnished by CONTRACTOR shall be wrapped and packaged to preserve an original as-new condition under normal conditions for storage. The spare parts shall be properly tagged and coded so that later identification as to their intended equipment usage will be clear. The tags may be steel imprinted type variety, provided that they are wired with stainless steel wire or permanently taped to the component or box. All items supplied shall be packaged separately and clearly marked as "Spare Parts" and shipped with the equipment in accordance with the instructions from COMPANY. Packing lists shall be furnished complete and in detail so that parts can be handled without uncrating, if desired.

DOCUMENTATION REQUIREMENTS

CONTRACTOR shall provide documentation for quotation, approval and record to the COMPANY

WEIGHT CONTROL

The transportation, installation, and operation of this equipment requires the consideration of weight for the project. Accurate estimates of weight are required and must be provided by CONTRACTOR at the bid (preliminary estimate), submittal of approval drawings (detailed design estimate) and at shipment (weighted) for each panel.

DELIVERABLES FOR APPROVAL, FOR CONSTRUCTION, CERTIFIED AS-BUILT

- Instrument Data Sheets and Outlines (updated and certified).
- Controller specifications, Outlines, all hardware manuals and programming documentation including all communication modules, I/O modules, and the latest updates.
- Detailed network interconnecting diagram showing all network connections to controllers, PLCs, work stations, CCTV cameras, CCTV monitors, PABX systems, radio system, hubs, routers, and control devices and detailed field bus wiring to loops. Standard loop diagrams for all 4-20 mA devices. Interconnection wiring diagrams for all other discrete and analog signals.
- Logic narratives, logic diagrams, cause and effect diagrams, safe charts per API 14C, HAZOP reviews, SIL rating determination reports per ISA S84.01, programs for process control, ladder logic diagrams, sequence charts, control flow charts, and elementary wiring schematics. In addition, the HAZOP review shall be attended by the OWNER or his Designee.
- Completed instrumentation indexes and instrument installation schedules and cross references.
- Complete Bill of Materials (beyond the instrument data sheets).

- Valve, orifice plate, level instrument, etc., certified calculations for sizing as well as any pressure temperature or flow conversions. It is expected that the conversions will be done on a standard Excel spreadsheet. Copies on 3-1/2" floppy disks or CD-Rom shall be provided.
- Instrument location and routing plans and details.
- Instrument installation details

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INTEGRATED CONTROL SYSTEM

General

The ICS integrated control system is intended to handle all the monitoring, continuous and logical control and safety functions required to operate this plant and its remote facilities.

Summary of the ICS integrated control system

The ICS integrated control system will consist of:
Foundation™ Fieldbus – Linking Device Clusters with Full Redundancy for Safe Area environment. – SMAR DFI302 or equivalent.

- The Linking Device Clusters will use common Foundation™ Fieldbus HSE hardware, communications and technology as per the following FF-Linking Device Cluster diagram and be used for separate:
  - PCS - Process Control systems
  - SSS - Safety Shutdown Systems
  - FSG - Fire and Gas systems

- The quantity of clusters used for each of the three functions will be determined by the I/O requirements for each process and auxiliary unit and the geographic distribution of the field devices.

- Used for SSS and FSG these non-certified (TUV) Linking Device Clusters will be employed on the basis that HAZOP review will determine a SIL rating attainable by this alternate

- A redundant HSE fiber optic 100 Mbps high speed Ethernet Process Control network will interconnect all Linking Device Clusters (PCS,SSS and F&G) to:

  - all Workstations (Operator, Engineering, Application, Maintenance) regardless of their location

  - all modules performing specialized functions such as historian, report generator, matrix control, asset management, etc.

- A separate non-redundant HSE fiber optic 100 Mbps high speed Ethernet Plant network will be interfaced to the Process Control network and additionally interconnect:

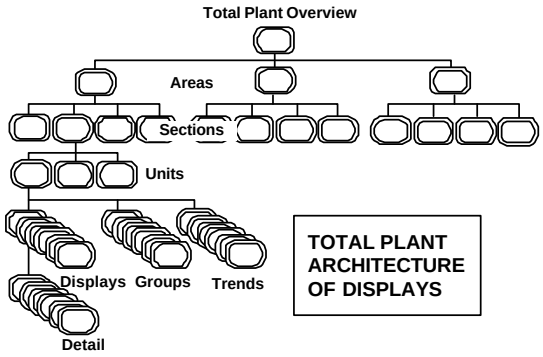
  - The PABX system
  - The CCTV system
  - PC terminals in locations such as:
    - Administrative Building
    - Warehouse
    - Workshop
    - Security
    - Cafeteria
    - Senior Deluxe Rooms
    - Senior Staff Single Rooms
    - Central and remote Control Rooms
    - Motor Control Centers
    - Utility Buildings.

General

Workstations shall be based on the latest standard technology, running the Windows 2000 operating system. Workstation location and functionality will be as indicated on the following diagram.

Operator Workstations

Operator workstations shall provide graphical displays of the Plant. There shall be a total plant architecture of displays, displays of The total plant, the various areas, each unit, major grouping of equipment, details etc. with a logical approach to vertical and horizontal navigation. All displays should use common developed dynamic sub-pictures indicating all aspects of loop behavior. Alarm conditions should be indicated regardless of which display is being shown.



Characteristics of the Architecture, the Displays and the Navigation between displays should include:

- Panoramic Vision
- Progressive Exposure
- Pattern Recognition
- Intuitive Navigation
- Simplicity
- Alarm Management
- Operator Assistance

Judicious use of graphic and tabular representation should be made to best satisfy the needs of a given display.
Displays should take into account the requirements of all modes of operation including:

- Normal
- Process Upset
- Acknowledged Process Upset
- Recovery
- Shutdown

Engineering Workstations

Each engineering workstation shall provide the following functions:

- Configuration
- Database generation
- Graphics display generation and modification
- Control Strategy development
- Field device configuration and maintenance
- Function block configuration and linking
- Report generation and modification
- System Diagnostics
- Utility program access
- Assignment of specific plant area functions to a specific workstation
- The workstation hard drive should be a minimum of 40 GBs.
- Removable storage media provided at each engineering workstation including a CD-ROM Burner

Application Workstation

An application workstation will have access to the total plant integrated database.

Printers

At a minimum, one laser printer and one color ink jet printer should be supplied to support printing from the workstations, connected via a separate network bus between the printers and all workstations, engineering stations, and the Application station.

Foundation™ Fieldbus DEVICES

Any Foundation™ Fieldbus device used on this project should, at minimum:

- Be listed by Foundation™ and have Interoperability Test (ITK) 4.0 and higher certified
- If bus powered, have a maximum current consumption not exceeding 12 mA
- Have as many as 17 types of Function blocks including the 14 standard Foundation™ Fieldbus Function blocks
- Have instantiability, with the flexibility to choose one Function Block as many times as necessary - up to 20 Function Blocks per device. (i.e. 2 PID blocks to provide primary and cascade control in one Smart Valve positioner/controller.)
- Function blocks should include Flexible Function Block permitting implementation within each Foundation™ Fieldbus field device of functions such as and including:
  - Self tuning of control loop
  - Fuzzy logic
  - Model Predictive control
  - Matrix control
- Even though the PID function block could be used in any Foundation™ Fieldbus field device, both the primary PID and the secondary PID (cascade) function block should be in the control valve smart positioner/controller. The PID function block should provide information to the HMI that the control loop is normal mode of operation . There should be no extra charge for the inclusion of PID function blocks or Asset Management parameter access
- All regulatory control including cascade, feed forward, lead lag will be performed in the FF field devices.
- Have a total cycle time of less than 500ms even if device has two PID blocks
- True interoperability with Foundation™ Fieldbus approved device from any other manufacturer.

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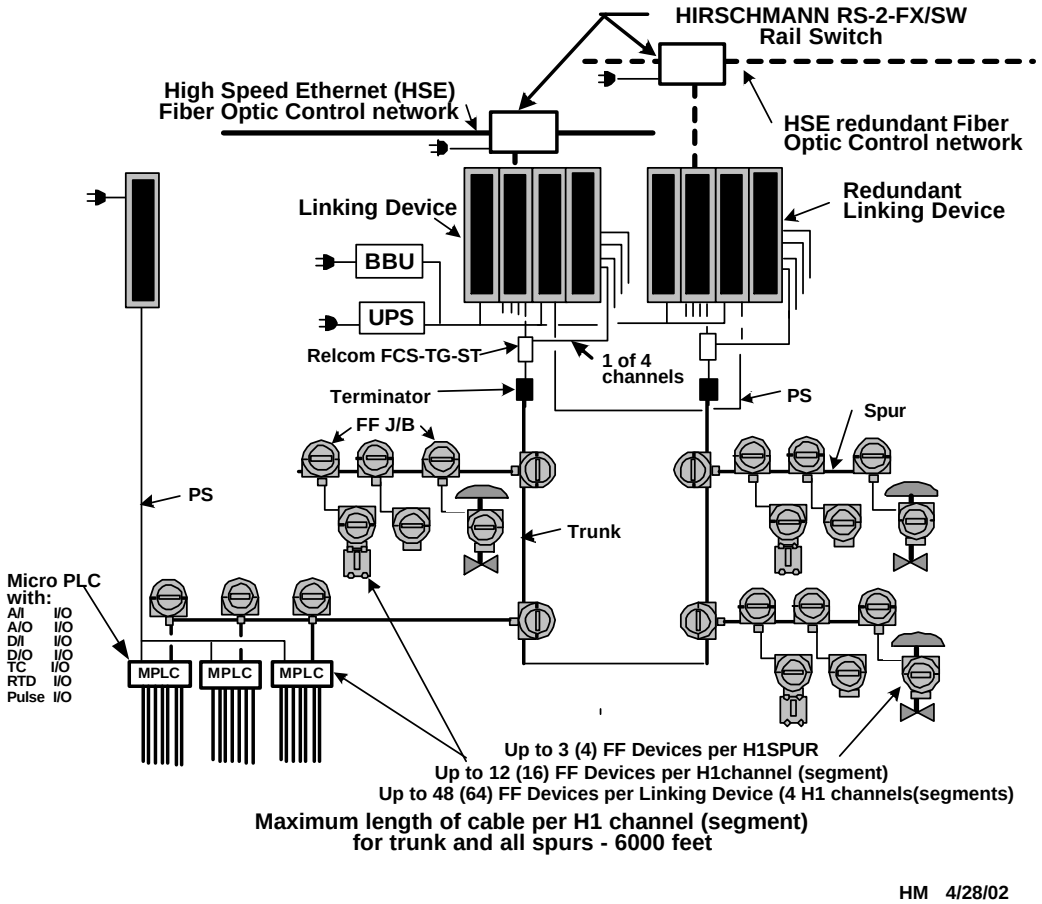
PROCESS, SSS AND F&G CLUSTERS

- FF - LINKING DEVICE CLUSTER, FULLY REDUNDANT in a Safe Area Environment:
  - Trunk and Spurs should be interconnected using #16 IEC1158 (ISA-SP50) type A shielded, armored, twisted-pair cable with suitable connectors.
  - The sum of the trunk length + all spur lengths for each H1 segment should not exceed 6000 feet (1900 meters)
  - Fieldbus junction box used to connect a spur to a trunk should permit connecting and removing a device without disturbing the entire bus

FF - Linking Device Cluster with Full Redundancy safe area environment



Power Supply

The power available to the control system will be 24 VDC. Proposed controllers must include a calculation of power consumption. The power consumption estimate should include power consumption by the communication system, based on estimates of the communications polling cycle and message length, and by all field devices operable simultaneously. Power shall be supplied to redundant services from different sources.

Available Power at the Project location

Power available will be 220 VAC, 60 Hz. A reliable power system should be designed including the following:

- Redundant UPS Systems to Power PCS and auxiliary equipment
- Redundant 24 VDC power supplies as required for specific equipment

The controllers and I/O subsystem are to operate from 24 VDC power and a 24 VDC redundant battery backup system shall be provided. The AC UPS will only be used to provide emergency power for operator workstations and auxiliary systems as required.

Backup control power must be guaranteed at least for 2 hours at full load.

Process Control System and Marshaling Cabinets

All indoor control system electronics should be housed in NEMA 12 industrial cabinets. Fused terminal strips must be provided between discrete input-output terminal blocks and field wiring. No direct connections to device I/O terminal blocks will be allowed. 20% installed and wired spare terminals should be provided above all future and present needs, including future cryogenic units and compressors. Analog inputs and outputs and discrete inputs and outputs should be located on separate terminal strips. High-voltage discrete AC inputs or outputs, if any, shall also be located on separate terminal strips. A grounded steel barrier is to separate the discrete, analog, and AC circuits

Lightning Protection.

All external wiring should pass through lightning protection barriers; this includes input/output signals, power supply connections, and communication links. Fiber optic links whose converters are mounted inside the cabinets are not included.

Install lightning rods and utilize good, safe grounding practices. See Grounding and Electrical specifications.

Communication networks within the Integrated Control System total network loading should be 30% or less at 100M Mbps. System expansion requirements shall be in accordance with this specification and with project procurement documents. System expansion shall be achievable without shutting down controllers not directly involved with expanding any specific part of the system.

Software Revisions

All software, exclusive of application software, shall be the most recent revision that is applicable to the system hardware, as agreed to in writing by the COMPANY or ENGINEER.

The system shall allow for upgrading of system operating software on all redundant modules of the system without the necessity of shutting down the process, without losing the operator interface, and without the loss of access to any control function.

Specially written application software shall not require modifications to be run under new releases of the system operating software. Any new release of system operating software shall be backward compatible with files created using the previous software releases.

Electrical Area Classification

Buildings containing ICS equipment will be rated as electrically unclassified.

I/O Wiring, Terminal Blocks, I/O Cabling

I/O wiring and network communications cables (data highway, Foundation fieldbus or equivalent HSE and H1, ethernet, etc.) shall maintain a minimum separation of 75 mm from any AC power cables. Fiber optic cables are excluded from this requirement, but they must be kept away from sources of heat and potential trauma.

Vendor installed cables shall be designed and installed in such a way as to allow cable disconnection in order to service the equipment. Cables shall not interfere with circuit board removal.

It shall not be necessary to remove power or field wiring to replace a process control or input/output module.

Cabinet and Workstation Grounding

AC safety ground and instrumentation circuit ground shall conform to NEC, Article 250.

Further, good reasonable engineering practices for electronic noise suppression and lightning protection shall be followed. Active Transient Protectors shall be furnished for surge and lightning protection.

Inputs and Outputs

As may be Provided to/from the Process Controller and to/from the Safety Shutdown System

Discrete Inputs and Outputs

The system shall be capable of accepting the following discrete input types:

a. 24 VDC

b. 120 vac

c. 240 vac

The system shall be capable of providing the following discrete output types:

a. 24 VDC

b. 120 vac

c 240 vac

d. voltage-free relay or solid state outputs

Discrete output circuits shall be provided with protection for the switching of inductive loads.

All discrete I/O circuits shall be designed to ensure that accidental normal mode connection of up to 300 VAC or 300 VDC for an unlimited period of time shall not cause damage other than to the I/O module to which it is connected.

Analog Inputs and Outputs

to/from the PCS, SSS and F&G clusters.

The system shall be capable of accepting the following analog input types

a. 4-20 mA dc with concurrent smart transmitter (HART) protocol

b. 1-5 Vdc

c. Thermocouples. .

d. Platinum resistance temperature detectors (RTD)

The system shall be capable of providing the following analog output types:

a. 4-20 mA dc with concurrent (HART) protocol

Analog input modules shall be able to power 4-20 mA field instrumentation loops with a loop resistance of 600 ohms.

Pulse Inputs

The system shall be capable of accepting pulse inputs, for example from turbine flowmeters.

Alarm and Message Handling

ESD and Alarm System

Alarms and shutdown systems shall be designed and installed such that serious deviations from normal operating conditions, which, if not corrected, could endanger the plant, will shutdown either equipment experiencing the problem or the entire plant. All alarm switches shall be arranged to open in the alarm condition (fail-safe operation). ESD stations will be provided such

that manual shutdown of the plant will be possible from several locations within the plant.

Automatic shutdown and interlock systems shall perform a shutdown or prevent a start-up of equipment or portions of the plant when operations has determined that prevailing conditions would be a serious hazard. A pre-shutdown alarm prior to a shutdown is required with all automatic shutdown devices, where practical.

All alarms shall be displayed on the alarm/shutdown printer and Operator workstations. The PCS system shall have the capability to easily setup alarm suppression for multiple shutdowns (where the secondary alarms are spawned by the initial alarm and trip). Local alarm annunciating for plant sub-systems shall be repeated on the PCS workstations.

Audible alarms and visual beacons shall be installed at strategic points throughout the process plant area.

The alarm and shutdown system shall be a 24 VDC system.

Sequence of shutdown operation shall be shown on a shutdown logic diagram developed subsequent to Cause and Effect Diagrams.

The ESD System's logic provides an automatic response to abnormal process variables, loss of key utilities like instrument air and power, shutdown requests from operators, stand alone packaged systems, the PCS, Fire & Gas systems, etc. to insure that the plant, well cluster and flowlines operate in a safe manner. Final configuration of all the ESD inputs and outputs to the final elements will depend upon the Cause & Effect Diagrams generated after the HAZOP review by the detail design contractor.

General

Process alarms and designated system alarms shall be annunciated, displayed at workstations, and stored in the history files stored in the global database. Normal plant operator actions and events, and normal system actions and events shall not be alarmed. However, these events shall be stored in history files.

Alarms and messages shall be grouped to allow the user to readily identify and respond to alarms and conditions (e.g., in priority sequence) in his area of responsibility.

For any process alarm, it shall be possible, by no more than one mouse click or similar action, for an operator to access a display from which he may take corrective action.

All operator actions that affect process control parameters or alarms shall be stored in history files, including (but not limited to):

b. Alarm inhibit/enable
c. Controller mode change (auto/manual/etc.)
d. Controller setpoint change
e. Controller tuning parameter changes
f. Alarm limit changes

System Alarm Initiation

All devices connected to the PCS communications network shall be monitored for failures. A system alarm shall be generated for each failure detected.

Process and System Alarms History Retention

All alarms shall be stored in history files that can be archived to removable media. It shall be possible to recall alarms from these history files in on-screen display lists and in printed lists according to selectable filtering options. This system shall include an embedded OSI PI date historian.

Process and System Alarms Audible Annunciation

All alarms for a process area may be assigned to any workstation at configuration time. All alarms shall be displayed on the workstation(s) designated. The audible alarm shall be user configurable for different tones or patterns. The system shall have an adjustable volume control. It shall be possible to acknowledge process alarms only from a workstation configured for those alarms.

Process and System Alarms Visual Annunciation

Alarms shall cause visible display annunciation at, and only at, a workstation configured for those alarms. It shall be possible to acknowledge process alarms only from a Workstation configured for those alarms.

Active Process Alarms Summary

There shall be a summary display of active process alarms. Accessing this alarm summary display from any other screen shall require no more than one mouse click or similar action. This display shall show all process alarms currently in alarm condition. Display of any alarm shall not clear unless the alarm is acknowledged and the condition initiating the alarm has returned to normal condition.

System Diagnostics

On-line and off-line diagnostics shall be provided to assist in system maintenance and troubleshooting, for every major system component and peripheral. For peripheral devices that do not provide diagnostics (e.g., printers or terminals), the system must detect and provide an error indication for the failure of these devices.

Data Collection and Trending

A configurable, real time and historical data collection package shall be available to support process data trending, logging, and reporting.

On-line process data collection and storage shall not require any additional configuration.

Historical data must be available to remote desktop PC's, using standard, off-the-shelf viewing and analysis software, including Microsoft Excel and Access.

Trend Displays

Every operator and engineering workstation shall provide viewing of real-time and historical trend information. Data collected in any historian package shall be available to all workstations.

The system shall support user-defined sets of trends so that commonly viewed historical information can be defined as a trend once and can then be easily accessed by selecting a link on the screen. There should be no practical limit to the number of sets of trends that can be defined. Each trend set shall support up to 8 separate trends. Selection of points to be trended shall be menu driven.

Both historical and real-time trend information shall be integrated into a single trend within a trend window, with seamless movement between the two. If the trend window is scrolled to the left, then values from historical data files will be displayed. If the trend window is scrolled to the right past the most recent historical data, then current real-time data will be displayed as it is collected.

Zooming in or out and scrolling to the left or right within a trend shall be possible with no more than two mouse clicks or similar actions. A mechanism for selecting a point on a trend, such as a hairline cursor, and reading the digital values of the trend at that point, shall be provided.

Reports

A reporting utility shall be provided. It shall be possible to use any variable in the system or the history files in a report. It shall be possible for all reports to be displayed on a workstation screen as well as printed on a report printer. Hourly, daily, monthly, end-of-month, quarterly and yearly reports shall be supported. Reports shall be printed and/or saved to disk when designated process events occur. It shall be possible to activate a report in the following manner:

Upon demand (operator request)

Scheduled (shift, daily and monthly)

Upon event occurrence

It shall be possible to transfer data via standard off-the-shelf software tools to generic report writers.

The Integrated Control System should include Foundation Fieldbus **Online Asset Management** and provide at minimum the following:

- Viewing device configuration for intelligent field devices.
- Generating, maintaining, and viewing the device database for all current and historical device data.
- Perform device and database comparison and reconciliation.
- Provide a device audit trail.
- Provide device alert monitoring.
- Provide “as found” and “as left” calibration and test capability.
- Provide tag search for Foundation fieldbus or equivalent devices and database data.
- Provide support for Fieldbus, HART, and conventional device asset management.

- Provide online help.
- Provide security for device configuration.
- Provide database import/export capabilities.

Control System Services

Services offered with the Integrated Control System (ICS) shall include the following as a minimum:

- System configuration should be performed using the standard tools supplied with the system. Special care should be taken during the generation of the database to produce robust and well-designed templates and reuse them as much as possible across the configuration.
- A configuration tool shall be provided to generate or modify database and configuration data. The configuration tool shall employ fill-in-the-blanks or graphical block connecting format.
- The configuration tool shall allow drag-and-drop functionality to move or copy configuration data from one location to another.
- The user shall be able to view control strategies as defined in the configuration while they execute in real time, as well as view the real-time input and output values. When a tag is selected, the operator shall be able to press a single button to view the control strategy.
- Graphic screens should be generated using the system standard tools. Should the supplier decide to use a third-party application to generate process graphics, a licensed copy of the software shall be installed on the engineering workstation.

Historical database definition should be performed during system configuration via the embedded data historian. A set of standard trends and reports will be agreed upon during engineering development. The Historical database shall be sized to allow historization of all control valves.

Control System Availability

A single failure anywhere in the system shall not result in the loss of regulatory control to more control loops than those associated with a single process input/output/H1 module. Failure of any single device shall not affect the ability of the system to communicate with other devices in the system. Switchover from a failed system module to its backup shall not disrupt any system functions.

The loss of failure of any one controller, power supply, network card, network segment, switch, or hub shall not impair system operation.

Redundant equipment and software shall be continuously monitored for errors. All modules shall be diagnosed on-line. Errors shall be alarmed with an error message identifying the failed module.

External Interfaces

Serial Interface - Auxiliary Control Systems

The following capabilities shall be provided as required for communicating to auxiliary systems:

- RS-232C, RS-422, and RS-485 with full and half-duplex operation, and the following selectable baud rates: 9600, 19200, 38400, 57600, and 115200 baud as required for ancillary devices.
- IEEE 802.3 Fast Ethernet TCP/IP protocol at 100 MBPS, with RJ45 connector, over unshielded Category 5 twisted pair cabling within the Control Building.
- IEEE 802.3 Fast Ethernet TCP/IP Protocol, at 100 MBPS via type sm fiber optic cable in full duplex.
- Modbus over RS-485 serial link is to be configured in one of the Linking device cluster as the Master and gathering information from other Linking device or Modbus slaves,.

OPC Interface

The PCS shall be able to communicate bi-directionally with the ESD/F&G controller, PLCs, and remote building control systems using an OPC redundant server. The OPC interface shall be configured in a client-server relationship with the PCS as a client and the auxiliary system as the server.

There shall be no need to write any custom code to set up the OPC interface.

It shall be possible to remotely access the PCS or SSS from any connection on the control ethernet LANs using any standard off-the-shelf web browser such as Netscape's Navigator or Microsoft's Internet Explorer. Vendor shall list as an option all hardware and software needed to allow users to view process graphics and displays, events, and historic as well as real-time trends. All information viewed remotely shall update in real time.

All web browser access shall be secure. It shall be for viewing purposes only. It shall be possible to configure different security access privileges for different users.

TeleCommunicatIon SYSTEM

The telecommunication system is intended to allow remote operation of the facilities from the CCS as well as providing CCTV and PABX communication between buildings.

The telecommunication system will have the following main subsystems as a minimum:

- Redundant digital controllers with Ethernet NIC's at remote buildings for process control and monitoring
- Safety Shutdown at remote buildings, including Redundant Controllers, hardwired to valves, safety system transmitters, and other devices.
- UHF radio telemetry backup communications.
- Radio links should be based on spread spectrum UHF or MicroWave radio modems. A preliminary engineering study to determine the radio system components should be issued. All the system components including antennas, masts, cables, power supplies,

etc. should be included. The need for radio repeater stations should not be needed. Radio data transmission baud rate must be 9600 baud or higher, with an error rate lower than 1 in 10,000, 99.5% of the time.

- Control Network Data Transmission System, an IEEE 802.3 Fast Ethernet, 100 MBPS, 100BASE-FX, Full Duplex Backbone over Single Mode Fiber Optic cable, using Hirschmann RS-2-FX/SM Rail Switches in a Redundant Ring configuration in-plant and throughout the remote network to the Junction and at all Well Cluster sites.
- A second separate but similar network for the CCTV and PABX, except instead of the redundant ring topology, it shall be a linear bus. It shall also be full duplex over single mode fiber optic cable and shall utilize Hirschmann RS-2-FX/SM rail switches.
- A total of 6 fiber pairs connect each well plus 4 spare fiber pair minimum for contingency.
- Closed Circuit TV (CCTV) and Communications

  CCTV and telephone communication shall be provided at each building. It shall communicate with the Central Control Room CCTV Monitoring and Recording Console and with the PABX Panel via the dedicated IEEE 802.3 Fast Ethernet 100MBPS communications networks.

INSPECTION AND TESTING

This section describes the minimum requirements for inspection and testing and does not relieve CONTRACTOR of his obligation to carry out other inspection and testing as required by the codes and standards.

Introduction

The Testing Procedures applicable to all aspects of a control system have evolved over the years as dictated by the inherent characteristics of the control system. Major differences have resulted for

- Conventional analog single loop control systems
- DCS and PLC control systems.

Foundation™ Fieldbus control system testing.

Since, in Foundation™ Fieldbus control systems there are no all-inclusive, multi function, multiplexed systems as normally found in all DCS or PLC systems, and since the Foundation™ Fieldbus control system architecture and its components returns us to the fundamental advantages of single loop integrity, FAT and SAT tests normally provided for DCS or PLC systems are not applicable

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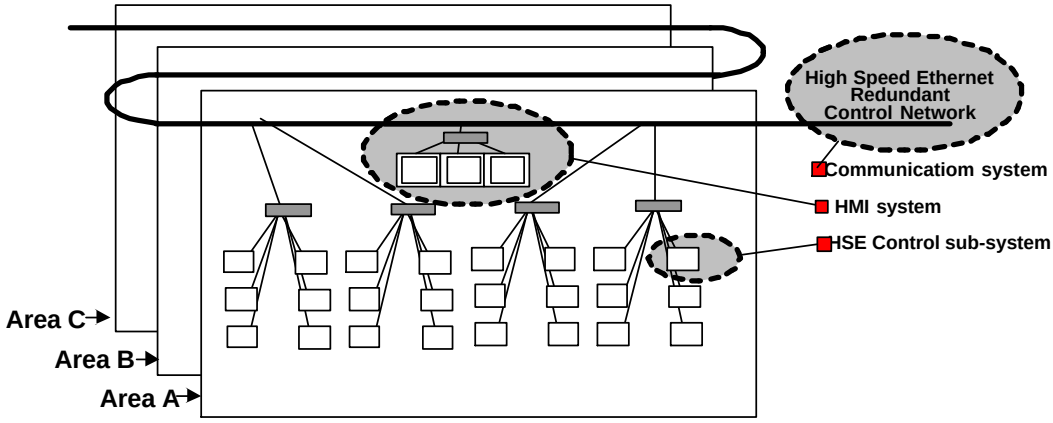
Recommended Foundation™ Fieldbus control system testing procedures follows:

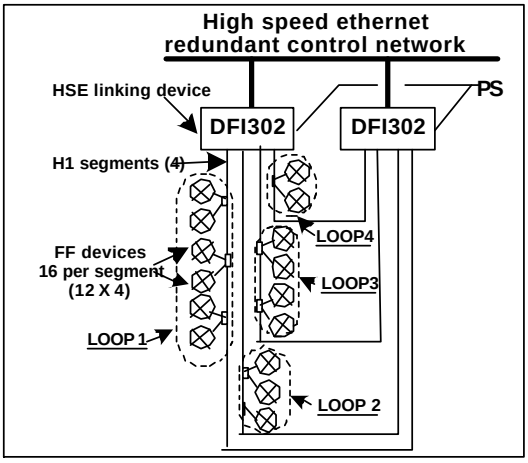
Total Plant Foundation ™ Fieldbus Control System Overview

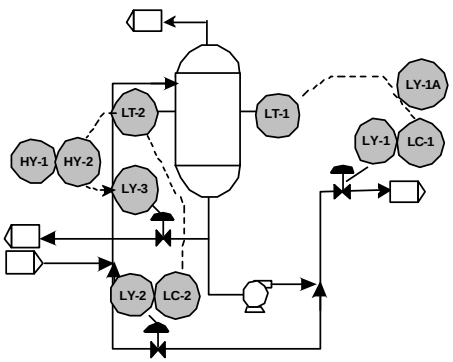


Control System testing elements will be addressed as follows:

- HSE Control sub-systems
- Communication system
- HMI system

HSE Control sub-systems





Engineering and documentation

Using Process Flow Diagrams (PFDs), Piping and Instrument Diagrams (P&IDs) (and modified PFDs showing the Foundation ™ Fieldbus control strategies and components) and using Engineering Workstation configuration capabilities

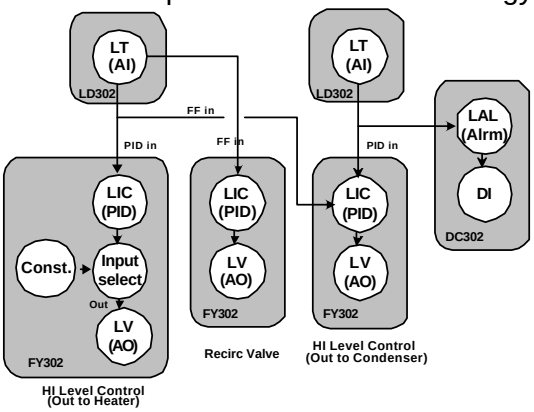
- Individual Control Strategies are developed to satisfy the process requirements. These show all function blocks within each device and the interaction between devices and blocks.

- Engineering Workstation will be used to produce the configuration and documentation necessary for:
- Full definition and configuration of the devices within the control strategy.
- The interconnections between the devices.
- Verification that the control strategies completely satisfy the process control requirements.
- The actual configuration of each

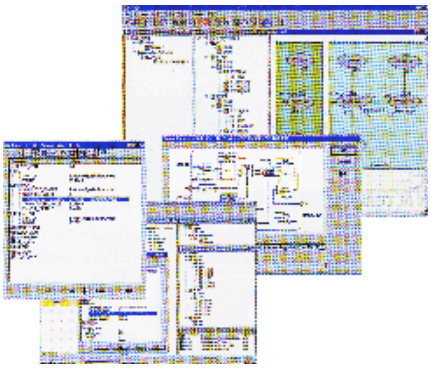
and every FF device.

- Serve as the basis for testing of each and every control strategy and its elements.

- Because of the commonality of the FF devices and control strategies, the most complex and all-inclusive control loop and strategy should first be developed as the reference control strategy for the project and be tested for interoperability. All other control loops and control strategies will then be depopulated versions of this representative control strategy.



Reference CONTROL STRATEGY



Workstastion Configurator and DataBase Builder

Testing and commissioning

After completion of all loop control strategies and the definition of every device and every function block within that device, using the Workstation configurator, the entire control system will have been completed and verified, the database completed and system fully documented. Documentation prepared by the Workstation system will be available as electronic media or hard copy.

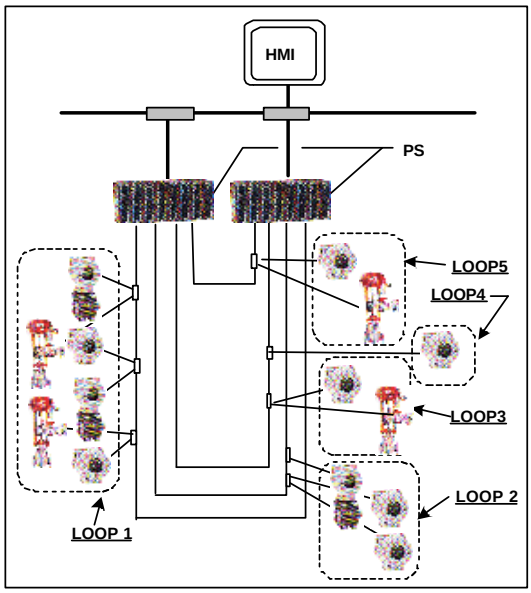
Reference System implementation

It is now time to implement a fully operational Reference system as developed in the engineering phase and incorporating at least one each devices that will be used within the total control system. The preferred location would be at the site as part of the training facility.

This will be used for a number of purposes.

- To fully verify the interoperability and operation of all the components to be used within the total plant control system.
- To verify all aspects of the reference control strategy. This ensures the proper operation of any depopulated version of the reference control strategy.
- To develop the control strategy, with the proper tags, and the proper devices for each of the indicating or control loops. The documentation generated will assist in the installation of all field devices and their interconnection.
- Once the installation complete, it will serve to configure each device and fully verify the loop operation. – this will essentially provide 100% verification and validation of the control system.

It will permit plant personnel to perform all aspects of testing with the presence and attendance of designated and qualified, manufacturer personnel



Reference system

Having the fully implemented reference system at the site training center will permit these courses to be provided at the site at the user's convenience as well customized courses for Casual and Intensive Users including:

- User's Overview Training for System Engineers, I&C Technicians and Operations Personnel
- System Maintenance Training Engineers and I&C Technicians
- Process Engineering

Conducting most courses at the site will ensure the maximum effectiveness by being fully specific to the actual Total Plant Control System and will ensure the Buyer taking full possession of the system.

Communication System Testing

Since the components used in the High Speed Ethernet (HSE)Redundant Fiber Optic Process Control Network will be off-the-shelf, testing will be limited to using switches, and other components incorporated as part of the reference control system and the linking to the Man Machine Interface and other systems.

HMI – Human Machine Interface System

In conjunction with the reference system at the site, display stations should communicate with the Foundation Fieldbus devices using the proper OPC (Ole for Process Control) drivers

A display following the above recommendations should be developed incorporating all devices and tags that make up the reference system. This will also serve for verification of the behavior of the dynamic sub-pictures.

TAGGING

Each panel shall be tagged with a permanently attached stainless steel identification tag, approximately 2-1/2" x 4". CONTRACTOR identification on any removable part of the panel is unacceptable.
In addition to the tag number, the nameplate shall also contain:

Company:	-
Project Name:	-
Equipment type:	-
Purchase Order Number:	-
Year Manufactured:	-

PREPARATION FOR SHIPMENT

After the completion of assembly, control panels and other assemblies shall be thoroughly cleaned of all grease and loose debris. All openings, machined surfaces, bulkhead and threaded connections shall be protected by coating with rust preventative or by having plugs installed. All bulkhead connections shall have tubing plugs installed.

CONTRACTOR

Shall be responsible for providing any bracing, clips and/or brackets necessary for temporary support during transportation. CONTRACTOR shall also provide the magnitude of temporary loads at the support points. Final details of temporary bracing, clips and brackets shall be subject to approval by COMPANY.

Completed units shall not ship until released by COMPANY.

SPARES

CONTRACTOR shall provide two (2) priced recommended spare parts lists for the systems specified herein. One list shall cover commissioning. The second list shall cover the first year of operation. CONTRACTOR shall provide both commissioning and operating spare parts as specified on the lists subject to review and confirmation by COMPANY. COMPANY will place future orders for spare parts based on CONTRACTOR's submittals and recommendations.
All spare parts furnished by CONTRACTOR shall be wrapped and packaged to preserve an original as-new condition under normal conditions for storage. The spare parts shall be properly tagged and coded so that later identification as to their intended equipment usage will be clear. The tags may be steel imprinted type variety, provided that they are wired with stainless steel wire or permanently taped to the component or box. All items supplied shall be packaged separately and clearly marked as "Spare Parts" and shipped with the equipment in accordance with the instructions from COMPANY. Packing lists shall be furnished complete and in detail so that parts can be handled without uncrating, if desired.

DOCUMENTATION REQUIREMENTS

CONTRACTOR shall provide documentation for quotation, approval and record to the COMPANY

WEIGHT CONTROL

The transportation, installation, and operation of this equipment requires the consideration of weight for the project. Accurate estimates of weight are required and must be provided by CONTRACTOR at the bid (preliminary estimate), submittal of approval drawings (detailed design estimate) and at shipment (weighted) for each panel.

DELIVERABLES FOR APPROVAL, FOR CONSTRUCTION, CERTIFIED AS-BUILT

- Instrument Data Sheets and Outlines (updated and certified).
- Controller specifications, Outlines, all hardware manuals and programming documentation including all communication modules, I/O modules, and the latest updates.
- Detailed network interconnecting diagram showing all network connections to controllers, PLCs, work stations, CCTV cameras, CCTV monitors, PABX systems, radio system, hubs, routers, and control devices and detailed field bus wiring to loops. Standard loop diagrams for all 4-20 mA devices. Interconnection wiring diagrams for all other discrete and analog signals.
- Logic narratives, logic diagrams, cause and effect diagrams, safe charts per API 14C, HAZOP reviews, SIL rating determination reports per ISA S84.01, programs for process control, ladder logic diagrams, sequence charts, control flow charts, and elementary wiring schematics. In addition, the HAZOP review shall be attended by the OWNER or his Designee.
- Completed instrumentation indexes and instrument installation schedules and cross references.
- Complete Bill of Materials (beyond the instrument data sheets).
- Valve, orifice plate, level instrument, etc., certified calculations for sizing as well as any pressure temperature or flow conversions. It is expected that the conversions will be done on a standard Excel spreadsheet. Copies on 3-1/2" floppy disks or CD-Rom shall be provided.
- Instrument location and routing plans and details.
- Instrument installation details

Foundation ä Fieldbus Specification with Power Supply redundancy in safe area environment

9/16/2002

Foundation ä Fieldbus Specification with Power Supply redundancy for safe area environment 9/16/2002

INTEGRATED CONTROL SYSTEM

General

The ICS integrated control system is intended to handle all the monitoring, continuous and logical control and safety functions required to operate this plant and its remote facilities.

Summary of the ICS integrated control system

The ICS integrated control system will consist of:
Foundation™ Fieldbus – Linking Device Clusters with Power Supply Redundancy for safe area environment. – SMAR DFI302 or equivalent.

- The Linking Device Clusters will use common Foundation™ Fieldbus HSE hardware, communications and technology as per the following FF-Linking Device Cluster diagram and be used for separate:
  - PCS - Process Control systems
  - SSS - Safety Shutdown Systems
  - FSG - Fire and Gas systems

- The quantity of clusters used for each of the three functions will be determined by the I/O requirements for each process and auxiliary unit and the geographic distribution of the field devices.

- Used for SSS and FSG these non-certified (TUV) Linking Device Clusters will be employed on the basis that HAZOP review will determine a SIL rating attainable by this alternate

- A redundant HSE fiber optic 100 Mbps high speed Ethernet Process Control network will interconnect all Linking Device Clusters (PCS,SSS and F&G) to:

  - all Workstations (Operator, Engineering, Application, Maintenance) regardless of their location

  - all modules performing specialized functions such as historian, report generator, matrix control, asset management, etc.

- A separate non-redundant HSE fiber optic 100 Mbps high speed Ethernet Plant network will be interfaced to the Process Control network and additionally interconnect:

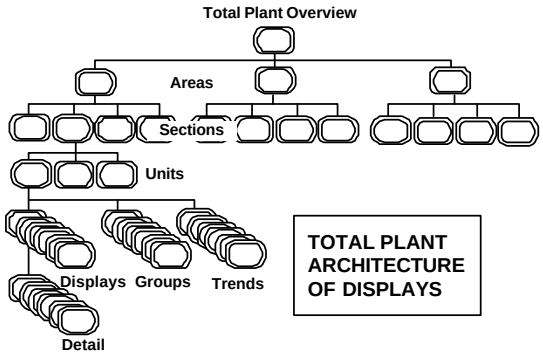
  - The PABX system
  - The CCTV system
  - PC terminals in locations such as:
    - Administrative Building
    - Warehouse
    - Workshop
    - Security
    - Cafeteria
    - Senior Deluxe Rooms
    - Senior Staff Single Rooms
    - Central and remote Control Rooms
    - Motor Control Centers
    - Utility Buildings.

General

Workstations shall be based on the latest standard technology, running the Windows 2000 operating system. Workstation location and functionality will be as indicated on the following diagram.

Operator Workstations

Operator workstations shall provide graphical displays of the Plant. There shall be a total plant architecture of displays, displays of The total plant, the various areas, each unit, major grouping of equipment, details etc. with a logical approach to vertical and horizontal navigation. All displays should use common developed dynamic sub-pictures indicating all aspects of loop behavior. Alarm conditions should be indicated regardless of which display is being shown.



Characteristics of the Architecture, the Displays and the Navigation between displays should include:

- Panoramic Vision
- Progressive Exposure
- Pattern Recognition
- Intuitive Navigation
- Simplicity
- Alarm Management
- Operator Assistance

Judicious use of graphic and tabular representation should be made to best satisfy the needs of a given display.
Displays should take into account the requirements of all modes of operation including:

- Normal
- Process Upset
- Acknowledged Process Upset
- Recovery
- Shutdown

Engineering Workstations

Each engineering workstation shall provide the following functions:

- Configuration
- Database generation
- Graphics display generation and modification
- Control Strategy development
- Field device configuration and maintenance
- Function block configuration and linking
- Report generation and modification
- System Diagnostics
- Utility program access
- Assignment of specific plant area functions to a specific workstation
- The workstation hard drive should be a minimum of 40 GBs.
- Removable storage media provided at each engineering workstation including a CD-ROM Burner

Application Workstation

An application workstation will have access to the total plant integrated database.

Printers

At a minimum, one laser printer and one color ink jet printer should be supplied to support printing from the workstations, connected via a separate network bus between the printers and all workstations, engineering stations, and the Application station.

Foundation™ Fieldbus DEVICES

Any Foundation™ Fieldbus device used on this project should, at minimum:

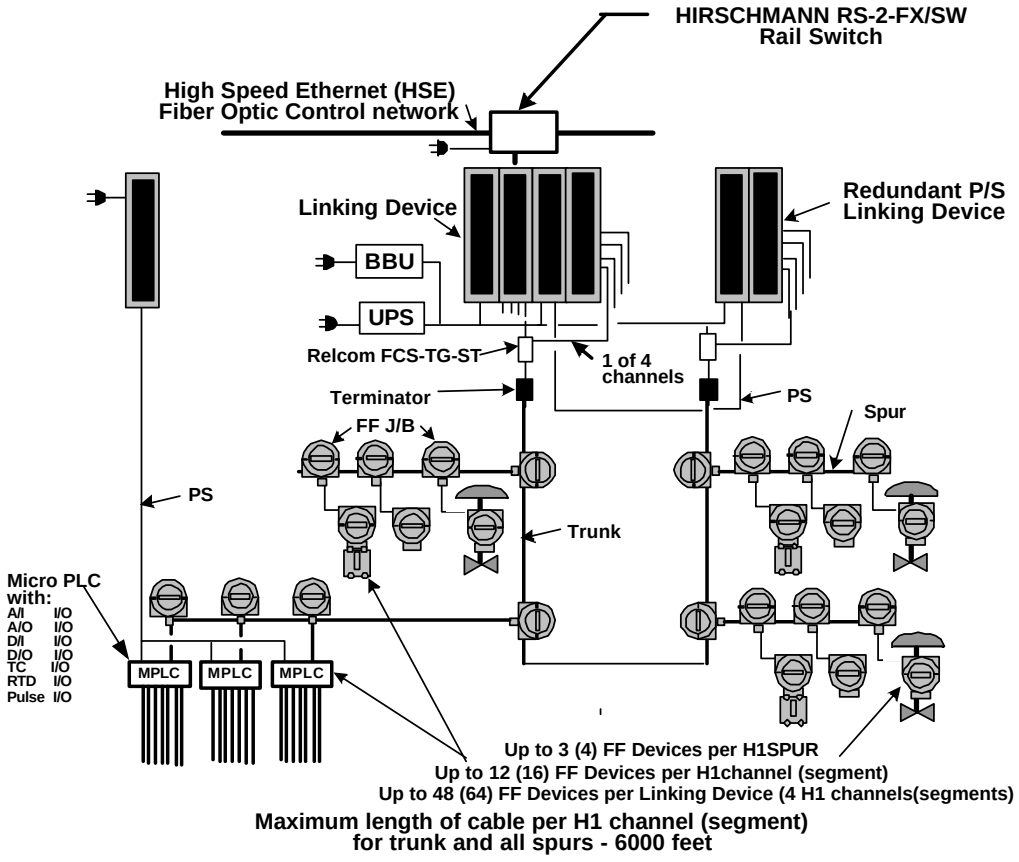
- Be listed by Foundation™ and have Interoperability Test (ITK) 4.0 and higher certified
- If bus powered, have a maximum current consumption not exceeding 12 mA
- Have as many as 17 types of Function blocks including the 14 standard Foundation™ Fieldbus Function blocks
- Have instantiability, with the flexibility to choose one Function Block as many times as necessary - up to 20 Function Blocks per device. (i.e. 2 PID blocks to provide primary and cascade control in one Smart Valve positioner/controller.)
- Function blocks should include Flexible Function Block permitting implementation within each Foundation™ Fieldbus field device of functions such as and including:
  - Self tuning of control loop
  - Fuzzy logic
  - Model Predictive control
  - Matrix control
- Even though the PID function block could be used in any Foundation™ Fieldbus field device, both the primary PID and the secondary PID (cascade) function block should be in the control valve smart positioner/controller. The PID function block should provide information to the HMI that the control loop is normal mode of operation . There should be no extra charge for the inclusion of PID function blocks or Asset Management parameter access
- All regulatory control including cascade, feed forward, lead lag will be performed in the FF field devices.
- Have a total cycle time of less than 500ms even if device has two PID blocks
- True interoperability with Foundation™ Fieldbus approved device from any other manufacturer.

Foundation ä Fieldbus Specification with Power Supply redundancy for safe area environment 9/16/2002

PROCESS, SSS AND F&G CLUSTERS

- FF - LINKING DEVICE CLUSTER, with REDUNDANT Power Supply, with all field devices in a safe area environment shall be Smar DFI302 or equivalent
  - Trunk and Spurs should be interconnected using #16 IEC1158 (ISA-SP50) type A shielded, armored, twisted-pair cable with suitable connectors.
  - The sum of the trunk length + all spur lengths for each H1 segment should not exceed 6000 feet (1900 meters)
  - Fieldbus junction box used to connect a spur to a trunk should permit connecting and removing a device without disturbing the entire bus

FF - Linking Device Cluster with P/S Redundancy safe area environment



Power Supply

The power available to the control system will be 24 VDC. Proposed controllers must include a calculation of power consumption. The power consumption estimate should include power consumption by the communication system, based on estimates of the communications polling cycle and message length, and by all field devices operable simultaneously. Power shall be supplied to redundant services from different sources.

Available Power at the Project location

Power available will be 220 VAC, 60 Hz. A reliable power system should be designed including the following:

- Redundant UPS Systems to Power PCS and auxiliary equipment
- Redundant 24 VDC power supplies as required for specific equipment

The controllers and I/O subsystem are to operate from 24 VDC power and a 24 VDC redundant battery backup system shall be provided. The AC UPS will only be used to provide emergency power for operator workstations and auxiliary systems as required.

Backup control power must be guaranteed at least for 2 hours at full load.

Process Control System and Marshaling Cabinets

All indoor control system electronics should be housed in NEMA 12 industrial cabinets. Fused terminal strips must be provided between discrete input-output terminal blocks and field wiring. No direct connections to device I/O terminal blocks will be allowed. 20% installed and wired spare terminals should be provided above all future and present needs, including future cryogenic units and compressors. Analog inputs and outputs and discrete inputs and outputs should be located on separate terminal strips. High-voltage discrete AC inputs or outputs, if any, shall also be located on separate terminal strips. A grounded steel barrier is to separate the discrete, analog, and AC circuits

Lightning Protection.

All external wiring should pass through lightning protection barriers; this includes input/output signals, power supply connections, and communication links. Fiber optic links whose converters are mounted inside the cabinets are not included.

Install lightning rods and utilize good, safe grounding practices. See Grounding and Electrical specifications.

Communication networks within the Integrated Control System total network loading should be 30% or less at 100M Mbps. System expansion requirements shall be in accordance with this specification and with project procurement documents. System expansion shall be achievable without shutting down controllers not directly involved with expanding any specific part of the system.

Software Revisions

All software, exclusive of application software, shall be the most recent revision that is applicable to the system hardware, as agreed to in writing by the COMPANY or ENGINEER.

The system shall allow for upgrading of system operating software on all redundant modules of the system without the necessity of shutting down the process, without losing the operator interface, and without the loss of access to any control function.

Specially written application software shall not require modifications to be run under new releases of the system operating software. Any new release of system operating software shall be backward compatible with files created using the previous software releases.

Electrical Area Classification

Buildings containing ICS equipment will be rated as electrically unclassified.

I/O Wiring, Terminal Blocks, I/O Cabling

I/O wiring and network communications cables (data highway, Foundation fieldbus or equivalent HSE and H1, ethernet, etc.) shall maintain a minimum separation of 75 mm from any AC power cables. Fiber optic cables are excluded from this requirement, but they must be kept away from sources of heat and potential trauma.

Vendor installed cables shall be designed and installed in such a way as to allow cable disconnection in order to service the equipment. Cables shall not interfere with circuit board removal.

It shall not be necessary to remove power or field wiring to replace a process control or input/output module.

Cabinet and Workstation Grounding

AC safety ground and instrumentation circuit ground shall conform to NEC, Article 250.

Further, good reasonable engineering practices for electronic noise suppression and lightning protection shall be followed. Active Transient Protectors shall be furnished for surge and lightning protection.

Inputs and Outputs

As may be Provided to/from the Process Controller and to/from the Safety Shutdown System

Discrete Inputs and Outputs

The system shall be capable of accepting the following discrete input types:

a. 24 VDC

b. 120 vac

c. 240 vac

The system shall be capable of providing the following discrete output types:

a. 24 VDC

b. 120 vac

c 240 vac

d. voltage-free relay or solid state outputs

Discrete output circuits shall be provided with protection for the switching of inductive loads.

All discrete I/O circuits shall be designed to ensure that accidental normal mode connection of up to 300 VAC or 300 VDC for an unlimited period of time shall not cause damage other than to the I/O module to which it is connected.

Analog Inputs and Outputs

to/from the PCS, SSS and F&G clusters.

The system shall be capable of accepting the following analog input types

a. 4-20 mA dc with concurrent smart transmitter (HART) protocol

b. 1-5 Vdc

c. Thermocouples. .

d. Platinum resistance temperature detectors (RTD)

The system shall be capable of providing the following analog output types:

a. 4-20 mA dc with concurrent (HART) protocol

Analog input modules shall be able to power 4-20 mA field instrumentation loops with a loop resistance of 600 ohms.

Pulse Inputs

The system shall be capable of accepting pulse inputs, for example from turbine flowmeters.

Alarm and Message Handling

ESD and Alarm System

Alarms and shutdown systems shall be designed and installed such that serious deviations from normal operating conditions, which, if not corrected, could endanger the plant, will shutdown either equipment experiencing the problem or the entire plant. All alarm switches shall be arranged to open in the alarm condition (fail-safe operation). ESD stations will be provided such

that manual shutdown of the plant will be possible from several locations within the plant.

Automatic shutdown and interlock systems shall perform a shutdown or prevent a start-up of equipment or portions of the plant when operations has determined that prevailing conditions would be a serious hazard. A pre-shutdown alarm prior to a shutdown is required with all automatic shutdown devices, where practical.

All alarms shall be displayed on the alarm/shutdown printer and Operator workstations. The PCS system shall have the capability to easily setup alarm suppression for multiple shutdowns (where the secondary alarms are spawned by the initial alarm and trip). Local alarm annunciating for plant sub-systems shall be repeated on the PCS workstations.

Audible alarms and visual beacons shall be installed at strategic points throughout the process plant area.

The alarm and shutdown system shall be a 24 VDC system.

Sequence of shutdown operation shall be shown on a shutdown logic diagram developed subsequent to Cause and Effect Diagrams.

The ESD System's logic provides an automatic response to abnormal process variables, loss of key utilities like instrument air and power, shutdown requests from operators, stand alone packaged systems, the PCS, Fire & Gas systems, etc. to insure that the plant, well cluster and flowlines operate in a safe manner. Final configuration of all the ESD inputs and outputs to the final elements will depend upon the Cause & Effect Diagrams generated after the HAZOP review by the detail design contractor.

General

Process alarms and designated system alarms shall be annunciated, displayed at workstations, and stored in the history files stored in the global database. Normal plant operator actions and events, and normal system actions and events shall not be alarmed. However, these events shall be stored in history files.

Alarms and messages shall be grouped to allow the user to readily identify and respond to alarms and conditions (e.g., in priority sequence) in his area of responsibility.

For any process alarm, it shall be possible, by no more than one mouse click or similar action, for an operator to access a display from which he may take corrective action.

All operator actions that affect process control parameters or alarms shall be stored in history files, including (but not limited to):

b. Alarm inhibit/enable
c. Controller mode change (auto/manual/etc.)
d. Controller setpoint change
e. Controller tuning parameter changes
f. Alarm limit changes

System Alarm Initiation

All devices connected to the PCS communications network shall be monitored for failures. A system alarm shall be generated for each failure detected.

Process and System Alarms History Retention

All alarms shall be stored in history files that can be archived to removable media. It shall be possible to recall alarms from these history files in on-screen display lists and in printed lists according to selectable filtering options. This system shall include an embedded OSI PI date historian.

Process and System Alarms Audible Annunciation

All alarms for a process area may be assigned to any workstation at configuration time. All alarms shall be displayed on the workstation(s) designated. The audible alarm shall be user configurable for different tones or patterns. The system shall have an adjustable volume control. It shall be possible to acknowledge process alarms only from a workstation configured for those alarms.

Process and System Alarms Visual Annunciation

Alarms shall cause visible display annunciation at, and only at, a workstation configured for those alarms. It shall be possible to acknowledge process alarms only from a Workstation configured for those alarms.

Active Process Alarms Summary

There shall be a summary display of active process alarms. Accessing this alarm summary display from any other screen shall require no more than one mouse click or similar action. This display shall show all process alarms currently in alarm condition. Display of any alarm shall not clear unless the alarm is acknowledged and the condition initiating the alarm has returned to normal condition.

System Diagnostics

On-line and off-line diagnostics shall be provided to assist in system maintenance and troubleshooting, for every major system component and peripheral. For peripheral devices that do not provide diagnostics (e.g., printers or terminals), the system must detect and provide an error indication for the failure of these devices.

Data Collection and Trending

A configurable, real time and historical data collection package shall be available to support process data trending, logging, and reporting.

On-line process data collection and storage shall not require any additional configuration.

Historical data must be available to remote desktop PC's, using standard, off-the-shelf viewing and analysis software, including Microsoft Excel and Access.

Trend Displays

Every operator and engineering workstation shall provide viewing of real-time and historical trend information. Data collected in any historian package shall be available to all workstations.

The system shall support user-defined sets of trends so that commonly viewed historical information can be defined as a trend once and can then be easily accessed by selecting a link on the screen. There should be no practical limit to the number of sets of trends that can be defined. Each trend set shall support up to 8 separate trends. Selection of points to be trended shall be menu driven.

Both historical and real-time trend information shall be integrated into a single trend within a trend window, with seamless movement between the two. If the trend window is scrolled to the left, then values from historical data files will be displayed. If the trend window is scrolled to the right past the most recent historical data, then current real-time data will be displayed as it is collected.

Zooming in or out and scrolling to the left or right within a trend shall be possible with no more than two mouse clicks or similar actions. A mechanism for selecting a point on a trend, such as a hairline cursor, and reading the digital values of the trend at that point, shall be provided.

Reports

A reporting utility shall be provided. It shall be possible to use any variable in the system or the history files in a report. It shall be possible for all reports to be displayed on a workstation screen as well as printed on a report printer. Hourly, daily, monthly, end-of-month, quarterly and yearly reports shall be supported. Reports shall be printed and/or saved to disk when designated process events occur. It shall be possible to activate a report in the following manner:

Upon demand (operator request)

Scheduled (shift, daily and monthly)

Upon event occurrence

It shall be possible to transfer data via standard off-the-shelf software tools to generic report writers.

The Integrated Control System should include Foundation Fieldbus **Online Asset Management** and provide at minimum the following:

- Viewing device configuration for intelligent field devices.
- Generating, maintaining, and viewing the device database for all current and historical device data.
- Perform device and database comparison and reconciliation.
- Provide a device audit trail.
- Provide device alert monitoring.
- Provide “as found” and “as left” calibration and test capability.
- Provide tag search for Foundation fieldbus or equivalent devices and database data.
- Provide support for fieldbus, HART, and conventional device asset management.
- Provide online help.

- Provide security for device configuration.
- Provide database import/export capabilities.

Control System Services

Services offered with the Integrated Control System (ICS) shall include the following as a minimum:

- System configuration should be performed using the standard tools supplied with the system. Special care should be taken during the generation of the database to produce robust and well-designed templates and reuse them as much as possible across the configuration.
- A configuration tool shall be provided to generate or modify database and configuration data. The configuration tool shall employ fill-in-the-blanks or graphical block connecting format.
- The configuration tool shall allow drag-and-drop functionality to move or copy configuration data from one location to another.
- The user shall be able to view control strategies as defined in the configuration while they execute in real time, as well as view the real-time input and output values. When a tag is selected, the operator shall be able to press a single button to view the control strategy.
- Graphic screens should be generated using the system standard tools. Should the supplier decide to use a third-party application to generate process graphics, a licensed copy of the software shall be installed on the engineering workstation.

Historical database definition should be performed during system configuration via the embedded data historian. A set of standard trends and reports will be agreed upon during engineering development. The Historical database shall be sized to allow historization of all control valves.

Control System Availability

A single failure anywhere in the system shall not result in the loss of regulatory control to more control loops than those associated with a single process input/output/H1 module. Failure of any single device shall not affect the ability of the system to communicate with other devices in the system. Switchover from a failed system module to its backup shall not disrupt any system functions.

The loss of failure of any one controller, power supply, network card, network segment, switch, or hub shall not impair system operation.

Redundant equipment and software shall be continuously monitored for errors. All modules shall be diagnosed on-line. Errors shall be alarmed with an error message identifying the failed module.

External Interfaces

Serial Interface - Auxiliary Control Systems

The following capabilities shall be provided as required for communicating to auxiliary systems:

- RS-232C, RS-422, and RS-485 with full and half-duplex operation, and the following selectable baud rates: 9600, 19200, 38400, 57600, and 115200 baud as required for ancillary devices.
- IEEE 802.3 Fast Ethernet TCP/IP protocol at 100 MBPS, with RJ45 connector, over unshielded Category 5 twisted pair cabling within the Control Building.
- IEEE 802.3 Fast Ethernet TCP/IP Protocol, at 100 MBPS via type sm fiber optic cable in full duplex.
- Modbus over RS-485 serial link is to be configured in one of the Linking device cluster as the Master and gathering information from other Linking device or Modbus slaves,.

OPC Interface

The PCS shall be able to communicate bi-directionally with the ESD/F&G controller, PLCs, and remote building control systems using an OPC redundant server. The OPC interface shall be configured in a client-server relationship with the PCS as a client and the auxiliary system as the server.

There shall be no need to write any custom code to set up the OPC interface.

It shall be possible to remotely access the PCS or SSS from any connection on the control ethernet LANs using any standard off-the-shelf web browser such as Netscape's Navigator or Microsoft's Internet Explorer. Vendor shall list as an option all hardware and software needed to allow users to view process graphics and displays, events, and historic as well as real-time trends. All information viewed remotely shall update in real time.

All web browser access shall be secure. It shall be for viewing purposes only. It shall be possible to configure different security access privileges for different users.

TeleCommunicatIon SYSTEM

The telecommunication system is intended to allow remote operation of facilities and from the CCS as well as providing CCTV and PABX communication between buildings and the central control room.

The telecommunication system will have the following main subsystems as a minimum:

- Redundant digital controllers with Ethernet NIC's at remote buildings for process control and monitoring
- Safety Shutdown System for each wellhead, including Redundant Controllers, hardwired to valves, safety system transmitters, and other devices.
- UHF radio telemetry backup communications.
- Radio links should be based on spread spectrum UHF or MicroWave radio modems. A preliminary engineering study to determine the radio system components should be

issued. All the system components including antennas, masts, cables, power supplies, etc. should be included. The need for radio repeater stations should not be needed. Radio data transmission baud rate must be 9600 baud or higher, with an error rate lower than 1 in 10,000, 99.5% of the time.

- Control Network Data Transmission System, an IEEE 802.3 Fast Ethernet, 100 MBPS, 100BASE-FX, Full Duplex Backbone over Single Mode Fiber Optic cable, using Hirschmann RS-2-FX/SM Rail Switches in a Redundant Ring configuration in-plant and throughout the remote network to the buildings.
- A second separate but similar network for the CCTV and PABX, except instead of the redundant ring topology, it shall be a linear bus. It shall also be full duplex over single mode fiber optic cable and shall utilize Hirschmann RS-2-FX/SM rail switches.
- A total of 6 fiber pairs connect each well plus 4 spare fiber pair minimum for contingency.
- Closed Circuit TV (CCTV) and Communications

  CCTV and telephone communication shall be provided at each building. It shall communicate with the Central Control Room CCTV Monitoring and Recording Console and with the PABX Panel via the dedicated IEEE 802.3 Fast Ethernet 100MBPS communications networks.

INSPECTION AND TESTING

This section describes the minimum requirements for inspection and testing and does not relieve CONTRACTOR of his obligation to carry out other inspection and testing as required by the codes and standards.

Introduction

The Testing Procedures applicable to all aspects of a control system have evolved over the years as dictated by the inherent characteristics of the control system. Major differences have resulted for

- Conventional analog single loop control systems
- DCS and PLC control systems.

Foundation™ Fieldbus control system testing.

Since, in Foundation™ Fieldbus control systems there are no all-inclusive, multi function, multiplexed systems as normally found in all DCS or PLC systems, and since the Foundation™ Fieldbus control system architecture and its components returns us to the fundamental advantages of single loop integrity, FAT and SAT tests normally provided for DCS or PLC systems are not applicable

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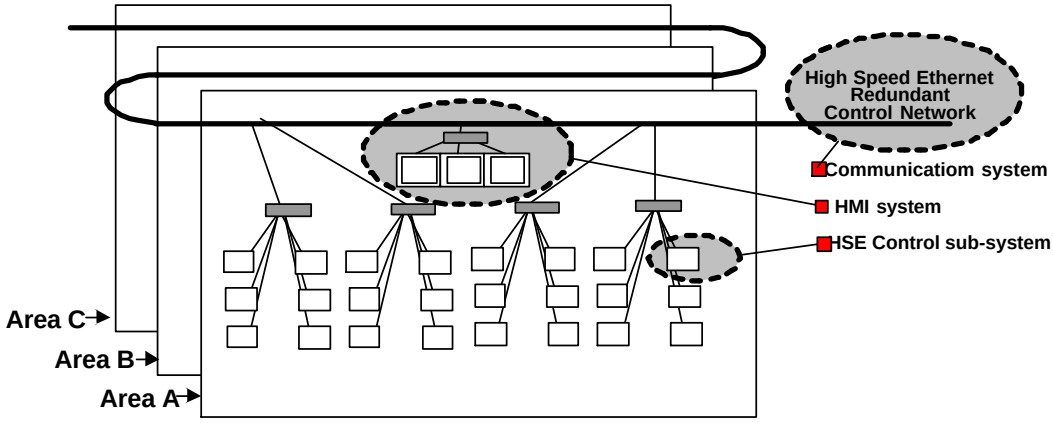
Recommended Foundation™ Fieldbus control system testing procedures follows:

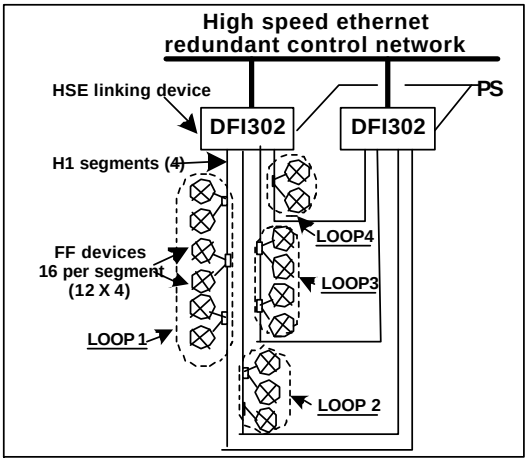
Total Plant Foundation ™ Fieldbus Control System Overview

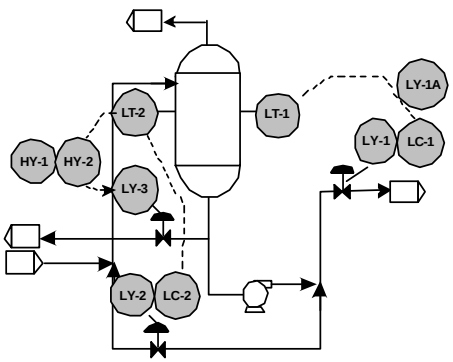


Control System testing elements will be addressed as follows:

- HSE Control sub-systems
- Communication system
- HMI system

HSE Control sub-systems





Engineering and documentation

Using Process Flow Diagrams (PFDs), Piping and Instrument Diagrams (P&IDs) (and modified PFDs showing the Foundation ™ Fieldbus control strategies and components) and using Engineering Workstation configuration capabilities

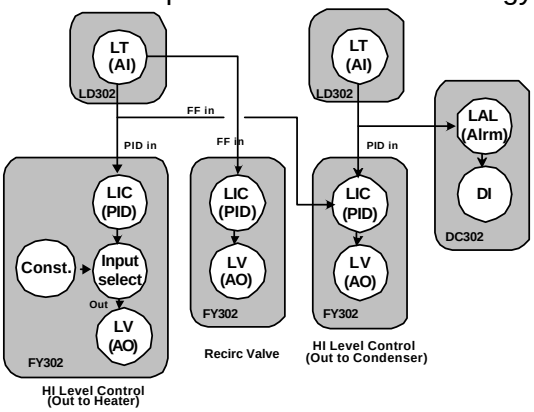
- Individual Control Strategies are developed to satisfy the process requirements. These show all function blocks within each device and the interaction between devices and blocks.

- Engineering Workstation will be used to produce the configuration and documentation necessary for:
- Full definition and configuration of the devices within the control strategy.
- The interconnections between the devices.
- Verification that the control strategies completely satisfy the process control requirements.
- The actual configuration of each

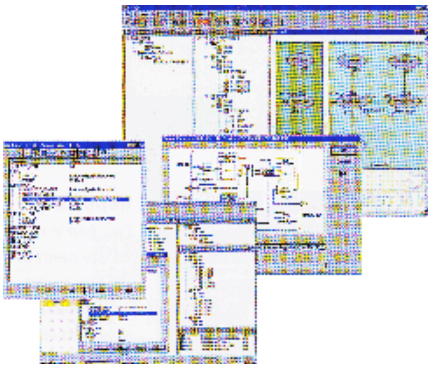
and every FF device.

- Serve as the basis for testing of each and every control strategy and its elements.

- Because of the commonality of the FF devices and control strategies, the most complex and all-inclusive control loop and strategy should first be developed as the reference control strategy for the project and be tested for interoperability. All other control loops and control strategies will then be depopulated versions of this representative control strategy.



Reference CONTROL STRATEGY



Workstastion Configurator and DataBase Builder

Testing and commissioning

After completion of all loop control strategies and the definition of every device and every function block within that device, using the Workstation configurator, the entire control system will have been completed and verified, the database completed and system fully documented. Documentation prepared by the Workstation system will be available as electronic media or hard copy.

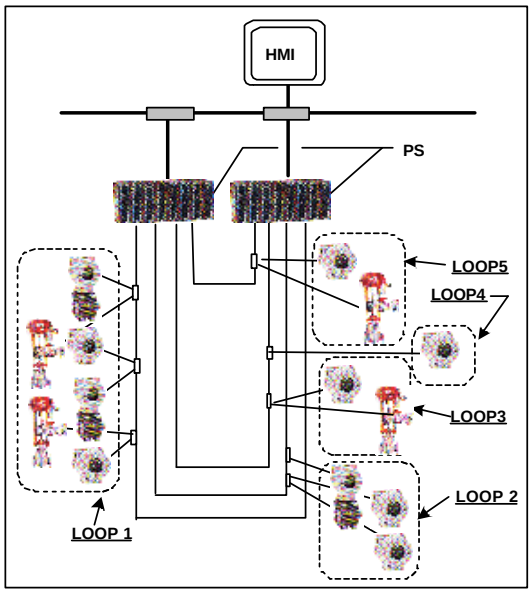
Reference System implementation

It is now time to implement a fully operational Reference system as developed in the engineering phase and incorporating at least one each devices that will be used within the total control system. The preferred location would be at the site as part of the training facility.

This will be used for a number of purposes.

- To fully verify the interoperability and operation of all the components to be used within the total plant control system.
- To verify all aspects of the reference control strategy. This ensures the proper operation of any depopulated version of the reference control strategy.
- To develop the control strategy, with the proper tags, and the proper devices for each of the indicating or control loops. The documentation generated will assist in the installation of all field devices and their interconnection.
- Once the installation complete, it will serve to configure each device and fully verify the loop operation. – this will essentially provide 100% verification and validation of the control system.

It will permit plant personnel to perform all aspects of testing with the presence and attendance of designated and qualified, manufacturer personnel



Reference system

Having the fully implemented reference system at the site training center will permit these courses to be provided at the site at the user's convenience as well customized courses for Casual and Intensive Users including:

- User's Overview Training for System Engineers, I&C Technicians and Operations Personnel
- System Maintenance Training Engineers and I&C Technicians
- Process Engineering

Conducting most courses at the site will ensure the maximum effectiveness by being fully specific to the actual Total Plant Control System and will ensure the Buyer taking full possession of the system.

Communication System Testing

Since the components used in the High Speed Ethernet (HSE)Redundant Fiber Optic Process Control Network will be off-the-shelf, testing will be limited to using switches, and other components incorporated as part of the reference control system and the linking to the Man Machine Interface and other systems.

HMI – Human Machine Interface System

In conjunction with the reference system at the site, display stations should communicate with the Foundation Fieldbus devices using the proper OPC (Ole for Process Control) drivers

A display following the above recommendations should be developed incorporating all devices and tags that make up the reference system. This will also serve for verification of the behavior of the dynamic sub-pictures.

TAGGING

Each panel shall be tagged with a permanently attached stainless steel identification tag, approximately 2-1/2" x 4". CONTRACTOR identification on any removable part of the panel is unacceptable.
In addition to the tag number, the nameplate shall also contain:

Company: -

Project Name: -

Equipment type: -

Purchase Order Number: -

Year Manufactured: -

PREPARATION FOR SHIPMENT

After the completion of assembly, control panels and other assemblies shall be thoroughly cleaned of all grease and loose debris. All openings, machined surfaces, bulkhead and threaded connections shall be protected by coating with rust preventative or by having plugs installed. All bulkhead connections shall have tubing plugs installed.

CONTRACTOR

Shall be responsible for providing any bracing, clips and/or brackets necessary for temporary support during transportation. CONTRACTOR shall also provide the magnitude of temporary loads at the support points. Final details of temporary bracing, clips and brackets shall be subject to approval by COMPANY.

Completed units shall not ship until released by COMPANY.

SPARES

CONTRACTOR shall provide two (2) priced recommended spare parts lists for the systems specified herein. One list shall cover commissioning. The second list shall cover the first year of operation. CONTRACTOR shall provide both commissioning and operating spare parts as specified on the lists subject to review and confirmation by COMPANY. COMPANY will place future orders for spare parts based on CONTRACTOR's submittals and recommendations.
All spare parts furnished by CONTRACTOR shall be wrapped and packaged to preserve an original as-new condition under normal conditions for storage. The spare parts shall be properly tagged and coded so that later identification as to their intended equipment usage will be clear. The tags may be steel imprinted type variety, provided that they are wired with stainless steel wire or permanently taped to the component or box. All items supplied shall be packaged separately and clearly marked as "Spare Parts" and shipped with the equipment in accordance with the instructions from COMPANY. Packing lists shall be furnished complete and in detail so that parts can be handled without uncrating, if desired.

DOCUMENTATION REQUIREMENTS

CONTRACTOR shall provide documentation for quotation, approval and record to the COMPANY

WEIGHT CONTROL

The transportation, installation, and operation of this equipment requires the consideration of weight for the project. Accurate estimates of weight are required and must be provided by CONTRACTOR at the bid (preliminary estimate), submittal of approval drawings (detailed design estimate) and at shipment (weighted) for each panel.

DELIVERABLES FOR APPROVAL, FOR CONSTRUCTION, CERTIFIED AS-BUILT

- Instrument Data Sheets and Outlines (updated and certified).
- Controller specifications, Outlines, all hardware manuals and programming documentation including all communication modules, I/O modules, and the latest updates.
- Detailed network interconnecting diagram showing all network connections to controllers, PLCs, work stations, CCTV cameras, CCTV monitors, PABX systems, radio system, hubs, routers, and control devices and detailed field bus wiring to loops. Standard loop diagrams for all 4-20 mA devices. Interconnection wiring diagrams for all other discrete and analog signals.
- Logic narratives, logic diagrams, cause and effect diagrams, safe charts per API 14C, HAZOP reviews, SIL rating determination reports per ISA S84.01, programs for process control, ladder logic diagrams, sequence charts, control flow charts, and elementary wiring schematics. In addition, the HAZOP review shall be attended by the OWNER or his Designee.
- Completed instrumentation indexes and instrument installation schedules and cross references.
- Complete Bill of Materials (beyond the instrument data sheets).
- Valve, orifice plate, level instrument, etc., certified calculations for sizing as well as any pressure temperature or flow conversions. It is expected that the conversions will be done on a standard Excel spreadsheet. Copies on 3-1/2" floppy disks or CD-Rom shall be provided.
- Instrument location and routing plans and details.
- Instrument installation details

Foundation ä Fieldbus Specification with no redundancy in safe area environment

9/16/2002

Foundation ä Fieldbus Specification with no redundancy in safe area environment **9/16/2002**

INTEGRATED CONTROL SYSTEM

General

The ICS integrated control system is intended to handle all the monitoring, continuous and logical control and safety functions required to operate this plant and its remote facilities.

Summary of the ICS integrated control system

The ICS integrated control system will consist of:
Foundation™ Fieldbus – Linking Device Clusters in safe area environment. – SMAR DFI302 or equivalent.

- The Linking Device Clusters will use common Foundation™ Fieldbus HSE hardware, communications and technology as per the following FF-Linking Device Cluster diagram and be used for separate:
  - PCS - Process Control systems
  - SSS - Safety Shutdown Systems
  - FSG - Fire and Gas systems

- The quantity of clusters used for each of the three functions will be determined by the I/O requirements for each process and auxiliary unit and the geographic distribution of the field devices.

- Used for SSS and FSG these non-certified (TUV) Linking Device Clusters will be employed on the basis that HAZOP review will determine a SIL rating attainable by this alternate

- A redundant HSE fiber optic 100 Mbps high speed Ethernet Process Control network will interconnect all Linking Device Clusters (PCS,SSS and F&G) to:

  - all Workstations (Operator, Engineering, Application, Maintenance) regardless of their location

  - all modules performing specialized functions such as historian, report generator, matrix control, asset management, etc.

- A separate non-redundant HSE fiber optic 100 Mbps high speed Ethernet Plant network will be interfaced to the Process Control network and additionally interconnect:

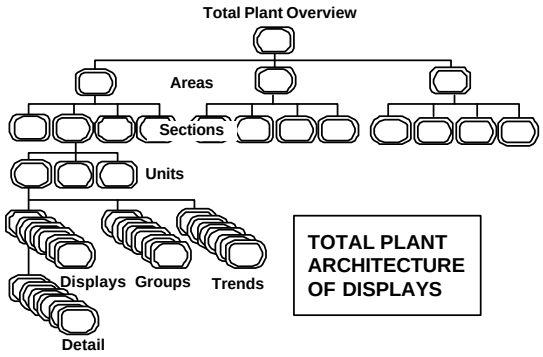
  - The PABX system
  - The CCTV system
  - PC terminals in locations such as:
    - Administrative Building
    - Warehouse
    - Workshop
    - Security
    - Cafeteria
    - Senior Deluxe Rooms
    - Senior Staff Single Rooms
    - Central and remote Control Rooms
    - Motor Control Centers
    - Utility Buildings.

General

Workstations shall be based on the latest standard technology, running the Windows 2000 operating system. Workstation location and functionality will be as indicated on the following diagram.

Operator Workstations

Operator workstations shall provide graphical displays of the Plant. There shall be a total plant architecture of displays, displays of The total plant, the various areas, each unit, major grouping of equipment, details etc. with a logical approach to vertical and horizontal navigation. All displays should use common developed dynamic sub-pictures indicating all aspects of loop behavior. Alarm conditions should be indicated regardless of which display is being shown.



Characteristics of the Architecture, the Displays and the Navigation between displays should include:

- Panoramic Vision
- Progressive Exposure
- Pattern Recognition
- Intuitive Navigation
- Simplicity
- Alarm Management
- Operator Assistance

Judicious use of graphic and tabular representation should be made to best satisfy the needs of a given display.
Displays should take into account the requirements of all modes of operation including:

- Normal
- Process Upset
- Acknowledged Process Upset
- Recovery
- Shutdown

Engineering Workstations

Each engineering workstation shall provide the following functions:

- Configuration
- Database generation
- Graphics display generation and modification
- Control Strategy development
- Field device configuration and maintenance
- Function block configuration and linking
- Report generation and modification
- System Diagnostics
- Utility program access
- Assignment of specific plant area functions to a specific workstation
- The workstation hard drive should be a minimum of 40 GBs.
- Removable storage media provided at each engineering workstation including a CD-ROM Burner

Application Workstation

An application workstation will have access to the total plant integrated database.

Printers

At a minimum, one laser printer and one color ink jet printer should be supplied to support printing from the workstations, connected via a separate network bus between the printers and all workstations, engineering stations, and the Application station.

Foundation ä Fieldbus DEVICES

Any Foundation™ Fieldbus device used on this project should, at minimum:

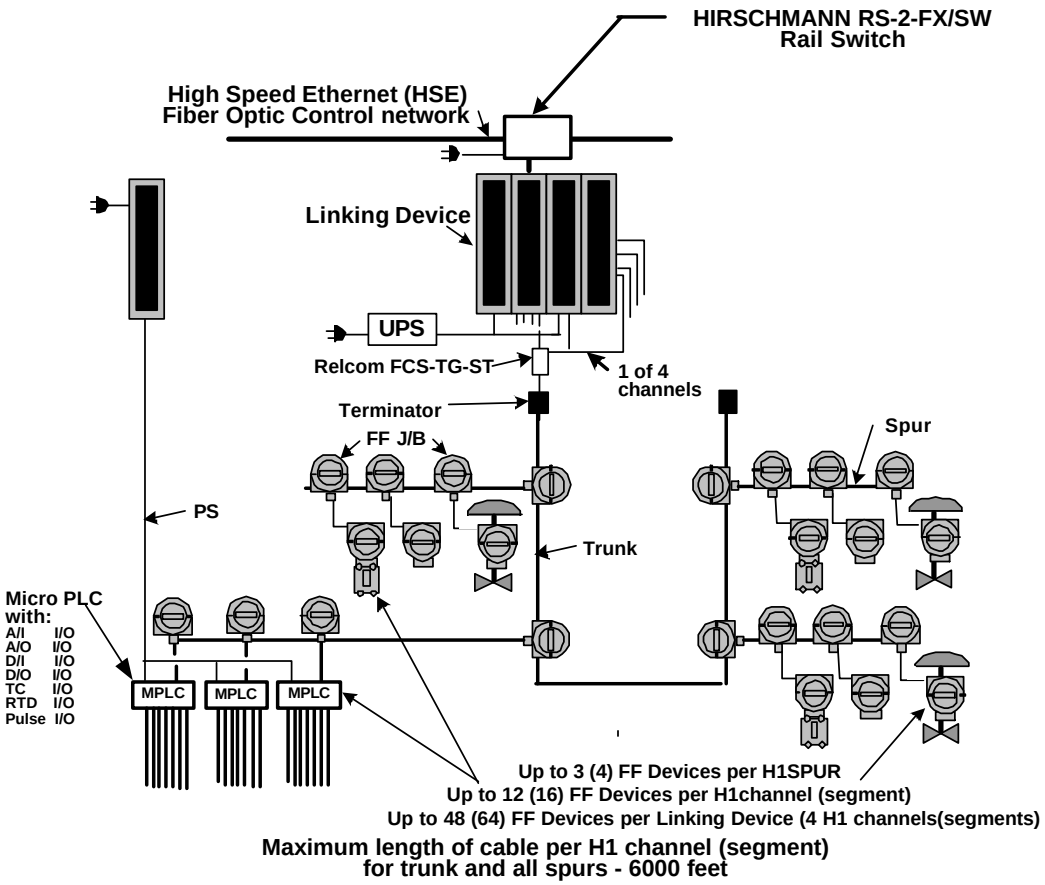
- Be listed by Foundation™ and have Interoperability Test (ITK) 4.0 and higher certified
- If bus powered, have a maximum current consumption not exceeding 12 mA
- Have as many as 17 types of Function blocks including the 14 standard Foundation™ Fieldbus Function blocks
- Have instantiability, with the flexibility to choose one Function Block as many times as necessary - up to 20 Function Blocks per device. (i.e. 2 PID blocks to provide primary and cascade control in one Smart Valve positioner/controller.)
- Function blocks should include Flexible Function Block permitting implementation within each Foundation™ Fieldbus field device of functions such as and including:
  - Self tuning of control loop
  - Fuzzy logic
  - Model Predictive control
  - Matrix control
- Even though the PID function block could be used in any Foundation™ Fieldbus field device, both the primary PID and the secondary PID (cascade) function block should be in the control valve smart positioner/controller. The PID function block should provide information to the HMI that the control loop is in normal mode of operation . There should be no extra charge for the inclusion of PID function blocks or Asset Management parameter access
- All regulatory control including cascade, feed forward, lead lag will be performed in the FF field devices.
- Have a total cycle time of less than 500ms even if device has two PID blocks
- True interoperability with Foundation™ Fieldbus approved device from any other manufacturer.

Foundation ä Fieldbus Specification with no redundancy in safe area environment 9/16/2002

PROCESS, SSS AND F&G CLUSTERS

- FF - LINKING DEVICE CLUSTER, shall be Smar DFI302 or equivalent
  - Trunk and Spurs should be interconnected using #16 IEC1158 (ISA-SP50) type A shielded, armored, twisted-pair cable with suitable connectors.
  - The sum of the trunk length + all spur lengths for each H1 segment should not exceed 6000 feet (1900 meters)
  - Fieldbus junction box used to connect a spur to a trunk should permit connecting and removing a device without disturbing the entire bus

FF - Linking Device Cluster with No Redundancy safe area environment



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Power Supply

The power available to the control system will be 24 VDC. Proposed controllers must include a calculation of power consumption. The power consumption estimate should include power consumption by the communication system, based on estimates of the communications polling cycle and message length, and by all field devices operable simultaneously. Power shall be supplied to redundant services from different sources.

Available Power at the Project location

Power available will be 220 VAC, 60 Hz. A reliable power system should be designed including the following:

- Redundant UPS Systems to Power PCS and auxiliary equipment
- Redundant 24 VDC power supplies as required for specific equipment

The controllers and I/O subsystem are to operate from 24 VDC power and a 24 VDC redundant battery backup system shall be provided. The AC UPS will only be used to provide emergency power for operator workstations and auxiliary systems as required.

Backup control power must be guaranteed at least for 2 hours at full load.

Process Control System and Marshaling Cabinets

All indoor control system electronics should be housed in NEMA 12 industrial cabinets. Fused terminal strips must be provided between discrete input-output terminal blocks and field wiring. No direct connections to device I/O terminal blocks will be allowed. 20% installed and wired spare terminals should be provided above all future and present needs, including future cryogenic units and compressors. Analog inputs and outputs and discrete inputs and outputs should be located on separate terminal strips. High-voltage discrete AC inputs or outputs, if any, shall also be located on separate terminal strips. A grounded steel barrier is to separate the discrete, analog, and AC circuits

Lightning Protection.

All external wiring should pass through lightning protection barriers; this includes input/output signals, power supply connections, and communication links. Fiber optic links whose converters are mounted inside the cabinets are not included.

Install lightning rods and utilize good, safe grounding practices. See Grounding and Electrical specifications.

Communication networks within the Integrated Control System total network loading should be 30% or less at 100M Mbps. System expansion requirements shall be in accordance with this specification and with project procurement documents. System expansion shall be achievable without shutting down controllers not directly involved with expanding any specific part of the system.

Software Revisions

All software, exclusive of application software, shall be the most recent revision that is applicable to the system hardware, as agreed to in writing by the COMPANY or ENGINEER.

The system shall allow for upgrading of system operating software on all redundant modules of the system without the necessity of shutting down the process, without losing the operator interface, and without the loss of access to any control function.

Specially written application software shall not require modifications to be run under new releases of the system operating software. Any new release of system operating software shall be backward compatible with files created using the previous software releases.

Electrical Area Classification

Buildings containing ICS equipment will be rated as electrically unclassified.

I/O Wiring, Terminal Blocks, I/O Cabling

I/O wiring and network communications cables (data highway, Foundation fieldbus or equivalent HSE and H1, ethernet, etc.) shall maintain a minimum separation of 75 mm from any AC power cables. Fiber optic cables are excluded from this requirement, but they must be kept away from sources of heat and potential trauma.

Vendor installed cables shall be designed and installed in such a way as to allow cable disconnection in order to service the equipment. Cables shall not interfere with circuit board removal.

It shall not be necessary to remove power or field wiring to replace a process control or input/output module.

Cabinet and Workstation Grounding

AC safety ground and instrumentation circuit ground shall conform to NEC, Article 250.

Further, good reasonable engineering practices for electronic noise suppression and lightning protection shall be followed. Active Transient Protectors shall be furnished for surge and lightning protection.

Inputs and Outputs

As may be Provided to/from the Process Controller and to/from the Safety Shutdown System

Discrete Inputs and Outputs

The system shall be capable of accepting the following discrete input types:

a. 24 VDC

b. 120 vac

c. 240 vac

The system shall be capable of providing the following discrete output types:

a. 24 VDC

b. 120 vac

c 240 vac

d. voltage-free relay or solid state outputs

Discrete output circuits shall be provided with protection for the switching of inductive loads.

All discrete I/O circuits shall be designed to ensure that accidental normal mode connection of up to 300 VAC or 300 VDC for an unlimited period of time shall not cause damage other than to the I/O module to which it is connected.

Analog Inputs and Outputs

to/from the PCS, SSS and F&G clusters.

The system shall be capable of accepting the following analog input types

a. 4-20 mA dc with concurrent smart transmitter (HART) protocol

b. 1-5 Vdc

c. Thermocouples. .

d. Platinum resistance temperature detectors (RTD)

The system shall be capable of providing the following analog output types:

a. 4-20 mA dc with concurrent (HART) protocol

Analog input modules shall be able to power 4-20 mA field instrumentation loops with a loop resistance of 600 ohms.

Pulse Inputs

The system shall be capable of accepting pulse inputs, for example from turbine flowmeters.

Alarm and Message Handling

ESD and Alarm System

Alarms and shutdown systems shall be designed and installed such that serious deviations from normal operating conditions, which, if not corrected, could endanger the plant, will shutdown either equipment experiencing the problem or the entire plant. All alarm switches shall be arranged to open in the alarm condition (fail-safe operation). ESD stations will be provided such

that manual shutdown of the plant will be possible from several locations within the plant.

Automatic shutdown and interlock systems shall perform a shutdown or prevent a start-up of equipment or portions of the plant when operations has determined that prevailing conditions would be a serious hazard. A pre-shutdown alarm prior to a shutdown is required with all automatic shutdown devices, where practical.

All alarms shall be displayed on the alarm/shutdown printer and Operator workstations. The PCS system shall have the capability to easily setup alarm suppression for multiple shutdowns (where the secondary alarms are spawned by the initial alarm and trip). Local alarm annunciating for plant sub-systems shall be repeated on the PCS workstations.

Audible alarms and visual beacons shall be installed at strategic points throughout the process plant area.

The alarm and shutdown system shall be a 24 VDC system.

Sequence of shutdown operation shall be shown on a shutdown logic diagram developed subsequent to Cause and Effect Diagrams.

The ESD System's logic provides an automatic response to abnormal process variables, loss of key utilities like instrument air and power, shutdown requests from operators, stand alone packaged systems, the PCS, Fire & Gas systems, etc. to insure that the plant, well cluster and flowlines operate in a safe manner. Final configuration of all the ESD inputs and outputs to the final elements will depend upon the Cause & Effect Diagrams generated after the HAZOP review by the detail design contractor.

General

Process alarms and designated system alarms shall be annunciated, displayed at workstations, and stored in the history files stored in the global database. Normal plant operator actions and events, and normal system actions and events shall not be alarmed. However, these events shall be stored in history files.

Alarms and messages shall be grouped to allow the user to readily identify and respond to alarms and conditions (e.g., in priority sequence) in his area of responsibility.

For any process alarm, it shall be possible, by no more than one mouse click or similar action, for an operator to access a display from which he may take corrective action.

All operator actions that affect process control parameters or alarms shall be stored in history files, including (but not limited to):

b. Alarm inhibit/enable
c. Controller mode change (auto/manual/etc.)
d. Controller setpoint change
e. Controller tuning parameter changes
f. Alarm limit changes

System Alarm Initiation

All devices connected to the PCS communications network shall be monitored for failures. A system alarm shall be generated for each failure detected.

Process and System Alarms History Retention

All alarms shall be stored in history files that can be archived to removable media. It shall be possible to recall alarms from these history files in on-screen display lists and in printed lists according to selectable filtering options. This system shall include an embedded OSI PI date historian.

Process and System Alarms Audible Annunciation

All alarms for a process area may be assigned to any workstation at configuration time. All alarms shall be displayed on the workstation(s) designated. The audible alarm shall be user configurable for different tones or patterns. The system shall have an adjustable volume control. It shall be possible to acknowledge process alarms only from a workstation configured for those alarms.

Process and System Alarms Visual Annunciation

Alarms shall cause visible display annunciation at, and only at, a workstation configured for those alarms. It shall be possible to acknowledge process alarms only from a Workstation configured for those alarms.

Active Process Alarms Summary

There shall be a summary display of active process alarms. Accessing this alarm summary display from any other screen shall require no more than one mouse click or similar action. This display shall show all process alarms currently in alarm condition. Display of any alarm shall not clear unless the alarm is acknowledged and the condition initiating the alarm has returned to normal condition.

System Diagnostics

On-line and off-line diagnostics shall be provided to assist in system maintenance and troubleshooting, for every major system component and peripheral. For peripheral devices that do not provide diagnostics (e.g., printers or terminals), the system must detect and provide an error indication for the failure of these devices.

Data Collection and Trending

A configurable, real time and historical data collection package shall be available to support process data trending, logging, and reporting.

On-line process data collection and storage shall not require any additional configuration.

Historical data must be available to remote desktop PC's, using standard, off-the-shelf viewing and analysis software, including Microsoft Excel and Access.

Trend Displays

Every operator and engineering workstation shall provide viewing of real-time and historical trend information. Data collected in any historian package shall be available to all workstations.

The system shall support user-defined sets of trends so that commonly viewed historical information can be defined as a trend once and can then be easily accessed by selecting a link on the screen. There should be no practical limit to the number of sets of trends that can be defined. Each trend set shall support up to 8 separate trends. Selection of points to be trended shall be menu driven.

Both historical and real-time trend information shall be integrated into a single trend within a trend window, with seamless movement between the two. If the trend window is scrolled to the left, then values from historical data files will be displayed. If the trend window is scrolled to the right past the most recent historical data, then current real-time data will be displayed as it is collected.

Zooming in or out and scrolling to the left or right within a trend shall be possible with no more than two mouse clicks or similar actions. A mechanism for selecting a point on a trend, such as a hairline cursor, and reading the digital values of the trend at that point, shall be provided.

Reports

A reporting utility shall be provided. It shall be possible to use any variable in the system or the history files in a report. It shall be possible for all reports to be displayed on a workstation screen as well as printed on a report printer. Hourly, daily, monthly, end-of-month, quarterly and yearly reports shall be supported. Reports shall be printed and/or saved to disk when designated process events occur. It shall be possible to activate a report in the following manner:

Upon demand (operator request)

Scheduled (shift, daily and monthly)

Upon event occurrence

It shall be possible to transfer data via standard off-the-shelf software tools to generic report writers.

The Integrated Control System should include Foundation Fieldbus **Online Asset Management** and provide at minimum the following:

- Viewing device configuration for intelligent field devices.
- Generating, maintaining, and viewing the device database for all current and historical device data.
- Perform device and database comparison and reconciliation.
- Provide a device audit trail.
- Provide device alert monitoring.
- Provide “as found” and “as left” calibration and test capability.
- Provide tag search for Foundation fieldbus or equivalent devices and database data.
- Provide support for Fieldbus, HART, and conventional device asset management.

- Provide online help.
- Provide security for device configuration.
- Provide database import/export capabilities.

Control System Services

Services offered with the Integrated Control System (ICS) shall include the following as a minimum:

- System configuration should be performed using the standard tools supplied with the system. Special care should be taken during the generation of the database to produce robust and well-designed templates and reuse them as much as possible across the configuration.
- A configuration tool shall be provided to generate or modify database and configuration data. The configuration tool shall employ fill-in-the-blanks or graphical block connecting format.
- The configuration tool shall allow drag-and-drop functionality to move or copy configuration data from one location to another.
- The user shall be able to view control strategies as defined in the configuration while they execute in real time, as well as view the real-time input and output values. When a tag is selected, the operator shall be able to press a single button to view the control strategy.
- Graphic screens should be generated using the system standard tools. Should the supplier decide to use a third-party application to generate process graphics, a licensed copy of the software shall be installed on the engineering workstation.

Historical database definition should be performed during system configuration via the embedded data historian. A set of standard trends and reports will be agreed upon during engineering development. The Historical database shall be sized to allow historization of all control valves.

Control System Availability

A single failure anywhere in the system shall not result in the bss of regulatory control to more control loops than those associated with a single process input/output/H1 module. Failure of any single device shall not affect the ability of the system to communicate with other devices in the system. Switchover from a failed system module to its backup shall not disrupt any system functions.

The loss of failure of any one controller, power supply, network card, network segment, switch, or hub shall not impair system operation.

Redundant equipment and software shall be continuously monitored for errors. All modules shall be diagnosed on-line. Errors shall be alarmed with an error message identifying the failed module.

External Interfaces

Serial Interface - Auxiliary Control Systems

The following capabilities shall be provided as required for communicating to auxiliary systems:

- RS-232C, RS-422, and RS-485 with full and half-duplex operation, and the following selectable baud rates: 9600, 19200, 38400, 57600, and 115200 baud as required for ancillary devices.
- IEEE 802.3 Fast Ethernet TCP/IP protocol at 100 MBPS, with RJ45 connector, over unshielded Category 5 twisted pair cabling within the Control Building.
- IEEE 802.3 Fast Ethernet TCP/IP Protocol, at 100 MBPS via type sm fiber optic cable in full duplex.
- Modbus over RS-485 serial link is to be configured in one of the Linking device cluster as the Master and gathering information from other Linking device or Modbus slaves,.

OPC Interface

The PCS shall be able to communicate bi-directionally with the ESD/F&G controllers, PLCs, and remote building control systems using an OPC redundant server. The OPC interface shall be configured in a client-server relationship with the PCS as a client and the auxiliary system as the server.

There shall be no need to write any custom code to set up the OPC interface.

It shall be possible to remotely access the PCS or SSS from any connection on the control ethernet LANs using any standard off-the-shelf web browser such as Netscape's Navigator or Microsoft's Internet Explorer. Vendor shall list as an option all hardware and software needed to allow users to view process graphics and displays, events, and historic as well as real-time trends. All information viewed remotely shall update in real time.

All web browser access shall be secure. It shall be for viewing purposes only. It shall be possible to configure different security access privileges for different users.

TeleCommunicatIon SYSTEM

The telecommunication system is intended to allow remote operation of remote process units from the CCS as well as providing CCTV and PABX communication between buildings and the Central control room.

The telecommunication system will have the following main subsystems as a minimum:

- Redundant digital controllers with Ethernet NIC's at remote buildings for process control and monitoring
- Safety Shutdown System for each remote building, including Redundant Controllers, hardwired to valves, safety system transmitters, and other devices.
- UHF radio telemetry backup communications.

- Radio links should be based on spread spectrum UHF or MicroWave radio modems. A preliminary engineering study to determine the radio system components should be issued. All the system components including antennas, masts, cables, power supplies, etc. should be included. The need for radio repeater stations should not be needed. Radio data transmission baud rate must be 9600 baud or higher, with an error rate lower than 1 in 10,000, 99.5% of the time.
- Control Network Data Transmission System, an IEEE 802.3 Fast Ethernet, 100 MBPS, 100BASE-FX, Full Duplex Backbone over Single Mode Fiber Optic cable, using Hirschmann RS-2-FX/SM Rail Switches in a Redundant Ring configuration in-plant and throughout the remote network to remote buildings.
- A second separate but similar network for the CCTV and PABX, except instead of the redundant ring topology, it shall be a linear bus. It shall also be full duplex over single mode fiber optic cable and shall utilize Hirschmann RS-2-FX/SM rail switches.
- A total of 6 fiber pairs connect each well plus 4 spare fiber pair minimum for contingency. .
- Closed Circuit TV (CCTV) and Communications

  CCTV and telephone communication shall be provided at each building. It shall communicate with the Central Control Room CCTV Monitoring and Recording Console and with the PABX Panel via the dedicated IEEE 802.3 Fast Ethernet 100MBPS communications networks.

INSPECTION AND TESTING

This section describes the minimum requirements for inspection and testing and does not relieve CONTRACTOR of his obligation to carry out other inspection and testing as required by the codes and standards.

Introduction

The Testing Procedures applicable to all aspects of a control system have evolved over the years as dictated by the inherent characteristics of the control system. Major differences have resulted for

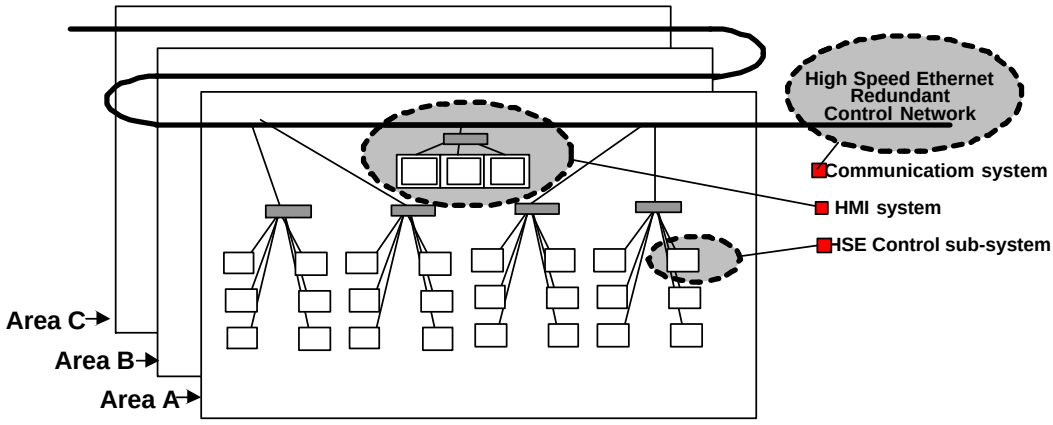
- Conventional analog single loop control systems
- DCS and PLC control systems.

Foundation™ Fieldbus control system testing.

Since, in Foundation™ Fieldbus control systems there are no all-inclusive, multi function, multiplexed systems as normally found in all DCS or PLC systems, and since the Foundation™ Fieldbus control system architecture and its components returns us to the fundamental advantages of single loop integrity, FAT and SAT tests normally provided for DCS or PLC systems are not applicable

Recommended Foundation™ Fieldbus control system testing procedures follows:

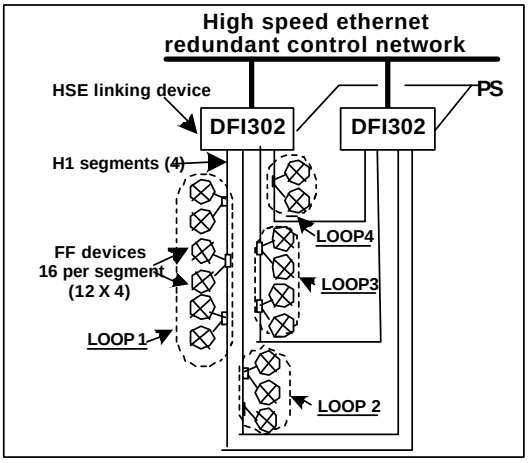
Total Plant Foundation ™ Fieldbus Control System Overview



Control System testing elements will be addressed as follows:

- HSE Control sub-systems
- Communication system
- HMI system

HSE Control sub-systems

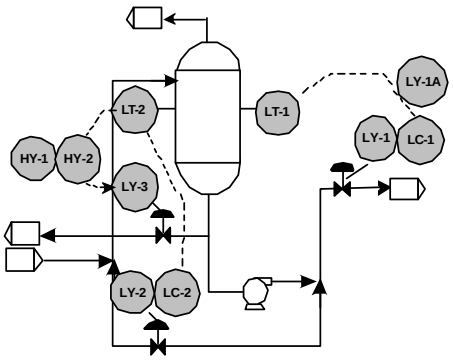


Engineering and documentation

Using Process Flow Diagrams (PFDs), Piping and Instrument Diagrams (P&IDs) (and modified PFDs showing the Foundation ™ Fieldbus control strategies and components) and using Engineering Workstation configuration capabilities

- Individual Control Strategies are developed to satisfy the process requirements. These show all function blocks within each device and the interaction between devices and blocks.

- Engineering Workstation will be used to produce the configuration and documentation necessary for:
- Full definition and configuration of the devices within the control strategy.
- The interconnections between the devices.
- Verification that the control

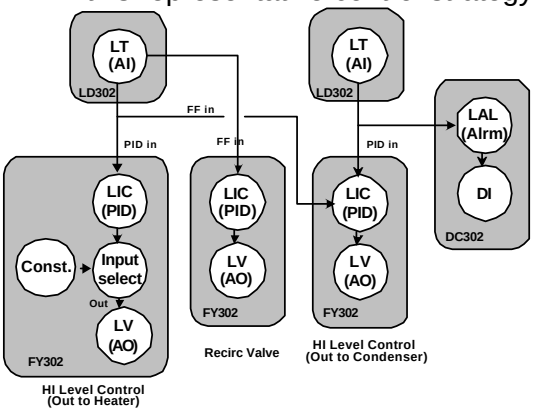


modified PFD

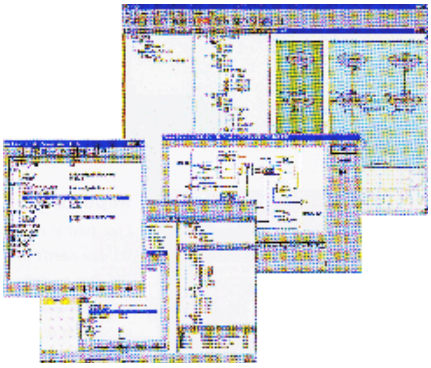
strategies completely satisfy the process control requirements.

- The actual configuration of each and every FF device.
- Serve as the basis for testing of each and every control strategy and its elements.

- Because of the commonality of the FF devices and control strategies, the most complex and all-inclusive control loop and strategy should first be developed as the reference control strategy for the project and be tested for interoperability. All other control loops and control strategies will then be depopulated versions of this representative control strategy.



Reference CONTROL STRATEGY



Workstastion Configurator and DataBase Builder

Testing and commissioning

After completion of all loop control strategies and the definition of every device and every function block within that device, using the Workstation configurator, the entire control system will have been completed and verified, the database completed and system fully documented. Documentation prepared by the Workstation system will be available as electronic media or hard copy.

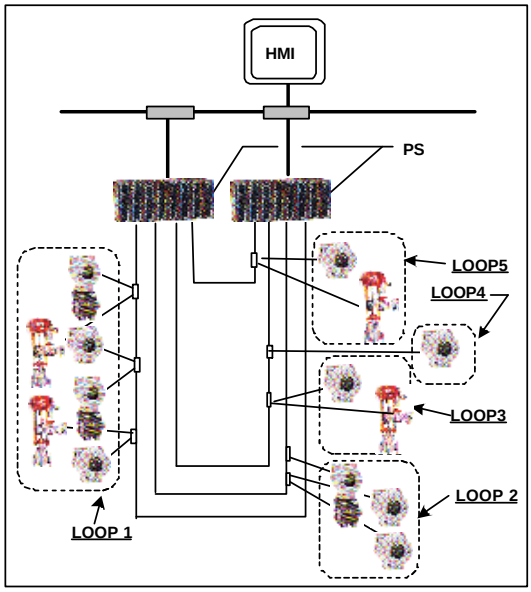
Reference System implementation

It is now time to implement a fully operational Reference system as developed in the engineering phase and incorporating at least one each devices that will be used within the total control system. The preferred location would be at the site as part of the training facility.

This will be used for a number of purposes.

- To fully verify the interoperability and operation of all the components to be used within the total plant control system.
- To verify all aspects of the reference control strategy. This ensures the proper operation of any depopulated version of the reference control strategy.
- To develop the control strategy, with the proper tags, and the proper devices for each of the indicating or control loops. The documentation generated will assist in the installation of all field devices and their interconnection.
- Once the installation complete, it will serve to configure each device and fully verify the loop operation. – this will essentially provide 100% verification and validation of the control system.

It will permit plant personnel to perform all aspects of testing with the presence and attendance of designated and qualified, manufacturer personnel



Reference system

Having the fully implemented reference system at the site training center will permit these courses to be provided at the site at the user's convenience as well customized courses for Casual and Intensive Users including:

- User's Overview Training for System Engineers, I&C Technicians and Operations Personnel
- System Maintenance Training Engineers and I&C Technicians
- Process Engineering

Conducting most courses at the site will ensure the maximum effectiveness by being fully specific to the actual Total Plant Control System and will ensure the Buyer taking full possession of the system.

Communication System Testing

Since the components used in the High Speed Ethernet (HSE)Redundant Fiber Optic Process Control Network will be off-the-shelf, testing will be limited to using switches, and other components incorporated as part of the reference control system and the linking to the Man Machine Interface and other systems.

HMI – Human Machine Interface System

In conjunction with the reference system at the site, display stations should communicate with the Foundation Fieldbus devices using the proper OPC (Ole for Process Control) drivers

A display following the above recommendations should be developed incorporating all devices and tags that make up the reference system. This will also serve for verification of the behavior of the dynamic sub-pictures.

TAGGING

Each panel shall be tagged with a permanently attached stainless steel identification tag, approximately 2-1/2" x 4". CONTRACTOR identification on any removable part of the panel is unacceptable.
In addition to the tag number, the nameplate shall also contain:

Company:	-
Project Name:	-
Equipment type:	-
Purchase Order Number:	-
Year Manufactured:	-

PREPARATION FOR SHIPMENT

After the completion of assembly, control panels and other assemblies shall be thoroughly cleaned of all grease and loose debris. All openings, machined surfaces, bulkhead and threaded connections shall be protected by coating with rust preventative or by having plugs installed. All bulkhead connections shall have tubing plugs installed.

CONTRACTOR

Shall be responsible for providing any bracing, clips and/or brackets necessary for temporary support during transportation. CONTRACTOR shall also provide the magnitude of temporary loads at the support points. Final details of temporary bracing, clips and brackets shall be subject to approval by COMPANY.

Completed units shall not ship until released by COMPANY.

SPARES

CONTRACTOR shall provide two (2) priced recommended spare parts lists for the systems specified herein. One list shall cover commissioning. The second list shall cover the first year of operation. CONTRACTOR shall provide both commissioning and operating spare parts as specified on the lists subject to review and confirmation by COMPANY. COMPANY will place future orders for spare parts based on CONTRACTOR's submittals and recommendations.
All spare parts furnished by CONTRACTOR shall be wrapped and packaged to preserve an original as-new condition under normal conditions for storage. The spare parts shall be properly tagged and coded so that later identification as to their intended equipment usage will be clear. The tags may be steel imprinted type variety, provided that they are wired with stainless steel wire or permanently taped to the component or box. All items supplied shall be packaged separately and clearly marked as "Spare Parts" and shipped with the equipment in accordance with the instructions from COMPANY. Packing lists shall be furnished complete and in detail so that parts can be handled without uncrating, if desired.

DOCUMENTATION REQUIREMENTS

CONTRACTOR shall provide documentation for quotation, approval and record to the COMPANY

WEIGHT CONTROL

The transportation, installation, and operation of this equipment requires the consideration of weight for the project. Accurate estimates of weight are required and must be provided by CONTRACTOR at the bid (preliminary estimate), submittal of approval drawings (detailed design estimate) and at shipment (weighted) for each panel.

DELIVERABLES FOR APPROVAL, FOR CONSTRUCTION, CERTIFIED AS-BUILT

- Instrument Data Sheets and Outlines (updated and certified).
- Controller specifications, Outlines, all hardware manuals and programming documentation including all communication modules, I/O modules, and the latest updates.
- Detailed network interconnecting diagram showing all network connections to controllers, PLCs, work stations, CCTV cameras, CCTV monitors, PABX systems, radio system, hubs, routers, and control devices and detailed field bus wiring to loops. Standard loop diagrams for all 4-20 mA devices. Interconnection wiring diagrams for all other discrete and analog signals.
- Logic narratives, logic diagrams, cause and effect diagrams, safe charts per API 14C, HAZOP reviews, SIL rating determination reports per ISA S84.01, programs for process control, ladder logic diagrams, sequence charts, control flow charts, and elementary wiring schematics. In addition, the HAZOP review shall be attended by the OWNER or his Designee.

- Completed instrumentation indexes and instrument installation schedules and cross references.
- Complete Bill of Materials (beyond the instrument data sheets).
- Valve, orifice plate, level instrument, etc., certified calculations for sizing as well as any pressure temperature or flow conversions. It is expected that the conversions will be done on a standard Excel spreadsheet. Copies on 3-1/2" floppy disks or CD-Rom shall be provided.
- Instrument location and routing plans and details.
- Instrument installation details

INTEGRATED CONTROL SYSTEM

Hirschmann RE-2-FX/SW Rail Switch

PLANT NETWORK

CONTROL NETWORK

PABX

CCTV

JUNCTION

Operator Workstation

UHF

HSE redundant Fiber Optic

High Speed Ethernet (HSE) Fiber Optic

PLANT NETWORK

CONTROL NETWORK

SAFE Area

HAZARDOUS Area

1-------- to ----------N

Linking Device Clusters

SM3- PC 1
SM3- PC 2
SM3- PC 3
SM3- PC 4
SM3- SS 1
SM3- SS 2
SM3- FG 1

SM-3

SM1- PC 1
SM1- PC 2
SM1- PC 3
SM1- PC 4
SM1- SS 1
SM1- SS 2
SM1 FG 1

SM-1

CR1- PC 1
CR1- PC 2
CR1- PC 3
CR1- PC 4
CR1- SS 1
CR1- SS 2
CR1- FG 1

CR-1

CR3- PC 1
CR3- PC 2
CR3- PC 3
CR3- PC 4
CR3- SS 1
CR3- SS 2
CR3- FG 1

CR-3

#1 #2 #3 #4

Operator Workstations

#1 #2

Engineering Workstations

#1

Application Workstation

1-------- to ----------N

Linking Device Clusters

Redundant Historians Ind SQL Plant Network Interface

Redundant Integrated Control System Database

PABX

CCTV

#1

UHF

PCs in

#N

CCR
Admin Bldg
Warehouse
Workshop
Security
Cafeteria
Senior Deluxe Rooms
Senior Staff Single Rooms

CCR- PC 1
CCR- PC 2
CCR- PC 3
CCR- PC 4
CCR- PC 5
CCR- PC 6
CCR- PC 7

CCR- PC 8
CCR- PC 9
CCR- PC 10
CCR- PC 11
CCR- PC 12
CCR- PC 13
CCR- PC 14

CCR- PC 15
CCR- PC 16
CCR- PC 17
CCR- PC 18
CCR- PC 19
CCR- PC 20
CCR- PC-21

CCR- SS 1
CCR- SS 2
CCR- SS 3
CCR- SS 4
CCR- SS 5
CCR- SS 6
CCR- SS 7

CCR- FG 1
CCR- FG 2
CCR- FG 3
CCR- FG 4

CCR

INTEGRATED CONTROL SYSTEM

HM 5/01/02