

DEP SPECIFICATION

# INSPECTION AND FUNCTIONAL TESTING OF INSTRUMENTS

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DESIGN AND ENGINEERING PRACTICE

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## 1. INTRODUCTION

### 1.1 SCOPE

This DEP specifies requirements and gives recommendations for inspection and testing of instruments, before and after installation, during the construction and start-up phases of new plants, modified plants or after planned shutdowns. It also covers requirements for storage and hydrotesting of instrumentation systems in the field. It defines activities and requirements to confirm that instrumentation conforms to the Principal's requirements and is installed and functioning according to the approved engineering/construction drawings and data.

This DEP also addresses the development of a Quality Plan for instrumentation.

The following stages of activities are covered in this DEP:

1. Factory Acceptance Test (FAT) and Site Acceptance Test (SAT);
2. check on incoming instruments and installation materials, including storage;
3. pre-installation inspection;
4. inspection of Systems, System Cabinets, and Cable Tray and Wiring Systems;
5. post-installation inspection;
6. pre-loop check;
7. loop check;
8. instrument System Checks;
9. hydrotest and line flushing support activities;
10. process tubing leak test;
11. pre-start-up activities.

This DEP contains mandatory requirements to mitigate process safety risks in accordance with Design Engineering Manual DEM 1 – Application of Technical Standards.

This is a revision of the DEP of the same number dated February 2013; see (1.5) regarding the changes.

### 1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

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

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

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

## 1.3 DEFINITIONS

### 1.3.1 General definitions

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

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

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

The word **shall** indicates a requirement.

The capitalised term **SHALL [PS]** indicates a process safety requirement.

The word **should** indicates a recommendation.

The word **may** indicates a permitted option.

### 1.3.2 Specific definitions

| Term                                      | Definition                                                                                                                                                                                                                                                                                                                             |
|-------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>BPCS</b>                               | Basic Process Control System                                                                                                                                                                                                                                                                                                           |
| <b>Bus</b>                                | An H1 Foundation Fieldbus cable between a host and field devices connected to a single H1 segment.                                                                                                                                                                                                                                     |
| <b>Calibration</b>                        | Adjustment of an instrument's ZERO and SPAN by observing the changes in its output caused by manual changes to its input. Both the input and output signals are monitored with test equipment that is more accurate than the instrument being calibrated. Calibration also includes setting switch set points by using test equipment. |
| <b>Calibration Check</b>                  | Testing of an instrument's calibration during the pre-loop and loop check processes. This is done with test equipment monitoring the instrument's inputs and outputs. Typically, a device's calibration is checked at 0%, 25%, 50%, 75% and 100% of span                                                                               |
| <b>Commissioning, Foundation Fieldbus</b> | Putting into service the Foundation Fieldbus devices connected on the segments, and downloading the offline configuration to these devices. Electronically, the device is placed into service. Note that the device may still require operational activation as part of the Process Commissioning and Startup.                         |
| <b>Configuration</b>                      | Manual or bulk entry of engineered parameters or programs into a microprocessor-based device (e.g., Foundation Fieldbus device).                                                                                                                                                                                                       |
| <b>Configuration Download</b>             | Data transfer of engineered parameters or programs from an electronic file into a microprocessor-based device (e.g., Configuring a Foundation Fieldbus or HART device from a portable PC or DCS Data Management System).                                                                                                               |
| <b>DCS</b>                                | Distributed Control System. Also referred to as BPCS (Basic Process Control System)                                                                                                                                                                                                                                                    |

| Term                                     | Definition                                                                                                                                                                                                                                                                                                                                                                                                                         |
|------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Device Coupler/ Segment Protector</b> | Segment connection device that connect FF devices in the field to the H1 segment and can provide a current-limited (i.e., short circuit protection) junction. The common FF name is device coupler or segment protector for non-intrinsically safe (non-IS) spur output and Multi-barrier or Field bus barrier for IS spur outputs.                                                                                                |
| <b>Factory Acceptance Test (FAT)</b>     | <p>A set of predefined test procedures conducted at the Supplier's works after the system has been assembled, and before the system is shipped to Principal's site.</p> <p>The FAT is when the system is demonstrated to meet the functional, integrity and performance requirements. It is not the tests that the Supplier is expected to carry out prior to the visit by the Principal for the FAT.</p>                          |
| <b>Fieldbus</b>                          | Digital, two-way, multi-drop communication link among intelligent measurement and control devices. It serves as a local area network (LAN) for advanced process control, remote input/output and high speed factory automation applications.                                                                                                                                                                                       |
| <b>Field Inspection</b>                  | Verifying that field instruments are installed and configured according to the Principal's requirements                                                                                                                                                                                                                                                                                                                            |
| <b>Fire and Gas System (FGS)</b>         | The Fire and Gas system, as a term in this document, encompasses the fire and gas detection equipment, signal processing, monitoring, alarming and voting. The FGSs function is to generate confirmed fire initiators for ESD (Emergency Shutdown) and personnel safety functions.                                                                                                                                                 |
| <b>Function Test</b>                     | Simulation of the transmitter process variable input to demonstrate the operation of the loop. A function test is not a precise calibration check and accuracy of $\pm 5\%$ is typically sufficient. Generally, the instrument's output is not monitored with test equipment. Control valves are function tested in a similar manner by manually moving the appropriate controller output and observing the actual valve position. |
| <b>H1</b>                                | Foundation Fieldbus network operating at 31.25 kbit/s.                                                                                                                                                                                                                                                                                                                                                                             |
| <b>HART</b>                              | The Highway Addressable Remote Transducer Protocol (HART) is a digital industrial automation protocol and is considered a de-facto standard for digital communications with 4-20 mA smart process instrumentation.                                                                                                                                                                                                                 |
| <b>Historical Trend</b>                  | A graphical display on the HMI which allows the operator to view historical data available along with real-time data.                                                                                                                                                                                                                                                                                                              |
| <b>Human Machine Interface (HMI)</b>     | The means by which information is communicated between human(s) and the PAS (for example, monitors, indicating lights, push-buttons, horns, alarms). The HMI is also known as the operator interface.                                                                                                                                                                                                                              |
| <b>Inputs and Outputs (I/O)</b>          | Inputs and Outputs to a system (PES, DCS, etc.). Some typical I/O types include 4–20 mA analog input/output, 24 VDC discrete input/output, and are to/from field instrumentation or other systems.                                                                                                                                                                                                                                 |

| Term                                             | Definition                                                                                                                                                                                                                                                                                                                                                                                                                   |
|--------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Inspection of Instruments</b>                 | Verification that instruments and instrument systems comply with requirements.                                                                                                                                                                                                                                                                                                                                               |
| <b>Instrument Asset Management System (IAMS)</b> | DCS-based asset management system that facilitates configuration, diagnostics and troubleshooting on Smart field devices.                                                                                                                                                                                                                                                                                                    |
| <b>Instrument Loop</b>                           | Several instruments that are pneumatically, electronically or software connected to provide control, indication, alarm, or shutdown function.                                                                                                                                                                                                                                                                                |
| <b>Instrumented Protective Function (IPF)</b>    | <p>A function comprising one or more sensors, a Logic Solver and one or more Final Elements whose purpose is to prevent or mitigate hazardous situations and that have SIL 1, SIL 2, SIL 3 or SIL 4. An IPF is intended to achieve or maintain a safe state for the process, in respect of a specific hazardous event.</p> <p>In IEC 61508 and IEC 61511, an IPF is referred to as a Safety Instrumented Function (SIF).</p> |
| <b>Instrumented Protective System</b>            | The electromechanical, electronic and/or programmable electronic Logic Solver component of the Instrumented Protective Function, complete with input and output equipment. Synonymous with SSDS and SIS.                                                                                                                                                                                                                     |
| <b>Instrument System</b>                         | PLC Systems, Instrumented Protective Systems, Tank Gauging Systems, or Complex Control Loops that contain more than one instrument loop.                                                                                                                                                                                                                                                                                     |
| <b>Integrated Factory Acceptance Test (IFAT)</b> | A FAT that includes 3 <sup>rd</sup> party systems not supplied by the Supplier that hosts the FAT and that aims to demonstrate correct functioning of interfaces to these 3 <sup>rd</sup> party systems.                                                                                                                                                                                                                     |
| <b>Logic Solver</b>                              | The portion of either a DCS or an IPS that performs one or more logic function.                                                                                                                                                                                                                                                                                                                                              |
| <b>Loop Check</b>                                | Procedure used to demonstrate proper operation of an instrument loop for formal acceptance of the loop by QA/QC.                                                                                                                                                                                                                                                                                                             |
| <b>MOS</b>                                       | Maintenance override switches used to override IPF sensors to enable maintenance or on-line functional testing.                                                                                                                                                                                                                                                                                                              |
| <b>OLE for Process Control (OPC)</b>             | The OPC Specification is a non-proprietary technical specification that defines a set of standard interfaces based upon Microsoft's COM/DCOM technology. The application of the OPC standard interface makes possible interoperability between automation/control applications, field systems/devices and business/office applications.                                                                                      |
| <b>On-line Process Stream Analysers</b>          | Instruments which monitor the specific properties of process streams other than flow, level, pressure or temperature. They are also referred to as Quality Measuring Instruments (QMIs).                                                                                                                                                                                                                                     |

| <b>Term</b>                                          | <b>Definition</b>                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Operation Override Switch (OOS)</b>               | Operational override is a short-term (typically less than 2 hours) deactivation of a safety input or output device for operation start-up purpose.                                                                                                                                                                                                                                                                                                              |
| <b>Operator Interface</b>                            | See HMI.                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Equipment Package</b>                             | Single or combined units of equipment supplied by a Supplier which include instrumentation or to which instrument requirements may apply.                                                                                                                                                                                                                                                                                                                       |
| <b>Peer-to-Peer Communications</b>                   | Communications between two processors via the system's data highway or another communications link.                                                                                                                                                                                                                                                                                                                                                             |
| <b>PLC</b>                                           | Programmable Logic Controller – a microprocessor based control system that is customarily used to perform complex, discrete switching logic.                                                                                                                                                                                                                                                                                                                    |
| <b>Pre-Loop Check</b>                                | Procedure used to identify/solve problems prior to the loop check.                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Process Automation System (PAS)</b>               | Process Automation System – consisting of the DCS, IPS and FGS.                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Process Commissioning and Start-up Activities</b> | Operational activation of instruments and instrument systems under operating conditions. It often includes handing over the instruments and systems for continued use to the operating and maintenance departments. This activity also includes the tuning of control loops, seal liquid filling of impulse lines, commissioning of Advanced Process Control (APC), surge and condition monitoring applications and final adjustment of settings for all items. |
| <b>Programmable Electronic System (PES)</b>          | System for control, protection or monitoring based on one or more programmable electronic devices, including all elements of the system such as power supplies, sensors and other input devices, data highways and other communication paths, actuators and other output devices.                                                                                                                                                                               |
| <b>QA (Quality Assurance)</b>                        | Activity performed by the Principal (and managing Contractor if applicable) to assure that the field Contractor is adequately performing Quality Control.                                                                                                                                                                                                                                                                                                       |
| <b>QC (Quality Control)</b>                          | Work process performed by installation Contractor's instrument inspectors, and the processes they use to determine and approve quality.                                                                                                                                                                                                                                                                                                                         |
| <b>Real-Time Trend</b>                               | A graphical display on the HMI that allows the operator to view real-time data commencing from when the trend is initiated on the display.                                                                                                                                                                                                                                                                                                                      |
| <b>Redundancy</b>                                    | Use of multiple elements or systems to perform the same function; redundancy can be implemented by identical elements (identical redundancy) or by diverse elements (diverse redundancy).                                                                                                                                                                                                                                                                       |

| <b>Term</b>                                | <b>Definition</b>                                                                                                                                                                                                                                                                                                                                                                                                                  |
|--------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Remote I/O</b>                          | The opposite of centralized I/O: a system where the I/O modules are located remotely to the processor, usually in the field close to the process elements being controlled/monitored.                                                                                                                                                                                                                                              |
| <b>Safety Instrumented System (SIS)</b>    | <p>Instrumented system used to implement one or more SIFs. (Ref. IEC 61511)</p> <p>A SIS is composed of any combination of sensors, logic solvers, and final elementss. It also includes communication and ancillary equipment (e.g., cables, tubing, power supply, impulse lines, heat tracing).</p> <p>A SIS can include software.</p> <p>A SIS can include human action as part of a SIF (see ISA TR84.00.04:2015, part 1).</p> |
| <b>Segment</b>                             | The complete single H1 Foundation Fieldbus network from the Host FF interface card to the Field devices. Segment length can be extended by Repeaters to form a longer H1 Fieldbus.                                                                                                                                                                                                                                                 |
| <b>Segment Trace</b>                       | Signal waveform as presented on an oscilloscope or other graphic wave form device that depicts the shape characteristics of the signal present on a segment.                                                                                                                                                                                                                                                                       |
| <b>Site Acceptance Test (SAT)</b>          | A set of predefined procedures conducted at a job site after the system has been reassembled, and sometimes with testing of modifications to the software tested at FAT. For this document, SAT includes all system testing and verification prior to start of loop check. Sometimes referred to as the SIFT (Site Integration Functional Test).                                                                                   |
| <b>Spur</b>                                | H1 branch line connecting a single FF device to a Device Coupler or a Fieldbus barrier.                                                                                                                                                                                                                                                                                                                                            |
| <b>Special Systems</b>                     | Special instrument systems often dedicated to equipment packages. For example, speed control systems, surge control systems, weigh cell systems, vibration monitoring systems, and slide valve hydraulic control systems.                                                                                                                                                                                                          |
| <b>System Architecture or Architecture</b> | Arrangement and functional connectivity of DCS and IPS hardware and related I/O, HMI, Historian and third party subsystems.                                                                                                                                                                                                                                                                                                        |
| <b>System Check</b>                        | Procedure used to demonstrate proper operation of an instrument system for formal acceptance of the system by QA/QC. Procedure involves tests that are developed during design.                                                                                                                                                                                                                                                    |
| <b>Terminator</b>                          | Impedance-matching module used at or near each end of a transmission line that has the same characteristic impedance of the line. Terminators are used to minimize signal distortion and reflection, which can cause data errors by converting between current variations and voltage variations. .                                                                                                                                |
| <b>Valve Signature</b>                     | Graphical representation of the performance characteristics of a valve as it is stroked from open to close and close to open.                                                                                                                                                                                                                                                                                                      |

| Term                        | Definition                                                                                                                                                                                                                                                                                                                       |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Wireless gateway</b>     | The central unit for a wireless instrument network. The gateway monitors the network and optimizes the communication. The gateway is also the bridge between the wireless instrument and the DCS.                                                                                                                                |
| <b>Wireless Hybrid</b>      | A hybrid network is a combination of star and mesh instruments.                                                                                                                                                                                                                                                                  |
| <b>Wireless Mesh</b>        | A wireless network in which each instrument could act as a repeater for other devices to route information to/from the gateway.                                                                                                                                                                                                  |
| <b>Wireless Star</b>        | A wireless network in which each device has a direct link to a gateway.                                                                                                                                                                                                                                                          |
| <b>Wireless Transmitter</b> | <p>An instrument with an antenna for wireless communication. Normally these instruments have batteries.</p> <p>Wireless adapters (wireless thumbs) can be attached to normal hard wired devices to make stranded device diagnostic available. The power for the wireless adapters is normally fed by the hard-wired devices.</p> |
| <b>Work Pack</b>            | A group of post-FAT software and/or hardware changes organized into a single package for purposes of identification, tracking and subsequent implementation and testing after FAT is complete.                                                                                                                                   |

#### 1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets ( ). Other documents referenced by this DEP are listed in (17).

## 1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated February 2013. The changes followed a requirements quality review and not a full technical update. The following are the main, non-editorial changes.

| Section/Clause | Change                                                                                                                                                            |
|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2.             | Restructured requirements                                                                                                                                         |
| 3.             | Removed duplication, reference to specific Manufacturers                                                                                                          |
| 4.1            | Restructured and clarified requirements, enforced use of shall/should/may for normative statements. Reorganised listed checks as Table 4.1Removed redundant text. |
| 4.3            | Reworded DEM1 requirement.                                                                                                                                        |
| 5              | Restructured requirements                                                                                                                                         |
| 6              | Restructured requirements, removed redundant text                                                                                                                 |
| 7              | Restructured requirements                                                                                                                                         |
| 8              | Restructured requirements, removed redundant text                                                                                                                 |
| 9.1            | Restructured requirements, removed redundant text                                                                                                                 |
| 9.3            | Restructured requirements, removed redundant text                                                                                                                 |
| 9.4            | Restructured requirements, removed redundant text                                                                                                                 |
| 9.6            | Restructured requirements, removed redundant text                                                                                                                 |
| 10.1           | Restructured requirements, removed redundant text                                                                                                                 |
| 10.2           | Restructured requirements, removed redundant text                                                                                                                 |
| 10.6           | Restructured requirements, removed redundant text                                                                                                                 |
| 10.11          | Restructured requirements, removed redundant text                                                                                                                 |
| 11.3           | Restructured requirements, removed redundant text                                                                                                                 |
| 11.4           | Restructured requirements, removed redundant text                                                                                                                 |
| 15             | Clarified DEM1 requirement                                                                                                                                        |
| 16             | Restructured requirements, removed redundant text, added Table 16.1                                                                                               |
| Appendix B     | Removed supplier names                                                                                                                                            |

## 1.6 COMMENTS ON THIS DEP

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

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

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

## 1.7 DUAL UNITS

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

## 1.8 NON NORMATIVE TEXT (COMMENTARY)

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

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

## 2. QUALITY PLAN

1. Contractor shall prepare a comprehensive Quality Plan for the inspection and functional testing of instruments in accordance with ISO 9000, or equivalent, covering as a minimum:
  - a. inspection and functional testing scope, a list of inspection and loop testing requirements;
  - b. the criteria that are used to decide whether or not a particular activity is to be carried out;
  - c. pass/fail criteria for both hardware and software testing;
  - d. supplier inspection and test procedures and instructions;
  - e. supplier assistance that may be required to test and commission instruments, instrument systems, or Equipment Packages;
  - f. skills and competences required for the inspection and loop testing work;
  - g. communications and communication means (e.g., radio, intercom) required for inspection and loop testing;
  - h. test equipment to be used and their traceability to standards (Appendix B);
  - i. the quality documents (i.e., procedures, specifications (e.g., DEPs), acceptance criteria and work instructions) to be used and to be completed in assuring quality in each activity;
  - j. the organisation and reporting hierarchy of all involved in inspection and loop testing;
  - k. the independency of the organization responsible for signing off on the FAT, field inspection and testing, or SAT from the organization performing the work;
  - l. for instance, the Supplier or company that has a financial relationship with the Supplier who programs the IPS cannot sign off on the IPS FAT;
  - m. time schedule and approval milestone also considering activities that interface with other disciplines that, for example, carry out radiography inspections, pressure tests and flushing;
  - n. progress reporting;
  - o. audits by the Principal of Contractor's inspection and loop testing activities.
2. All documents and drawings that are used shall be listed and controlled.
3. The scheme shown in (Appendix A) may be used to prepare the Quality Plan.

### 3. GENERAL REQUIREMENTS

1. Instrument staff doing the loop checking shall be provided with the following:
  - a. training on the systems and technology that are being used;
  - b. suitable test equipment. See (Appendix B) for a typical, non-exhaustive list of test equipment;
  - c. system (e.g., DCS and IPS) administration support;  
*This DEP uses the term DCS Supplier as the party who is responsible for the DCS system configuration while inspection and loop testing work is on-going;*
  - d. specialist support for the systems involved (e.g., Fieldbus, HART, Wireless, Instrument Asset Management System, IPS).
2. The Contractor shall develop inspection sheets and Loop Check Report forms based on this DEP, (8) through (12), the project PAS technology used, and the Quality Plan (2);
3. Inspection findings shall be recorded in a traceable manner (i.e., with tag number reference and test personnel).
  - a. The inspection sheets and Loop Check Reports may be used for this purpose.
  - b. A Loop Check Report shall be completed for each instrument loop documenting the work carried out in accordance with this DEP.
4. A common integrated instrument database (e.g., Smart Plant Instrumentation SPI) may be used to generate these sheets automatically.
5. Instrument specification sheets in the database shall be updated to "Issued for Construction" status, prior to use during the loop check process.
6. Refer to DEP 32.30.20.13-Gen. for deliverables for smart instrumentation.
7. Existing instrument loops that are modified in a project shall be subject to Pre-Loop Check and Loop Check.
8. Loop Check Reports shall be completed to include the Manufacturer, model, device revision and calibration of the existing instruments to be monitored and tested.
9. Instruments shall conform to Supplier's published specifications.
  - a. Instruments that do not meet Supplier's specifications shall be returned to the Supplier or repaired.
10. Permanent instrument tags shall be installed during pre-installation inspection or when the device is installed.

11. The following items shall be carried out when construction is still on-going, i.e., before the activity is completed:
  - a. cable trench inspection;
  - b. underground cable inspection (to be inspected before back-filling);
  - c. earthing integrity tests;
  - d. point to point wiring checks;
  - e. inspection of in-line instruments e.g., orifice plate dimensions and orientation;
  - f. field junction box inspection;
  - g. instrument cabinet inspection;
  - h. validate that the straight length requirements for flow meters are met;
  - i. inspection of process connections, including QMI sample take off and return arrangements;
  - j. instrument accessibility;
  - k. ensuring that welding activities shall not affect the electronic instruments already installed.
12. Whenever possible, the use of the Instrument Asset Management System during instrument testing should be maximized.

**4. FACTORY ACCEPTANCE TEST (FAT), INTEGRATED FAT (IFAT), SITE ACCEPTANCE TEST (SAT)**

1. The Contractor shall list and agree with the Principal those instruments and instrument systems that need to be subjected to a FAT and SAT.
2. Refer to DEP 32.30.20.11-Gen. Section 10.2 for Specific FAT requirements for F&G systems.

#### 4.1 PROCESS AUTOMATION SYSTEM FAT

##### 4.1.1 Documents for FAT

1. The documentation required for a FAT may vary depending on the size and complexity of the PAS.
2. Version control of the FAT procedure shall be implemented to assure that the latest test plan is being used.
3. The following documentation should be available for the FAT:
  - a. by the Manufacturer/Supplier:
    - i. pre-FAT certificate approved by MAC project manager and Pre-FAT testing results;
    - ii. FAT procedure;
    - iii. system architecture overview block diagram;
    - iv. system loading (station/controller/gateway) for the system;  
*The loading normally contains all the system features that are to be included in the system functionality.*
    - v. PAS DCS/PLC architecture drawing(s);
    - vi. PAS HMI architecture drawing(s);
    - vii. PAS Network architecture drawing(s), including network addresses and component names;
    - viii. PAS Panel general arrangement drawing(s);
    - ix. PAS Panel power distribution/wiring drawing(s);
    - x. agreed Sub-system layout across processors;
    - xi. functional Logic Diagrams.
  - b. by the Contractor:
    - i. P&IDs/PEFSs;
    - ii. equipment room layouts;
    - iii. hardwired interface detail;
    - iv. safeguarding Cause and Effect Diagrams;
    - v. I/O Taglist (Master Instrument List – SPI - Smart Plant Instrumentation);
    - vi. I/O and/or Fieldbus segment health and loading schedules;
    - vii. range, alarm and trip schedule (RATS List);
    - viii. process Control Narratives and Complex Loop documentation;
    - ix. IPF Requirement Specification documentation as per DEP 32.80.10.10-Gen.
    - x. third-Party Interface documentation - Communications layout, including Cable Schedule (Fibre/Ethernet);
    - xi. high level Functional Design Specification.

#### 4.1.2 Revision control

1. The Supplier shall have a revision control process for revision approvals and implementation tracking.
2. The Supplier's revision control process should include maintaining backups of all application software.
3. All software changes requiring changes to Cause and Effect shutdown logic or trip set points SHALL [PS] only be programmed when authorized according to the project's Management of Change procedure.
4. At every download of compiled code to a processor, regardless of whether on-line or off-line changes are made, a backup shall be made by the Supplier of the application software.
5. Prior to a download, the Supplier shall backup tuneable parameters, verify and safeguard against parameters accidentally being set back to previous values by the software download.
6. The set of tuneable parameters in the running application software (e.g., alarm levels, PID tuning) shall be backed-up daily or at a frequency as agreed with the Principal.

#### 4.1.3 FAT staging and testing plan

##### 4.1.3.1 Overview

*The PAS staging consists of assembling the complete system, interconnecting all system components, communication networks and servers and powering the system up.*

1. The PAS shall be staged at the Supplier's facility, unless the project specifically specifies another location.
2. Safeguarding logic SHALL [PS] be verified (including correct operation of MOS functionality, automatic and manual operational overrides, fall back strategies and fault degradation) and witnessed by certifying authorities, if applicable.
3. System configuration and performance requirements shall be verified. Refer to DEP 32.80.10.10-Gen.
4. All testing documents shall be signed off (as quality plan) and dated once operation has been demonstrated in accordance with the test criteria.

##### 4.1.3.2 FAT execution

1. The Supplier shall conduct the FAT and demonstrate that the system is configured and functioning according to the design requirements.

##### 4.1.3.3 Remediation

1. The Supplier shall have a remediation plan in place.
2. The Supplier's remediation plan shall include generation of a full and complete Non-conformance Report (NCR) for incomplete tests or identified deficiencies.
3. The NCR list shall be maintained and updated by the Supplier as remedial actions are completed.
4. Prior to the start of the testing, the Supplier shall obtain the Contractor's approval to classifications for deficiencies.