AP-2.3
AutoPASS TSP Suitability for Use – OBE Test Description

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DOCUMENT STATUS

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REVISION HISTORY

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3.0	23 February 2024	NPRA	Updated and restructured

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1. PREFACE

1.1 Objectives

This document specifies the acceptance test strategy and test cases for On-Board Equipment (OBE) to be used within AutoPASS Samvirke. Toll Service Providers (TSP) provide Service Users (SU) with an OBE that is detected in charging points equipped with Roadside Equipment (RSE) operated by a Toll Charger (TC). Before an OBE can be taken in use in AutoPASS, an approval of the type of OBE is required.

The NPRA Directorate of Public Roads, Legislation and Regulatory Authority, Road User Charging (in this document just denoted NPRA) has the authority to specify technical and operational requirements for equipment used by all actors in AutoPASS Samvirke. A description of the roles is presented in ref. [7].

This document describes the process for the final acceptance of OBE provided by a TSP. The successful approval is only valid for the tested OBE with the tested software and hardware version. Any change to the OBE software or hardware will make it necessary for the NPRA to consider the need for repeating the approval process.

The test description in this document applies for all scenarios involving a new or modified OBE in AutoPASS, i.e. both for a TSP applying for approval as a new AutoPASS TSP, and for an existing AutoPASS TSP introducing a new or modified OBE. In the case of a new AutoPASS TSP, there is also an additional technical acceptance procedure for the TSP's back office interface to AutoPASS HUB and further to other systems in the AutoPASS infrastructure. The overall "Suitability for Use" test strategy is described in the document in ref. [7].

1.2 Reference Documents

The following table lists the documents that are referenced in this document. Other documents of relevance to the topic of this document may also be listed:

Table 1 – Reference Documents

Ref.	Document Title	Description
1.	AP-1.0 AutoPASS Definisjoner, Standarder og Direktiver	Lists and describes all concepts, definitions, standards, and directives that are relevant for the specifications of AutoPASS Samvirke.
2.	AP-1.3 AutoPASS EFC Security architecture	Outlines the principles for security and encryption in AutoPASS.
3.	AP-1.5A Overordnet kravspesifikasjon for AutoPASS vegkantutstyr	General requirements for roadside equipment.
4.	AP-1.5B Detaljerte krav til AutoPASS vegkantutstyr	Detailed requirements for roadside equipment.
5.	AP-1.6 Requirements for On-board Equipment (OBE) for use in AutoPASS Samvirke	Minimum requirements for OBE to be approved and used in AutoPASS Samvirke.
6.	AP-1.6A AutoPASS OBE Statement of Compliance	A statement of compliance to all requirements in AP-1.6 to be filled out by TSP
7.	AP-2.2 AutoPASS TSP Suitability for use - Test Strategy	An overall test strategy for Suitability for use tests for TSP that applies for being part of AutoPASS Samvirke

8.	AP-2.3B Test plan template	A test plan template that the TSP uses to work out the test plan for the acceptance test. This test plan is also a template for the test report.
9.	AP-2.5 Søknadsskjema for godkjenning av brikke	A template application to be filled in by a TSP for a new or modified OBE to be accepted in AutoPASS Samvirke

1.3 Concepts, Definitions, Standards, and Directives

For concepts, definitions, standards, and directives, please see ref. [*1*].

1.4 Prerequisites

The OBE must be designed and manufactured according to the following specification in order to be approved in AutoPASS:

ref. [*5*]

To verify that the OBE functions as intended in the AutoPASS environment, the OBE shall be tested on roadside equipment designed and manufactured according to the following specifications:

ref. [*3*] and ref. [*4*]

2. PROCESS OVERVIEW FOR A NEW OR MODIFIED OBE

2.1 General

A full approval test for a new OBE follows the processes shown in *Figure 1*. However, a full test of a new or modified OBE is not always required for an established TSP. This document also describes simplified test cases to be used when the NPRA decides them to be sufficient.

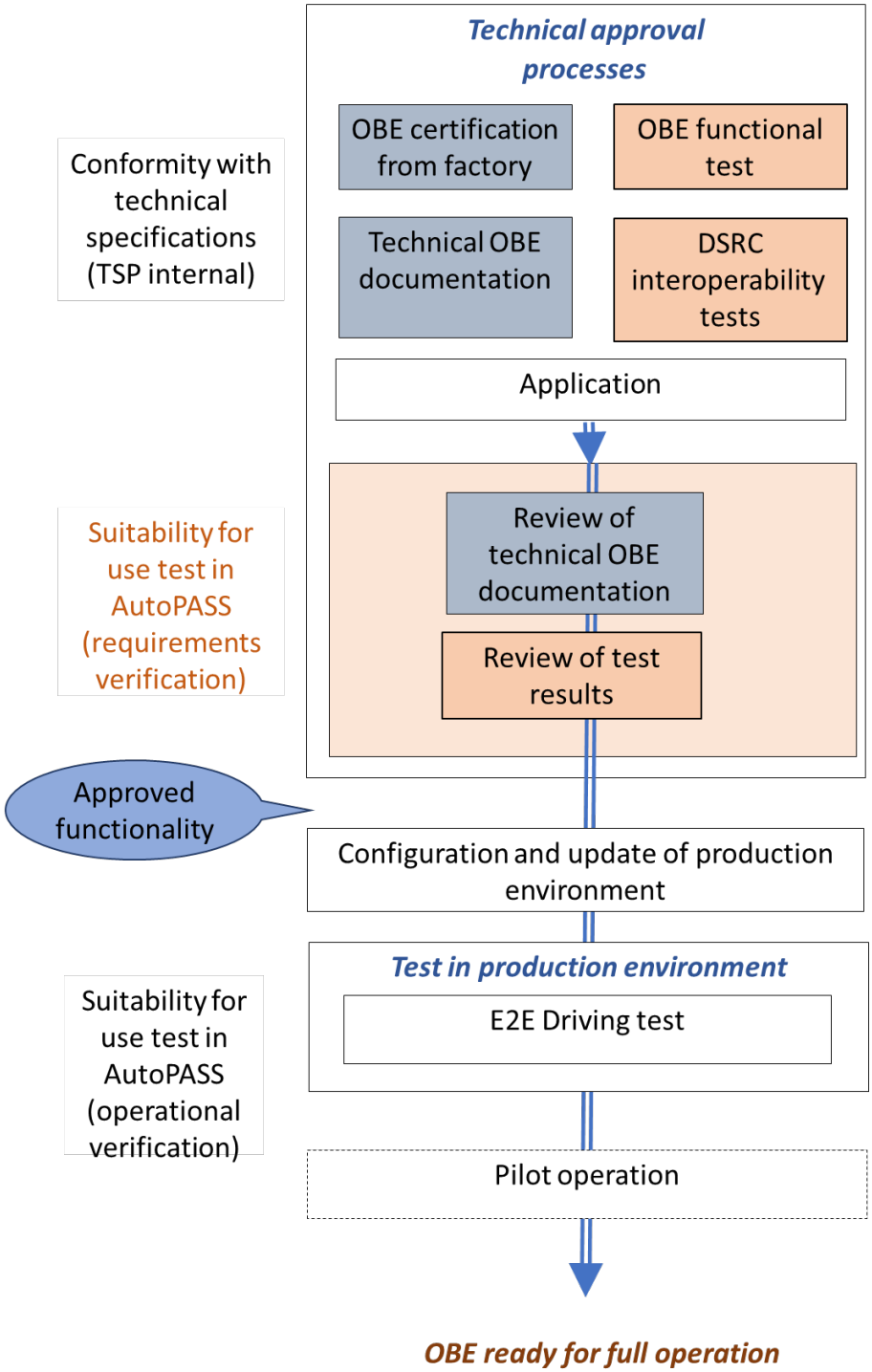


Figure 1. Full technical approval process for new AutoPASS OBE

When an approved TSP in AutoPASS wants to introduce a new or modified OBE, an application for use in AutoPASS must be submitted to the NPRA. The OBE application can be categorized as one of the following:

a) New model/type of OBE that is not in use in AutoPASS
b) New OBE model/type for this TSP, but the OBE is already in use by another TSP in AutoPASS
c) Updated version of an OBE that has already been approved by the same TSP, but with changes in hardware or software, new personalization procedures or other types of changes.

A test regime with different levels applies because there is a large range of variation in performance uncertainty for the OBE used in AutoPASS RSE for the categories and also for different scenarios for the categories. Category a) requires the most comprehensive testing while test procedures for b) and c) may be less extensive.

2.2 Changes in already accepted OBE

Any change of an approved OBE shall be reported to the NPRA, also where there are no changes that should affect performance.

If there is a change to the exterior design, photos of the new design must be submitted to the NPRA at least 30 days prior to it being issued to customers.

If an OBE has been through a modification that affects conformity to the NPRA's OBE requirements, or in any other way may affect the performance in AutoPASS, it is not sufficient to report it. In this case the NPRA will require an application for the continued use of a modified OBE. If a TSP is in doubt whether there is a version change that requires an application or not, the TSP shall submit an inquiry to the NPRA with a change description. If the NPRA regards the change to be insignificant, the OBE will be approved without any further tests. Otherwise, the TSP will be asked to send an application for the modified OBE.

The following list (not exhaustive) defines the most relevant modification cases of the OBE for AutoPASS.

- Change of the DSRC hardware
- Modification of the DSRC protocol stack
- Modification of the OBE hardware or software architecture
- Modification of the OBE operating system
- New or modified OBE functionality, also in OBE elements not related to AutoPASS
- Changed EFC_ContextMark and/or security keys
- Alteration of the EquipmentClass

A change report must be submitted by the TSP describing in detail all software and hardware modification that have been made to the OBE. This report will be the base for the decision concerning a required reassessment of the OBE. A major change of the OBE could result in a full approval process as defined for a new OBE type. The TSP must describe what kind of assessment they have made for the change in the OBE and the risk it entails for changed performance. The level of risk is assessed based on the change that has been made. A short analysis of the risk is expected from the TSP.

It is expected that the AutoPASS TSP (typically through their OBE manufacturer) performs a set of DSRC tests with prototypes after any OBE modification. The report of these tests should also

contain a comparison of the performance before and after the change (regression test). These test results and the TSP's own conclusions are part of the information required for the decision process for a reapproval. The NPRA may require receiving a protocol of the performed tests.

2.3 Overview of the test and approval process

The approval process for a new or modified OBE has the following main steps:

i. The TSP must submit an application for the new or modified OBE that they want approved for use in AutoPASS.
ii. In the application, the TSP must answer a list of questions about the OBE to be approved. Also, other documentation must be submitted, see requirements in chapter *2.4*.
iii. The NPRA will assess the application and decide on the test level. There are fixed criteria for the decision of test level, see chapter *2.5*.

The TSP should submit the application to the NPRA on the new or modified OBE as early as possible prior to the planned introduction to users. The application and test process may take some time, e.g. when there is a need for RSE updates. Therefore, it is recommended that a complete application is submitted to the NPRA up to six months prior to the planned introduction to users.

As shown in *Figure 1,* the full approval process is divided into three main test and verification phases:

- Review of conformity with technical specifications/standards and review of results from the manufacturer's OBE tests
- Comprehensive E2E driving test in the production environment
- Monitoring during the pilot operation phase

Approval of a new TSP in AutoPASS will require all these phases. Different scenarios of a new or modified OBE for an approved TSP will in many cases not require the same amount of verification and testing before approval. The three test phases as described above represent three different test levels, where one of them will be required by the NPRA depending on the scenario according to chapter *2.5*. The three test levels are:

C1. Full approval process. Includes both review of conformity of the OBE's technical specifications to AutoPASS' technical requirements and review of the manufacturer's test results. In addition this level also includes E2E driving test (same as test level 2).
C2. Only E2E driving test in the production environment is required
C3. Only pilot operation is required

Chapter *2.5* will describe the criteria for the required test level.

2.4 Content of an application for a new or modified OBE

The application form (ref. [*9*]) shall be signed by an authorized person from the TSP. It contains a list of statements to be answered concerning the OBE to be approved.

In addition, the following shall be included in the application as appendices:

- Statement of Compliance to the technical requirements for OBE in AutoPASS. The template for this document can be found in ref. [*6*].
- In case of modification to an approved OBE; - A Change report that gives a detailed description of the changes, and also how this relates to the documentation that was submitted when the OBE was originally approved. The NPRA may require submission of complete updated documentation.
- Data sheet of the OBE type or equivalent technical information

- Photos of the actual OBE design. There must be clear images from the front and back sides of the OBE as well as one image of where the PAN is printed as a number. Images shall be taken perpendicularly to each surface of the OBE.

2.5 Criteria for deciding the type of test that is required

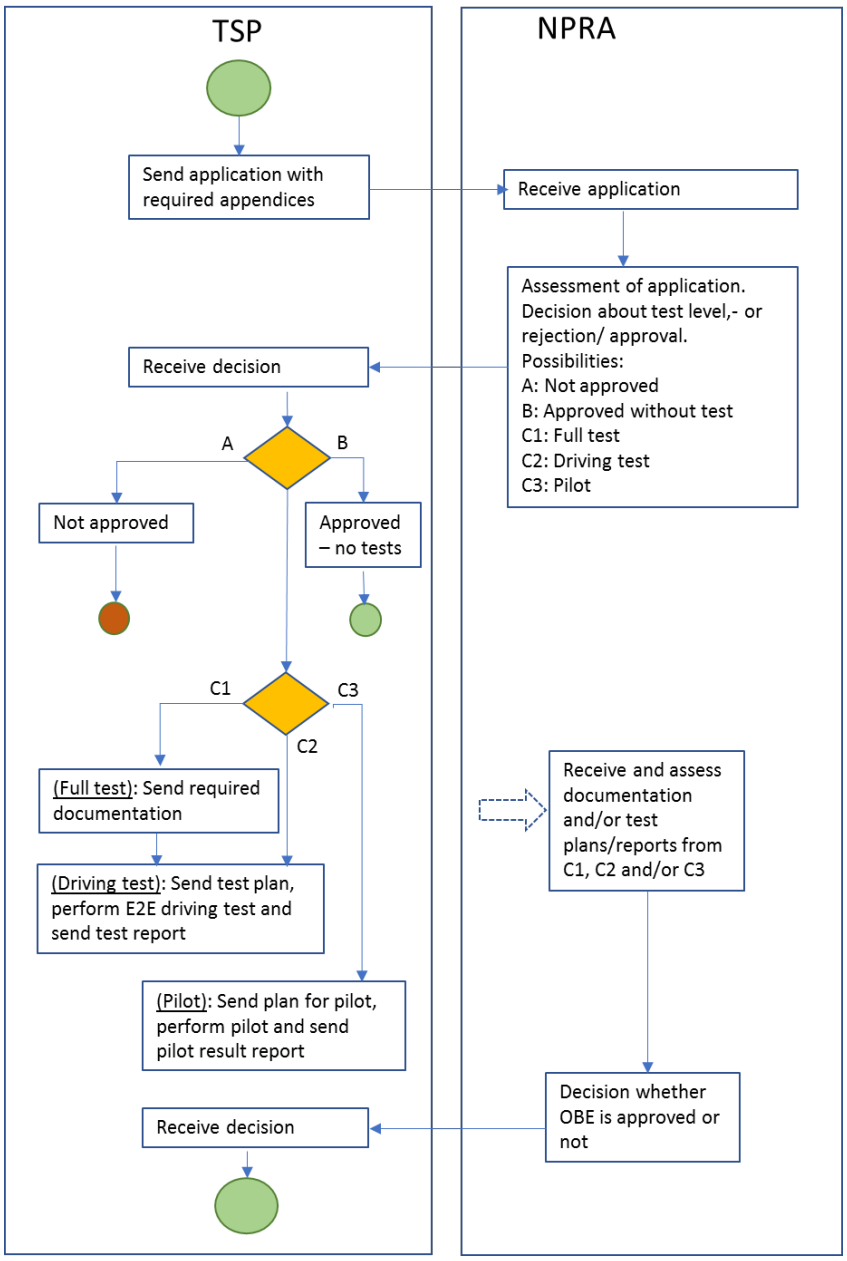
The NPRA will, based on information in the application, decide either of the following subcategories of new or modified OBE with required test level (the A, B, C1, C2, C3 denotation of test level as shown in *Figure 2*). The leftmost column in the table is the category of OBE application (a, b or c, as defined in chapter *2.1*).

Table 2 – Subcategories with corresponding test levels

Cat.	NPRA's decision on subcategory of OBE application	Required test level
a	A new type of OBE that is not in use in AutoPASS.	Full approval process (C1)
b	A new OBE type for this TSP, but the OBE is already in use by another TSP in AutoPASS in a different version. The version change is deemed by the NPRA to be major and to represent significant uncertainty concerning OBE performance or compatibility.	Full approval process (C1)
b	A new OBE type for this TSP, but the OBE is already in use by another TSP in AutoPASS, possibly in a different version. The version change is deemed by the NPRA to be minor and to represent reduced uncertainty concerning the OBE performance or compatibility.	E2E Driving test in production environment (C2)
c	A modified version of an OBE that has previously been approved for the same TSP. The version change is deemed by the NPRA to be major and to represent significant uncertainty concerning changed OBE performance or compatibility.	Full approval process (C1)
c	A modified version of an OBE that has previously been approved for the same TSP. The version change is deemed by the NPRA to be minor and to represent limited uncertainty concerning the OBE performance and compatibility.	E2E Driving test in production environment (C2)
c	A modified version of an OBE that has previously been approved for by the same TSP in AutoPASS. The OBE has been through modifications that is deemed by the NPRA to be (close to) insignificant, and hence to represent only a neglectable uncertainty concerning the OBE performance and compatibility.	Pilot only (C3)
c	May apply where there is a slightly modified version of an approved OBE. The change is unlikely to have impact on performance, e.g. minor change of design on the OBE case or on non-critical components in the OBE.	The OBE is accepted without any further test (A)

2.6 Overview of the application process and required test levels

Figure 2 shows the full application process. When the NPRA has received the required support documentation for the application, the NPRA will assess the submitted material and conclude on which of the alternatives described in chapter *2.5* that is to be the outcome of the process.



If the decision is C1, "Full test", the NPRA will request that the TSP submits for review the documents described in chapter *3*. Also driving test must be executed.

As the next step for C1, "Full test", or if the decision from the NPRA is C2, "Driving test", the TSP must work out a suitable test plan. The driving test can start when the RSE equipment in the test stations are ready/updated.

See the description of driving tests in chapter *4*.

If the decision from the NPRA is that C3, "Pilot" is sufficient as an approval test, the NPRA will ask the TSP to work out a plan for the pilot. When the RSE equipment is updated, the pilot period can start.

See the description of pilot operation in chapter *5*.

Figure 2. Application process for new or modified AutoPASS OBE

The TSP has the right to appeal the decision taken by the NPRA.

3. REQUIREMENTS TO ADDITIONAL DOCUMENTATION FOR FULL TEST

3.1 General

This chapter describes the requirements for the documentation that the TSP shall submit when a "Full test" (C1 in *Figure 2*) is required from the NPRA. The required material is:

- Full documentation of the OBE
- Statements of conformity to standards
- Test reports

3.2 Full OBE documentation

Full technical documentation of the OBE is required. The documentation must contain sufficient documentation to verify conformity to the technical specification for AutoPASS. It must also contain a detailed description of the OBE configuration. The descriptions shall include all elements of the OBE.

3.3 OBE Conformity declaration constituents

3.3.1 Conformity to standards

The conformity to specification declaration for an OBE contains the CE certification of the OBE to all relevant standards with the conformity statements, the certificate(s) including evaluation report(s) and detailed test reports. The declaration may be prepared by the TSP or the OBE manufacturer on behalf of the TSP.

The conformity declaration shall in particular consider conformity of the OBE to:

- The DSRC transaction according to EN 15509 and related DSRC standards

  and
- Other requirements to standards defined in ref. [*5*] and the related documents.

3.3.2 CE marking and declaration

The manufacturer shall affix CE markings to the product where feasible. In compliance with Annex IV of Decision 2009/750/EC, a CE marking relative to EETS is accompanied by a Declaration, which will clearly specify that it concerns conformity to specifications. This "EC" Declaration should contain all relevant information to identify:

- The OBE version covered by the declaration
- The European legislation according to which it is issued
- The manufacturer or its authorized representative
- The Notified Body if applicable
- Reference to relevant standards
- Other normative or required documents as appropriate

3.4 Test reports

3.4.1 General

For a new OBE type in AutoPASS or major changes in an any OBE type, the manufacturer and/or a Notified Body shall produce test reports from all performed DSRC-relevant OBE tests. In the application for a new or modified OBE, it is sufficient to confirm that such tests have been carried out successfully. If test level "Full test" (C1 in *Figure 2*) is required, the NPRA will normally ask to receive test reports.

It is expected that a new OBE is tested in a lab environment or test RSE. If the NPRA finds existing tests to be insufficient, the NPRA may require additional tests. Such tests shall be planned and if relevant also performed in cooperation between TCs, the NPRA and the TSP, possibly also their subcontractors. The responsibility for all the test phases remains with the TSP.

The TC is entitled to appoint and authorize a company/organization (e.g. the supplier of the RSE) to carry out some or all tests.

All test results shall be fully documented in a test report. The list below defines the information that shall be included in the report for each test case:

- Test name and number
- Run number and total number of test runs
- Hardware and software version of the tested OBE
- Test location, versions and/or identification of used RSE test equipment
- Description of test run (if applicable including special observations)
- Test result description (including test passed/not passed)
- Test date and test duration (e.g. start and end time)
- Name of the responsible tester
- Reference to test log files or supplementary test documentation if available

Generally, test security keys should be used when testing takes place in a test environment.

3.4.2 DSRC interoperability tests

The following shows the expectation of the performed DSRC interoperability tests:

OBE tests defined in EN 15876 for all layers.

> The results of the OBE test defined by EN 15876 shall be reported by the Proforma Conformance Test Report (PCTR) as defined in Annex C of this test standard. The PCTR shall include conformance log and detailed test results whenever possible.

Testing of OBE transaction reliability and stability (rotor test or comparable).

> A test report documenting the transaction reliability and stability of OBE software is also required. Such a test may be obtained in a test setup where OBE samples are moved repeatedly through the communication zone in order to test adequate OBE read performance. Other test procedures may be acceptable. Each OBE in this setup shall perform several tens of thousands of transactions to generate a statistically significant result. The target for this test is no more than 5 failed transactions out of 100,000. A correct transaction is defined as a transaction delivering adequate data for correct tolling to the RSE database.

3.4.3 Functional OBE tests

The following shows the expectation of the performed functional tests:

The functions of the OBE to be tested are:

1. Tests of correct behaviour of security key computations for access control, as well as for authentication for both TC and TSP
2. Readability of OBE
3. Data content in OBE transaction in OBE-RSE interface
4. Signalling to Service User (sound in OBE)

Recommended test cases for functional tests are presented in Appendix A, chapter *6.*

4. END-TO-END (E2E) DRIVING TESTS IN PRODUCTION ENVIRONMENT

This test step/level implies that TSP shall perform end-to-end (E2E) driving tests with the OBE in the production environment in cooperation with the relevant AutoPASS TCs. The driving test is part of "Full test" (C1 in *Figure 2*) and also a separate test level (C2 in *Figure 2*).

An E2E driving test related to OBE has the following scope:

An AutoPASS contract is established by the TSP and an OBE is issued. During the test, this OBE is read by a TC's RSE, and a transaction is generated and transferred to AutoPASS IP. The correct price is set by AutoPASS IP, and a priced transaction is transferred through the AutoPASS HUB to the TSP's back office system and is cleared. The TSP's back office system acknowledges this transaction.

The TSP shall work out a test plan according to a template (ref. [*8*]) or similar which the NPRA shall approve.

The E2E tests in the production environment will be carried out by the TSP's test personnel. Test contracts for the test vehicle(s) must be established. Actual customers are not involved. In the E2E test in the production environment, the OBE shall be tested in a few AutoPASS RSE in operation, at least one from each RSE supplier. If an RSE supplier has several major main versions of RSE in AutoPASS, all versions should be tested.

The TSPs test driver(s) shall be provided with five OBE and each OBE shall pass each station twice at least. A high degree of readability is required to accept the OBE. If the results after a driving test in any way are questionable, the NPRA may request that a re-test or pilot be carried out.

Test cases for E2E driving tests, including acceptance criteria, are presented in *Appendix B: End-to-end test*. A test log is written during the test, and in the post-processing of the log it is filled in with transaction data. Most important here is the signal code from the RSE that tells whether the OBE was read correctly, alternatively that the passage was enforced with video. It must also be verified that specified data fields follow the transaction and are transferred correctly through the various systems. The results form the basis for a test report that must be sent to the NPRA for assessment.

The test can reveal poor or no reading in some of the RSE facilities. This is not necessarily due to direct errors either in the OBE or RSE. Both suppliers can claim they follow the specification/standard. If poor/no reading occurs, the TSP and TC (possibly in cooperation with their suppliers) must investigate the reason(s) and decide how to correct it. When the correction is done, the performance must be verified through a new driving test in the affected RSE. If the OBE is modified, it will normally also be necessary to perform a re-test in the other test stations.

A simplified driving test may also be conducted, e.g. when an already approved OBE type for the TSP has changed its EFC_ContextMark and/or security keys. In this case the general performance of the OBE is known. It is sufficient to verify readability in one RSE from each of the RSE suppliers with one successful reading of a passage in each station. The purpose of this is to confirm the OBE configuration, and also that the RSE are updated with the correct setup. The acceptance requirement in this case is to send a report to the NPRA that verifies the abovementioned criteria for readability.

When the E2E driving test has been completed, the TSP must ensure that the AutoPASS contracts that were used during the test are terminated.

5. PILOT OPERATION

Pilot operation involves OBE used in normal traffic through toll stations, i.e. where pilot users drive in AutoPASS facilities on an ordinary basis. During the pilot operation, real ("friendly") service users will use all the AutoPASS functions for paying their tolls. This is to verify that the TSPs equipment, as well as other technical, administrative, and commercial processes, are well-functioning in small-scale operation and thus are ready to be commissioned full-scale. The purpose of the pilot operation will be limited to testing OBE readability if it is performed by an established TSP.

Pilot operation is used in the following cases:

a) Pilot operation (test level 3) has been decided
b) If the results of a driving test are in any way questionable, the NPRA may request a pilot to be carried out

In the case of a), the TSP may request to run test level 2 (E2E Driving test) instead, if the TSP finds this test level more convenient to arrange.

The TSP must first draw up a plan for issuing pilot OBE to pilot drivers ("friendly users"). This must be according to the requirements drawn up by the NPRA, and the plan must be accepted by the NPRA before any pilot can take place.

A pilot operation will typically involve issuing OBE to 20-50 pilot users. Normally, after approx. 1000 AutoPASS transactions with these pilot OBE, the TSP prepares a report to be sent to the NPRA. If the volume of pilot transactions is significantly lower than expected, any report that is then sent will be regarded as temporary. The NPRA must receive a final report when the agreed number of transactions has been reached. The pilot report must present statistics for all passages in AutoPASS for the pilot users, and the statistics must also show if the transactions were based on a successful OBE reading or not.

It is expected that the TSP will observe the readability of the OBE at the initial phase of the pilot operation. If there is poor readability on the OBE initially, the pilot test should be halted, and measures should be taken to address the issue.

When the NPRA has assessed this pilot report, the NPRA will decide on whether the OBE is approved or not. The criteria for approving the pilot will correspond to the criteria from the driving test. If poor reading is observed in any individual stations, this must then be assessed separately.

In some specific situations, a simplified pilot may be conducted. This applies typically in the same situation as described for a driving test, e.g. when an already approved OBE type for the TSP has changed its EFC_ContextMark. In this case, a limited pilot operation may suffice. The assessment of the pilot report will concentrate on systematic defects in the OBE reading.

6. APPENDIX A: FUNCTIONAL OBE TEST

6.1 Objectives and overview

The following chapter describes recommended test cases for the functional OBE tests.

The main objectives of the functional OBE tests are:

- Verification of the OBE security keys and corresponding security calculations when the OBE is in interaction with Roadside equipment. (FT.1)
- Verification of correct reading of protected data in the OBE, i.e. PAN (FT.1)
- Verification of the OBE functionality when being in the communication zone of Roadside equipment for a long time (FT.2)
- Verification of the OBE functionality in interaction with the beacon in case of slow entry into the communication zone (FT.2)

Implicit in all tests are verification of the transaction reliability and stability of the OBE.

In all tests, test keys should be used if possible.

6.2 Laboratory test cases

All test cases in this chapter are performed under laboratory conditions.

Test name	**Basic transaction security issues – stand-alone beacon**	**No.: FT.1**
Purpose	Verification of the OBE security keys and corresponding security calculations when the OBE is in interaction with Roadside equipment. Also verification of audible signal from the OBE and that required data from the OBE is read correctly.	
Equipment	Stand-alone beacon application in laboratory.	
Description	As security level 1 is used in AutoPASS, all OBE are provided with Access keys in addition to Authentication keys. The structure of authentication keys in the OBE supports both TC and TSP verification of genuine OBE transactions. Master Access keys and Authentication keys are transferred to the test Roadside equipment. The test shall verify that the OBE and RSE between them are able to perform correct security calculations and thereby to generate a valid transaction with correct data.	
Intention	Verification of valid transactions: Check that the correct AC_CR is calculated by the RSE in order to have access to protected data in the OBE. Check that the MAC_TSP is read correctly by RSE. Check that the MAC_TC is read and processed correctly by RSE. Check that all supported attributes in OBE protected by security mechanisms are read correctly, i.e. Personal Account Number (PAN). Check correct MMI (signalling to user)	

Test name	**Transaction – static conditions**	**No.: FT.2**
Purpose	Verification of the OBE functionality in interaction with Roadside equipment.	
Equipment	Stand-alone beacon with EFC Application	
Description	Keep an OBE in the communication area of an RSE with fixed BeaconID for more than 5 minutes. Verification of the acoustic signal of the OBE; checking of the toll transaction record.	
Intention	Correct behaviour of the OBE being in the communication zone for at least 5 minutes: Only one transaction is performed. Correct OBE data presented by the OBE and collected in the toll transaction record.	

7. APPENDIX B: END-TO-END TEST

7.1 Objectives and overview

Generally, the End-to-End (E2E) tests verify the full compatibility of the OBE and the TSP's back office interface. The test description in this document only specifies test cases that apply for OBE reading and transaction processing.

The E2E test will also be part of the approval procedures for a new TSP. However, more comprehensive verifications of functionality in the back office systems are then required. Descriptions of these verifications are not covered by this document.

7.2 E2E test cases in the production environment

A number of suitable RSE in operative use must be configured to accept the new OBE.

Test name	**E2E - OBE in AutoPASS production environment**	**No.: E2E.1**
Purpose	Verification of the OBE functionality in interaction with Roadside equipment connected to the AutoPASS core systems and back office systems of other actors.	
Equipment	Selected operative AutoPASS toll stations where all different types of equipment in operative use from all RSE suppliers are represented. Vehicles with at least 5 test OBE per OBE type to be tested.	
Description	OBE with valid test contract (on whitelist). Passages are performed with the vehicle at normal speed. All available lanes may be used for the test. Each test OBE is tested at least twice in each toll station. The test report must contain a driving log matched against the toll transactions received by the back office system of the TSP.	
Intention	Check of the readability of the OBE in RSE. A high readability is required: Total for each station: At least 90% readability to be accepted Test results of less than 90% readability will be assessed individually based on the test environment and operational conditions for the actual toll station. Correct matching of the driver's test log with the toll transaction records received by the TSP. For the valid OBE, one valid transaction is created, and no enforcement transaction is created.	