PIP PCTPA001
Testing of Process Analyzer Systems
PURPOSE AND USE OF PROCESS INDUSTRY PRACTICES

In an effort to minimize the cost of process industry facilities, this Practice has been prepared from the technical requirements in the existing standards of major industrial users, contractors, or standards organizations. By harmonizing these technical requirements into a single set of Practices, administrative, application, and engineering costs to both the purchaser and the manufacturer should be reduced. While this Practice is expected to incorporate the majority of requirements of most users, individual applications may involve requirements that will be appended to and take precedence over this Practice. Determinations concerning fitness for purpose and particular matters or application of the Practice to particular project or engineering situations should not be made solely on information contained in these materials. The use of trade names from time to time should not be viewed as an expression of preference but rather recognized as normal usage in the trade. Other brands having the same specifications are equally correct and may be substituted for those named. All Practices or guidelines are intended to be consistent with applicable laws and regulations including OSHA requirements. To the extent these Practices or guidelines should conflict with OSHA or other applicable laws or regulations, such laws or regulations must be followed. Consult an appropriate professional before applying or acting on any material contained in or suggested by the Practice.

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1. Introduction

1.1 Purpose
This Practice provides requirements for inspection and acceptance testing of process analyzer systems and field enclosures.

1.2 Scope
This Practice describes requirements inspection and acceptance tests for process analyzer systems performed as follows:
a. On process analyzer(s) performed by the OEM
b. On the fabricated process analyzer systems and shelter(s) performed by the Analyzer System Vendors (ASV)
c. On the installed systems on site as a requirement for turnover to the owner

2. References
Applicable parts of the following Practices, industry codes and standards, and references should be considered an integral part of this Practice. The edition in effect on the date of contract award should be used, except as otherwise noted. Short titles are used herein where appropriate.

2.1 Process Industry Practices (PIP)
- PIP PCEPA002 - Process Analyzer Project Implementation Guidelines
- PIP PCSPA002 - Process Analyzer System Data Sheet Instructions
- PIP PCSPA002-D - Process Analyzer System Data Sheet

3. Definitions
owner: The party who owns the facility wherein the process analyzer systems will be used

4. Requirements

4.1 General

4.1.1 Inspection and acceptance testing of process analyzer systems on a major capital project can require the participation of only one or several of the following resource groups:
a. Owner company personnel
b. Engineering & Construction contractor personnel
c. Analyzer System Vendors (ASV)
d. Analyzer Original Equipment Manufacturer (OEM)

4.1.2 Physical inspections shall be performed by both the ASV and the OEM.

4.1.3 Acceptance testing shall be performed at factory (FAT) and at site (SAT). Test procedures shall be approved by Owner prior to testing.

4.1.4 Before performing an acceptance test, statistical quality control (SQC) performance data shall be provided by the ASV and/or the OEM.
4.1.5 If specified on purchaser’s process analyzer system data sheet, *PIP PCSPA002-D*, system-specific inspections and tests shall be performed before final inspection.

4.2 **Original Equipment Manufacturer (OEM) Tests**

4.2.1 **General**

4.2.1.1 OEM tests are acceptance tests performed at the analyzer OEM’s facility.

4.2.1.2 OEM tests shall have defined and measurable parameters with repeatability factors or tolerance factors stated in the data sheets or in engineering notes.

*Comment:* Examples of these tests are baseline drift, repeatability, resolution, signal ranges, etc.

4.2.1.3 The analyzer manufacturer shall provide all testing equipment required.

4.2.1.4 Inspection and acceptance tests at an analyzer OEM shall be limited to “complex analyzers” or analyzers that require specific applications engineering or development beyond that which is normally defined in an OEM’s literature.

4.2.1.5 All analyzers and peripheral support hardware for each analyzer shall be powered and operational during inspections and tests.

4.2.1.6 The tasks outlined in Sections 4.2.2 through 4.2.4 shall be completed during this stage of the testing and inspection.

4.2.2 **Hardware Inspection**

4.2.2.1 Visually inspect and verify that the each analyzer meets stated, specified, or approved outline mounting and dimensions.

4.2.2.2 Visually inspect and verify fit and finish of each analyzer housing, cabinet, or enclosure.

4.2.2.3 Visually inspect and verify type and location of all electrical and tubing penetrations of each analyzer housing or cabinet.

4.2.2.4 Visually inspect and verify conformance to approved interconnecting diagrams for electrical and signal wiring.

4.2.2.5 Visually inspect and verify conformance to specified materials of construction.

4.2.2.6 Visually inspect and verify conformance to specified utility and safety alarm relay and indication systems.

4.2.2.7 Visually inspect and verify conformance of equipment to specified electrical specifications.

4.2.2.8 Visually inspect and verify conformance of equipment to specified electrical area classification to include, e.g., Underwriter Laboratory (UL) labeling, Factory Mutual (FM), and Canada Safety Association (CSA) approvals.

4.2.2.9 Verify presence of all required accessories and options.
4.2.2.10 Visually verify presence and conformance to specified wire tags, labels, and equipment tag numbers.

4.2.3 Analyzer Performance Tests

4.2.3.1 Witness and verify operation and calibration of all inputs and outputs.

4.2.3.2 Witness and verify zero and span calibration with known standards.
   a. Witness and verify acceptable or specified signal-to-noise ratio.
   b. Witness and verify stability (drift) and reproducibility runs against stated specifications.
   c. Witness and verify that the analyzer meets required linearity.
   d. Witness and verify analyzer response time against specification.

4.2.3.3 Witness and verify acceptable compensation for stated background interferences.

4.2.3.4 Witness and verify operation and performance of internal diagnostics.

4.2.3.5 Verify operating software version number against specifications.

4.2.3.6 Functionally test all alarm and alarm indication circuits.

4.2.3.7 Verify SQC data against performance requirements.

4.2.4 OEM Test Documentation

4.2.4.1 Review and verify that all required documentation is complete and in acceptable format.

4.2.4.2 Obtain signoff by owner, or by owner-authorized agent, of inspection discrepancies (punch list).
   a. The punch list shall define items for correction, acknowledged exceptions, or deficiencies.
   b. The signoff shall include timing for satisfactory resolution of all items by responsible organization.

4.2.4.3 Re-inspect as required to ensure compliance and note all deficiencies on the punch list.

4.3 Factory Acceptance Tests (FAT)

4.3.1 General

4.3.1.1 FATs are performed at the ASV’s facility after complete fabrication and assembly of the analyzer system(s).

4.3.1.2 These tests shall have defined and measurable parameters that encompass the complete analyzer system including any support peripherals such as analyzer shelters or buildings and all ancillary equipment.

4.3.1.3 Reviewing documentation and conducting physical inspection for compliance to codes and standards plus adherence to the analyzer system engineering specification shall be part of this acceptance test.
4.3.1.4 The ASV shall supply all equipment required for testing (e.g., air velocity, shelter interior sound levels, steam generators, etc.).

4.3.1.5 Sample transport and sample conditioning systems are normally custom engineered and fabricated by the analyzer OEM or ASV and shall require inspection and acceptance testing.

4.3.1.6 Analyzer system shelters are normally custom-engineered and fabricated by the analyzer OEM or an ASV and shall require inspection and acceptance testing.

4.3.1.7 All analyzers and peripheral support hardware for each analyzer shall be powered and operational during inspections and tests.

4.3.1.8 All analyzer enclosure or shelter utility and alarm systems shall be powered, fully operational, and demonstrated.

4.3.1.9 The tasks outlined in Sections 4.3.2 through 4.3.6 shall be completed during this stage of the testing and inspection.

4.3.2 Shelter

4.3.2.1 Review all required certificates of analyzer OEM to ensure compliance with specifications (e.g., welding certifications, electrical area classification compliance, Professional Engineer (PE) certification of base support structure).

4.3.2.2 Visually inspect and verify conformance to shelter dimensional and mounting specifications.

4.3.2.3 Visually inspect and verify conformance to specified shelter materials of construction and fabrication requirements.

4.3.2.4 Visually inspect and verify conformance to specified/approved sample system enclosure type, materials of construction, location, and mounting.

4.3.2.5 Visually inspect and verify conformance to specified electrical components, piping and valves, and mounting hardware.

4.3.2.6 Visually inspect and verify conformance to specified electrical grounding requirements.

4.3.2.7 Visually inspect and verify conformance of HVAC system to specification, including issuance of a certificate of compliance to the electrical area classification.

4.3.2.8 Visually inspect and verify conformance of HVAC to specified dimensional and mounting specifications.

4.3.2.9 Visually inspect and verify size and location of all utility and process connection points.

4.3.2.10 Visually inspect and verify shelter layout against specifications and approved drawings.

4.3.2.11 Visually inspect and verify accessibility and maintainability of all utility and analyzer systems and peripheral support hardware components.
4.3.2.12 Visually inspect and verify presence of all enclosure utility and safety alarm sensors and indicators.

4.3.2.13 Visually inspect and verify specification compliance for all “bolt on” or field-mounted accessories, e.g., awnings, cylinder racks, and sample recovery systems.

4.3.2.14 Visually inspect and verify shelter lift points against approved lifting drawings.

4.3.3 Sample System

4.3.3.1 Visually inspect and verify sample system against approved flow diagrams.

4.3.3.2 Visually inspect and verify accessibility, operability, and maintainability of as-built sample system.

4.3.3.3 Visually inspect and verify sample system components against approved manufacturer lists.

4.3.3.4 Visually inspect and verify sample-wetted materials of construction against specifications (e.g., o-rings, diaphragms, floats, rotameter tubes, and similar components).

4.3.3.5 Visually inspect and verify all sample system component tagging and labeling.

4.3.3.6 Visually inspect and verify presence, size, and range of all sample system and utility support indicators and control devices (e.g., pressure gauges, cabinet heater, dial thermometer, temperature controller, cabinet purge flowmeter, heat exchangers, insulation, and heat tracing).

4.3.3.7 Visually inspect and verify presence of all sample system safety alarm and indicating systems.

4.3.3.8 Visually inspect and verify proper cabinet penetrations for all electrical, utility, and sample line penetrations.

4.3.3.9 Visually inspect and verify sample probe assemblies for conformance to specified requirements. Inspection should include verification of proper sizing, materials of construction, tagging, flange bolt patterns, welds, and weld certifications.

4.3.3.10 Visually inspect and verify proper labeling (externally and internally) of all sample cabinet penetrations.

4.3.3.11 Verify total sample flow to analyzer house interior against stated design parameters.

4.3.4 Shelter Performance Testing

4.3.4.1 Verify proper operation of all electrical utility functions (e.g., interior and exterior lighting, HVAC, analyzer power, sample system power, UPS power feeds, switches, and breakers).

4.3.4.2 Verify proper operation and calibration of all shelter alarm and shutdown systems (e.g., oxygen deficiency, smoke detectors, combustible gas
detectors, toxic gas detectors, shelter pressurization/flow sensors, visual and audible alarms, analog, and digital outputs).

4.3.4.3 Functionally check and verify total airflow and velocity against stated pressurization and air change requirements.

4.3.4.4 Verify total utility flows (e.g., N₂, H₂) to analyzer shelter interior.

### 4.3.5 Analyzer and Sample System Performance Testing

4.3.5.1 Pressure-test and leak-check all sample systems.

4.3.5.2 Functionally check the operation of all manual and automatic stream-switching valves, calibration valves, automatic system isolation valves, and valve position indicators.

4.3.5.3 Functionally check the operation and calibration of the sample temperature controls, heating/cooling system controllers, and indicators.

4.3.5.4 Functionally check the operation and calibration of all sample system alarm and/or shutdown systems (e.g., toxic gas leak detectors and combustible gas detectors).

4.3.5.5 Verify sizing and calibration, and functionally check the operation of all sample system flow indicators and controllers.

4.3.5.6 Verify sizing and calibration, and functionally check the operation of all sample pressure regulators, indicators, and pressure relief valves.

4.3.5.7 Functionally check and verify all analog/digital interconnections and communications for owner systems.

### 4.3.6 FAT Documentation

4.3.6.1 Review and verify that all required documentation is complete and in acceptable format.

4.3.6.2 Obtain signoff by owner, or by owner-authorized agent, of inspection discrepancies (punch list). The punch list shall define items for correction, acknowledged exceptions, or deficiencies. The signoff shall include timing for satisfactory resolution of all items by responsible organization.

4.3.6.3 Re-inspect as required to ensure compliance with all deficiencies noted on the punch list.

### 4.4 Site Acceptance Tests (SAT)

#### 4.4.1 General

4.4.1.1 The SAT demonstrates analyzer system performance following a defined period of uninterrupted, on-line operation and shall be in accordance with the performance test requirements.

4.4.1.2 SATs, including the documentation requirements and standards compliance, shall be fully defined at the bidding stage of an analyzer project.

*Comment:* See Section 4.6 of *PIP PCEPA002.*
4.4.1.3 The tasks outlined in Section 4.4.2 shall be completed during this stage of the testing and inspection.

4.4.2 Performance Tests

4.4.2.1 Check and verify proper installation of sample probes, sample lines, calibration gas tubing runs, and all utility and vent headers.

4.4.2.2 Check and verify operation of heat-traced sample lines and controller operation.

4.4.2.3 Verify total system (analyzer and sample system) response time with introduction of known zero and span calibration standards.

4.4.2.4 Verify sample system flow, temperature, and pressure operation against stated design parameters.

4.4.2.5 Verify calibrated analyzer on-stream analytical response against plant lab or grab sample analysis.

4.4.2.6 Functionally check and verify all analog/digital interconnections and communications to owner systems.

4.4.2.7 Verify operation and performance of each analytical system against specified turnover criteria (e.g., 5 days continuous operation).

4.4.2.8 Verify performance of all shelter and sample system alarm functions.