

GENERAL SPECIFICATION

INSTRUMENTATION

GS EP INS 110

Instrumentation for package units
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General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 2 of 48

Contents

1. Scope	4
2. Reference documents.....	4
3. Definitions and abbreviations	5
4. Instrumentation and control philosophy.....	6
4.1 Life Cycle and Obsolescence Management	6
4.2 Package type definition	7
4.3 Remote Maintenance and Diagnostic (RMD)	9
5. General instrumentation principles	10
5.1 Instruments	10
5.2 Area classification/protection.....	11
5.3 Cabling	11
5.4 Instrument air/gas and hydraulic energy distribution	12
5.5 Power supply	12
5.6 Earthing	14
5.7 Fire and gas.....	14
5.8 SIL calculations.....	14
6. Unit Control Panels	14
6.1 Logic solvers.....	15
6.2 Supervisory system.....	20
6.3 Communication with the ICSS and other systems.....	21
6.4 Vibrations Analysis System implementation	25
6.5 Communication with the MCC.....	26
6.6 Actuation of On-Off Valves.....	27
6.7 Cyber security	27
6.8 PLC and Marshalling cabinets.....	27
7. Package Vendor scope of work	28
7.1 General.....	28
7.2 Engineering and design	28

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 3 of 48

7.3	Scope of supply	28
7.4	Services	29
8.	P4 Package requirements.....	29
8.1	General Instrumentation Principles	29
8.2	Applicable sections of this Specification	29
8.3	Unit Control Panel (UCP)	30
8.4	Interface Architecture Requirements	31
Appendix 1	Typical scope of work for package instrumentation and control Part 1: Supply	32
Appendix 2	Typical scope of work for package instrumentation and control Part 2: Engineering	34
Appendix 3	Obsolescence Dossier.....	38
Appendix 4	Generic Package Power Supply & Distribution Diagram.....	39
Appendix 5	Tests requirements.....	40
Appendix 6	General UCP / ICSS /Other systems Architecture	47
Appendix 7	P4 type packages examples.....	48

1. Scope

This document covers the works, equipment, services and responsibilities that shall be provided or executed by the package Vendor for instrumentation associated with major mechanical or process equipment, systems or units.

2. Reference documents

The reference documents listed below form an integral part of this General Specification.

External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the effective date of this document.

Reference	Title
ATEX European Directive 94/9/EC	European Directive on the approximation of the Laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres
European Directive 2004/108/EC	European Directive on the approximation of the Laws of Member States relating to electro-magnetic compatibility (EMC)
IEC 61000-5	Sections related to the Electromagnetic compatibility (EMC) - Part 5: Installation and mitigation guidelines
IEC 61131-3	Programmable controllers - Part 3: Programming languages
IEC 61508	Parts related to the Functional safety of electrical/electronic/programmable electronic safety-related systems
IEC 61511	Parts related to the Functional safety - Safety instrumented systems for the process industry sector
IEC 62061	Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems
IECEX	IEC System for Certification to Standards relating to Equipment for use in Explosive Atmospheres (IECEX System)

Total General Specifications

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published in the applicable yearly collection.

Reference	Title
GS EP ELE 011	Electrical requirements for packaged units
GS EP EXP 131	Design and installation of Process Data Server
GS EP INS 000	Minimum Contractor Document Requirements

Reference	Title
GS EP INS 101	Instrumentation engineering, supply and construction general requirements
GS EP INS 102	Instrumentation identification
GS EP INS 103	Instrumentation Database Management
GS EP INS 107	Design and installation of instrumentation links
GS EP INS 120	Control and Chokes Valves
GS EP INS 125	Safety Relief Valves and Rupture Discs
GS EP INS 131	Standard Functions and Functional Analysis Development Requirements
GS EP INS 134	Design and supply of integrated control and safety system
GS EP INS 135	Cyber Security requirements for design and supply of ICSS and Package Systems
GS EP INS 137	On/off valve control panels and actuators functional and construction requirements
GS EP INS 150	Design method for system configuration - Standard functions
GS EP INS 198	Safety and Fire & Gas Standard Functions
GS EP INS 900	Instrument hook-up diagrams
GS EP MEC 292	Rotating Machines Packages Installation Requirements
GS EP SAF 227	Safety rules for fire heaters
GS EP SAF 261	Emergency Shutdown and Emergency De-Pressurisation (ESD & EDP)
GS EP SAF 312	Fire and Gas detection systems
GS EP TEC 007	Obsolescence and Lifetime Cycle Management

3. Definitions and abbreviations

Company	TOTAL E&P or any TOTAL E&P subsidiary.
Contractor	Any Company TOTAL E&P has signed a Contract with for the Engineering, Procurement, Construction, and Installation of a part of a project.
Vendor	The package Vendor sub-contracted by the Contractor or by Company.
Package or package unit	Prefabricated process or utility self-contained unit, generally able to operate on its own, supplied fully tested and ready for immediate installation.

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 6 of 48

CCR	Central Control Room
DMZ	Demilitarized Zone
ESD	Emergency Shut Down system
EPC	Engineering Procurement Construction
EWS	Engineering WorkStation
FAT	Factory Acceptance Test
FGS	Fire and Gas System
FTA	Field Termination Assembly
HIPS	High Integrity Protection System
HMI	Human Machine Interface
ICSS	Integrated Control and Safety System
IMS	Instrument Management System
MCC	Motor Control Centre
MTTR	Mean Time To Repair
OS	Operating System
PCS	Process Control System
PDS	Process Data Server
PLC	Programmable Logic Controller
PSS	Process Safety System
SAT	Site Acceptance Test
SIE	Enterprise Information System
SII	Industrial Information System
SIL	Safety Integrity Level
SIS	Safety Instrumented System (i.e. PSS, ESD, FGS)
SOE	Sequence Of Event
UCP	Unit Control Panel
UPS	Uninterruptible Power Supply
VDU	Video Display Unit

4. Instrumentation and control philosophy

4.1 Life Cycle and Obsolescence Management

Facilities are typically designed with an expected design life in the order of 25 years. It is not practical to achieve such a design life for electronic based equipment without the requirement for upgrading.

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 7 of 48

UCP design shall therefore take into account the requirement that the electronic based systems and associated softwares will have to be upgraded during the design life of the facilities. These requirements shall be incorporated in the Basic Engineering technical documents.

UCP equipment scope shall be given specific attention to ensure all UCP equipment, components, software and individual elements and the respective running tools, test equipment, software and human skills can be maintained or replaced such that the original function and integrity of the package unit can continue in an uninterrupted manner for the field life.

Strategy for managing obsolescence needs to be regularly updated as an integral part of the core functions

- Design and development
- Sourcing and production
- In-service sustainability
- Vendors support.

An obsolescence dossier shall be established in accordance with **GS EP TEC 007** and continuously updated during the life cycle time (refer to Appendix 30 - Obsolescence Dossier).

The obsolescence dossier will consider the complete life cycle including:

- Bid stage
- Design phase
- Project delivery phase
- Operation & maintenance phase.

The Vendor shall detail his lifecycle management strategy focusing on product obsolescence, support options and further migration alternatives.

Package Vendor shall guarantee that:

- UCP components (including software and hardware) shall be fully supported and available over a period of at least 15 years after the SAT
- Maintenance services including availability of engineering services shall be available to support the UCP during the plant life time.

The design will include provisions to allow for an upgrade to the electronic systems to be performed with minimal disturbance to the process and utilities. Such provisions will typically include:

- Tie-in points for the future new equipment, while the old electronics are still functioning
- Avoidance of common components within the UCP for management of duty/stand-by equipment.

4.2 Package type definition

Basically, four types of packages shall be considered:

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 8 of 48

4.2.1 P1 type packages

The package is delivered with its instruments but without cables and cable ducts.

This type corresponds to packages with few instruments.

These packages are fully controlled by the ICSS.

The Vendor shall provide the Contractor with detailed documentation. Contractor is responsible for further integration of the P1 package into the installation and its functionality.

4.2.2 P2 type packages

The package is equipped with its instruments, cables and cable trays. Instruments are wired and connected up to junction boxes, located at the edge of the package skids.

This package type is foreseen for packages with many instruments but which control and safety logic is simple and does not exist as standard supply by the Vendor or for packages considered as integral part of the facility process functions.

These packages are fully controlled by the ICSS. The Vendor shall provide the Contractor with a detailed functional analysis to be forwarded to the ICSS Supplier. The Vendor shall be involved in the ICSS FAT to validate the control and safety algorithms.

4.2.3 P3 type packages

They are similar to P2 type packages, but control and shutdown functions are implemented in a dedicated packaged unit control system (UCP), with associated cabinets as part of the package scope of supply, including all relevant control equipment.

Control logic for a P3 type package should not require specific development and package Vendors should propose their own standard control algorithms.

The UCP always includes an automated system, performing total or partial control of the package, with its HMI. Multi-parameters monitoring devices, e.g. local hand controlled panels with buttons, switches and lamps, shall not be considered as UCP's.

P3 type package shall generally be supervised and controlled at a higher level by the ICSS. In this case, normal operations shall be controlled from the ICSS ("Remote" mode) but operations in "Local" mode shall be possible at the UCP. Full access to all package parameters shall only be possible from the UCP.

4.2.4 P4 type packages

P4 packages are systems comprising of their own instruments and Unit Control panel for the sole purpose of monitoring equipment, structures, pipelines, umbilicals, risers, reservoirs as well as environmental conditions.

These packages shall not perform any control or safety functions related to the supervision, control and safeguarding of the process plant and utility systems.

Generally measurements are collected to monitor integrity of equipment over a long term basis. The data can then be analysed equipment integrity purposes to allow longer term analysis.

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 9 of 48

Those measurements or data are not made available to the ICSS Operator Work Stations (OWS). Some P4 packages may, on an exceptional basis, require to alert operators to a specific event. This will be carried out by hardwired signals to the PCS.

Systems such as Overall Flow metering System, Vibrations Analysis System... shall not be treated as P4 packages, since they are based solely on software treatment of process & condition measurements.

Specific requirements applying to P4 type packages are addressed in § 8 of this Specification.

Refer to Appendix 7 for examples of some P4 type packages.

4.3 Remote Maintenance and Diagnostic (RMD)

According to project specific requirements, vendors may require to have access to data from the SII domain remotely, from outside the Company SIE network for maintenance or diagnostic purposes. All remote access shall require a specific study which shall be subject to approval by Company RSSC.

There are 2 types of Remote Maintenance and Diagnostic access:

- **Type 1**

Remote Maintenance by monitoring of specific plant data for supervision and analysis purposes (permanent connection and read only).

- **Type 2**

Remote Diagnostic for troubleshooting, diagnostic or administrative purpose (Antivirus Patch, COTS update...). This access shall be limited in time (non permanent connection read/write function).

Remote Access cybersecurity protection means shall be provided with the minimum following requirements:

- **Proof** Strong Authentication - Each Vendor that connects shall be authenticated with a PKI certificate issued by Company
- **Confidentiality** All flows crossing public networks (e.g. Internet) shall be encrypted
- **Integrity** Vendor PC conformity to Company requirements (to connect to Company security gateway, the Vendor PC shall have a supported antivirus program running, with virus signatures no older than 60 days).

The general principle is that direct connections between the systems within the SII domain and the outside world via Internet for any purpose through the use of modems etc are forbidden.

The remote vendor shall gain access to Company SIE network via Company DMZ (i.e. Total Connect).

The remote vendor shall not have direct access to SII but access via intermediary servers.

Any form of remote maintenance or diagnostics on Safety Instrumented Systems (PSS, ESD, FGS, HIPS) is forbidden.

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 10 of 48

Type 1 access is split into 2 sub-types:

- **Type 1a** access shall be carried out using the PDS/PI. Data will be made available to PDS server on SIE. Remote access will therefore collect data from the PDS server.
- **Type 1b** access shall be used in cases where PDS/PI cannot be used. For this sub-type a specific remote access server shall be installed in SII/SIE DMZ. This RMD server will receive data from the system within SII domain. Remote access vendor will then be able to communicate with the RMD server through an SSL connection via Company DMZ (Total Connect).

Type 2 access shall only be given to Vendor with specific means and procedure. These means and procedure shall allow site personnel to have a permanent and full control of the remote access operation, initiation and stop. Logging of all operations shall be performed.

A specific remote access server shall be installed in SII/SIE DMZ. This RMD server will receive/transmit data from/to system within SII domain. Remote access vendor will then be able to communicate with the RMD server through an SSL connection via Company DMZ (Total Connect).

Refer to Appendix 6 - for the general architecture and to **GS EP INS 135** for additional requirements.

5. General instrumentation principles

5.1 Instruments

Packages are equipped with all their instruments, necessary piping and accessories for process connection, cables and cable routings, according to their classification.

The packages instrumentation shall be uniform with the project general instrumentation, i.e. same technology, Manufacturer and model for the same use.

The instruments shall comply with **GS EP INS 101** requirements and be installed according to **GS EP INS 900** requirements.

The instruments and instrumentation functions shall be identified according to **GS EP INS 102**.

Actuated on-off valves shall comply with **GS EP INS 137** requirements.

Actuators with comply with **GS EP INS 101** requirements.

Control and choke valves shall be selected and supplied in compliance with **GS EP INS 120** requirements.

Safety relief valves and rupture discs shall be selected and supplied in compliance with **GS EP INS 125** requirements.

The use of on-off sensors (switches) for control and safety functions is not permitted: all process sensors shall be analogue, with HART protocol whenever available.

Sensors and final elements for control and safety functions shall be segregated; dual function is not permitted in order to avoid common-mode failures.

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 11 of 48

5.2 Area classification/protection

All equipment must comply with the requirements of the specific hazardous area where they are installed.

[ATEX European Directive 94/9/EC](#) shall apply in European Countries and associated countries (e.g. Norway, Island).

[ATEX European Directive 94/9/EC](#) or [IECEx](#) standards shall apply in other countries as per project specification(s) or existing facility specifications.

All field instruments shall be certified for zone 1.

Field instrument/equipment not certified for zone 1 shall be de-energized in case of gas detection.

For category 3 equipment, as per ATEX European Directive classification, certification by Manufacturer is not accepted. A "Statement of compliance" shall be delivered by a Notified Body

Preferred protection methods are Ex d, Ex e, Ex i, Ex m, Ex me according to IEC standards. Use of protection mode Ex p and Ex n shall be limited to specific applications and submitted to Company approval.

The selected project protection method shall apply to the packaged units.

The enclosures related certification shall consider all internal components including additional parts for possible extension.

Intrinsically safe circuits shall be installed in accordance with IEC regulations. An I.S. loop calculation sheet shall be submitted for each installed IS instrument.

Technical rooms shall be pressurized and so be safe areas.

5.3 Cabling

For all types of packages, when a special type of cable is required (i.e. fibre optic, non-standard multicore arrangement cables, coaxial, etc) it shall be specified and provided by the Vendor.

The length from package skid edge to the final connection point shall be calculated by the Contractor. Vendor shall verify this length is compatible with the technical requirements.

5.3.1 P1 packages

Junction boxes are not included in the package supply.

Instrument shall be connected to the plant junction boxes as defined by the Contractor.

5.3.2 P2 packages

Instruments within the package shall be wired and connected up to junction boxes located at the edge of the package skid. All cables shall be run on cable trays.

Junction boxes shall be grouped per signal type on steel frames. Signals segregation shall be as specified in [GS EP INS 107](#).

Junction boxes shall be accessible from the ground level and their arrangement shall allow easy access for installation and wiring of multi-cables.

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 12 of 48

The cables between the junction boxes and the marshalling cabinet shall be specified, provided and installed by the Contractor.

5.3.3 P3 packages

In addition to P2 packages requirements, P3 packages comprise the marshalling terminal strips, mirror of the package junction boxes, and the Field Termination Assemblies, mirror of the I/O cards.

Cross-wiring between the marshalling panels and the Field Termination Assemblies (FTA's) shall be done by the Vendor.

As an alternative and in order to minimize UCP size and installation works, remote I/O's can be used subject to Company approval.

5.3.4 P4 packages

Refer to paragraph 8.

5.4 Instrument air/gas and hydraulic energy distribution

Whatever the type of energy, the package shall be fed from a single connecting point. Internal distribution shall be arranged from this delivery point to the different customers.

When instrument gas is used, instruments exhausts shall be collected to a common vent line which shall be different from any process vent line. Hydraulic oil individual exhausts shall also be piped to a common return header. Both gas and hydraulic return headers shall be routed to flanged connections at skid edge.

Particular attention shall be paid by Company, Contractor and Package Vendor concerning the standardization of size system (metric or imperial) and Manufacturer of instrument tubing and fittings. Size system and Manufacturer are subject to strict single source standardization throughout the entire production facility for reasons of safety (risk of incidents due to mixed systems and non-interchangeable components), stock and maintenance. For long lead items being procured before EPC Contract award, the package bid and Purchase Order shall make provisions for post-contract definition of size system and Manufacturer for instrument tubing and fittings.

5.5 Power supply

5.5.1 P1 and P2 packages

The instrumentation on P1 and P2 packages shall be powered from the ICSS.

5.5.2 P3 packages

Electrical design shall comply with the requirements of **GS EP ELE 011**.

5.5.2.1 Power conversion and distribution

The Project Basic Engineering shall define the voltage source type(s) distributed to the UCP and associated earthing regime (i.e. IT, TT or TN-S, of which IT is the default regime offshore).

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 13 of 48

Unless specified differently by the project specifications, all packages shall be designed to be fed by:

- 2 off independent AC UPS power supplies (designated UPS-A and UPS-B)
- 1 off normal AC power supply.

The UPS power supplies shall be used in a 2 x 100% configuration serving all control, safety related equipment, while the normal power supply shall be used for non-critical equipment such as lighting, power sockets, ventilation and heating (unless considered critical).

The incoming UPS power feeders shall not be bonded together: a strict galvanic separation must be ensured.

Generally, HMI will be fed by one of UPS sources.

The Package Vendor shall provide all necessary equipment for power conversion from AC UPS, isolation and distribution of any other voltage level required for the package or the UCP.

The 0 and 24 VDC power rails for control equipment and instrumentation shall be fed by both UPS feeders via dedicated DC/DC or AC/DC power convertors; being bonded together using decouple diodes between power convertors and DC power rails.

Isolation transformer/converter should be provided in the UCP on the incomers since the provided UPS AC voltage source is of a floating type.

The package instruments shall be powered with 24V DC referenced to earth from the UCP.

All power supplies/converters and miscellaneous associated components shall be of the industrial type and DIN rail mounted.

5.5.2.2 Protection

Each power feeder to the UCP shall be powered via dedicated breakers and protection circuits in order that no single system component failure could cause loss of power supply to other components. The two power convertors feeding the common DC power rails shall be bonded together using separate decouple diodes, rated minimum 100% each. Single devices containing both decouple diodes are not permitted; separate decouple diodes with heat sink and fault contacts shall be used.

The design of the electrical distribution shall include the short circuit and selectivity calculations.

Power supply and distribution failures shall be alarmed, logged and transmitted to the ICSS as a single general cabinet power failure alarm, grouping:

- Fault contact for each power convertor
- Fault contact for each decouple diode
- Trip contact for each circuit breaker
- Trip contact for earth leak detector.

I/O and system components power distribution shall be designed to avoid common mode failure.

Each I/O module power supply shall be individually protected.

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 14 of 48

5.5.2.3 Generic package 24 VDC power supply & distribution diagram

The above-mentioned power supply, conversion and distribution principles related to 24 VDC powered equipment are summarized in the generic power supply diagram in Appendix 4.

24Vdc consumers within the UCP will each be protected by individual circuit breakers.

5.6 Earthing

Earthing of package instrumentation and associated equipment, field and technical room mounted, shall be in accordance with international rules and practices including [IEC 61000-5](#) and [European Directive 2004/108/EC dated 15 December 2004](#), with [GS EP INS 107](#) and with Appendix 4 of this specification.

5.7 Fire and gas

5.7.1 P2 and P3 packages

When required by project documents, fire and gas detection and associated actions (e.g. fire extinguishing) shall be supplied with the package.

Fire and gas signals can be processed either by the ICSS or by the UCP as defined in the project specifications.

When processed by the UCP, a dedicated SIL 2 rated logic solver shall be selected.

Criteria for selecting the fire and gas detectors are given in [GS EP SAF 312](#).

5.8 SIL calculations

SIL calculations shall be required for safety instrumented loops. All components within the loop (e.g. instrument, relay, FTA, etc.) shall be included within the calculation and verified that they meet the SIL requirements.

Calculations shall be validated by a third party approved by Company.

6. Unit Control Panels

This section applies to P3 type packages only.

The package control system shall be PLC based and shall perform the following functions:

- Process control
- Parameters monitoring and associated shutdown actions.

Additional functions will be also performed as per project specifications, such as:

- Supervision and data archiving functions
- Sequence Of Event recording
- Printing facilities
- Maintenance functions & diagnostics

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 15 of 48

- Performance monitoring
- Vibrations monitoring.

The UCP shall include marshalling and PLC cabinets.

The UCP shall integrate as much as possible all main control with HMI and subsystems such as anti-surge control, load control and vibrations monitoring. All HMI and subsystem controllers shall be panel-mounted. Normally there shall be no loose supplied items (such as printer, workstation, etc), except for the engineering workstation laptop, unless clearly defined in the project specification.

Control and safety functions may be combined into one PLC but all sensors, final elements, cabling, junction boxes shall be segregated; dual functions for sensors and final elements are not permitted.

The UCP will generally be located inside a pressurized technical room, thus considered as a safe area. Refer to the project environmental specification for further information about ambient conditions in the technical room.

When installed outside, in a process zone, the UCP shall be certified for the relevant hazardous area.

Refer to the project environmental specification and hazardous areas layout drawings for further information.

Depending on the complexity and required functionality of the package, the UCP may be composed of several PLC's and display units.

6.1 Logic solvers

6.1.1 Programmable Logic Controllers

The type (Manufacturer and model) of PLC shall be uniform with the other PLCs provided for the project and must be submitted to Company for approval.

The PLC shall be supplied with its own engineering workstation and all tools, hardware (including all necessary cables) and software with required licenses, necessary for control, configuration, development and maintenance.

For large packages, when a great number of information must be exchanged, the preferred solution is a package control system based on the same type of controller than the main ICSS, so as to be considered as a node of the ICSS network. In such cases, Vendor has the technical responsibility of the package control system and of its interface integration and definition in the ICSS. Special attention shall be paid to the firmware release for all modules.

6.1.2 SIL requirements

Generally, package control systems comprise only one PLC dealing with all the process control and shut-down functions.

This PLC shall be 3rd Party certified suitable for treating SIL 2 safety instrumented functions.

The PLC safety manual shall be followed for safety instrumented functions, which have been identified by package SIL assessment. Therefore, the Package Vendor shall apply the specific

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 16 of 48

SIL application and configuration instructions of PLC Manufacturer associated to the required SIL level.

This SIL requirement applies to all parts of logic solver including controller, system software, I/O modules and FTA's, relays, etc.

The Vendor shall provide the relevant certificates and associated reports.

The [IEC 62061](#) methodology and requirements shall be used to assign the SIL enabling the appropriate design of the package UCP.

Regarding the application software, the recommendations of [IEC 61511](#) shall be followed.

For rotating equipment package, it is accepted that safety instrumented functions may be treated independently of the PLC.

In this case, the package Vendor shall demonstrate that the protective functions meet the required minimum SIL 2.

For the specific application of fired heater, the Burner Management System (BMS) shall be SIL 3 certified, as per [GS EP SAF 227](#) requirement if a prescriptive approach is selected.

Otherwise a SIL assessment shall be produced, addressing the design of the instrumented protection system and applying the methodology developed in [IEC 61508](#) and [IEC 61511](#) (refer to alternative 2 description included in the [GS EP SAF 261](#)).

6.1.3 Reliability and availability calculations

Special attention shall be paid to the UCP availability in close relationship with importance of the package. A commonly admitted figure for UCP minimum availability is 99.97%, except for packages which have a major role in the control and mitigation of fires and explosions where a minimum availability of 99.99% is required.

MTTR shall be based on 4 hours, unless otherwise specified by project requirements.

Calculations shall include the I/O FTA's, power supplies and I/O interfaces (e.g. relays).

6.1.4 Hardware

6.1.4.1 General

The PLC shall be supplied in one cabinet (or set of cabinets) fully wired and tested. This shall include, but not limited to:

- Power generation and/or distribution with all protecting devices
- PLC chassis and modules
- System interconnecting cables
- Input/Output FTA's
- Cross-wiring to marshalling terminals
- Cabinet utilities, e.g. lighting, fans, temperature monitoring, heating/drying system when necessary, sockets, etc.

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 17 of 48

6.1.4.2 Maintainability and Availability requirements

Failure and subsequent on line replacement of any module shall not affect the working of any other component or cause a system failure.

On line replacement of any faulty redundant module shall be performed without affecting the relevant application.

Changeover of any redundant faulty equipment (from duty to back-up and back-up to normal configuration) shall be performed without affecting the relevant application.

After any outage, the system shall automatically resume normal operation.

The system shall incorporate a comprehensive set of diagnostic facilities to enable efficient fault detection. These diagnostics shall allow for the identification of faults down to individual module level. System fault repair will consist of the replacement of faulty modules.

6.1.4.3 Spareage requirement

Spare capacity shall be provided as follow:

- Power supply modules: each module shall not be loaded at more than 80% of total power consumption at in- rush conditions
- CPU memory: sufficient memory for the start-up configuration plus 20%
- Input/Output modules: 5% per type of card
- Spare slots in PLC rack: 5% of housing capacity.

Each input/output shall be pre-wired up to I/O mirror terminals.

6.1.4.4 Power supply modules

They shall be redundant and shall generate the PLC internal voltage rates.

Each module power supply shall be overload protected.

6.1.4.5 Central Processor Units

Memory modules shall be of the non-volatile type.

When RAM modules are used, they shall be battery saved. Batteries shall not be able to provide spark after the main power has been cut off due to gas detection.

A battery low voltage lamp shall be available on the CPU front face.

Every alarm shall be identified in the package supervisory system; a common alarm shall be sent to the ICSS.

The Vendor shall demonstrate the UCP capabilities (i.e. cycle time, communication time, etc.) are suitable for the required process performances.

When the package is defined as critical, redundant CPUs shall be provided for availability purpose.

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 18 of 48

6.1.4.6 Input/Output modules

When instruments (such as flowmeters, analysers and gas detectors) have their own power supply or use an external power supply, analogue I/O modules shall be protected by fuse on the input signal.

When an analogue input module powers the instrument on a separate (3rd) wire that wire shall also be fuse protected. Otherwise each input and/or output shall be individually short circuit protected and shall have electrical insulation between the PLC internal bus and the field loop.

All I/O modules shall be designed so that a short circuit or high voltage on one input (or output) shall not induce a fault on any other signal on the same I/O card. Fuses for analogue I/O signals shall be by default rated 63 mA, fast-blow type, unless required differently. Fuses for discrete I/O signals shall be slow-blow type and be rated as required for the particular signal.

Discrete Input and Output cards:

The cards shall have integrated LED's showing card and channels statuses.

Inputs shall be powered from the cards. Galvanic isolation shall be provided per channel.

Outputs shall be volt free contacts; power distribution shall be done at marshalling terminal strips.

Output signals for fire protection devices as well as specific inputs, such as manual activation buttons, shall be line monitored and powered from the card.

The Digital output shall be able to switch a minimum of 24 Vdc with 1 A. If not possible, then necessary relays shall be installed in the FTA's.

Analogue Input and Output cards:

The cards shall have integrated LED's showing card statuses.

Inputs and outputs shall be powered from the cards.

Input cards shall support 0-22 mA signals.

Output signals shall be 4-20 mA with 750 ohm maximum load.

6.1.4.7 I/O assignment

Process and Safety I/O modules shall be segregated.

All I/O loops implemented with a specific redundant configuration shall be hardwired to separate I/O modules. Sensors used in Moon voting logic shall be spread over N modules.

All I/O loops associated with main/backup equipment shall be hardwired to separate I/O modules.

6.1.4.8 Remote Inputs/Outputs

Use of remote I/O's installed in hazardous area shall be submitted to Company approval.

They shall be certified for use in Zone 1 and when used for safety functions shall meet the SIL requirements. Maintenance facilities shall include:

- Replacement of I/O or power supply modules under power

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 19 of 48

- Diagnostic data available at the ICSS or UCP maintenance/operator stations in the same way as for standard I/O's
- Parameters of smart transmitters available in technical rooms for commissioning purpose.

6.1.4.9 Communication cards

The cards shall have integrated LED's showing card and communication port statuses.

When redundant communication links with the ICSS are required, redundant communication cards shall be installed.

The communication cables and connectors shall be in the scope of the package Vendor.

6.1.5 PLC application software

PLC programming shall be carried out using a standard software tool installed on the EWS supplied with the UCP.

The configuration software shall authorize the studying, key-in, modifications, simulation of the application software from the programming PC without connection to the CPU.

It shall also allow on line monitoring of all PLC inputs, outputs and internal variables.

Special care shall be taken for automatic initialization (software, parameter, etc.) upon a black-start without the need for operator/technician intervention.

The programming languages shall be in accordance with [IEC 61131-3](#), preferably by function blocks and shall be able to support literal comments or descriptions.

Programs will be developed based on standard functions; these as far as possible will follow the principles of [GS EP INS 150](#) and the corresponding detailed GS This specification becomes mandatory when the package control application software is not a Vendor's standard.

All non Vendor standard functions shall be subject to preliminary acceptance testing.

The license of the application software shall be embedded in the installed program; the use of license USB sticks and the like are not permitted, because all USB ports are to be disabled for cyber security reasons as per [GS EP INS 135](#), and they are also a potential cause of failure for automatic restart after power failure (i.e. the required auto restart during black-start without the requirement for human intervention).

6.1.5.1 First up alarm

The first event initiating a shutdown shall be determined at the PLC level, displayed on the package HMI, and sent to the ICSS.

Only this alarm shall be sent to the ICSS. The other consequential alarms generated after the first event have to be managed by the PLC. All alarms shall be time stamped.

If several parts of the package are shut down due to several faults, the first up alarm shall be determined for each of them.

For more information about the first up alarm processing, see [GS EP INS 198](#) - Chapter 4.

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 20 of 48

6.2 Supervisory system

Packages are normally operated from the ICSS Operator Work Stations in the Central Control Room. Nevertheless, as not all data and parameters are transmitted to the ICSS, detail supervision functions shall be available at a display unit located on the UCP itself.

This shall include:

- Operating parameters display
- Trending functions
- Equipment statuses display
- Detail alarm processing
- Package safety displays
- Inhibition facilities
- Tuning
- System maintenance overview
- Local data archiving
- Sequence Of Event recording.

Failure of the UCP supervisory system shall not affect the package operation. Special attention shall be paid to the self-adjustment of the parameters when restarting the HMI computers.

6.2.1 Hardware

The package supervisory unit shall be installed in the UCP.

It shall include one or more colour VDU, with associated computer, keyboard, storage means, printer, if requested by project specifications, and as many hardwired signal lights and push buttons as necessary. VDU will generally be integrated in the PLC cabinet front door.

A local control panel, with command and display devices hardwired to the UCP, can be installed on the package for local operation, maintenance and emergency.

6.2.2 Software

Displays design shall follow **GS EP INS 134** and associated standard functions specifications, and, as far as possible, will be similar to the ones used for the ICSS HMI.

Faults diagnosis displays shall be available.

The display refreshment rate shall be 1 second at the maximum.

The display configuration software shall be installed on the EWS laptop.

6.2.3 Data archiving

Local data archiving and sequence of events by UCP shall be by default for minimum 3 months, unless specified otherwise by project specification(s) and/or by Package Vendor recommendation(s). A first-in first-out principle shall be used to ensure to no storage overflow occurs.

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 21 of 48

It shall be delivered with a software tool allowing data retrieval, sorting and trends drawing functions, and, if requested, connected to a printer for screen hardcopies and event list printouts.

The software tool shall allow transfer of the data to a standard office application (e.g. Excel).

6.3 Communication with the ICSS and other systems

UCP may be required to exchange data with the following systems, but not being limited to: ICSS, PDS, analysis vibrations system etc., as per project specifications.

General architecture shall be based on Appendix 6.

All communication components shall be high-quality industrial type and be rack or DIN-rail mounted, being powered by redundant power supplies.

6.3.1 Exchanged Data

Data exchange with packages is divided into:

- Communication between packages and ICSS; which shall support commands and information exchange as required for adequate safeguarding, control and remote Operator interface in the central control room
- Communication between packages and support systems; which shall support the collection of particular data by dedicated support systems (e.g. PDS, vibrations analysis system, etc) and with the potential distribution over the SIE network.

The list of recommended data to be interfaced with the ICSS and support systems for ensuring appropriate operations, trouble-shooting and data storage will depend on the project's Operating and Maintenance Philosophy and on the package specifications. This list shall be initiated by the Package Vendors and be commented and completed by the Contractor and Company based on the project's Control Philosophy and Functional Analysis for the process unit concerned.

The final list of data to be interfaced with the ICSS and support systems shall be kept to a rational minimum as reasonable possible, in order:

- To avoid an unnecessary traffic load on the communication link(s), and/or communication delay, due the amount of data to be transferred and processed by the ICSS or by the support systems
- To avoid an unnecessary amount of information for the Operator in the central control room
- To avoid unnecessary data to be stored in the PDS.

It shall be reminded that the UCP itself is also equipped with a local HMI for reasons of trouble-shooting and analysis in case of package failures; it is not the purpose to shift this functionality outside the UCP by transferring all possible data towards the PCS and/or support systems.

Particular package alarms shall be grouped into specific common alarms to the ICSS to reduce the amount of interfaced data in an efficient manner.

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 22 of 48

Package data to be transferred and to be stored in the PDS shall be kept to a rational minimum as reasonable possible, as required for future failure analysis / performance monitoring / maintenance planning as per Package Vendor and/or Company requirements.

As per project specification(s), the package UCP may have additional dedicated data exchange interfaces, such as:

- With the Instrument Management System (IMS)
- With the Vibrations Analysis System (VAS).

6.3.2 Synchronization and Time-Stamping

By default, the ICSS shall be the clock master for time synchronization of package UCPs.

In general, there is no requirement that time-stamping of transferred data is done at the source (package UCP), based on the principle that the package is autonomous for control and safeguarding. As such, the data transferred to the ICSS and support systems will be time-stamped upon arrival, unless required otherwise.

6.3.3 Communication Link with PCS

Serial links shall be used for communication between UCP and PCS, although hardwired links shall be used in case of small amount of data points (less than 25). In addition, critical data between UCP and PCS (e.g. speed control, feedback for rotating machinery) shall be hardwired as well.

The communication protocol of the serial link will be standardised on a single protocol for the whole project/facility.

Unless the project specification(s) state differently, the default design rules for serial interface with the PCS are:

- Using an industrial communication protocol with the lowest possible inherent obsolescence: not using protocols requiring an intermediate server(s) with operating system: instead communication cards with embedded operating system using a standard and field proven protocol such as ModBus shall be used
- The use of custom-built protocols, software and hardware is not permitted
- By default a TCP/IP link over Ethernet; serial RTU type links are only permitted when TCP/IP communication ports/cards are technically not possible / available on the market
- As an alternative, Profibus DP may be considered
- A direct connection to the ICSS network is permitted only if identical controllers are used as for the PCS
- In case of redundant links: each link shall have completely segregated components (incl. communication cards or controllers) to avoid common-mode failures.

The use of open protocols, such as OPC, for interfacing with the PCS is not permitted for reasons of high obsolescence, cyber security and additional hardware & software.

Concerning the availability of the serial link, the default rules are:

- Single (simplex) serial link: by default

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 23 of 48

- Redundant serial link: when the loss of HMI in the CCR is considered not acceptable
- Dual-redundant serial link: shall only be used for links in case the loss of communication induces a package shutdown.

Whether the loss of HMI in the CCR is considered not acceptable (therefore requiring a redundant link) shall be defined during Basic Engineering phase by a multi-disciplinary team (typically Operations, Process, Safety and ICSS engineers), and can be re-assessed during Detail Engineering as deemed necessary. Therefore, a dedicated package overview table stating all packages and the type of serial link shall be provided in the project's ICSS / Package Control Specification during Basic Engineering.

In case of 'dual-redundant' communication links using switches, then the required dual switches shall be supplied by the ICSS Supplier and be integrated inside the ICSS cabinets.

Optical fibre communication links shall be used when the PCS (and/or support systems) and UCP are located in different buildings. When optical communication links are specified, then the ICSS Supplier shall free-issue the copper-to-optical convertors, to be installed by the Package Vendor inside the UCP.

As per **GS EP INS 134**, the maximum allowable cycle time between UCP controller and PCS controller is 1 second, and which shall be tested during the UCP FAT.

6.3.4 Communication Link with SIS

The input & output links between UCP and SIS (i.e. the PSS, ESD and F&G systems) shall always be hardwired, and use segregated I/O components from PCS related signals.

However, status information signals (i.e. signals that have no function other than informative) from the SIS to the UCP may pass through the serial link with the PCS, when the associated communication delay is considered acceptable (e.g. valve position or process values from PSS required by the UCP during an automated start-up sequence).

Hardwired signals shall always be configured as fail-safe, i.e. trip actions shall be initiated in case of signal loss. Line-monitoring devices (with automatic failure alarm) shall be installed for each signal in case the fail-safe approach is not feasible or deemed impractical (e.g. fire-fighting actions) as per project's Safety Concept.

Interposing relays, when required, shall be SIL certified in accordance with the associated SIS in accordance with **GS EP SAF 261**, and shall be supplied and installed by the Package Vendor.

6.3.5 Local/Remote Management

Packages are normally operated in "remote" mode from the ICSS Operator workstations in the CCR, but the package shall always be capable to run in "local" mode using the UCP's HMI.

In case of failure of the serial communication link between UCP and PCS, the package shall automatically switch-over to "local" and be kept in operation under the control of its own control system. The management of local/remote shall be as per Operating Philosophy. Special care shall be taken for adjusting the internal logic values and settings after a loss of communication.

Safety functions shall remain active whatever the selected mode.

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 24 of 48

6.3.6 Communication Link with PDS

All packages shall allow for the transfer of all package data to the PDS unless project specifications define that for some specific non-critical systems such data transfer is not required. This shall be subject to Company approval.

PDS and its interfaces (i.e. interface nodes) shall be as per **GS EP EXP 131**.

This data transfer shall never be through the ICSS network unless:

- The corresponding package UCP is based on ICSS controllers.
- The amount of data to be transferred by the package is less than 100 tags and the ICSS gateway to the PDS can continue to ensure a traffic of 2,000 events/s for each group of 10,000 tags transferred to the PDS, as required by **GS EP EXP 131**.

Two architectures are allowed for transferring package data to the PDS:

1. UCP with a server

The preferred configuration is to use OPC protocol for transferring data to PDS interface node.

2. No server in UCP

In this case the PDS interface node shall communicate directly to the PLC with the following requirements:

- The PLC communication modules for PDS interface are not shared with other networks (e.g. ICSS to PLC or PLC to HMI)
- The PLC can manage and handle simultaneous communications with ICSS, OWS) and PDS at all times
- The PLC communication for PDS interface uses OPC or Modbus protocol.

The preferred architecture is 2.

The PDS interface node server(s) will be provided by ICSS Supplier for connection to all packages. Depending upon the number of packages and their criticality, redundant PDS interfaces nodes may be required in order to reduce risk of a common mode fault.

If a dedicated interface node using OPC protocol for a package is provided, then, in order to minimize the number of computers, the PDS OPC clients for data acquisition shall be hosted on UCP system. In the case of architecture 1, where the package HMI is also used as the OPC server function, then compatibility between the PDS interface node and HMI station shall be ensured.

In the case where SOE data has to be transferred to the PDS then OPC communications shall be used.

It shall be noted that open protocols such as OPC require PC/server - with MS Windows operating system. This has a number of inherent disadvantages which shall be addressed as part of the design:

- Obsolescence
- Cyber security

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 25 of 48

- An increased quantity of equipment, space, power consumption and heat dissipation
- Additional continuous maintenance (OS updates, patches, anti-virus, etc).

PDS communication links with packages do not require redundancy unless:

- The data storage and data availability of a particular package has been defined as critical. In this case, interfaces nodes shall be redundant as well
- The PDS interface node itself is redundant.

The overall architecture shall be subject to Cyber Security Risk assessment, as defined in **GS EP INS 135**.

6.3.7 Sequence Of Event Recording

It shall be reminded that SOE recording from packages by the ICSS SOE requires time stamping of the transferred data at the source, which is not possible when using communication protocol such as MODBUS, resulting in a complex interface requiring communication servers with operating systems (i.e. poor obsolescence, poor cyber security and additional hardware & software)

Therefore, by default, the SOE function shall be embedded inside the UCP HMI application, and packages are not interfaced with the ICSS SOE. The UCP PLC shall provide the required time-stamping for all alarms and events registered inside the package SOE recorder.

However, in case some particular alarms and events from particular packages are deemed critical for adequate plant operation, then an adequate solution shall be evaluated in a dedicated study during Basic Engineering and shall be subject to Company approval. In that case, it shall be limited to a few essential (grouped) events.

6.3.8 Communication Link with IMS

Data collection by the Instrument Management System (IMS) is an optional feature, as defined by the applicable project specifications.

The communication protocol between (selected) packages and IMS shall be ModBus TCP/IP over Ethernet. In any case, it shall not be possible to alter the instrument's configuration over this link.

Refer to the dedicated project specifications for the exact functionality and data to be exchanged.

By default, IMS communication link from packages do not require redundancy, unless the data storage and data availability of a particular package have been defined critical by Company.

Optical fibre communication links shall be used when the UCP and IMS are located in different buildings. When optical communication links are specified, then the party supplying the IMS will free-issue the copper-to-optical convertors, to be installed by the Package Vendor inside the UCP.

6.4 Vibrations Analysis System implementation

As per **GS EP MEC 292**, a vibration analysis system shall be implemented on site for the monitoring of the rotating equipment selected by the project.

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 26 of 48

Refer to the dedicated project specifications for the detailed functional requirements and data to be exchanged.

6.4.1 Communication link with the vibration analysis system

The communication protocol between (selected) packages and this system will depend on the selected Manufacturers of machine monitoring equipment (VTMS) embedded inside the UCP and of the Vibration Analysis System itself. However, this communication protocol will be standardized on a single protocol for the whole project/facility.

By default, this link does not require redundancy, unless the data storage and data availability of a particular package have been defined critical by Company.

Optical fibre communication links shall be used when the UCP and the vibrations analysis system are located in different buildings. When optical communication links are specified, then the parties supplying the Vibration Analysis System will free-issue the copper-to-optical convertors, to be installed by the Package Vendor inside the UCP.

6.4.2 Architecture interface

Refer to Appendix 6 of this General Specification.

Vibrations Analysis System will be located in SII; so any communication with UCPs of rotating equipment will remain within SII.

Local HMI for diagnostic and analysis will reside as well in SII.

When required by project specifications, assuming high speed communications are available, remote access (i.e. either within SIE, or external at remote vendor site) will be provided as necessary.

Therefore, cyber security requirements included in § 6.7 of this Specification and in **GS EP INS 135** as well as RMD requirements shall apply, especially concerning interface between SIE and SII.

Remote Maintenance and Diagnostic (RMD) server, residing in DMZ, shall permit traffic between the vibration analysis system located in SII and the remote Clients located in SIE (or elsewhere) through the firewall.

In case specific Vendor's HMI software is necessary to be installed on the SIE Client stations, project shall define clearly the battery limits and responsibilities between Vibrations Analysis System Vendor and Company (Project and IT department of the Affiliate), while taking into account obsolescence requirements, software compatibility with PCs supplied by Company, software supply and installation, hardware & software maintainability, upgrade and administration.

6.5 Communication with the MCC

The input & output links between UCP and MCC shall always be hardwired.

Interposing relays, when required, shall be SIL certified when SIL loop assignment has been established and shall be supplied and installed by the Package Vendor.

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 27 of 48

6.6 Actuation of On-Off Valves

When the actuation of any off-skid valve by the UCP is required, then these valves shall be equipped with a dedicated solenoid valve, directly hardwired to the UCP PLC. In a similar fashion, any on-skid valve (e.g. BDV) which requires a safety actuation by the SIS shall be equipped with a dedicated solenoid valve directly hardwired to PSS, ESD or F&G system.

Opening and closing of PSS or ESD actuated valves using the communication link between UCP and PCS is not permitted, nor using the PCS Standard Function blocks of these valves, nor via hardwired inputs to the PSS/ESD safety logic.

The additional solenoid valves, and associated valve control schematics, remain in the scope of supply of the party supplying the valve concerned.

6.7 Cyber security

When the supervisory and/or the engineering workstation are based on a computer, PC type using standard computer operating systems (Windows, etc) and/or standard network protocol (TCP/IP), the **GS EP INS 135** shall be applied.

The main rules are:

- Engineer/Maintenance modes shall not be accessible to Operators. Limitation by key, badges, passwords or any combination is mandatory
- Access to the operating system commands shall be restricted to Engineer mode only
- Operating system shall be configured such that all non-used service are disabled
- External mass storage devices (CD-ROM, floppy, USB memory, etc.) shall not be accessible in normal operation (could be removed from the set up)
- Back-up and restore procedure shall be written and tested
- When remote access for maintenance is necessary, a formal request shall be made to Company: **GS EP INS 135** shall be applied
- All software original licenses, software disks (including operating system) and tools shall be provided with a detailed procedure including all system parameters for a full re-installation from scratch
- Before start-up the Vendor shall verify and ensure that the UCP including all associated computers and associated configuration and maintenance tools are virus free
- The Vendor shall verify and ensure any electronic documentation supplied is virus free.

6.8 PLC and Marshalling cabinets

Field multi-cables shall be terminated in the UCP marshalling cabinet. Marshalling terminal strips shall be the mirror of the field junction boxes and all cores, including spare ones, shall be connected to a terminal block.

Details about the design and construction of marshalling and PLC cabinets are given in **GS EP INS 101** (§ 6.1.1 and 9.5), **GS EP INS 107** (§ 3.1.3, 4 and 5.2) and **GS EP INS 134** (§ 5 of the Appendix 3).

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 28 of 48

Special attention shall be paid to the signal segregation. Terminals for signals of different types/systems shall be installed in different sections.

When available space inside the technical room is reduced, combined marshalling/system (PLC) cabinets shall be studied and submitted to Company for approval.

7. Package Vendor scope of work

7.1 General

Appendix 1 and Appendix 2 depict the typical scope of work for supply and engineering related to control and instrumentation included within a package.

The tables are typical only and may be modified through particular requirements as stated in the project specifications. They will be reviewed and discussed in order to adjust the Vendor scope of supply.

7.2 Engineering and design

The Vendor documents shall be based on **GS EP INS 000** requirements.

In order to standardize the documents presentation, the documentation produced by the package Vendor shall be implemented using forms designed and provided to the Vendor by the Contractor.

The complete engineering and detailed design for the instrumentation, including the package control system shall be performed by the Vendor in accordance with Appendix 2.

All corrections or modifications requested by the Contractor/Company regarding the package supply and agreed by the Vendor will be performed under his responsibility to ensure that the modified unit is operable and safe regarding process and safety.

Package data shall be incorporated into the project instrument database as per requirements of the **GS EP INS 103**.

The Contractor shall provide the Vendor with the range of numbers to be used for numbering of the instruments. Double tagging, i.e. Vendor's tags different from Contractor's tags, is not allowed.

Detailed functional analysis (sometimes called control narratives) description shall comply with **GS EP INS 131** requirements.

Regarding the ICSS, the package Vendor scope of work shall include the definition of both process control and safety logic requirements to be included in the ICSS as well as the functions to be performed by the HMI to monitor and operate the package. The ICSS Supplier's scope of work shall include the engineering and implementation of the control logic and operating displays.

7.3 Scope of supply

The Vendor shall provide all instruments, control equipment and accessories (impulse lines, labels, cables glands, cables from instruments to the skid mounted junction boxes UCP, etc).

The Vendor shall also provide all package components necessary to a good working of the package and that are not installed on the skid (surge valves for compressors, UCP,

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 29 of 48

programming tools, HART communicator, etc.).

All software original licenses, software disks (including operating system) and tools shall be provided with a detailed procedure including all system parameters for a full re-installation from scratch.

Supplying OEM CD/DVD for the operating system and application program(s) with original license is mandatory. Licenses shall be embedded in the program; running from USB sticks or plug-in dongles is not permitted. List of all licenses shall be provided with products ID/references and Owners' names.

If the package control has to be implemented in the ICSS, all necessary information for the configuration, displays, etc, shall be provided by the Vendor.

7.4 Services

Services to be provided by the package Vendor shall include the co-ordination, assistance to the Contractor and ICSS Supplier during the studies, FAT, SAT, start-up, and performance tests stages.

Testing shall be performed as per Appendix 5 - Tests requirements.

7.4.1 Site Activities

The Vendor shall provide assistance for the Site Acceptance Test, pre-commissioning and commissioning operations, and start-up activities.

The SAT procedures shall be prepared by the Vendor and submitted to Contractor and Company agreements.

8. P4 Package requirements

8.1 General Instrumentation Principles

Packages will be provided with all their instruments, necessary hook-up accessories and data acquisition & processing units.

As far as possible, the packages instrumentation shall be uniform with the project general instrumentation, i.e. same technology, Manufacturer and model for the same use.

All equipment including instruments, cables and junction boxes shall comply with the requirements of **GS EP INS 101** for hazardous area requirements.

8.2 Applicable sections of this Specification

Requirements included in the below referenced sections of this General Specification shall fully apply to P4 packages:

- § 4.1 - Life Cycle and Obsolescence Management
- § 4.3 - Remote Maintenance and Diagnostic (RMD)
- § 5.1 - Instruments

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 30 of 48

- § 5.2 - Area classification/protection
- § 5.5.2 - P3 packages (Power supply)

This section will apply except a single rather than dual AC UPS will feed the package UCP.

- § 5.6 - Earthing
- § 6.1.4.2 - Maintainability and Availability requirements
- § 6.7 - Cyber security
- § 6.8 - PLC and Marshalling cabinets
- § 7.2 - Engineering and design
- § 7.3 - Scope of supply

Specific scope of work shall be defined at basic engineering stage for each P4 type package, based on P3 package scope definitions shown in Appendix 1 of this Specification. The scope of work shall include engineering, supply, documentation and testing, as well as assistance for installation, pre-commissioning, commissioning and start-up.

8.3 Unit Control Panel (UCP)

UCPs of P4 type packages will accommodate the following equipment as necessary:

- Cabinet utilities, e.g. lighting, fans, temperature monitoring, heating/drying system when necessary...
- Marshalling and wiring section including field and power distribution terminals
- Power protection devices
- Signals conditioning signals devices including intrinsic safety barriers, fiber optic converters, multiplexers...
- Data acquisition & processing units or data servers
- Communication modules
- HMI with local historian database as necessary.

Data acquisition & processing units may be based on PCs or PLCs.

The UCP will generally be located inside a pressurized technical room, thus considered as a safe area. Refer to the project environmental specification for further information about ambient conditions in the technical room.

When installed outdoor, the UCP shall be certified for minimum zone 2 as required by § 5.2 of this specification.

Refer to the project environmental specification and hazardous areas layout drawings for further information.

Spare capacity shall be taken into consideration for future additional measurements.

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 31 of 48

8.4 Interface Architecture Requirements

Even if t P4 type packages do not perform any control and safety functions, they shall be located in SII; refer to Appendix 6 of this Specification.

Any local specific HMI shall as well be located in SII.

Measurements & data from the P4 package will be transferred to the SIE PDS server, via interface nodes and firewall and will be made available on PDS clients.

Depending on the project complexity (i.e. quantity of P4 type packages), dedicated non-redundant PDS interface node(s) (i.e. segregated from PDS nodes dedicated to the ICSS and to P3 type packages) will be installed,

Therefore cyber security requirements included in the § 6.7 of this Specification and in the **GS EP INS 135** shall apply, especially concerning interface between SIE and SII.

In case where specific Vendor's HMI software is necessary to be installed on SIE Client stations, project shall define clearly battery limits and responsibilities between package Vendor and Company (Project and IT department of the Affiliate), while taking into account obsolescence, software compatibility with PCs supplied by Company, software supply and installation, hardware & software maintainability, upgrade and administration.

Appendix 1 Typical scope of work for package instrumentation and control

Part 1: Supply

- To be reviewed as per particular project requirements -

LEGEND: **V** = Package Vendor
C = Contractor
V/C = Vendor or Contractor defined by project specifications

Table 1.1 Supply	Package type (2)	Scope of work		
		Design	Supply	Install.
Designation				
Field instrumentation	P1, P2, P3	V	V	V
Emergency pushbuttons on machine, within skid area	P1, P2, P3	V	V	V
Fire & Gas detection	P1	C	C	C
Fire & Gas detection	P2, P3	V	V/C	V/C
Fire call points within skid limit	P1	C	C	C
Fire call points within skid limit	P2, P3	V	V/C	V/C
Fire & Gas visual and audible alarm devices in skid area	P1	C	C	C
Fire & Gas visual and audible alarm devices in skid area	P2, P3	V	V/C	V/C
Fire fighting within skid limit	P1, P2	C	C	C
Fire fighting within skid limit	P3	V	V/C	V/C
Cables trays within skid for control & instrumentation and instrument power supply	P2, P3	V	V	V
Junction boxes at skid edges	P2, P3	V	V	V
Local control panel on machine/skid	P2, P3	V	V	V
Electrical distribution to instrument and control devices within skid	P2, P3	V	V	V
Special cables (metering, serial, F.O., etc) within skid up to technical room	P1, P2, P3	V	V	V
Cables from skid instrumentation to plant JB's	P1	C	C	C
Cables from instrumentation to skid JB or local panel and associated cables glands	P2, P3	V	V	V
Cables from skid JB/panel or instrumentation to technical room and associated cables glands	P2, P3	C	C	C
Access means to instrumentation: gangways, ladders	P1, P2, P3	V	V	V
Instrument air/gas or hydraulic energy distribution network and isolation valves within skid	P1, P2, P3	V	V	V

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 33 of 48

Appendix 1

Table 1.1 Supply		Scope of work		
Designation	Package type (2)	Design	Supply	Install.
UCP	P3	V	V	C
Maintenance/configuration/test tools in Instrument Technical Room (1)	P3	V	V	V
Human–Machine Interface facilities within UCP	P3	V	V	V
PLC and HMI programs sources and property (1)	P3	V	V	V
Spare parts for pre-commissioning, commissioning and start-up	P1, P2, P3	V	V	

(1) After the SAT, the property of all software shall be transferred to the Company.

(2) P4 packages shall follow P3 supply principles.

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 34 of 48

Appendix 2

Appendix 2 Typical scope of work for package instrumentation and control

Part 2: Engineering

- To be reviewed as per particular project requirements -

LEGEND: V = Package Vendor
C = Contractor

(1) P4 packages shall follow P3 scope and engineering principles.

Table 2.1 General	Package type (1)	Scope of work	
		V	C
Designation			
Engineering rules and tools (procedures, typical drawings, forms, database format, documents numbering, etc)	P1, P2, P3	Implements	Produces & Updates
Instrumentation general specification	P1, P2, P3	Implements	Produces & Updates
Numbering rules for equipment	P1, P2, P3	Implements	Produces & Updates
Tagging rules for instruments	P1, P2, P3	Implements	Produces & Updates
Tagging rules for wiring	P2, P3	Implements	Produces & Updates
P&ID's	P2, P3	Produces & Updates	Comments
Equipment list	P1, P2, P3	Produces & Updates	Comments
Package operating, control and safety philosophy	P2, P3	Produces & Updates	Comments
Safety logic diagrams / cause & effect matrixes	P2, P3	Produces & Updates	Comments
Utilities consumption (Inst. air/gas, AC/DC power...)	P1, P2, P3	Produces & Updates	Comments

Instrumentation for package units

Rev.: 08

Effective date: 11/2012

Page: 35 of 48

Appendix 2

Table 2.2 Instruments		Scope of work	
Designation	Package type (1)	V	C
Package layout drawing with instrumentation, JB's, cable routing, F&G, etc	P1, P2, P3	Produces & Updates	Comments
Instrument index	P1, P2, P3	Produces & Updates	Comments
Instrument database (using Instrument database software tool)	P1, P2, P3	Comments	Produces & Updates
Instrument data sheets	P1, P2, P3	Produces & Updates	Comments
Calculation notes (PSV's, control valves, flow-meters, level sketches...)	P1, P2, P3	Produces & Updates	Comments
Intrinsic Safety loops calculation sheets	P2, P3	Produces & Updates	Comments
Instruments hook-up typical drawings	P1, P2, P3	Implements	Produces & Updates
Instruments hook-up drawings (itemized)	P1, P2, P3	Produces & Updates	Comments
Junction Boxes connection diagrams (using Instrument database software tool)	P1	Comments	Produces & Updates
Junction Boxes connection diagrams (using Instrument database software tool)	P2, P3	Initiates & Comments	Produces & Updates
Marshalling terminal strips connection diagrams (using Instrument database software tool)	P3	Initiates & Comments	Produces & Updates
Card image termination modules connection diagrams (using Instrument database software tool)	P3	Initiates & Comments	Produces & Updates
Instrument cables index (individual and multi-cables) (using Instrument database software tool)	P2, P3	Initiates & Comments	Produces & Updates
Instrument loop diagrams (using Instrument database software tool)	P2, P3	Initiates & Comments	Produces & Updates
Instrument loop diagrams (using CAD software)	P2, P3	Initiates & Comments	Produces & Updates
Installation manual (for installation by others)	P1, P2, P3	Produces & Updates	Comments
Material Take-Off (MTO) with Manufacturers references	P1, P2, P3	Produces & Updates	Comments

Instrumentation for package units

Rev.: 08

Effective date: 11/2012

Page: 36 of 48

Appendix 2

Table 2.3 UCP		Scope of work	
Designation	Package type (1)	V	C
Package control system architecture diagram	P3	Produces & Updates	Comments
UCP detailed functional analysis	P3	Produces & Updates	Comments
UCP / ICSS interface requirements (operating modes, interlocks logic diagrams, exchanged data, operating displays, alarm...)	P3	Initiates & Comments	Produces & Updates
SIL and availability calculations	P3	Produces & Updates	Comments
UCP Inputs/Outputs list (using Instrument database software tool)	P3	Initiates & Comments	Produces & Updates
UCP programming: rules, typical function blocks	P3	Produces & Updates	Comments
PLC program with detailed documentation	P3	Produces & Updates	Comments
UCP / ICSS digital link signals index (with memory allocation)	P3	Produces & Updates	Produces & Updates
ICSS HMI mimic displays detailed design	P3	Comments	Produces & Updates
UCP HMI display design: rules, standard functions, typical blocks...	P3	Produces & Updates	Comments
UCP HMI mimic displays detailed design	P3	Produces & Updates	Comments
UCP - Typical interconnection diagram	P3	Produces & Updates	Comments
UCP - Electrical distribution diagram	P3	Produces & Updates	Comments
UCP - Grounding diagram	P3	Produces & Updates	Comments
UCP - Cabinets detailed layout drawings	P3	Produces & Updates	Comments
UCP - Internal wiring diagrams	P3	Produces & Updates	Comments
UCP - Detailed part list	P3	Produces & Updates	Comments

Instrumentation for package units

Rev.: 08

Effective date: 11/2012

Page: 37 of 48

Appendix 2

Table 2.4 Final documents		Scope of work	
Designation	Package type (1)	V	C
Obsolescence dossier (refer to the hereafter description)	P3	Produces & Updates	Comments
Control/instruments/equipment Vendor documentation.	P1, P2, P3	Produces & Updates	Comments
Operating manuals	P1, P2, P3	Produces & Updates	Comments
Maintenance manuals	P1, P2, P3	Produces & Updates	Comments
Risks assessment study for remote maintenance and diagnostic	P3	Produces & Updates	Comments
Instrument calibration reports	P1, P2, P3	Produces & Updates	Comments
Test reports	P1, P2, P3	Produces & Updates	Comments
FAT procedures	P2, P3	Produces & Updates	Comments
FAT reports	P2, P3	Produces & Updates	Comments
Performance tests procedure	P2, P3	Produces & Updates	Comments
Performance tests performing and report	P2, P3	Produces & Updates	Comments
SAT procedures	P2, P3	Produces & Updates	Comments
Electrical / ATEX certificates	P1, P2, P3	Produces & Updates	Comments
Material / painting certificates	P1, P2, P3	Produces & Updates	Comments
Certification dossier for local authorities	P1, P2, P3	Produces & Updates	Comments
SIL certificates	P1, P2, P3	Produces & Updates	Comments

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 38 of 48

Appendix 3 Obsolescence Dossier

The contents of the dossier shall include as a minimum:

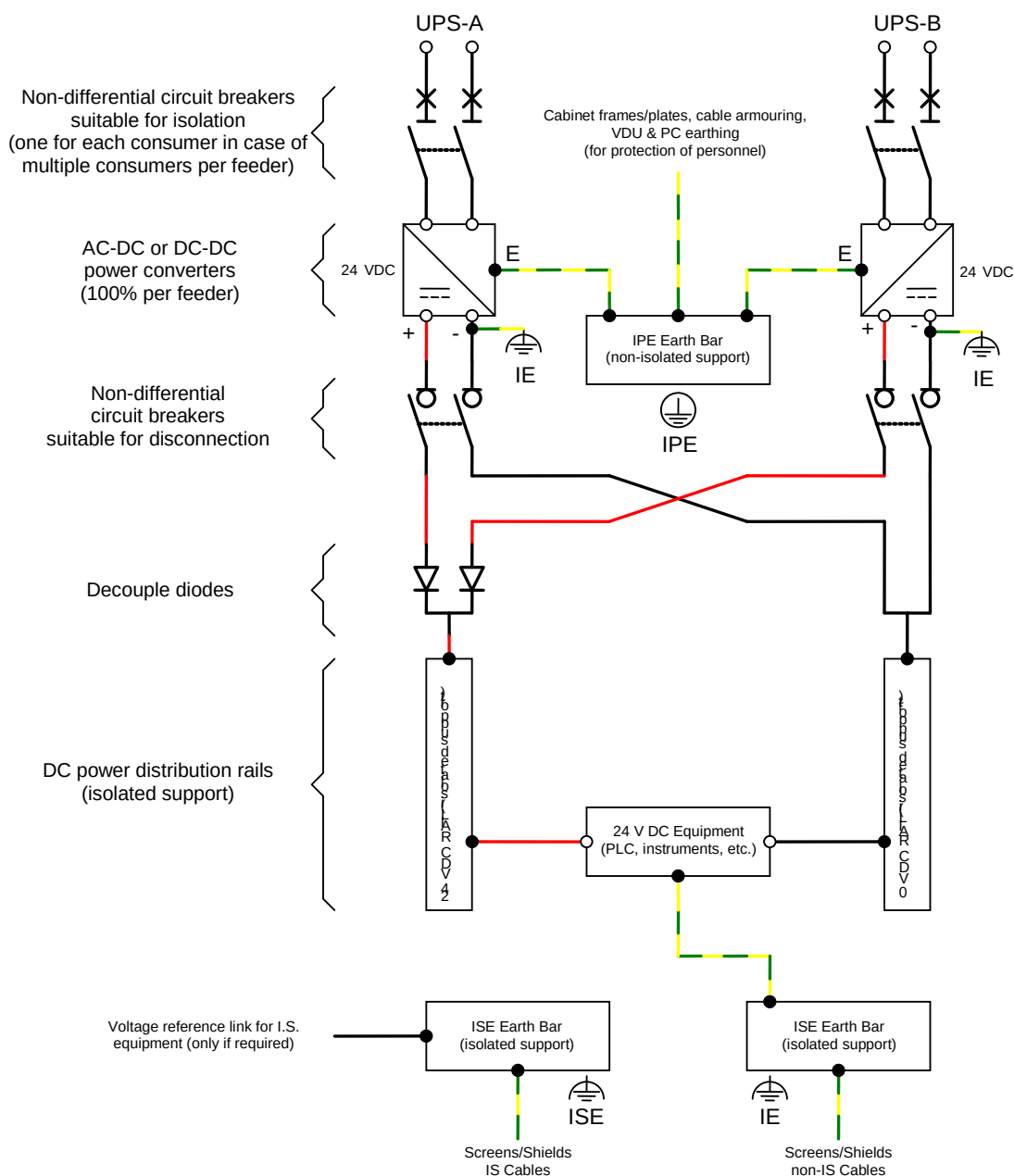
- Equipment Inventory
 - Bill Of Material (BOM)
 - . Comprehensive list with identification of all components up to the card level including Third Party equipment (e.g. routers, switches, servers)
 - . Software releases.
 - Obsolescence status of all main equipment, components and software:
 - . End of spare parts availability,
 - . End of support (i.e. design engineering support, technical after sale support)
 - . Product Change Notice (PCN)
 - . Product Discontinuance Notice (PDN)
 - . End of Life (EOL).
- Vendor support
 - Availability
 - Location.
- Replacement strategy of all components and associated software.
- Replacement schedule.

All above data shall be tabled in a database or spreadsheet application.

The obsolescence dossier shall be further complemented during the detailed engineering stage and shall detail all aspects of equipment life cycle.

Appendix 4 Generic Package Power Supply & Distribution Diagram

For 24 VDC powered equipment



For interconnection of IPE/ISE/IE earth bars and bonding to PE network, refer to **GS EP INS 107**.

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 40 of 48

Appendix 5 Tests requirements

1. Testing Methodology

The testing activity shall include the following phases:

- Standard Functions Tests
- Factory Acceptance Tests (FAT)
- Integrated Factory Acceptance Tests (IFAT)
- Yard /On site Acceptance Tests (SAT).

Vendor shall demonstrate that UCP hardware supply and configuration meets the project requirements at each of the above testing stages.

The UCP arrangement during IFAT will reflect the final UCP site configuration/architecture, including all communication interfaces with systems such as IMS, PDS, vibrations analysis system, SOE...

The test will include equipment not part of the Vendor scope of supply (e.g. Servers, Routers, Firewall ...) which will be provided by other Vendors, as per Project specifications.

The package, including the UCP if any, shall be fully commissioned and tested in the Vendor factory prior to delivery.

2. Testing Preparation

Vendor shall give Contractor/ Company notification of the readiness for any tests one calendar month prior to the beginning of the tests, unless specified differently by the Project.

Before commencement of tests witnessed by Company, Vendor shall produce evidence that the internal tests based on the approved Test plan have been carried out successfully in submitting the results of his own testing.

Vendor shall prepare a Test Plan including:

- Full set of test procedures for approval by Contractor/Company
- Software modification control procedure (P3 type package)
- Testing Schedule including Internal tests
- Resources and Equipment list
- Test log book
- List of all documentation available for the tests.

For P3 type package, Vendor shall provide all necessary tools and consumables required for the proper performance of the tests.

This includes all necessary measurement, control and simulation equipment, such as but not limited to:

- Hardwired Inputs / Outputs Simulation: ON/OFF switches simulate DI (Digital Input), potentiometers to simulate AI (Analog Input), Lights or LEDs to simulate DO (Digital Output), Ampere meter to simulate AO (Analog Output)

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 41 of 48

- Communication network load and serial link analyzers
- Dummy equipment
- Fibre optic patch panel, patch cords...).

Vendor may be required to conduct several tests, which may be considered as non-standard by the Vendor.

In addition to Company and Contractors, Certification / Classification Authority might also witness FAT/IFAT.

Testing shall be performed in using project documents in latest AFC status (Approved for Construction) approved by the Company. They shall include, but not limited to:

- Package standard functions specifications
- Functional analysis / Control narrative / sequence for process functions including utilities and interfaces with packages and external systems (e.g. vibrations analysis system...).
- Cause & Effect matrixes and Shut-down Logic Diagrams for Safety functions including Fire and Gas
- I/O database
- PID (Piping and Instruments Diagrams).

3. Recordings and corrections follow-up

All tests shall be recorded on the Test log book, including test number record, test name, duration, test results, events, punch list including failure details, and comments added manually to supplement test documentation.

All errors / discrepancies detected during the tests shall be corrected during the concerned test.

In case of major finding, the testing may be stopped until the correction has been implemented.

Vendor shall repeat the concerned sequence testing and/or perform any re-testing to verify the correct operation of the system. Furthermore, Vendor shall demonstrate that no other section of the application has been impacted by the modification; else this re-testing shall be extended to those sections.

After all tests Vendor shall issue complete test reports with completed test sheets, copies of displays, printouts etc as necessary. All test sheets will be scanned and available on an electronic PC format.

Impacted documentation shall be updated to reflect the system configuration at the end of the IFAT.

Vendor shall ensure strict software control procedure is applied so that once one test is completed and accepted the configuration software is frozen.

4. Documentation compliance

At each testing phase, the full compliance of the UCP shall be checked according to the project documentation and purchase order.

All the documentation produced by the Vendor will be checked as per project requirements.

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 42 of 48

Appendix 5

It is the responsibility of the Vendor to update as necessary all the documentation to reflect the “as built” hardware and software.

All licenses shall be listed.

5. Package Unit Factory Acceptance Test

It shall mainly include the following checkings, but not limited to:

- A comprehensive review of package drawings and documents, at their latest issue
- A comprehensive inspection including locations and installation checking of all instruments
- The accessibility of main elements
- The leak and pressure tests
- The energy consumption checking
- Wiring (continuity, earth, ground, etc.)
- Earthing network
- Instruments / panels / equipment taggings
- Noise level checking
- Instruments calibration.

Spare parts and consumables shall also be visually checked (quality, quantity, conformity, etc) and functionally checked where applicable (P3 type package).

6. UCP Factory Acceptance Test for P3/P4 type package

The Factory Acceptance Test shall be a series of tests to demonstrate that UCP meets the project design and functional requirements.

Prior to the start of the FAT, Vendor shall install the latest version of the firmware, software and operating systems.

In case of change of any firmware / software release during FAT/IFAT, tests shall be repeated.

6.1 “Standard Functions” Tests

All project “Standard Functions” shall be tested prior to any application configuration.

Those tests shall demonstrate the full functionality of Project Standard Functions in normal and abnormal conditions (loss of power supply, communication network failure, default value, cold start...).

They shall include the verification of:

- Internal logic and interfaces with other Standard Functions
- HMI (mimics, face plates/detailed mimics, alarms and events list, trends...).

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 43 of 48

Appendix 5

The full whole equipment/devices selected for the project shall be assembled, with no simulated equipment, to ensure the full compatibility; it shall include, but not limited to:

- I/Os modules
- Field Termination Assemblies
- Interfaces devices (e.g. IS barriers, Surge Protection Device, Hart multiplexer, relays, ON/OFF valves Partial Stroke Testing interfaces modules...) as per project requirements
- Transmitter/F&G detector/ Control valve positioner/detector of each type.

6.2 Mechanical Inspection

The Mechanical Inspection of all cabinets and equipment (e.g. Vibration Temperature Monitoring System) shall include the following minimum requirements.

- Visual inspection of quality, layout, labels, paint finish, lighting, sizing, wiring, cabling, routing, spares, accessibility, etc.
- Quantity of equipments in accordance with the Purchase Order (including consumables and spare parts)
- Spareage capacity
- Conformity to the “as built” documents and project requirements.

6.3 Hardware Tests

The Hardware Panel Typical Test shall include the following minimum requirements.

- Insulation tests
- Heat dissipation tests
- Continuity tests
- Earthing tests.

6.4 I/O Test

This test shall apply to 100 % of hardwired inputs/outputs in using simulator panel hardwired to marshalling cabinets or Field Termination Assemblies.

The demonstration of the correct configuration of the loop shall be made in checking all relevant parameters (e.g. scale, engineering units, control & alarm & trip thresholds, alarm & events list, historical...) by means of the project HMI (i.e. displays and associated face plates configured for the project).

6.5 Logic/Control/Monitoring Tests

The Logic/Control Tests shall include:

- 100% functional test of all control logic and sequences
- 100% functional test of all safety system logic including Fire and Gas functions as per Shut-down logic diagrams and C&E matrices

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 44 of 48

Appendix 5

- Full testing of interlocks and realignments where data is exchanged between ICSS and UCPs (measurements, interlocks, permissive status, safety trip status, clock synchronization...)
- Verification of all mimics and displays including mimics structure, call up and chaining
- Verification of historian server and SOE where applicable.

6.6 System Tests

These tests shall include but not limited to:

- Electrical power tests
- Voltage variation tests
 - Each daily test will start with an overall power switch-off during a few minutes. Overall diagnostics shall be performed after this interrupt.
 - "Black start" procedure test: after any outage, the system shall automatically resume normal operation without any manual action.
- Power supply grounding, earth fault monitoring system and fault localization
- System configuration and download
- System on line re-configuration
- Redundancy, "hot swap" and recovery functionalities to be completed as necessary
- System reactions in downgraded situation to be completed as necessary
- Full testing of all interfaces to be completed as necessary
- System reactions in downgraded situation:
 - Loss of power on the different UCP components such as, but not limited to: controllers & logic solvers, main racks, I/O racks, remote I/Os racks, any communication module, switches, routers, optical converters...
 - The system behavior shall be monitored when resumed to normal situation/configuration.
 - This analysis will encompass the following, but not limited to: bumpless take-over where redundant or TMR configuration applies, response time, alarming, automatic restart...

The system diagnostic facilities and alarm view shall be checked for each test.

6.7 Capacity and performance tests

These tests shall address HMI, servers, communication network and interface equipment, process, safety, F&G controllers in checking response times, cycle time controllers, spares capacity (I/Os, CPUs, power supplies) versus project requirements.

6.8 Cyber-security tests

As per requirements of the **GS EP INS 135** and § 6.6, those tests shall demonstrate how cyber security requirements have been implemented.

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 45 of 48

They shall include the following parts, but not limited to:

- Remote access where applicable
- Audit of operating system configuration
- Audit of network configurations where applicable
- Audit of configuration settings (access control list, permissions, passwords...)
- Identification of each type of controller
- Back-up /restoration procedures (e.g. operating system and network configuration, application software, historian database...)
- Possible vulnerabilities.

7. Integrated Factory Acceptance Test (IFAT) for P3/P4 type package

IFAT is not only a communication test, but a complete test for all required interfaces.

It will be performed, depending on project requirements and schedule:

- Either at ICSS Supplier premises with the assistance of the Package Vendor
- Either at package Vendor premises with the ICSS Supplier assistance.

In this last case, the ICSS Supplier shall supply the minimum equipment necessary for the package control and monitoring from the ICSS HMI (through project mimics) in using project equipment and not simulators. In addition, others functions shall also be tested, such as acquisition of data by IMS, Alarm & Events server and PDS respectively, as per projects requirements.

It will include for instance controller(s), communication module(s), combined Operator Working & Engineering, various equipment and servers as per project requirements (e.g. IMS, PDS, Alarm & Events server), all packaged in cabinet(s) or enclosure for easy transportation to the Package Vendor premises.

IFAT shall include:

- Data communication test
- Exchanged data verification (e.g. signal type, tags, addresses, engineering units), flow charts or logics tests including interlocks
- All ICSS HMI aspects through ICSS Standard Functions implementation: monitoring, alarms list, first fault, maintenance inhibit...
- The different operating modes (e.g. local and remote, automatic and manual)
- Clock synchronization
- Communication failure management:
 - Bumpless change-over in case of faulty communication channel when redundant communication applies and communication recovery
 - Black start.
- Communication response time and data flow load.

General Specification		GS EP INS 110
Instrumentation for package units		
Rev.: 08	Effective date: 11/2012	Page: 46 of 48

- Hardwired signals between ICSS and UCP
- All exchanged data with the different servers and routers (IMS, PDS, Alarm & Events server) as per project requirements.

This test shall be based on the Package interface specification.

8. Yard Acceptance Test and On site Acceptance Test

Vendor will be expected to assist with unpacking, installing and hook up the system ready for commissioning.

Yard / On site acceptance test will therefore demonstrate that all equipment are correctly powered up, fully operational to allow loop commissioning tests to start and that no alteration has occurred due to transportation, installation and assemblies activities.

The Site Acceptance test (SAT) will consist of a series of tests to demonstrate that:

- All equipment have not been affected during transport and handling
- All equipment have been correctly installed and assembled
- All equipment/software have been delivered including consumables and spare parts
- All documentation relevant has been delivered
- Powering and earthing is fully operational
- All software are correctly implemented
- System integrity has not been affected in transport
- Systems are fully functional
- All devices, modules, cables and connectors are well fastened and running properly
- Redundancies are fully operational
- All systems and faulty alarms are cleared
- Field interfaces are fully functional
- Communication interfaces and networks are fully functional
- Back-up systems are fully operational.

Enterprise Information System (SIE)

PDS/PI CLIENT on SIE PC

PDS/PI SERVER

DeMilitarized Zone (DMZ)

Vibration Analysis System

Vibration Analysis Server

Industrial Information System (SII)

Monitoring (SII-M)

Integrated Control and Safety Systems (ICSS)

Legend:

- DeMilitarized Zone
- Vibration Analysis System
- Vibration Analysis Server

Appendix 7 P4 type packages examples

P4 types packages will be defined on a case by case basis by the project.

Environmental conditions monitoring

- Bio diversity monitoring system
- Geotechnics and subsidence monitoring system
- Continuous emission monitoring
- 4D seismic and micro seismic monitoring system
- ...

Production reservoir monitoring

- Distributed temperature sensing system (DTS)
- ...

Umbilicals & risers & flowlines monitoring

- Pipeline/riser monitoring system
- ...

Piping

- Erosion
- ...

Structure integrity monitoring

- Hull fatigue monitoring system
- Fatigue structure monitoring system
- ...