



5.1 AutoPASS Test strategy

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1	19-10-2007	Per Einar Pedersli	After a major revision
2	14.4.2011	Jo Andersen	Tests and approval milestones are adapted to general contract conditions. Test sequences, responsibilities and main test issues are modified. IST 1-3 are replaced with IST short-term and IST long-term. IST maintenance is defined
3	14.11.2014	Per Einar Pedersli	IST-test have been replaced by KPI-tests.

TABLE OF CONTENTS

1. INTRODUCTION	4
2. SPECIFICATION OF THE TESTS	5
2.1 TEST PROCEDURES	5
2.2 VERIFICATION METHODS	5
3. TEST DOCUMENTATION.....	6
3.1 TEST PLAN	6
3.2 TEST PROCEDURE	6
3.3 TEST REPORT.....	6
3.4 TEST RESULTS DEVIATION	7
3.5 TEST PROTOCOL.....	7
4. TEST CATEGORIES AND SEQUENCES.....	8
5. GENERIC APPROVAL TESTS.....	9
5.1 FACTORY ACCEPTANCE TEST (FAT).....	9
5.2 PRODUCTION TEST (PT).....	11
5.3 INSTALLATION TESTS.....	12
6. ACCEPTANCE TESTS	13
6.1 CUSTOMER ACCEPTNACE TEST - SITE ACCEPTANCE TEST (SAT).....	13
6.2 APPROVAL PERIOD	14

1. INTRODUCTION

This document describes the tests to be performed for the complete delivery, i.e. hardware and software. This includes an overall description of the different types of tests to be performed. It is also described in which order the tests shall be performed, as well as the prerequisites for starting each test. For each test it is defined which party is responsible for working out the test procedure, the approval of the tests themselves, the execution of the tests and the approval of the test results.

The approval milestones are adapted to the general contract conditions.

2. SPECIFICATION OF THE TESTS

2.1 TEST PROCEDURES

This document does not specify any tests in detail. The more detailed test procedures shall be worked out during the delivery before performance of each test and shall be based on the structure of the test sequence and Requirements specifications. The Contractor shall document conformance with all requirements in the Customer Requirement specification.

The Customer has specified some tests as a part of the Requirement specification, which shall be included in the final test procedures:

- Autopass radio link protocol test
- Easygo specification test procedure

What test sequence each requirement is to be tested is marked in the Requirement specification.

If the Contractor for some reason wants to change the test category for some requirements this must be specified as a reservation to the Requirements in accordance with specified procedure. The reason for changing this must be described.

The Contractor may conduct additional tests to ensure that all requirements are fulfilled.

The Customer may at any time specify and perform additional tests on the equipment.

2.2 VERIFICATION METHODS

The compliance with the requirements may be verified in accordance with one of these verification methods:

Method	Description
Document approval	The verification of the requirements is done by approval of delivered documents.
Testing	The verification of the requirement is done by verifying that the deliverables fulfil the requirement under an exhaustive set of controlled conditions. Testing is aiming at exposing errors.
Analysis	The verification of a requirement is done by means of analytical argumentation.
Inspection	The verification of the requirement shall be provided by a visual observation of the presence of an object that represents the realisation of the requirement and that the object has necessary qualities and characteristics. The results shall be documented by means of check lists or written conclusions.

The method used for the verification will be specified by the Customer.

3. TEST DOCUMENTATION

3.1 TEST PLAN

The Contractor shall describe all the test sequences in an overall test plan with this main content:

- Test description
- Time milestones
- Organisation and responsibilities
- Test resources
- General methods and tools

The Contractor shall submit the plan for the Customer's review prior to DVT milestone. If the Customer discovers that the plan is incomplete or not suitable for performing the tests in questions, the Contractor shall make necessary adjustments until the Customer approves the plan. Customer shall approve the plan without undue delay.

3.2 TEST PROCEDURE

The Contractor shall work out test procedures before performing each test sequence. The test procedure shall contain:

- Requirement description with reference to the Requirement specification
- Test methods for each test
- Data collection method
- Statistics
- Type of analysis
- Headlines in the test report
- Protocol layout

3.3 TEST REPORT

The Contractor shall for each test sequence work out a Test report with this content:

- Purpose of the test
- Reference to the Test procedure
- Data collection and sample
- Compliance to the Customer Requirement specification
- Analysis
- Conclusions
- Appendices: Detailed data and statistics

3.4 TEST RESULTS DEVIATION

During execution of the different tests, deviations (i.e. errors or failure to meet the requirements) may be encountered. Deviations will be classified into severity class and dealt with as described in the Agreement.

Categorisation of the deviations is done initially by the Contractor's leader of the test team and may be adjusted by the Customer. The Customer has final authority to assign category.

3.5 TEST PROTOCOL

The Contractor shall provide a test protocol. The test protocol shall as minimum content the following:

What test category it represent, date for the test, reference to test procedure and test report, description on how to handle deviations, description on the next test category and signature by both the Contractor and Customer.

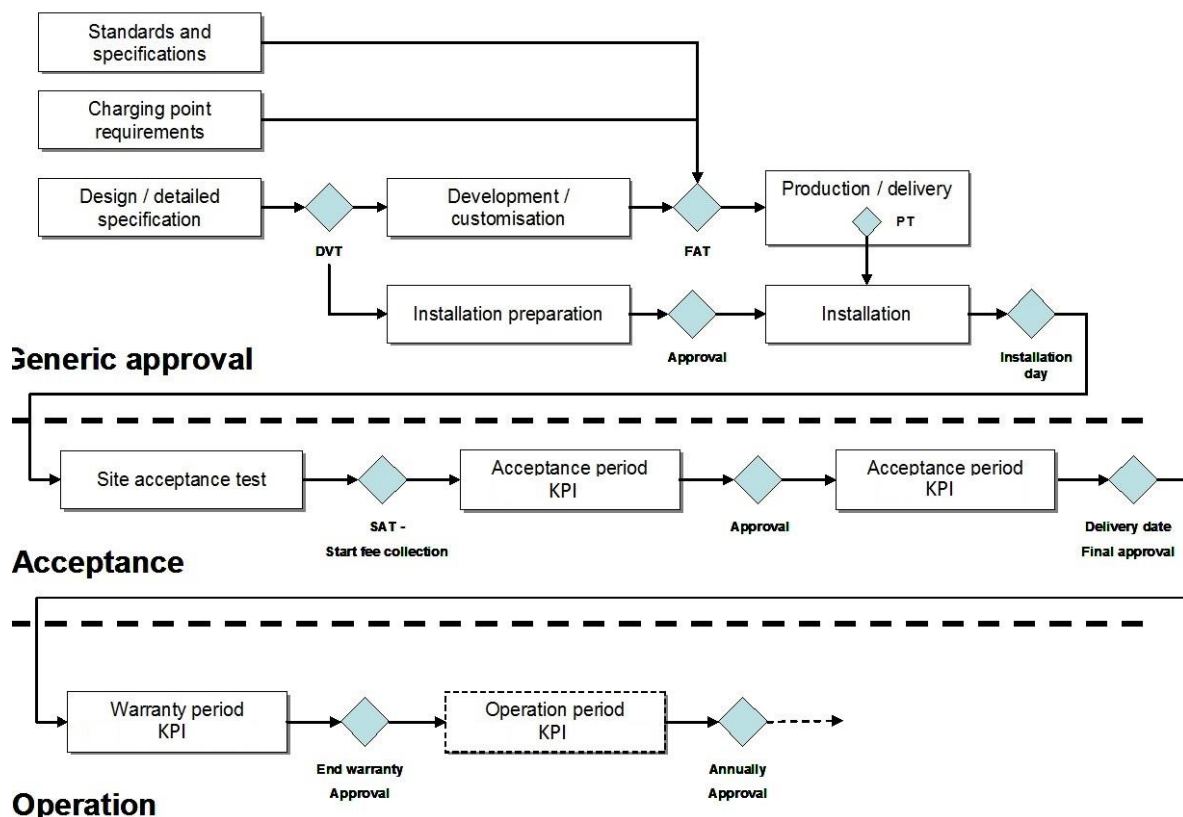
4. TEST CATEGORIES AND SEQUENCES

The tests are divided into two categories: Generic approval tests and Acceptance tests.

- “Generic approval tests” are tests that are performed on one or a few units, testing if the design and construction are adhered to the requirements. The tested units are assumed to be representative for a larger quantity of produced equal units.
- “Acceptance tests” are tests used for approval of the total delivery (units, functionality, integration, installation and interfaces) and are parts of the Acceptance test and Approval period described in the general conditions of the contract.
- “Tests during operation” shall be performed quarterly (every 3 months) during the operation period, i.e. the time period after Delivery date.

Each requirement in the Requirement specification shall be tested as early as possible, in order to minimise the uncertainties associated with a complex system.

Main activities, test sequences and contractual milestones for approval is shown in this figure:



5. GENERIC APPROVAL TESTS

Generic approval tests cover these specific tests:

- Design verification test (DVT)
 - Detailed design/specification
- Factory Acceptance test (FAT)
 - Standards and specifications for approval and conformance
 - Autopass radio link protocol test
 - Technical and physical requirements
 - Charging point functionality tests
- Production Test (PT)
 - Tests of each unit during production
- Installation tests
 - Installation preparation test
 - Installation day test

The Generic approval tests shall be approved before performing the Acceptance tests.

5.1 DESIGN VERIFICATION TEST (DVT)

The DVT shall verify that the system design is compliant to all functional requirements in the Requirement specification. The DVT must be done as a review and approval of the design documents and detailed specifications delivered by the Contractor. The document review may be supplemented with demonstrations or simulations.

Test procedure specified by	Contractor
Verification method	Document approval
Test procedure accepted by	Customer
Testing performed by	Contractor
Tests performed at	As decided by Contractor
Test results approved by	Customer

5.2 FACTORY ACCEPTANCE TEST (FAT)

The Factory Acceptance Test (FAT) is performed in order to verify that the system performs according to Requirements specification, both the individual modules as well as the entire system. The purpose of the FAT is to make sure that all requirements will be fulfilled, before any equipment is shipped to the Customer.

The FAT requires a functional Charging point to be built. All equipment to be included in the final Charging points for permanent use shall also be included in the test. However, equipment that is costly to include and do not have critical interfaces can be simulated. A critical interface is an interface that is non-trivial to model, and the Contractor shall seek approval from the Customer concerning interfaces that are deemed to be critical.

Test procedure specified by	Contractor
Verification method	Testing
Test procedure accepted by	Customer
Testing performed by	Contractor
Tests performed at	Contractor's factory, Contractor's test site, Customer's test site if available
Test results approved by	Customer

5.2.1 Standards and specifications for approval / conformance

This includes, but is not limited to, the following:

- CE marking, in accordance with the relevant EC directives
- That the DSRC Equipment shall be in conformance with ETSI requirements
- Compliance with the requirements of the EMC directive
- European Council Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment

Test procedure specified by	EC / ETSI / National authorities. The Contractor shall test the equipment against all tests that apply for products of the given nature, and that by law or regulation is required for the given application of the product. The Contractor shall inform the Customer of which tests and requirements that applies for the product(s).
Verification method	Testing
Test procedure accepted by	Customer
Testing performed by	Accredited laboratory
Tests performed at	As specified by the laboratory performing the test
Test results approved by	Customer

5.2.2 Autopass radio link protocol tests

The DSRC Radio link protocol tests will be used to qualify conformance to the DSRC interface.

In addition to these tests the equipment shall fulfil requirements with respect to handle the EasyGO+ agreed DSRC Applications.

The protocol tests will be used to detect problems related to:

- Implementation of the interface.
- Interoperability between equipment of different origin.

Test procedure specified by	Customer (from the Requirement specification)
Verification method	Testing
Test procedure accepted by	Customer
Testing performed by	Contractor
Tests performed at	Premises selected by the Contractor
Test results approved by	Customer

5.2.3 Technical and physical requirements

Tests of the technical and physical requirements detect problems concerning durability, environmental conditions, use and maintenance.

Test procedure specified by	Contractor
Verification method	Testing
Test procedure accepted by	Customer
Testing performed by	Contractor
Tests performed at	Premises selected by the Contractor
Test results approved by	Customer

5.2.4 Charging point functionality tests

This test sequence consists of test qualifying specific functional requirements, like requirements related to all the system components, i.e. charging by OBU and LPN, vehicle detection, content of transactions and exceptions, content of status files, signal light functionality, image quality, DSRC functionality for Autopass and Easygo+, MCS functionality and capacity, etc.

The main interfaces and integration with other modules shall be handled as integration tests, i.e. the interface between CPE and CS, interface between CPE and MCS and interface between CPE and TTP.

Test procedure specified by	Contractor
Verification method	Testing
Test procedure accepted by	Customer
Testing performed by	Contractor
Tests performed at	Premises selected by the Contractor
Test results approved by	Customer

5.3 PRODUCTION TEST (PT)

The Production test (PT) is a test performed on all produced units, and includes screening and logging of parameters. The reason for performing the PT is to test the produced units as early as possible, to avoid malfunctioning devices being shipped to the Contractor.

The Contractor is responsible for establishing quality control routines and test procedures to make sure that all manufactured items meet Requirement specification and are set forth in the Contractors quality assurance system.

Test procedure specified by	Contractor
Verification method	Testing, Inspection
Test procedure accepted by	Contractor
Testing performed by	Contractor
Tests performed at	As decided by Contractor
Test results approved by	Contractor. Summary of test results shall be accepted by Customer.

5.4 INSTALLATION TESTS

During installation preparation and the actual installation at each charging point tests shall be performed by means of inspections and check lists.

5.4.1 Installation preparation test

After the preparation work before installation of the delivery is completed, the Contractor shall approve that the site is ready for installation work. The test shall be done by inspection. The procedure may be a check list.

Responsibility for installation preparation test:

Test procedure specified by	Contractor
Verification method	Inspection
Test procedure accepted by	Contractor
Testing performed by	Contractor
Tests performed at	All installations
Test results approved by	Contractor

5.4.2 Installation day test

After completion of the installation work, the Customer shall approve the installations according to the contract conditions.

The test shall verify that the installations are in accordance with good engineering practice, contain all specified equipments, are equipped with the required documentation, and are interfaced with power supply and communication lines.

Responsibilities for installation day test are:

Test procedure specified by	Contractor
Verification method	Inspection
Test procedure accepted by	Customer
Testing performed by	Contractor
Tests performed at	All installations
Test results approved by	Customer

6. ACCEPTANCE TESTS

Acceptance tests cover tests of each batch or unit delivered and the functionality for the integrated system. The tests are split into these different categories:

- Customer acceptance test - Site Acceptance Test
- Approval period

6.1 CUSTOMER ACCEPTNACE TEST - SITE ACCEPTANCE TEST (SAT)

The SAT is performed in order to verify that a specific site is delivered and installed in accordance with the contract requirements. This will then include checking both what is delivered and that the functionality is as specified. The SAT shall enable the Customer to start collecting fees.

The SAT shall verify that the charging point:

- Is correctly configured
- Perform correctly the payment methods and give correct information to the driver (variable message signs and signal lights) within the full charging area
- Handles functionality correctly with respect to generating transactions, video images, charging point status, security implementation, alarms and exception messages
- Communicates with the central system (CS) according to the Requirement specification
- Communicates with the monitoring and control system (MCS)

The SAT cannot reveal that the image quality is sufficient for collecting the toll fee under all weather and light conditions. However, some sets of requirements shall be verified at the SAT as these do not change over time. The vehicle Images shall be inspected to verify that:

- The vehicle images fulfils requirements with respect to privacy
- The vehicle images fulfils requirements with respect to resolution for the image of the vehicle licence plate.
- The vehicle image contains data information additional to the original image

Various driving scenarios shall be conducted at the charging point. The driving scenarios shall demonstrate that the charging point handles the required payment functionality for the complete charging area. The lane for opposing traffic shall be included if such functionality is required.

The Customer reserves the right to perform additional tests at any sites. The Contractor shall assist while performing these tests.

Test procedure specified by	Contractor
Verification method	Testing, Inspection
Test procedure accepted by	Customer
Testing performed by	Contractor
Tests performed at	All installations
Test results approved by	Customer

6.2 APPROVAL PERIOD

6.2.1 KPI-reporting

The KPI-reporting is a summary of the results from test of long-term properties of the equipment. The purpose of the test is to verify that the quality is maintained on the same level as specified in the Requirement specification. This is typical for tests of the system's performance and durability, as well as verification of statistical parameters. A sufficient sample is needed to achieve statistical significance.

KPI's to be reported	Customers decision, see requirement specifications
Verification method	Collecting data, analysis, reporting
Data collection	Contractor, toll company, operating company
Reports performed by	Customer
Reports performed at	All installations
Quality approval	Customer
Approval period	3 months

6.2.2 KPI Test

All the KPI results is an analysis of the quality of the delivery and shall reveal issues to be investigated further through more detailed testing if necessary.

The KPI test may involve other parties than the Contractor and the Customer, i.e. toll company, operating company, etc. The KPI consists of these main activities:

- Data collection
- Data calculations and presentations
- Analysis
- Conclusions
- Needs for further tests and investigations
- Reporting

The Contractor shall continuously measure results and compare with the requirements given in the Customer requirement specification for these Key performance indicators (KPI):