

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Automation systems in the process industry –
Factory acceptance test (FAT), site acceptance test (SAT), and site integration
test (SIT)**

**Systèmes d'automatisation dans l'industrie de transformation –
Essais d'acceptation en usine (FAT), essais d'acceptation sur site (SAT) et
essais d'intégration sur site (SIT)**



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**AUTOMATION SYSTEMS IN THE PROCESS INDUSTRY –
FACTORY ACCEPTANCE TEST (FAT), SITE ACCEPTANCE TEST (SAT),
AND SITE INTEGRATION TEST (SIT)**

FOREWORD

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IEC 62381 has been prepared by subcommittee 65E: Devices and integration in enterprise systems, of IEC technical committee 65: Industrial-process measurement, control and automation. It is an International Standard.

This third edition cancels and replaces the second edition published in 2012. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) General re-organization of the standard;
- b) Current technology incorporated;
- c) Optional factory integration test (FIT) added;

- d) Replaced the forms in the annexes with detailed checklists of activities which can be used to develop project-specific test plans; and
- e) Provided additional references to other applicable standards.

The text of this International Standard is based on the following documents:

Draft	Report on voting
65E/1080/FDIS	65E/1092/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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- reconfirmed,
- withdrawn, or
- revised.

INTRODUCTION

There is an increasing trend in the process industry to shorten the time period for project execution. At the same time, the complexity of automation systems is being increased due to the number of connected systems and the use of new technologies, for example, wired and wireless field sensor networks.

Experience has shown that the owner, the buyer and the vendor have long and extensive discussions to unambiguously establish the scope of activities and responsibilities in order to achieve timely delivery and acceptance of automation systems.

This document provides requirements and guidance on acceptance testing of control system installations, which can lead to a mutual understanding about the scope of activities of each party.

AUTOMATION SYSTEMS IN THE PROCESS INDUSTRY – FACTORY ACCEPTANCE TEST (FAT), SITE ACCEPTANCE TEST (SAT), AND SITE INTEGRATION TEST (SIT)

1 Scope

1.1 General applicability

This International Standard defines requirements and checklists for the factory acceptance test (FAT), the factory integration test (FIT), the site acceptance test (SAT), and the site integration test (SIT). These tests are carried out to demonstrate that the automation system meets the requirements of the applicable specification.

This document provides a means for all parties, including the owner, the buyer, and the vendor, to clearly establish and agree on the scope of activities and responsibilities involved in performing these tests in order to achieve a timely delivery and acceptance of the automation system. The activities specified in this document can be used to develop test plans adapted to the specific requirements of the process/plant/equipment.

The annexes of this document contain checklists which are available for consideration when preparing specific test procedures and documentation for a specific automation system.

1.2 Exclusions

1.2.1 Prior- and post-test activities

Engineering and manufacturing activities prior to or after the FAT, FIT, SAT and SIT, such as loop checks and commissioning, are not covered by this document.

1.2.2 Regulated industries

For applications in the pharmaceutical or other highly specialized industries, additional guidelines (for example, good automated manufacturing practice (GAMP)), definitions and stipulations apply in accordance with other applicable existing standards.

1.2.3 Safety instrumented systems

The user can utilize this document to develop necessary testing for basic checks of a safety system, however, this document does not cover validation of a safety system. IEC 61511 provides requirements for checks and validation of safety instrumented systems.

1.2.4 Manufacturing execution systems

Testing and verification of manufacturing execution systems (MES) is not covered by this document.

1.2.5 Advanced process control

Testing and verification of advanced process control (APC) is not covered by this document.

1.2.6 Security for industrial automation and control systems

Although this document includes a limited number of network checks, it does not cover complete network and system security. IEC 62443 provides requirements for automation and control systems cyber security.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 62382, *Control systems in the process industry – Electrical and instrumentation loop check*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1.1

advanced process control

APC

several tools and techniques whose common characteristic is taking process automation beyond the limits of single-loop control

Note 1 to entry: APC includes model-based software that is used to direct the process operation and is commonly referred to as multivariable predictive control or model predictive control.

3.1.2

automation system

complete system for the monitoring and control of production facilities

Note 1 to entry: An automation system can include a BPCS and can also include a SIS and other subsystems.

3.1.3

basic process control system

BPCS

system which responds to input signals from the process, its associated equipment, other programmable systems and/or operators and generates output signals causing the process and its associated equipment to operate in the desired manner but which does not perform any SIF

Note 1 to entry: A BPCS includes all of the devices necessary to ensure that the process operates in the desired manner.

Note 2 to entry: A BPCS typically can implement various functions such as process control functions, monitoring, and alarms.

[SOURCE: IEC 61511-1:2016, 3.2.3]

3.1.4

buyer

company purchasing the equipment or control system from the vendor

Note 1 to entry: The buyer can be the owner of the equipment or control system, or the buyer can be another company.

3.1.5**cold commissioning**

phase, during which the activities associated with the testing and operation of equipment or facilities using test media such as water or inert substances prior to introducing any chemical in the system take place

3.1.6**control system**

system which responds to input signals from the process and/or from an operator and generates output signals causing the process to operate in the desired manner

Note 1 to entry: The control system includes sensors and final elements and can be either a BPCS or a SIS or a combination of the two.

[SOURCE: IEC 61511-1:2016, 3.2.10]

3.1.7**detailed design specification**

separate document that shows how the system functions and meets the requirements established in the functional requirements specification

3.1.8**factory acceptance test****FAT**

activity, including inspection and testing, to demonstrate that the automation system, subsystem, or component is in accordance with the specification and is typically conducted at the vendor's facility

3.1.9**factory integration test****FIT**

activity, including inspection and testing, conducted at the vendor's facility to demonstrate that the merging of some or all of the various subsystems and components into one overall automation system functions in accordance with the specification

3.1.10**functional requirements specification****FRS**

specification listing the detailed operational requirements for a control system (i.e., what the system does, not how it does it)

3.1.11**hot commissioning**

phase during which the activities associated with the testing and operation of equipment or facilities using the actual chemical process prior to making an actual production run take place

3.1.12**manufacturing execution system****MES**

computerized system used in manufacturing to track and document the transformation of raw materials to finished goods

3.1.13**owner**

company that operates the production facilities where the automation system is or will be installed

3.1.14

precommissioning

phase during which the activities of non-operating adjustments, cold alignment checks, cleaning, and testing of machinery take place

3.1.15

process industry

industry that has a continuous or batch flow and uses chemical reactions, separations, or mixing techniques in order to create new products, modify existing products or treat waste, and includes the following types of industries: chemical, petrochemical, water and wastewater treatment, paper, cement, etc.

Note 1 to entry: Process industry does not include such industries as equipment/machine manufacturing or other similar industries. It does not include industries which are subject to regulations which have specialized validation requirements.

3.1.16

punch list

list of all problems found, the corrective action to be taken, party responsible and date completed

Note 1 to entry: Other information categories can be added as required.

3.1.17

safety instrumented function

SIF

safety function to be implemented by a safety instrumented system (SIS)

[SOURCE: IEC 61511-1:2016, 3.2.66]

3.1.18

safety instrumented system

SIS

instrumented system used to implement one or more SIFs

Note 1 to entry: A SIS is composed of any combination of sensor(s), logic solver(s), and final element(s) (e.g., see Figure 6 of IEC 61511:2016). It also includes communication and ancillary equipment (e.g., cables, tubing, power supply, impulse lines, heat tracing).

Note 2 to entry: A SIS can include software.

Note 3 to entry: A SIS can include human action as part of a SIF.

[SOURCE: IEC 61511-1:2016, 3.2.67, modified – Figure 6 and reference to ISA TR84.00.04:2015 part 1 have been omitted.]

3.1.19

site acceptance test

SAT

activity, including inspection and testing, conducted at the site of the installation, to demonstrate that the installation of the automation system, any subsystem, or any component is in accordance with the applicable standards, codes, specifications, and installation instructions

3.1.20

site integration test

SIT

activity, including inspection and testing, conducted at the site of the installation, to demonstrate that the merging of the various subsystems and components into one overall automation system is completed and that all components work together in accordance with the specification

3.1.21**tag**

unique identifier assigned to a process measurement, calculation, or device within the automation system

3.1.22**user requirements specification****URS**

document that defines the user's (owner's) requirements for the automation system

3.1.23**vendor**

manufacturer, distributor, or systems integrator of the automation system, subsystem, or component

3.2 Abbreviated terms

The following abbreviated terms are used (for terms not otherwise defined in this Clause 3):

DCS	Distributed control system
E&I	Electrical and instrumentation
ERP	Enterprise resource planning
HMI	Human machine interface
I/O	Input and output
P&ID	Piping (or process) and instrumentation diagram
PLC	Programmable logic controller
UPS	Uninterruptible power supply

4 Overview of automation system testing**4.1 General**

An automation system is to be tested at various stages in its development and implementation. Each new automation system shall be subjected to three tests to demonstrate proper operation in accordance with project-specific requirements: factory acceptance test (FAT), site acceptance test (SAT) and site integration test (SIT). Loop tests shall be performed in accordance with IEC 62382, which typically occur after SIT. All these tests shall be completed, with any open items documented and agreed upon by all parties involved in the tests, prior to the system being placed in operation. An optional fourth test, factory integration test (FIT) can also be performed on all or part of the system while at the vendor's factory.

The typical order of execution of these tests is:

- The factory acceptance test (FAT) is performed on the automation system, subsystem or component before it leaves the vendor's factory to demonstrate that it functions in accordance with the project-specific requirements.
- The factory integration test (FIT) is a fourth, optional testing point to demonstrate that the merging of some or all the various subsystems and components function as specified. This test is performed after or in conjunction with the FAT, before the automation system, subsystem or component leaves the vendor's factory.
- The site acceptance test (SAT) is performed after installation on site to demonstrate the automation system, subsystem, or component is in accordance with the applicable standards, codes, specifications, and installation instructions. This test is performed after each subsystem is installed.

- The site integration test (SIT) is performed after the SAT to demonstrate that the merging of the various subsystems and components into one overall automation system is complete and that all subsystems and components work together as specified in the test plan. This test can be performed on two or more subsystems or components after each has been installed and successfully completed a SAT or after all subsystems and components have been installed and successfully completed a SAT.

Figure 1 provides a general illustration of a portion of the timeline of a project from construction to production and when the above tests occur. The industry and the specifics of a project can vary the relative timing of each test.

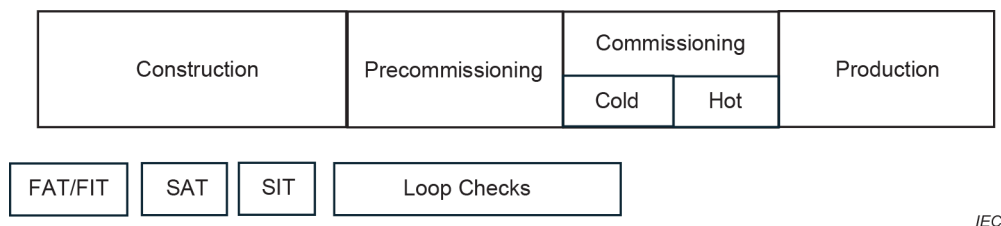


Figure 1 – Project phases and E&I testing

4.2 Methods of test performance

This document provides checklists for developing test plans for the automation system. Traditionally, these tests are performed using manual methods. With modern systems, these tests can also be performed using automated methods, depending on the system's capability. If automated methods are used, it is the vendor's responsibility to demonstrate that the automated tests completely cover all aspects of the test plan and are validated.

4.3 Project design changes

Changes made to the project design during or at any time after FAT, whether to the detailed design scope or as a correction/adjustment made during testing, shall be formally documented and their full impact on the automation system shall be determined, including the impact of the changes on test plans and already completed tests. Involved parties (e.g. owner, buyer, vendor) shall be informed of all changes impacting project scope/cost/schedule, safety, or system performance and shall approve changes as required by the project. Project design and test plan documentation shall be revised and completed tests re-performed, where necessary, to reflect all design changes.

4.4 Adapted procedures in the event of modifications to existing systems

This document generally describes testing of new systems. If a modification or upgrade to a system that is currently in operation is being tested, additional precautions should be considered. During design of the modification/upgrade, changes should not be made in the field (on the owner's operational system) until testing is complete. If any changes are made to the operational system during this time, those changes shall be tracked and be implemented in the new system being tested before FAT. For example, all changes (logic, I/O, graphics, etc.) made in the field after the software freeze date shall be implemented in the automation system before the FAT. This ensures changes made by operations for example, are captured in and tested with the new system.

5 Factory acceptance test (FAT)

5.1 General

This Clause 5 provides the activities that are precursors to, conducted during, and provided after the FAT. The purpose of the FAT is to demonstrate that the automation system, subsystem, or component is in accordance with the URS and FRS and to verify the functionality, performance, and stability of the hardware and software delivered by the vendor.

5.2 Performance

The FAT shall be performed after manufacture of the automation system and prior to installation in the field.

NOTE The FAT typically is performed by the vendor. The buyer typically witnesses the test activities. There can be buyers who want to carry out some parts of the FAT themselves. This is established on a project-related basis.

5.3 Pre-FAT activities

5.3.1 General

Prior to commencing the FAT, the following activities shall be completed:

- a) vendor tests;
- b) documentation;
- c) test plan; and
- d) test schedule.

5.3.2 Vendor tests

The vendor shall conduct all vendor standard and any necessary custom tests of the system. Reports documenting the tests shall be available for buyer inspection.

5.3.3 Documentation

Reference documentation shall be assembled prior to the FAT. This documentation primarily consists of the purchase order to the vendor and all requirements and information included with that order describing the requirements for the system, its installation, and its performance. This documentation serves as the basis for development of the FAT functionality test requirement document. These documents can include, but are not limited to, the following categories:

- User requirements specification: document(s) defining the project scope and design conventions and guidelines;
- Functional requirements specification: document(s) defining the detailed design requirements, including system functional requirements;
- Information to vendor: scope requirements changes, changes to automation system hardware or software, or other additions or clarifications provided to the vendor during execution of the project;
- Vendor documentation: documentation developed by the vendor during the execution of the work, including complete documentation of all system I/O and interlocks;
- Process control narratives, updated to reflect any changes made during testing; and
- Master alarm list, updated to reflect any changes made during testing.

5.3.4 Test plan

A written test plan and specification documenting the tests to be conducted, the applicable acceptance criteria to be used for each test, safety instructions, facilities/tools/hardware/software, and staffing shall be developed and agreed to by buyer and the vendor in advance of the tests. This plan shall clarify who, the buyer or the vendor, is to perform each test and the criteria for acceptance of test results. The test plan shall address all of the following areas applicable to the specific project per the URS and FRS:

- Overall scope of the tests, including hardware, software, configuration/programming, documentation, etc.;
- Hardware, including construction, spare space, access for maintenance, agreement with drawings, wiring/cabling, terminations, labeling in accordance with project documentation/drawings, requirements, and acceptance criteria;
- Performance of required application-related functions and operator interface and controls, including simulation of system inputs and outputs and acceptance criteria;
- Performance of system-related functions and acceptance criteria;
- Provision of adequate infrastructure by the vendor to demonstrate the required functionality;
- Review of software revisions, updates or modifications to date from the time the software was downloaded to the system and any vendor's recommended updates which are considered as a fix;
- Interoperability testing of intelligent field devices with the system (i.e., highway addressable remote transducer (HART), fieldbus, etc.);
- Review of vendor's report of tests and checks performed on the system and readiness of the system for FAT;
- Review of application programming, operator graphics, and database completeness;
- Development of an action plan of how to handle all tests that were not completed during the FAT, excluded from the FAT, or require re-performance after the FAT;
- Testing of the system grounding before energization;
- Testing of interfaces to other systems or subsystems;
- Review of hardware and/or software (e.g. third party) specifically excluded from the FAT and how and when it will be tested; and
- System in operation mode with all network and system security functioning (field settings in place).

NOTE 1 Refer to IEC TR 63082-1 for intelligent device management.

NOTE 2 Refer to Annex A for an example of a testing checklist.

5.3.5 Test schedule

A test schedule (activities and time schedule) shall be mutually agreed upon between the buyer and the vendor. Staffing requirements shall be agreed upon between the buyer and all other parties to satisfy schedule requirements. The FAT schedule shall be reviewed to confirm that it supports the project schedule for when the automation system is required to be delivered on site.

5.4 FAT punch list

5.4.1 General

With respect to the test specification, any incomplete work or non-conformances detected during the FAT shall be recorded on a punch list for correction of same by the party agreed upon by the vendor and the buyer. Each punchlist item shall be assigned one of the following categories:

- Immediate – FAT to be paused for rectification, FAT to continue after rectification;
- On-going – Rectification during FAT, will be completely rectified by end of FAT (typically for multiple instances of the same issue, each of which will be rectified as encountered and by the end of the FAT, all will be rectified. Rectification is performed before test. If later re-test is required, the item is classified as "Repeat");
- Repeat – FAT to be repeated for this item after rectification and before completion of FAT;
- Before shipment – To be rectified after FAT but before the system is shipped to the site, re-test, if any, to be documented and conducted during SAT;
- At site – Remaining work to be rectified after shipment, i.e., at site, and re-test, if any, to be documented and conducted during SAT or SIT; or
- Future – To capture issues not in the project or FAT scope but something to be addressed in the future.

A FAT punch list, at a minimum, shall include:

- reference to the applicable specification/FAT test plan requirement;
- description of the issue;
- description of the resolution and date completed; and
- sign-off area for buyer and the vendor for acceptance, if not recorded otherwise.

5.4.2 Correction

As items on the punch list are rectified, verification shall be documented. For any changes or corrections made during the FAT that can in any way affect previously completed tests, those tests shall be re-performed and documented.

5.4.3 Corrections after FAT

All problem corrections and subsequent re-checks should be executed during the FAT. If this is not possible, problem rectification can be undertaken after the FAT if mutually agreed to by buyer and the vendor. Problem correction to be completed after the FAT shall include the following steps:

- Identification of re-work needed;
- Action plan/time schedule, including responsible person(s);
- Execution of re-work;
- Re-test (of re-work and anything possibly affected by the re-work);

NOTE Whether the buyer is to witness the re-test is to be agreed upon with the vendor.

- Notification of completion; and
- Acceptance of re-check.

5.5 Documentation of FAT

5.5.1 General

The results of the FAT shall be completely documented, including:

- a) FAT report;
- b) FAT final documentation; and
- c) FAT completion.

5.5.2 FAT report

Minutes or a report of the FAT shall be developed and issued to all parties reflecting:

- Attendees;
- Tests performed;
- Open issues and agreements for their resolution; and
- Buyer approval to ship or other disposition of the system.

5.5.3 FAT final documentation

Final documentation of the FAT shall include:

- Signed copies of the test function plans;
- Dated and signed copies of all other documents generated during the FAT;
- FAT punch list, updated with the latest status of each item;
- Documentation of the actual hardware and software (including versions) tested;
- Documentation of all software and hardware configurable parameters used;
- Backup copy(ies) of the final complete system and application software;
- Documentation of system loading observed during the test and spare capacity;
- An index and color copies of all applicable graphic displays; and
- Update of all system-related documentation to reflect the FAT-complete status of the system.

5.6 FAT completion

The FAT shall be considered complete when all the required functions have been demonstrated and verified to be in accordance with the FAT plan and specifications, with the exception of the mutually agreed remaining punch list items. Upon successful completion of the FAT, authorized representatives of the buyer and the vendor shall sign the FAT test results/report. If a formal certificate is required, the form can be provided by the buyer or the vendor. The vendor shall ensure the preservation of the final state of the FAT to guarantee that there are no modifications or subsequent interventions in the equipment.

6 Factory integration test (FIT)

6.1 General

This Clause 6 provides the activities that are precursors to, conducted during, and provided after the FIT. The FIT is an optional test that can be conducted after or in conjunction with the FAT at the factory before shipment of the system. The purpose of the FIT is to conduct some, or all the SIT integration tests at the factory to identify and resolve problems earlier and at lower cost than in the field. Like the SIT, the FIT demonstrates that interconnected systems function together in order to achieve results based on the control philosophy and project-specific requirements. Performing a FIT can present financial or schedular advantages for the project. All interested parties (e.g., buyer, vendor(s)) shall agree on whether a FIT will be performed for the specific project and, if so, the scope and schedule for that test.

Tests conducted in the FIT are a partial or complete set of system interoperability tests to be conducted in the field during the SIT. Whether or not these tests were performed during the FIT, all the SIT tests shall be performed during the SIT in the field, after installation of all systems, subsystems and components.

6.2 Performance

The FIT, if to be performed, shall be performed after completion of or in conjunction with the FAT and prior to shipment of the system to the owner.

NOTE The FIT typically is performed by the vendor. The buyer typically witnesses the test activities. There can be buyers who want to carry out some parts of the FIT themselves. This is established on a project-related basis.

6.3 Pre-FIT activities

6.3.1 General

Prior to commencing the FIT, the following activities shall be completed:

- a) FAT, including updated FAT punch list;
- b) FIT test plan; and
- c) FIT test schedule.

6.3.2 Test plan

A written test plan and specification documenting the tests to be conducted, the applicable acceptance criteria to be used for each test, safety instructions, facilities/tools/hardware/software, and staffing shall be developed and agreed to by buyer and the vendor(s) in advance of the tests. This plan shall clarify who, buyer or the vendor, is to perform each test and the criteria for acceptance of test results. The test plan shall address all the following areas applicable to the specific project:

- Overall scope of the tests, including systems, hardware, software, configuration/programming, documentation, etc.;
- Tests to confirm interoperability of systems involved; and
- FAT functional tests of individual systems to be re-performed after interface to other system(s).

NOTE Refer to Annex C for an example of a testing checklist.

6.3.3 Test schedule

A test schedule (activities and time schedule) shall be mutually agreed upon between buyer and the vendor(s). Staffing requirements shall be agreed upon between the buyer and all other parties to satisfy schedule requirements.

6.4 FIT punch list

6.4.1 General

With respect to the test specification, any incomplete work or non-conformances detected during the FIT shall be recorded on a punch list for correction of same by the appropriate party. Punch list items shall be categorized as follows:

- Immediate – FIT to be paused for rectification, FIT to continue after rectification;
- On-going – Rectification during FIT, will be completely rectified by end of FIT (typically for multiple instances of the same issue, each of which will be rectified as encountered and by the end of the FIT, all will be rectified. Rectification is performed before test. If later re-test is required, the item is classified as "Repeat");
- Repeat – FIT to be repeated for this item after rectification and before completion of FIT;
- Before shipment – To be rectified after FIT but before the system is shipped to the site, re-test, if any, to be documented and conducted during SIT;
- At site – Remaining work to be rectified after shipment, i.e., at site, and re-test, if any, to be documented and conducted during SAT or SIT; or
- Future – To capture issues not in the project or FIT scope but something to be addressed in the future.

A FIT punch list, at a minimum, shall include:

- reference to specification/FIT test plan requirement;
- description of the issue;
- person(s) responsible for resolution;
- description of the resolution and date completed; and
- sign-off area for buyer and the vendor for acceptance, if not handled otherwise.

6.4.2 Correction

As items on the punch list are rectified, verification shall be documented. Any changes or corrections made during the FIT that can in any way affect previously completed tests require that those tests be re-performed and documented.

6.4.3 Correction after FIT

All problem corrections and subsequent re-checks should be executed during the FIT. If this is not possible, problem rectification can be undertaken after the FIT if mutually agreed to by buyer and the vendor. Problem correction to be completed after the FIT shall include the following steps:

- Identification of re-work needed;
- Action plan/time schedule, including responsible person(s);
- Execution of re-work;
- Re-test, of re-work and anything possibly affected by the re-work, including agreement with the vendor on the possible need for the buyer to witness re-test;
- Notification of completion; and
- Acceptance of re-check.

6.5 Documentation of FIT

6.5.1 General

The results of the FIT shall be completely documented, including:

- a) FIT report;
- b) FIT final documentation; and
- c) FIT completion.

6.5.2 FIT report

Minutes or a report of the FIT shall be developed and issued to all parties reflecting:

- Attendees;
- Tests performed;
- Open issues and agreements for their resolution; and
- Buyer acceptance of the system, with or without issues.

6.5.3 FIT final documentation

Final documentation of the FIT shall include:

- Signed copies of the test function plans;
- Dated and signed copies of all other documents generated during the FIT;
- FIT punch list, updated with the latest status of each item;
- Documentation of the actual hardware and software (including versions) tested;
- Documentation of all software and hardware configurable parameters used;
- Backup copy(ies) of the final complete system and application software;
- Documentation of system loading observed during the test and spare capacity;
- An index and color copies of any graphic displays modified or added since the FAT; and
- Update of all system-related documentation to reflect the FIT-complete status of the system.

6.6 FIT completion

The FIT shall be considered complete when all the required functions have been demonstrated and verified to be in accordance with the FIT plan and specifications, with the exception of the mutually agreed remaining punch list items. Upon successful completion of the FIT, authorized representatives of the buyer and the vendor(s) shall sign the FIT test results/report. If a formal certificate is required, the form can be provided by the buyer or the vendor. The vendor shall ensure the preservation of the final state of the FIT to guarantee that there are no modifications or subsequent interventions in the equipment.

7 Site acceptance test (SAT)

7.1 Performance

The SAT shall be performed after the delivery and installation of the system at the site. The SAT is performed to demonstrate the proper functionality of the system after delivery and installation.

NOTE The SAT typically is performed by the vendor. The buyer typically witnesses the test activities. There can be buyers who want to carry out some parts of the SAT themselves. This is established on a project-related basis.

7.2 Pre-SAT activities

7.2.1 General

Prior to conducting the SAT, the relevant hardware/software components shall be delivered to the site and properly installed. The following items shall be completed during the installation of the automation system/subsystem/components before the SAT can be carried out:

- Hardware installation (all system components including controllers, I/O cards, marshalling racks, power supplies, operating/engineering stations);
- Grounding system installed for the relevant hardware being tested;
- Network communications installed (for example, hubs, switches);
- Review of software revisions, updates or modifications from FAT to date;
- Automation system power up and download of correct software;
- A full backup of any software/code that has been installed at the start of the SAT test; and
- I/O check of any I/O that will be tested during the SAT.

7.2.2 Test plan

A written test plan and specification documenting the tests to be conducted, the applicable acceptance criteria to be used for each test, safety instructions, facilities/tools/hardware/software, and staffing shall be developed and agreed to by buyer and the vendor in advance of the tests. This plan shall clarify who, buyer or the vendor, is to perform each test and the criteria for acceptance of test results. The test plan shall address all the following areas applicable to the specific project:

- Overall scope of the tests, including hardware, software, configuration/programming, documentation, etc.;
- Hardware, including installation, agreement with installation drawings, wiring/cabling, terminations, labeling as per project documentation/drawings, requirements, and acceptance criteria;
- Software, including the loaded automation system software and the loaded custom configuration, programs and graphics are the correct version and are functioning properly;
- FAT functional tests to be re-performed after installation;
- FAT tests that were not performed/completed during the FAT and completion of any other open FAT punch list items;
- FIT functional tests to be re-performed after installation;
- FIT tests that were not performed/completed during the FIT and completion of any other open FIT punch list items;
- Network and system security (e.g. proper firewall rules and network segmentation); and
- Tests such as interlock checks, complex functionality checks and sequence or batch checks, which are to be performed after loop checks.

Hardware and software configurations should comply with FAT results.

NOTE Refer to Annex B for an example of a testing checklist.

7.2.3 Test schedule

A test schedule (activities and time schedule) shall be mutually agreed upon between the buyer and the vendor. Staffing requirements shall be agreed upon between the buyer and all other parties to satisfy schedule requirements. The SAT contains checks that are to be performed before loop checks and can contain checks that are to be performed after loop checks.

NOTE For guidance for loop checks refer to IEC 62382.

7.3 SAT punch list

7.3.1 General

With respect to the test specification, any incomplete work or non-conformances detected during the SAT shall be recorded on a punch list for correction of same by the appropriate party. Each punchlist item shall be assigned one of the following categories:

- Immediate – SAT to be paused for rectification, SAT to continue after rectification;
- On-going – Rectification during SAT will be completely rectified by end of SAT (typically for multiple instances of the same issue, each of which will be rectified as encountered and by the end of the SAT, all will be rectified. Rectification is performed before test. If later re-test is required, the item is classified as "Repeat".);
- Repeat – SAT to be repeated for this item after rectification and before completion of SAT; or
- Future – Something that is not required to be resolved prior to the start of commissioning or that is captured as an issue not in the project or SAT scope but something to be addressed in the future.

A SAT punch list, at a minimum, shall include:

- reference to specification/SAT test plan requirement;
- description of the issue;
- person(s) responsible for resolution;
- description of the resolution and date completed; and
- sign-off area for buyer and the vendor for acceptance, if not recorded otherwise.

7.3.2 Correction

As items on the punch list are rectified, verification shall be documented. Any changes or corrections made during the SAT that can in any way affect previously completed tests require that those tests be re-performed and documented.

7.3.3 Correction after SAT

All problem corrections and subsequent re-checks should be executed during the SAT. If this is not possible, problem rectification can be undertaken after the SAT if mutually agreed to by the buyer and the vendor. Problem correction to be completed after the SAT should include the following steps:

- Identification of re-work needed;
- Action plan/time schedule, including responsible person(s);
- Execution of re-work;
- Re-test, of re-work and anything possibly affected by the re-work, including agreement with the vendor on the possible need for the buyer to witness the re-test;
- Notification of completion; and
- Acceptance of re-check.

7.4 Documentation of SAT

7.4.1 General

The results of the SAT shall be completely documented, including:

- a) SAT report;
- b) SAT final documentation; and
- c) SAT completion.

7.4.2 SAT report

Minutes or a report of the SAT shall be developed and issued to all parties reflecting:

- Attendees;
- Tests performed;
- Open issues and agreements for their resolution; and
- Buyer acceptance of the system, with or without open issues.

7.4.3 SAT final documentation

Final documentation of the SAT shall include:

- Signed copies of the test function plans;
- Dated and signed copies of all other documents generated during the SAT;
- SAT punch list, updated with the latest status of each item;
- Documentation of the actual hardware and software (including versions) tested;
- Documentation of all software and hardware configurable parameters used;
- Backup copy(ies) of the final complete system and application software;
- Documentation of system loading observed during the test and spare capacity;
- An index and color copies of any graphic displays modified or added since the FAT; and
- Update of all system-related documentation to reflect the SAT-complete status of the system.

7.5 SAT completion

The SAT shall be considered complete when all the required functions have been demonstrated and verified to be in accordance with the SAT plan and specifications, with the exception of the mutually agreed remaining punch list items. Upon successful completion of the SAT, authorized representatives of the buyer and the vendor shall sign the SAT test results/report. If a formal certificate is required, the form can be provided by the buyer or the vendor. The vendor shall ensure the preservation of the final state of the SAT to guarantee that there are no modifications or subsequent interventions in the equipment.

8 Site integration test (SIT)

8.1 Performance

The SIT shall ensure that interconnected systems function together in order to achieve results based on the control philosophy and project-specific requirements. The SIT consists of testing the communication and interaction between the automation subsystems or with other systems to ensure desired functional performance. The SIT can be one overall test with multiple sections, one for each subsystem, or it can be multiple tests, one for each subsystem.

The SIT shall be performed after the SAT for each system/subsystem involved has been successfully completed. The SIT is performed to test the combination of two or more independent systems that have been connected in order to obtain the functionality desired by the control philosophy for the complete automation system. For example, a SIT shall be conducted when integrating the following types of systems that communicate in any way with other parts of the automation system using other than traditional I/O (e.g. analog inputs/outputs, discrete inputs/outputs), the functionality of which is verified in the loop tests:

- Automation systems that are part of an equipment package unit and have their own DCS/PLC or controller;
- Analyzer systems;
- Safety instrumented systems;
- Combining DCS/PLCs from more than one vendor or manufacturer;
- Higher level systems such as MES, ERP; and
- Any other communications between automation subsystems or between the automation system and any other systems.

NOTE The SIT typically is performed by the vendor. The buyer typically witnesses the test activities. There can be buyers who want to carry out some parts of the SIT themselves. This is established on a project-related basis.

8.2 Pre-SIT activities

8.2.1 General

Prior to conducting the SIT, the relevant hardware/software components of all systems and subsystems to be involved in the SIT shall have satisfactorily completed their respective SAT. Installation of all communications and interconnections (e.g., direct connected signals or network physical interface layer) between systems and subsystems shall be complete. A full backup of any software/code that has been installed at the start of the SIT test shall be made.

8.2.2 Test plan

A written test plan and specification documenting the tests to be conducted, the applicable acceptance criteria to be used for each test, safety instructions, facilities/tools/hardware/software, and staffing shall be developed and agreed to by the buyer and the vendor(s) in advance of the tests. This plan shall clarify who, the buyer or the vendor, is to perform each test and the criteria for acceptance of test results. The test plan shall address all of the following areas applicable to the specific project:

- Overall scope of the tests, including systems, hardware, software, configuration/programming, documentation, etc.;
- Tests to confirm interoperability of systems involved; and
- FAT or SAT functional tests of systems to be re-performed after interface to other system(s).

NOTE Refer to Annex C for an example of a testing checklist.

8.2.3 Test schedule

A test schedule (activities and time schedule) shall be mutually agreed upon between buyer and the vendor(s). Staffing requirements shall be agreed upon between the buyer and all other parties to satisfy schedule requirements.