

DEP SPECIFICATION

INTELLIGENT FIELD DEVICES – DESIGN AND CONFIGURATION

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DESIGN AND ENGINEERING PRACTICE



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PART I – INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for design and configuration of FOUNDATION™ Fieldbus, HART, and Wireless instrumentation.

The use of this DEP is primarily for engineers and designers involved in projects that make use of intelligent field devices including FOUNDATION™ Fieldbus, HART, and Wireless devices. The inclusion of intelligent devices in the Process Automation System introduces changes to work processes, project schedules, deliverables, etc., and this DEP provides a guide to the management of these project tasks.

Excluded from the scope of this DEP are:

- a. Advanced diagnostic modules for troubleshooting the physical layer of Foundation Fieldbus networks.
- b. Intelligent field device maintenance.
- c. Use of FOUNDATION™ Fieldbus or HART capable devices in Safety Instrumented Systems. Only capturing the data from HART devices when connected to Safety Instrumented Systems will be covered; refer to DEP 32.80.10.10-Gen. for details in implementation of Safety Instrumented Systems.
- d. Implementation of Wireless field devices including network design.
- e. Use of HSE linking devices to connect Foundation Fieldbus H1 segments or linking devices to connect multiple wireless clusters for data sharing without the use of a control system.

This is a revision of the DEP of the same number dated September 2011; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them. Any authorised access to DEPs does not for that reason constitute an authorization to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in facilities related to oil and gas production, gas handling, oil refining, chemical processing, gasification, distribution and supply/marketing. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process shall be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regards to the safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for it. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

The following are definitions of terms used in this DEP. A comprehensive list of definitions related to FOUNDATION™ Fieldbus can be found on the Fieldbus Foundation web site at <http://www.fieldbus.org/>.

Term	Definition
automation system	A process automation, control and diagnostic system that is composed of distinct modules. These modules may be physically and functionally distributed over the plant area. The automation system contains all the modules and associated software required to accomplish the regulatory control and monitoring of a process plant. This definition of automation system excludes field instruments, remote terminal units, auxiliary systems and management information systems.
basic device	Any physical device not having the capability to control communications on an H1 Fieldbus segment.
Burst mode	A communication relationship where the HART slave device periodically transmits (responds) without individual poll requests from the master
bus	A H1 Fieldbus communications system comprised of the cabling between a host system and the field devices. This system may be comprised of multiple segments, and the length of the home run cable can be extended through the use of repeaters.
capabilities files	Capability files are a set of files that includes Device Descriptions (DD) and the Capability File itself, also known as CFF. The CFF is a virtual description of the device that allows system off-line configuration.
Common Practice Commands	Common practice commands are optional, but most HART devices implement some of these commands. This includes setting the range, loop test, self-test, reset, zero trim, current trim, and change the transfer function, etc.
complex control	A control scheme for FOUNDATION™ Fieldbus in which more than three field devices are involved, the use of advanced functionality where blocks are not available in the FF devices, or where advanced control or specific failure behaviours are required. Project deviation from this definition shall require approval from the SME.
configurable	The capability to select and connect standard hardware modules to create a system; or the capability to change functionality or sizing of software functions by changing parameters without having to modify or regenerate software.
configuration	The physical installation of hardware modules to satisfy system requirements; or the selection of software options to satisfy system requirements.
connector	A coupling device used to connect the wire medium to a Fieldbus device or to another segment of wire.

Term	Definition
control loop	A group of Function Blocks (FBs) that execute at a specified rate within a Fieldbus device or distributed across the Fieldbus network.
coupler	A physical interface between a trunk and spur, or a trunk and a device.
cycle	The scanning of inputs, execution of algorithms and transmission of output values to devices.
deterministic	Ability to measure the maximum delay in delivery of a message between any two nodes in a network. Any network protocol that depends on random delays to resolve mastership is nondeterministic.
Device Description (DD)	Within Foundation Fieldbus, an extended description of each object in the Virtual Field Device (VFD), and includes information needed for a control system or host system to understand the meaning of data in the VFD. This allows full configuration in both online and offline modes. For HART devices, the DD is an electronic data file that describes specific features and functions of a device including details of menus and graphic display features to be used by host applications (including handheld devices) to access all parameters and data in the corresponding device. This allows limited offline configuration while providing full online configuration functionality.
Device type	In Foundation Fieldbus and HART terms, the device type includes both the device model series and the specific revision for that device model. For example two same model series but with different revisions would result in two different device types.
Device Specific Commands	Device specific commands are unique to the type of HART device. This includes sensor calibration trim, sensor type selection, advanced setup/configuration like radar level transmitter echo curve, and advanced diagnostics such as valve signature, etc.
Dynamic variables	The four principal HART device variables, referred to as PV, SV, TV, and QV
Event notification	HART slave uses burst communication to spontaneously transmit diagnostics status change without a specific request from the master
factory acceptance test (FAT)	The final test at the Supplier's facility of the integrated system being purchased.
Failure alarm output	When a failure (sensor, device, or communication, etc.) is detected, the analogue current output is driven below 4 mA (low/down-scale) or above 20 mA (high/up-scale) masquerading as an extreme process variable; ideally conforming to the NAMUR NE-43 recommendation (< 3.6 mA, > 21 mA), which some receivers can interpret as invalid.

Term	Definition
Fieldbus	A digital, two-way, half-duplex, multi-drop communication link among intelligent measurement and control devices and automation and display systems. It can also transfer electrical power to devices and serves as a Local Area Network (LAN) for advanced process control, remote input/output and high-speed factory automation applications.
HART	Highway Addressable Remote Transducer. A bi-directional 1200 baud digital signal superimposed upon the 4-20 mA signal from field devices. (See http://www.HARTcomm.org)
HART filter	A filter used with HART devices required for some control systems. HART filters are used when the instrument is connected to a 4 to 20 mA DC control system output not designed for the HART communication protocol.
H1	A term used to describe a FOUNDATION™ Fieldbus network operating at 31.25 Kbit/s.
Home Run Cable	The trunk cable running between the host system H1 interface card and the field junction box housing the device coupler(s). The home run cable may have more than one H1 segment on it.
Host Profile Registration	The HIST become the Host Profile Registration when compatibility testing moved from the Suppliers to the Fieldbus Foundation as part of the inter-operability testing certification.
host system	Control system that has FOUNDATION™ Fieldbus capabilities to configure and operate FOUNDATION™ Fieldbus segments.
I/O input / output subsystem Interface	A device used to connect other types of communications protocols to a Fieldbus segment or segments
input	Signal from the field device to the host system.
interoperability	Capability of a device from one Manufacturer to interact with that of another Manufacturer on a Fieldbus network without loss of functionality.
interoperability test kit	Kit used by the Foundation to tick mark devices and confirm compliance with the relevant FOUNDATION™ Fieldbus standards. This is a pass/fail test. Only devices passing the full suite of tests receive the FOUNDATION™ Fieldbus "tick mark" (See http://www.fieldbus.org).
Line conditioner	A power supply impedance; used for example with HART partial stroke testers (PST) powered by the same two wires as a solenoid valve.
link	The logical medium by which H1 FOUNDATION™ Fieldbus devices are interconnected. It is composed of one or more physical segments interconnected by bus, Repeaters or Couplers. All of the devices on a link share a common schedule, which is administered by that link's current LAS. It is the data link layer name for a network.
Local master	A HART field device with capability to act as a master to poll the field devices for data.

Term	Definition
macrocycle	The repetitious scheduling of the FB within all the devices on a segment. The LAS is responsible for scheduling of the segment macrocycle.
Master	A HART host, wireless adapter, or a smart signal conditioner transmitting request to HART slave. Also includes some field devices such as flowmeters and radar level transmitters which use HART with "local master" capability go get readings from pressure and temperature transmitters
methods	An optional (but highly desirable) addition to Device Descriptions (DDs). Methods are used to define/ automate procedures (such as calibration) for operation of field devices.
mode	Control block operational condition, such as manual, automatic, or cascade.
Multi-drop topology	Multiple HART field transmitters connected in parallel to the same pair of wires in a bus topology only using digital communication, no analogue signal is used.
multiplexer	Host interface with multiple HART communication ports connecting to multiple 4-20 mA loops. This allows additional information (e.g. secondary measurements, diagnostics) from devices by "stripping" off the HART data. This information is then accessible to host software through a secondary network such as over RS-485 or Ethernet using application protocols such as PROFIBUS-DP and HART-IP, etc.
output	Signal generated by the host system and transmitted to a field device.
Pass-through	Ability of the control system to pass HART data from HART devices through the I/O cards, across the system hierarchy, up to computers with Instrument Asset Management System software and other applications.
Point-to-point (topology)	Single HART field device connected in the current loop, using simultaneous digital communication and real-time analogue signal
physical layer	Layer that receives messages from the Communications Stack and converts the messages into physical signals on the Fieldbus transmission medium, and vice-versa.
Poll-response	A HART communication relationship where the master request the slave device for information, and the slave device responds.
regulatory control	The functions of process measurement, control algorithm execution, and final control device manipulation that provide closed loop control of a plant process.
Report by exception	See triggered burst and event notification
Resource Block (RB)	An RB describes characteristics of the Fieldbus device such as the device name, manufacturer and serial number. There is only one RB in a device.

Term	Definition
segment	A section of a H1 Fieldbus that is terminated in its characteristic impedance. Segments can be linked by Repeaters to form a longer H1 Fieldbus. Each Segment can include up to 16 physical devices (although the practical or project limit can be lower).
Slave	The field device: transmitter, valve positioner, or analyser, etc. responding to HART requests from the master
spur	An H1 branch line final circuit connecting the field device to the Trunk via the device coupler.
tag	A collection of attributes that specify either a control loop or a process variable, or a measured input, or a calculated value, or some combination of these, and all associated control and output algorithms. Each tag is unique.
terminator	Impedance-matching module used at or near each end of a transmission line that has the same characteristic impedance of the line. Terminators are used to minimize signal distortion, which can cause data errors by converting between current variations and voltage variations. An H1 terminator also has another even more important function. It converts the current signal transmitted by one device to a voltage signal that can be received by all devices on the network.
topology	Shape and design of the Fieldbus network (for example, tree branch, daisy chain, point-to-point, bus with spurs, etc.).
Transducer Block (TB)	Block that decouples FBs from the local input/output (I/O) functions required to read sensors and command output hardware. TBs contain information such as calibration date and sensor type. There is usually one TB channel for each input or output of an FB.
transmitter	An active Fieldbus device containing circuitry, which applies a digital signal on the bus.
triggered burst	HART slave device periodically transmits (response) without individual requests from master, when certain preconfigured trigger condition is met
trunk	The main communication highway between devices on an H1 Fieldbus network. The Trunk acts as a source of main supply to Spurs on the network.
Universal Commands	Universal commands are supported by all HART devices, ensuring a base-level of interoperability. This includes reading the PV, loop current, change address, and information like tag, long tag, descriptor, date, sensor limits, sensor serial number, transfer function, range, damping, and write protection, final assembly serial number, etc.
visitor host	A temporarily connected HART or Foundation Fieldbus master device such as a portable handheld field communicator, laptop, or documenting calibrator
Wireless adapter	Media converter between HART capable devices and WirelessHART or ISA 100.11a, enabling HART enabled 4-20 mA devices to join a wireless network.

	Term	Definition
	workstation	A set of electronic equipment including, at a minimum, one monitor, keyboard(s) and associated pointing device(s).
1.3.3	Abbreviations	
	Term	Definition
	AI	analogue input
	AO	analogue output
	CiF	control in the field
	CFF	common file format
	CPU	central processing unit
	DCS	distributed control system/digital control system. May also be comprised of a PLC or RTU/SCADA based system.
	DD	device description
	DLOS	direct line of sight
	DVT	device verification test
	EDDL	electronic device description language
	EIRP	equivalent or effective isotropically radiated power
	ESL	enhanced smart loops (part of SPI)
	FAR	field access room
	FAT	factory acceptance test
	FB	Function Block
	FDT/DTM	field device tool/device type manager
	FSK	Frequency-shift keying
	HART	hiway addressable remote transducer
	HCF	HART communication foundation
	HPR	host profile registration
	HSE	High Speed Ethernet
	IAMS	instrument asset management system
	IEC	International Electro Technical Commission
	IMAN	initialised manual
	I/O	input output
	IPF	instrument protective function
	IS	intrinsic safety
	ISA	International Society of Automation
	ITK	interoperability test kit
	LAS	link active schedule
	LM	link master
	MAC	main automation contractor
	MAC address	media access control address
	MAI	multi analogue input
	MOC	management of change

Term	Definition
NAMUR	Normenarbeitsgemeinschaft für Mess- Und Regeltechnik in der Chemischen Industrie
PACO	process automation, control and optimisation
PEFS	process engineering flow sheets (same as P&ID)
PER	packet error rate
P&ID	pipng & instrumentation diagram (same as PEFS)
PID	proportional-integral-derivative control
PLC	Programmable logic controller
PST	Partial stroke test
PV	process variable
QV	Quaternary Variable
RB	Resource Block
RCM	reliability cantered maintenance
RSI	RF signal indication
RTU	remote terminal unit
SIL	safety integrity level
SIS	safety instrumented system
SME	subject matter expert
SPI	Smartplant Instrumentation (previous called INtools)
SV	Secondary Variable
TB	Transducer Block
TV	Tertiary Variable
UPS	uninterruptible power supply
WCI	Wireless Compliance Institute

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets (). Other documents referenced by this DEP are listed in (PART V).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a full revision of the DEP of the same number dated September 2011.

This DEP has been completely updated and brought in-line with lessons learned from projects applying Foundation Fieldbus.

Two new sections have been added to this DEP to deal with current technology in the workspace of intelligent instrumentation. The DEP is now organized in several Parts covering different technologies. Part III covers HART capable field devices and. Part IV covers wireless field devices based upon WirelessHART and ISA SP100.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the "Give feedback" link, fill in the online form and submit.
DEP Feedback System (Users with access to Shell Wide Web)	Enter comments directly in the DEP Feedback System which is accessible from the Technical Standards Portal http://swwww.shell.com/standards . Select "Submit DEP Feedback", fill in the online form and submit.
DEP Standard Form (Other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com .

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

1.7 DUAL UNITS

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

1.8 NON NORMATIVE TEXT (COMMENTARY)

Text shown in italic style in this DEP indicates text that is non-normative and is provided as explanation or background information only.

Non-normative text is normally indented slightly to the right of the relevant DEP clause.

PART II – FOUNDATION™ FIELDBUS

2. FOUNDATION™ FIELDBUS PROJECT REQUIREMENTS

2.1 INTRODUCTION

1. Proper utilization of FOUNDATION™ Fieldbus technology in projects requires the following changes compared to traditional technologies for connection of field devices:
 - a. The microprocessor based field devices are distributed in H1 segments and hence these segments now become an integral part of the DCS. This requires an integrated configuration, data management, and system architecture approach to field network design.
 - b. The system integration aspects of FOUNDATION™ Fieldbus requires more design, training, and testing activities to be performed earlier in the project lifecycle when compared to 4-20 mA based projects.
 - c. Additional training of the maintenance organization on FOUNDATION™ Fieldbus technology and configuration of the associated field devices. In addition, different troubleshooting tools are required compared to 4-20 mA.
 - d. The ability to distribute control between the DCS and the FOUNDATION™ Fieldbus field devices require additional consideration when designing device segments and process control solutions.
 - e. System, field device, and segment component testing processes require more attention than for simple analogue connections.
2. When implemented correctly, the benefits associated with FOUNDATION™ Fieldbus based devices include the following:
 - a. Diagnostic abilities associated with the devices themselves, the device related process measurements and the ability to self-alert on these detected performance issues.
 - b. As every measurement comes with status, informing the variable health, control blocks in the control system or in the devices (control in the field) can use the status to automatically drive the control to manual or to a safe position when the status is BAD or Uncertain, avoiding process upsets or accidents
 - c. Fully digital process measurements, both to/from the field devices and the DCS system, thereby avoiding the errors associated with digital to analogue (and vice versa) conversions.
 - i. Consistent accuracy over the device measurement span
 - ii. No drift that is commonly associated with the analogue-digital conversion and hence no calibration requirements
 - iii. Control valve actual position, in real time, is displayed to the Operator and logged in the system.
 - iv. Multiple process measurements available from the devices in a timely fashion (e.g., transmitter body temperature, temperature sensor multiplexers)
 - d. Less time spent during the loop check and commissioning activities when proper procedures are followed coupled with the appropriate knowledge level.
 - e. Lower cable pair count and hence less weight on cable trays. In addition, for some field devices (e.g. MOVs, signal multiplexers, multivariable devices), there will be field wiring savings.
 - f. Very fast deterministic loop response associated with control in the field reduces control variability by more than 30% (ARC study).

- g. Enables the migration from a reactive, preventative, or predictive based maintenance behaviour to a proactive behaviour thereby adding additional value to the services and time spent by the site's maintenance organization.

2.2 USE OF APPROVED PRODUCTS

1. Project staff shall utilize systems, field devices, and segment components that have passed rigorous approval processes. These processes include:
 - a. Release testing by the Supplier
 - b. FOUNDATION™ Fieldbus tests (HPR, ITK)
 - c. Host system Supplier integration tests
 - d. Integration tests (specific system and device combinations) performed by the Principal. In Shell, the PACO organization ensures fully tested interoperability and correctly configured device diagnostics.
 - e. In Shell, the list of PACO tested devices shall form the basis of site and project approved FOUNDATION™ Fieldbus field device list.
2. Project staff shall ensure that testing (device verification testing) of the required functionality of the FOUNDATION™ Fieldbus devices in combination with any Host system has been completed prior to system configuration. This directed testing by the Principal and the resulting reports/templates shall be used for device/system configuration.

2.3 VERSION AND VARIETY MANAGEMENT OF FF PRODUCTS

1. Within the project Define Phase, the selection of FOUNDATION™ Fieldbus devices to be used on a project shall be started and completed early in the Execute Phase. For fast track projects, only proven in use field devices should be used in order to mitigate risk.
2. Additionally, the model types and revision of the specific devices to be used for the project should be decided and frozen. It is important to control the variety of devices.
3. The purchase orders for the devices shall state the device version and the DD revision to be supplied.
4. The starting point for device selection shall be from the Principal's (in Shell the PACO controlled list) of tested devices, identified by manufacturer, model number, and device revision.

This will allow identification of project devices (device manufacturer, device model number, or device revision) that have not yet been tested and approved by the Principal (in Shell, PACO).

5. From a variety control aspect, a project shall minimize the different types of devices used for instrumentation.

For example, having all control valves provided with the same positioners (as much as possible) will help reduce:

- *Project testing effort*
- *Life cycle costs for instrumentation (spare parts, training, maintenance procedures, etc.).*
- *Commissioning effort*

2.4 PROJECT PROCEDURES

1. Project staff should utilize test or development systems during the project design phase.

2. Typical configurations of hardware and software shall be thoroughly tested before high volume replication. These tests shall be completed prior to system configuration. Some examples of integration test procedures are available from the Principal.
3. The FAT should utilize simulated I/O including FOUNDATION™ Fieldbus I/O if the host systems support adequate simulation. In that case only one Field device per model/revision is required at the FAT to perform the Device Verification Test (DVT).
4. However, when FOUNDATION™ Fieldbus Control in the Field is utilized, the FAT shall test the control solution using the actual devices to ensure correct device alerts, presentation of the diagnostics, alarms, and graphic indication are available.
5. In addition, the FAT shall confirm correct operation (message processing) of the IAMS to ensure the configured alerts and prioritization/routing of the alerts meets the project specifications.
6. The IAMS shall be fully configured and tested prior to starting commissioning of the facility.
7. Field test procedures for FOUNDATION™ Fieldbus devices and segments shall be planned for execution during the design phase and should be tested during integration tests.

Examples of field test procedures for FOUNDATION™ Fieldbus devices and segments are available from the Principal. These procedures are generally covered in more depth in other documents.

3. FOUNDATION™ FIELDBUS DCS SYSTEM REQUIREMENTS

3.1 INTRODUCTION

1. Only host systems as defined in the Shell Global Procurement MAC Strategy shall be used. The selection of the correct DCS is essential for a successful FOUNDATION™ Fieldbus technology implementation.

The various DCSs reflect different levels of FOUNDATION™ Fieldbus development. The Fieldbus Foundation now provides a test, FF-569, for host systems.

2. The host system shall be compliant to the latest Fieldbus Foundation host profile. In addition, any additional FOUNDATION™ Fieldbus features (that are not mandatory as part of the HPR) that are required by the project shall be tested to ensure the functionality is present. The HPR does not guarantee the required FOUNDATION™ Fieldbus performance; it only confirms that the host system supports the required FF functionality.
3. The status of and approved release information on DCS testing shall be obtained from the Principal if the system is new or revamped.

3.2 USE OF STANDARD PRODUCTS

1. The DCS shall be composed of the Manufacturer's standard hardware, host system software and firmware that can be configured to meet the stated requirements.
2. The Supplier's standard host system operating software shall not be modified to meet any of the user's requirements.
3. Application software shall be designed in a manner that requires no modification to the host system operating software.
4. Software design shall be such that future revisions or updates of the host system operating software will not affect the successful operation of the system.
5. The DCS H1 network topology and settings shall comply with the recommended FOUNDATION™ Fieldbus practices to enable communication with all targeted FOUNDATION™ Fieldbus devices.

3.3 SUPPORT FOR FOUNDATION™ FIELDBUS FUNCTIONALITY

3.3.1 DCS FOUNDATION™ Fieldbus functionality

1. DCS functionality shall be designed to integrate the features of FOUNDATION™ Fieldbus as follows:

All Shell Global Procurement Strategic MAC listed DCSs support this functionality.

- a. Prevention of duplicate device addresses; preferable via automatic device addressing
- b. Interoperability per the latest HPR test kits
- c. Direct configuration of devices (using DD or EDDL [preferred] technology)
- d. Direct integration of FOUNDATION™ Fieldbus device operating, maintenance and diagnostic data thereby making this data available within the host system and IAMS.
- e. Tuning parameters, modes, device alerts and quality of data.
- f. Field devices shall be configurable while the host system is operating without shutting down or resetting the network.
- g. The host system shall enable new field devices to be added to an existing network/segment (i.e., Device Tag/Placeholder) and fully configured without impacting the other devices on that segment.
- h. Device replacements of the same device revision shall be plug-and-play without requiring any special commissioning or start-up requirements (including automatic integration into the LAS schedule).

Having set-up wizards available, as part of the host system functionality, to assist in the device replacements of the same revision helps simplify this process. Further enhancements of the host systems need to simplify device replacement with replacement devices being different models and/or revisions.

- i. The host system shall enable field device firmware to be updated (over the H1 bus protocol) without shutting down or impacting the publish/subscribe cycle of that H1 segment.
- j. Only ITK approved FOUNDATION™ Fieldbus DD and CFF files shall be used.

Some host system Suppliers modify the CFF files to ensure proper device interoperability with their system.

- k. The DCS shall have a library of templates built from standard DD and CFF files or dedicated Supplier files pre-installed. In Shell, these templates shall be provided by PACO.

This will promote easy commissioning of the FOUNDATION™ Fieldbus devices.

- l. Instantiation of Function Block (FB) functionality shall not be used.

Not all host systems fully support instantiation. In addition, the use of instantiation may cause problems during device replacements of different device types.

- m. FDT/DTM framework must be installed on the IAMS and support FF, HART, and wireless protocols (WirelessHART and ISA100.11a).
- n. The host system (host system H1 functionality and IAMS) shall support full device diagnostic coverage
- o. Device replacement services shall be wizard or method based technology

3.3.2 Data transfer capabilities

1. A single master database in the DCS shall hold all the FOUNDATION™ Fieldbus device parameters. It is preferred that the same database be used by both the DCS and IAMS.
2. External configuration tools that bypass this master database shall not be used.

Current system tools negate the use of handheld equipment (visiting host) for configuration of the field devices. If handheld equipment needs to be used, then the host system should have some method to capture and identify that the configuration in the field device is different from the configuration in the host system device master database.

3. The FOUNDATION™ Fieldbus devices shall enable diagnostic information based upon NAMUR NE-107 (part of ITK 6.0 and FF-912). Integrated asset management packages and the control system should be employed to handle this diagnostic information.

3.4 SPARE CAPACITY AND EXPANSION

1. Design class shall be followed. Refer to DEP 00.00.07.87-Gen. for Design Class Foundation Fieldbus requirements with the following exceptions:

- a. The system shall have sufficient spare performance (e.g., communication idle time) to execute all required communication including diagnostic information.
- b. Each FOUNDATION™ Fieldbus H1 segment shall be capable of supporting at least 12 FOUNDATION™ Fieldbus physical devices. The actual segment loading shall be no more than 10 physical devices per segment with 2 spares at design freeze of the project. In addition, there shall be sufficient room in field junction boxes to support the 20 % spare requirement.

This allows for minimal late design changes without having to run additional cables out to the field junction box.

- c. Home run cables (trunk cables) carrying signals for more than one Foundation Fieldbus segment shall be provided with one spare pair. See (6.7.1) for additional details on cable requirements.
- d. Power supplies for FOUNDATION™ Fieldbus segments shall be sized to support item 3 and to support visiting hosts (e.g. handheld diagnostic equipment).
- e. The redundant power supplies shall be sized taking the following into consideration:
 - i. The power supply spare capacity shall be 30 % after using all the spares and taking into account the requirement specified in (7.5.1).

This requirement is for segment in-rush current requirements associated with initial power-up of the devices.

- ii. In case of failure of one power supply unit, the backup unit shall be able to take the full load (including the spare capacity requirements).

2. Refer to (6.2.2) and (7.5.3) for details.

3.5 REDUNDANCY

1. Design class shall be followed. Refer to DEP 00.00.07.87-Gen. for Design Class Foundation Fieldbus requirements with exceptions as specified below:
2. For availability reasons, the following redundant components shall be used:
 - a. Redundant power feeds shall be provided to the bulk power supplies.

- b. Redundant power feeds shall be independent (e.g., one power feed from Power Bus A and the second power feed from Power Bus B).
- c. Redundant bulk power supplies for supply of power to the FOUNDATION™ Fieldbus segment power supplies. Each bulk power supply shall be able to:
 - i. Supply full load (including spare capacity); and,
 - ii. Annunciate loss of AC power and low battery voltage via separate discrete contacts or other H1 bus independent method.
- d. Where the bulk power supplies are comprised of multiple power modules, it shall be possible to remove and insert a power module under power.
- e. Each power module shall annunciate trouble or error conditions via separate discrete contacts.
- f. The discrete contacts shall be capable of supporting contact sense or voltage sense wiring and shall be energized with closed contact output when indicating an error free condition.
- g. It shall be possible to replace either H1 card under power with no impact on the H1 segments associated with the redundant cards.
- h. It shall be possible to upgrade H1 card software/firmware without impacting communications on the related H1 segments.

Shell Strategic MAC approved DCSs meet this requirement.

- i. There shall be redundant FOUNDATION™ Fieldbus power conditioners. It shall be possible to replace either FOUNDATION™ Fieldbus power conditioner with no impact on the H1 segment(s) associated with the power conditioners.
- 3. For more details on power supply redundancy see (6.2).
 - 4. For more details on field device redundancy see (7.4).

3.6 ARCHITECTURE OF ENGINEERING AND MAINTENANCE WORKSTATION

- 1. It shall be possible to install more than one engineering workstation in a system.
- 2. Only one engineering workstation shall be necessary to perform all control and FOUNDATION™ Fieldbus configuration, database generation, and editing within a physical grouping of H1 interface cards.
- 3. It shall be possible to use multiple DCS engineering workstations simultaneously for configuration, database generation and editing within the same controller.
- 4. The automation system shall provide global configuration for both field devices and IAMS. It is preferred that the automation system has a single, global configuration database to be shared by all components of the system (including DCS and IAMS).
- 5. User shall not be required to enter the same data or configuration more than once.
- 6. The maintenance workstation for diagnostic data handling should reside next to or be integrated with the engineering workstation, as FOUNDATION™ Fieldbus maintenance requires simultaneous access to both platforms.
- 7. An integrated asset management package shall be provided as it is required to gain full benefits of FOUNDATION™ Fieldbus during commissioning and lifecycle activities. Refer to DEP 32.30.20.14-Gen. for asset management requirements.

4. SOFTWARE CONFIGURATION GUIDELINES

4.1 CONTROL SYSTEM GRAPHICS

1. The control system graphics presentation shall comply with DEP 30.00.60.15-Gen. and DEP 30.00.60.16-Gen.
2. In addition, dedicated FOUNDATION™ Fieldbus faceplates shall be applied. For new projects, the templates, as provided in the MAC toolkits, shall be used.

FOUNDATION™ Fieldbus provides an abundance of additional information to the DCS system user.

3. A dedicated asset management system shall be employed for the diagnostic data.
 - a. Appropriate routing of the FOUNDATION™ Fieldbus device alarms/alerts is required.
 - b. Only process related alarms shall be routed to the operator screens. This shall include loss of communications with the device when CiF is used.
 - c. All maintenance and device health related alarms/alerts shall be routed to the maintenance screens (note that exceptions can be made for critical loops).
4. For additional details see (8.4).

4.2 FOUNDATION™ FIELDBUS DEVICE SEGMENT ADDRESSING

1. Each Fieldbus device shall have a unique physical device tag and corresponding segment address.

A device tag is assigned to the device when it is commissioned and (for most device states) retains the tag in its memory when it is disconnected. The network address is the current address that the Fieldbus is using for the device.

The Fieldbus Foundation uses device addresses in the range 0-255. Each Supplier allocates the device address in a way that is somewhat unique. They all have reserved low numbers for overhead and DCS interfaces, and a group above that for live field devices, and some higher numbers for spares.

Addresses as described by the FOUNDATION™ Fieldbus specification are in accordance with the following ranges (note that DCS Suppliers may have implementation specific changes to the ranges listed below):

- 0-15 are reserved.
 - 16-247 are available for permanent devices. Some DCSs may further subdivide this range. This range is typically shortened for efficiency.
 - 248-251 are available for devices with no permanent address such as new devices or decommissioned devices.
 - 252-255 are available for temporary devices, such as handhelds.
2. Third-party systems or configuration tools (e.g. handheld configuration tools) connected through a communications interface to a H1 network shall NOT be used to:
 - a. interrupt the operation of any device within the system;
 - b. change device address;
 - c. affect the link schedule;
 - d. provide LAS functionality; and,
 - e. create database inconsistency issues (different settings in the device versus the host system)

Using handheld devices to make changes to Foundation Fieldbus devices and/or LAS scheduling or addressing can result in an impact to process control and loss of integrity of the DCS master database.

3. Third-party tools shall only use acyclic (client/server) communications.
4. Communication interfaces shall have user-administered security to control read/write access and to select allowed functionality.

Default settings in some configuration tools can disrupt link operation without any direct action by the operator of the tool. For example, a visiting configuration device can have LAS functionality as a setting that may interrupt the segment communications.

5. The field device management or IAMS implementation shall be capable of completely configuring parameters in the Resource Block (RB) and the Transducer Block (TB) associated with FOUNDATION™ Fieldbus devices.

The Shell Global Procurement Strategic MAC listed DCSs are capable of completely configuring the offline configuration of any approved FOUNDATION™ Fieldbus device using standard Capabilities Files (CFF).

6. The FOUNDATION™ Fieldbus H1 card in the DCS shall be configured to provide the primary LAS functionality. The redundant H1 card will take over the LAS in case of failure of the first card. In addition a FOUNDATION™ Fieldbus field device can also function as backup LAS.
7. When control in the field (CiF) is implemented, the backup LAS functionality shall be supplied by the redundant H1 card; no field devices shall be configured to provide the backup LAS functionality unless tested and approved by the Principal.

When there is no redundant H1 card, backup LAS functionality can be provided by a FOUNDATION™ Fieldbus field device to provide availability for CiF.

4.3 CONTROL FUNCTIONALITY LOCATION

1. CiF shall only be used when approved by the Principal and then only where very fast and deterministic process control requirements or tight and more accurate control is required. The SME for FOUNDATION™ Fieldbus shall be consulted by the Principal for CiF applications where additional project benefit is believed possible.

CiF is proven in use within Shell at many operating locations.

The use of CiF will optimize communication as less H1 communication is required and control loops show lower variability due to better synchronisation. In addition CiF may be used to decrease the host system controller load if necessary.

2. When agreed by the Principal, CiF should be used for simple single loop and cascade PID control within the same H1 segment. The PID FB shall be located in the final control element for single loop.
3. As with conventional control systems, loop and device failure modes shall be determined and the proper course of fail action identified for each control loop.
4. If the system allows execution of its function blocks in the H1 card, then use of this feature should be used, as it reduces control variability.
5. Complex control or loops associated with advanced process control shall be fully implemented in the controller.

Layering advanced process control on top of CiF adds publication (extending the cycle time) and removes the benefits obtained from the use of CiF alone.

4.4 SEGMENT SCHEDULING

1. The cyclic communication (publish/subscribe) shall only be used for deterministic control applications.

2. Monitoring devices (e.g., values not used for calculations or control solutions), updating of graphics, faceplates, etc., as well as configuration and diagnostic information for maintenance shall be implemented acyclically (client/server).
3. In some DCSs the type of communication (publish/ subscribe or client/server) can be defined for updating graphics. The correct communication type shall be selected during the control design and implementation phase.

5. FIELD DEVICE REQUIREMENTS

5.1 FIELDBUS REGISTRATION

1. All devices shall, as a minimum, satisfy the requirements of the Fieldbus registration laboratory.

In the case of the Fieldbus Foundation, this is assured by the FOUNDATION™ Fieldbus “check mark” logo and listing on the approved devices lists. This verifies interoperability of devices as indicated in the following example:



Figure 1 Example FOUNDATION™ Fieldbus check mark logo

The ITK (Interoperability Test Kit) is used in this registration process to check the required FOUNDATION™ Fieldbus functionality.

2. In addition to the ITK registration, FOUNDATION™ Fieldbus devices shall be approved by the host system/DCS Supplier and listed on the Principal's (in Shell, PACO) approved list for FOUNDATION™ Fieldbus devices. This will ensure interoperability at an enhanced level (e.g., asset management).

5.2 SUPPORT FOR FOUNDATION™ FIELDBUS FUNCTIONALITY

1. The Principal shall provide tested device templates which shall be used to provide initial set-up of FF devices and IAMS alerts.
2. For devices that have no templates provided by the Principal for either the device or the device revision, the device shall be tested, approved by the Principal, and then templated before use by the project for configuration of the DCS.
 - a. Once the device has been approved by the Principal for use on the project, a package shall be produced that contains the results of the testing and templating performed by PACO.
 - b. The package shall be DCS system specific to ensure full compliance with the host system implementation of FF devices, uploading and downloading, optimize diagnostics, and IAMS implementation.

5.3 USER APPLICATION BLOCKS

5.3.1 General

1. The purpose of FBs is to handle the control strategy. The RBs and TBs shall be used to configure the set-up of the devices (Configuration Blocks).
2. The Device Application Blocks shall be used to configure the required control strategy functionality of the device.

5.3.2 Resource block

1. The RB describes characteristics of the Fieldbus device such as the:
 - a. Device name,
 - b. Device model and revision
 - c. Manufacturer,
 - d. Serial number,
 - e. Available hardware,
 - f. Available software options, and
3. The RB controls the device communication.
4. There shall be only one RB in a device.

5.3.3 Transducer blocks

5.3.3.1 General

1. There is a minimum of one TB within a device.

The TB contains information such as calibration date and sensor type.

TBs decouple FBs from the local input/output (I/O) functions required to read sensors and command output hardware. This is where parameterisation, calibration and diagnostics for the device are carried out.

5.3.3.2 Device diagnostics

1. Device diagnostics shall be able to provide key information on the ability of the device to measure or control the process, including, but not limited to, basic device failure diagnostics and advanced diagnostics.
2. The following types of diagnostics should be evaluated and implemented as appropriate:
 - a. Basic diagnostics
 - i. Basic diagnostics are the device failure diagnostics that shall be viewable from any process control host system. They help determine common problems with the device, communication path, and host system.
 - ii. AI block (e.g., transmitters) diagnostics that indicate a device failure shall force the affected downstream loops into MAN (Manual). For failed AO block (e.g., valve positioner) all blocks upstream shall be forced into IMAN.
 - b. Advanced diagnostics
 - i. Advanced diagnostics include full device diagnostics so that the device's health and process diagnostics can be determined without it having to be removed from the process. Advanced diagnostics come in two forms, online and off-line.
 - ii. Online diagnostics perform their function while the device is performing its normal function, and provide the capability to alert Operations in real time if a problem needs attention. This function provides one of the primary benefits of FOUNDATION™ Fieldbus and shall be supported by all field devices.
 - iii. Offline tests are conducted on the device when the device tests will not impact the process (e.g. valve signature, echo curve on GWR).

When performing valve signatures, the control valve is either bypassed or the process is down. Similarly, performing offline tests

on transmitters may impact the process unless appropriate steps are taken to prevent this.

3. Device diagnostics shall have the capability to diagnose the following and shall provide key information on the impact that an output device (positioner on a valve) has on the process, including but not limited to, the following:
 - a. Position accuracy
 - b. Operating resolution
 - c. Total valve travel
 - d. Packing friction and hysteresis
 - e. Static and sliding friction
 - f. Deadband (travel deviation)
 - g. Operating temperature
4. For valve positioners and any other complex (e.g., guided wave radar or other devices where extended functionality is provided) FF device, the dedicated software package to analyse the positioner, or other complex device data, shall be fully interoperable with the host system IAMS.

The selection of host system asset management, positioner type (including diagnostic coverage) and interoperable software package is key for enabling successful diagnostics from FOUNDATION™ Fieldbus positioner/valve combinations.

5.3.4 Function blocks

1. FBs shall be used in user-defined function block applications to provide various functions required in a control system (for example, input, output, signal selection, and other control actions). The Fieldbus Foundation has defined several device profiles outlining the "root" requirement for several device types. This includes pressure, temperature, valves and some others. Devices that conform to these specifications are preferred.
2. FBs are built into Fieldbus devices, as needed, to achieve the desired control functionality. Some FBs can be built into the devices and some can be instantiated. The first option shall be used as it results in less confusion and configuration effort (that is, instantiated FBs shall not be used).
3. Unused FBs in some multivariable devices may need to be tagged or even partly configured to avoid nuisance alarms. Reference shall be made to the Manufacturer's device manual for optimal configuration.
4. For some field devices (e.g., MOVs), the FB execution times shall be checked as part of segment layout, network parameterisation, and device assignment.

An MOV should be implemented with a single DO block (on/off service) or single AO block (throttling service) both including actual position feedback. Multiple individual I/O function blocks for each of open and close command as well as opened and closed feedback, etc. should not be used.
5. When CiF is to be implemented on a project (with approval of the Principal), the instrument Manufacturer shall be consulted for FB availability in the required field devices. This will ensure the required features are available.
6. To ensure interoperability of the FBs required for the CiF implementation, comprehensive evaluation and testing shall be completed before taking design decisions for the control solution.
7. When implementing CiF, note that each Manufacturer can implement the PID algorithm with unique equations while still providing control in a device PID block. In

most cases the algorithm has no impact on the loop performance, as at present only simple control shall be applied with CiF.

8. However, in all CiF cases, attention shall be given for correct HMI presentation of FF device status, alarms, and alerts.
9. The presentation shall be consistent with presentation of non-CiF solutions.

5.4 CONTROL AND DATA HANDLING OF FOUNDATION™ FIELDBUS DEVICES

5.4.1 Fault handling

1. Fault detection and processing by ITK approved FOUNDATION™ Fieldbus devices shall comply with FOUNDATION™ Fieldbus standards.
2. PV status shall be available on tag basis and generated for inputs and calculated variables.
3. The PV status shall be set to *uncertain* if a device-measured value is out of range of the setting in the XD Scale in the AI block
4. The PV status shall set to *bad* if a value cannot be measured or calculated, or if device diagnostics have identified a failure (e.g., open thermocouple). If there is a communication loss with the field device, the behaviour shall be consistent with above.
5. PV status shall be propagated through control schemes and should be historized in the historian.

For example, valve positioner travel feedback is typically historized for troubleshooting and RCM analysis.

6. It shall be possible for a PV status to be used as a logical input to initiate control algorithm changes.
7. The behaviour between the Fieldbus field device and downstream function/control blocks shall mirror the project specifications as provided by DEP 32.30.20.15-Gen.
8. When a valve positioner cannot communicate on the H1 segment, it shall be possible to configure the output of the AO block for pre-defined behaviour. Behaviour options include hold last good value or configured fail state value (e.g. full open or full close).

a. Configured fault state:

- i. The configured fault state shall be either open, closed, hold last position or a directed percentage open.
- ii. The valve shall go to its configured fault state on loss of communication or upon a configured event. The fault state time, within the positioner, shall be configured to a minimum of 5 s. This will hold the last value (valve position) for 5 s during a communication failure and thereby increases plant availability by providing an opportunity to re-establish communications.
- iii. When hold last position is not used, the configured fault state value and positioner behaviour shall be 0 % closed (for air fail close) and 100 % open (for air fail open valves) or drive the valve to a pre-defined fault state value. However this shall be addressed on a case-by-case basis (with involvement, as a minimum, from process engineering, process control, HSSE, and operations).
- iv. The default setting for fault state behaviour shall be “hold to last position” until a risk ranking of the valve failure position is completed and resulting in a different Fault State Value as mentioned in (ii).
- v. Selection of fault state value shall be the sum of risk based analysis of safety balanced against plant availability. Caution using last value unless there is an ESD valve upstream that can be closed if the control valve segment is no longer visible.

- vi. There shall be a single faceplate in the control system for normally open valves and a similar faceplate for normally closed valves. Both faceplates shall have the same look and feel.
- vii. A configured event may be a loss of Input signal to the valve PID block, or a process event (emergency trip) or diagnostic event (valve fault)
- b. Mechanical fail state:
 - i. Mechanical fail state shall govern the valve behaviour when power is lost on the segment or power fluid (e.g. instrument air, hydraulic fluid) is lost to the positioner. In both these scenarios, the valve shall be driven in the direction as governed by the actuator design.

5.4.2 Regulatory control

5.4.2.1 Algorithms:

1. Standard FOUNDATION™ Fieldbus software algorithms shall be available to perform regulatory control functions.
2. These process control functions shall be performed by using predefined algorithms with configurable parameters.
3. When CiF has been implemented, the form of the PID equation available in the field device shall be documented and understood before successful tuning can be done. The PID equation, as stated above, can be different from Supplier to Supplier (or possibly device type to device type).
4. The set-up and tuning of the PID algorithm in the field device (when CiF is used) shall be consistent with requirements specified in DEP 32.30.20.15-Gen.

5.4.2.2 Setpoint clamps:

1. Upper and lower clamps shall be available on all setpoints.

5.4.2.3 Windup protection:

1. Control functions that include integral action shall be provided with windup protection.
2. Windup protection shall inhibit the integral action when the control block output is constrained by conditions such as:
 - a. Output at high or low limits of span.
 - b. Output at high or low clamps.
 - c. Output is connected to the setpoint of a secondary controller which is clamped.
 - d. Output is not connected to any valid device or algorithm.
 - e. Output tracking is active unless the primary controller is connected to a secondary controller which is not in cascade mode, or if a controller loses communication with the output module due to hardware failure.
3. The windup protection status shall be available for presentation to the operator in a standard faceplate display (per project standards), so the operator is aware of this condition.
4. The windup protection status shall set a parameter that is accessible to graphic displays and application programs.
5. Control functions and computational functions shall include the ability to propagate the windup parameter through multilevel control strategies.

5.4.3 Control and execution monitoring

1. When a device tag is selected, the operator shall be able to readily access the control strategy.

2. No additional configuration of the field device or the host shall be necessary to provide this functionality.

5.4.4 Factory configuration

1. Temperature transmitters (considered bulk devices) can be purchased without tag name or device address. The temperature transmitters shall be provided (configured) with the serial number.
2. The remaining FOUNDATION™ Fieldbus instruments shall be configured by the Manufacturer, including at least the following information:
 - a. Serial number
 - b. Tag name
 - c. (optional) Segment Device Address

Field devices that have process wetted components (e.g. diaphragms on pressure transmitters) or are engineered (e.g. valve positioners) require the tag name to ensure the correct device is installed on the correct service.

3. In addition, devices shall be ordered with LM functionality turned off. This will enable faster commissioning. If a project decides to implement CiF, the decision to turn on the LM in a field device shall only be made after a discussion with the Shell FOUNDATION™ Fieldbus SME.
4. If it is decided by a project to not apply pre-tagged and pre-addressed devices, a dedicated commissioning work procedure (specific to the selected DCS system) shall be provided in which tag and address setting is performed.

5.5 FIELD DEVICE POWER

5.5.1 General

1. Fieldbus devices shall be powered either from the segment (bus), or externally, depending on the device design.
2. All field devices shall be bus powered unless approved by the Principal.
3. If a device requires more power than can be provided from a FOUNDATION™ Fieldbus segment, the 4-wire approach shall be applied (separately powered).
4. The H1 communications port on the device shall be powered from the segment (5.5.3)
5. Nominal used bulk power voltage is 24V. Depending on power components used, it is advised to increase the bulk power supply to its maximum (28-29V)

Bus-powered FOUNDATION™ Fieldbus devices require 10 to 30 mA at between 9 and 32 volts. Most devices have a current consumption at 15 to 17 mA.

5.5.2 Polarity

1. The Fieldbus device's communication signal shall be polarity insensitive.
2. Devices and host systems shall not use inverted Fieldbus signal.
3. Some older FOUNDATION™ Fieldbus devices are polarity sensitive and if installed incorrectly will not work and may also cause network problems. Use of these devices on a project shall be approved by the Principal.
4. Although FF devices are polarity insensitive the spur cable should be connected according + and - indication on the device. In this way no confusion can arise with maintenance people with less training..

5.5.3 2-wire

1. Field devices shall be loop-powered from the host system, unless the device power consumption exceeds the limits of the segment. In the latter case 4-wire configuration shall be applied.

2. Because the 9 V_{dc} specified is an absolute minimum, at least 10 V_{dc} shall be maintained at the device end during steady-state and initial power-on of the segment.

5.5.4 4-wire

1. Externally powered devices (e.g., 4-wire devices) with FOUNDATION™ Fieldbus shall have electrical isolation between external power and Fieldbus signal.
2. The H1 communications port shall be powered from the segment and not from the external power supply to the device. Full H1 functionality shall be available from segment power only.

5.5.5 Wire shields – Added

1. Cable shield shall be trimmed and isolated in the instrument and totally isolated from the instrument housing, conduits, cable trays, other shields, junction box walls, etc. until the shield is connected to the segment reference ground.
2. When multiple segments are present in a junction box, the segment shield conductors shall be isolated from each other until the final shield connection reference point (typically in the marshalling cabinet where the home run cable is connected to the H1 interface card).

5.6 SERVICE CONDITIONS

5.6.1 General

1. Specific Fieldbus conditions shall not relax any device requirements related to FOUNDATION™ Fieldbus device selection.

5.6.2 Electrical certification (hazardous area classification)

1. All devices shall be certified by a nationally-recognized testing laboratory, and labelled for the Area classification (Zone or Division) where they will be installed.
2. Devices shall also meet any additional local regulations applicable to the installation.
3. Shell accepted electrical architecture for FOUNDATION™ Fieldbus projects includes:
 - a. Field devices shall be Ex d or explosion proof for Zone 1 and Zone 2 (equivalent Class 1 Div 1, Class 1 Div 2) all groups.
 - b. Field device shall be Ex ia approved for Zone 0 or (equivalent intrinsically safe) all groups.
 - c. FOUNDATION™ Fieldbus field junction boxes shall be installed in Zone 2 (Class 1 Div 2) or unclassified areas.
 - d. If a Zone 0 field device is required, the associated intrinsically safe barrier shall be located in the field junction box.
 - e. If required by local regulations or project design, an intrinsically safe concept shall be used. This includes:
 - i. Ex ic Zone 2
 - ii. Ex ia or ib Zone 1
 - iii. Ex ia Zone 0

6. FOUNDATION™ FIELDBUS SEGMENT COMPONENT REQUIREMENTS

6.1 GENERAL

1. A number of additional components are required to complete the FOUNDATION™ Fieldbus segments. These segment components are discussed in detail in (6.2) through (6.8). These components shall be approved by the host system Supplier and listed in the Principal's (in Shell, PACO) approved FF device list.

6.2 POWER SUPPLIES

6.2.1 General

1. FOUNDATION™ Fieldbus segment power shall be provided from either dedicated bulk power supplies (e.g., the power supplies shall not provide power for any other loads) along with FOUNDATION™ Fieldbus power conditioners or from FOUNDATION™ Fieldbus power supplies.
2. The supply to the FOUNDATION™ Fieldbus power supplies shall be provided from two independent sources. This is the preferred option (6.2.2).
3. Bulk power supplies and FOUNDATION™ Fieldbus power conditioners shall only be used with approval of the Principal; see (6.2.3) and (6.2.4).

6.2.2 FOUNDATION™ Fieldbus power supplies

1. FOUNDATION™ Fieldbus power supplies shall have the appropriate approval; see FF-831.
2. Power supplies shall:
 - a. be redundant;
 - b. support load sharing;
 - c. be output current limiting; and,
 - d. provide facilities for monitoring conditioner fault and/or failure in the DCS. There shall also be local visual indication of the failed module.
3. Redundant supplies shall be fed by dual sources or by a redundant feed arrangement (not on a single fuse).
4. One of the power sources shall be UPS providing a minimum reserve time slightly greater than the process requirements during power fail scenarios.
5. The reserve time shall be at least 30 min matching the UPS requirements in DEP 32.80.10.10-Gen.
6. All FOUNDATION™ Fieldbus power supplies shall be galvanically isolated.
7. Power supplies shall have the correct electrical approval for the associated field wiring design and field device approvals.
8. Fieldbus power supplies shall be used instead of conditioners (6.2.3). Although both are technically feasible, the latter entail greater risks.
9. Bulk power supplies coupled with FOUNDATION™ Fieldbus power conditioners shall only be used if approved by the Principal.

6.2.3 FOUNDATION™ Fieldbus power conditioner

1. The FOUNDATION™ Fieldbus power conditioner provides impedance matching from the FOUNDATION™ Fieldbus signal and the bulk power supply.

A standard bulk power supply absorbs the communications signal as it attempts to maintain a constant voltage level.
2. The power conditioner may be active (comprising semiconductor components) or passive (comprising an LR – inductive and resistive arrangement) used for isolating the power supply from the FOUNDATION™ Fieldbus segment.
3. Only galvanically isolated power conditioners shall be used.

6.2.4 Bulk power supplies

1. The use and design of bulk power supplies, when approved by the Principal, shall be either of a redundant or N+1 design.
2. The bulk power supplies shall be dedicated to supply of power for H1 segments only.