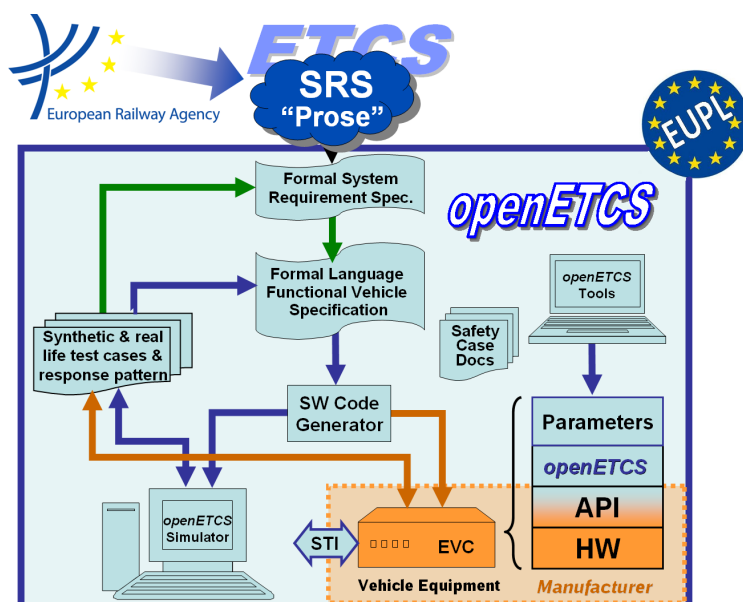


## Work-Package 1: “Management”

# Project Quality Assurance Plan

Izaskun de la Torre

July 1, 2013



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**Work-Package 1: “Management”**

**OETCS/WP1/D1.3.1  
July 1, 2013**

# Project Quality Assurance Plan

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SQS

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Description of work

Prepared for openETCS@ITEA2 Project

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## Document History

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Version	Date	Chapters modified	Reason	Name
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## 1 Introduction

### 1.1 Purpose

The purpose of the QA Plan is to define the processes, methods and tools that will be used to develop the OpenETCS project meeting ITEA requirements, following Open Source principles and practices and applying the SCRUM Methodology. Besides, two of the project outcomes, the OpenETCS software, the OpenETCS Tool Chain, will have to comply with CENELEC requirements.

Due to the nature of the OpenETCS project (R&D EU project with a complex list of project outcomes and deliverables), the QA Plan is specifically designed to provide a complete, consistent and integrated view of the development process at both project and product level (i.e. the development life-cycle is described partially in two different deliverables, the QA plan should manage to provide an integrated view).

The QA Plan also describes the activities to monitor and manage quality in all aspects of the project:

- Defining and ensuring that all processes and products are compliant with the corresponding standard and requirements, according to the required system/software safety integrity level
- Identifying nonconformances
- Providing timely quality status feedback to management and affected personnel
- Ensuring noncompliance issues are addressed

Therefore, it describes the QA functions, responsibilities and specific monitoring and control activities.

### 1.2 Goals of the openETCS project

The main goals and deliverables of the OpenETCS project are:

1. Creating a formal specification of the ETCS OBU functionality according to UNISIG Subset 026
2. An executable software package generated from the formal specification and a non-vital implementation of that software for laboratory test, simulation and reference purposes
3. A tools chain supporting both previous bullet points including code, test case and document generation meeting CENELEC EN50128:2011 (T3) requirements and certifiable for SIL4 software applications for signalling equipment (Certification itself is not part of the project)

### 1.3 Intended Audience

The QA Plan addresses all the stakeholders who are in the position to interact with OpenETCS project

Audience	Use	Role
OpenETCS Consortium Members	<p>It provides information and access to the QA procedures and guidelines to be followed/applied during the different phases of the project development life-cycle.</p> <p>It provides a consistent and integrated view of the development process followed.</p>	<p>Consultation</p> <p>Reviewer</p> <p>Contributor or Committer</p>
OpenETCS Quality Manager	It contains the quality targets to be achieved and the corresponding QA activities to be implemented and monitored.	Author
CENELEC Assessors	It shows the SQA strategy conceived and the one effectively implemented	To assess whether the project results comply to CENELEC standards
Open Source Community (Users, Adopters, Contributors, Committers)	<p>Provision of information and access to the QA related procedures and guidelines implemented.</p> <p>Provision of information on the on-going projects</p> <p>Provision of guidelines on how to participate to any of the projects</p>	For consultation and/or engagement
ITEA Representative	The QA Plan constitutes a Project Deliverable	For evaluation

## 1.4 Evolution

The first version of the document, prepared at the beginning of the project, will be updated regularly with the evolution of the OpenETCS project. The methods and tools to be applied during the development of the OpenETCS software products will be decided based upon the results of the research activities carried out during the project.

The QA Plan document will incorporate such decisions as they are taken with a proper justification of their appropriateness to meet the quality targets. The QA manager will guarantee the document is up to date.

The QA Plan document has been conceived as a reference document. This means that detailed descriptions of procedures, guidelines, methods and/or tools will not necessarily be included in the document but adequately referenced (*chapter 1.5*). The authors of such documents and/or Wiki pages will be responsible for keeping them updated. The QA manager will monitor such activities and will guarantee changes are appropriately reflected in the QA Plan, when appropriate.

The QA Manager will maintain the QA Plan backlog [?] [\[Wiki\]](#).

Major revisions of the QA Plan will be accomplished by the Committers to the Management Project. Minor review process will be done with the participation of the external community, following procedure [?]

## 1.5 References, Guidelines and Standards

Standards				
Internal Code	Name	Version	Repository	Responsible
[? ]	EN 50128		governance	CENELEC
[? ]	ISO 9001		governance	International Organization for Standardization
[? ]	SUBSET-023	3.0.0	SSRS	UNISIG
[? ]	SUBSET-026	3.3.0	SSRS	UNISIG

References				
Internal Code	Name	Version	Repository	Responsible
[? ]	Full Project Proposal (FPP)	3.0	management	Klaus-Rüdiger Hase
[? ]	Software Configuration Management Plan		governance	Jürgen Weiss
[? ]	Project Co-operation Agreement	02e	management	Bernd Hekele
[? ]	OpenECTS IP Policy	0.1	ecosystem	Bernd Hekele
[? ]	OpenETCS Internal Assessment Plan		internal-assessment	Cyril Cornu
[? ]	OpenETCS Validation & Verification Plan	01	validation	Marc Behrens Hardi Hungar
[? ]	QA Plan Backlog	0.1.0	governance	Izaskun de la Torre

Procedures				
Internal Code	Name	Version	Repository	Responsible
[? ]	Review Process	0.2.1	governance	Ainhoa Gracia
[? ]	Revision Process	0.2.1	governance	Ainhoa Gracia
[? ]	Change/Problem Management Process	0.1.0	governance	Izaskun de la Torre
[? ]	Grieving Handling Process		governance	Bernd Hekele
[? ]	Committee Approval Process		ecosystem	Jonas Helming
[? ]	openETCS Development Process		ecosystem	Jonas Helming
[? ]	Training Process		governance	<i>To be defined</i>

Guidelines				
Internal Code	Name	Version	Repository	Responsible
[? ]	Contribution guidelines	01	ecosystem	Bernd Hekele
[? ]	Committer Election Guideline		ecosystem	Jonas Helming
[? ]	openETCS Publishing Guideline		Dissemination	Stefan Rieger
[? ]	Expert Election Guideline		governance	<i>To be defined</i>

Templates				
Internal Code	Name	Version	Repository	Responsible
[? ]	Competence Matrix Template		governance	<i>To be defined</i>
[? ]	Expert database Template		governance	<i>To be defined</i>

## 1.6 Definitions and acronyms

Abbreviation	Meaning
ASR	Assessor
CCS	control-command and signalling subsystems
DES	Designer
ERTMS	European Rail Traffic Management System Train signalling system equipment based on a single Europe-wide standard for train control and command systems.
ERA	European Railway Agency
ETCS	European Train Control System It is a signalling, control and train protection system designed to replace the many incompatible safety systems currently used by European railways
EUPL	European Union Public Licence
EVC	European Vital Control
GSM-R (train radio)	Global System for Mobile Communications - Rail(way) It is an international wireless communications standard for railway communication and applications.
HR	Highly Recommended
HW	Hardware
IMP	Implementer
INT	Integrator
MVB	Multifunction Vehicle Bus It is a part of the Train Communication Network (TCN), and it takes part in digital operation in the train. MVB is the bus part in each coach, and the Wire Train Bus (WTB) allows connecting the MVB parts with the train control system.
NA	Not Applicable
OBU	On-Board Unit
PMP	Project Management Plan
REQ	Requirements Manager
R&D	Research and Development
SCMP	System Configuration Management Plan
SIL	Safety Integrity Level
SME	
SRS	Software Requirements Specification
SW	Software
SW-SIL	Software-Safety Integrity Level (EN 50128:2011)
TSI	Technical Specification for Interoperability
TST	Tester

VAL	Validator
VER	Verifier
V&V	Verification and Validation
WP	Work Package
FM	Formal Methods
IP	Intellectual Property
IP Clean	No IP without permission in writing

## 2 Project Organization

OpenETCS is a cooperative European-ITEA project. The project plan (objectives, work plan schedule, role of the partners, project organization) is described in the [?] FPP document, which is updated regularly (at least yearly). The project is accomplished according to the Project Co-operation Agreement (PCA) [?] signed by the partners.

The organization of the project has to meet the following constraints and challenges to succeed:

1. As an ITEA project, the project has to meet requirements imposed by the ITEA Office that affect both the organization and the outcomes of the project.
2. As an ITEA project, the effective involvement of the partners is sometimes hampered by external constraints (i.e. local financing, local approvals) so mechanisms to guarantee the “required competence” is available when needed are to be implemented. Besides, OpenETCS operates in a regulated environment where demonstrating the competence of the personnel assigned to the different activities is required.
3. Some of the results (software & tool chain) have to be certifiable; CENELEC SIL4 requirement [?] have to be followed and the corresponding evidence provided.
4. As an open source project, Open Source principles will be respected; high degrees of engagement from the community are intended.
5. As it is the intention to apply SCRUM, the appropriate responsibilities and mechanisms have to be implemented

The following chapters shows the mechanisms implemented at organizational level to guarantee the above mentioned objectives are achieved.

### 2.1 openETCS project organisation

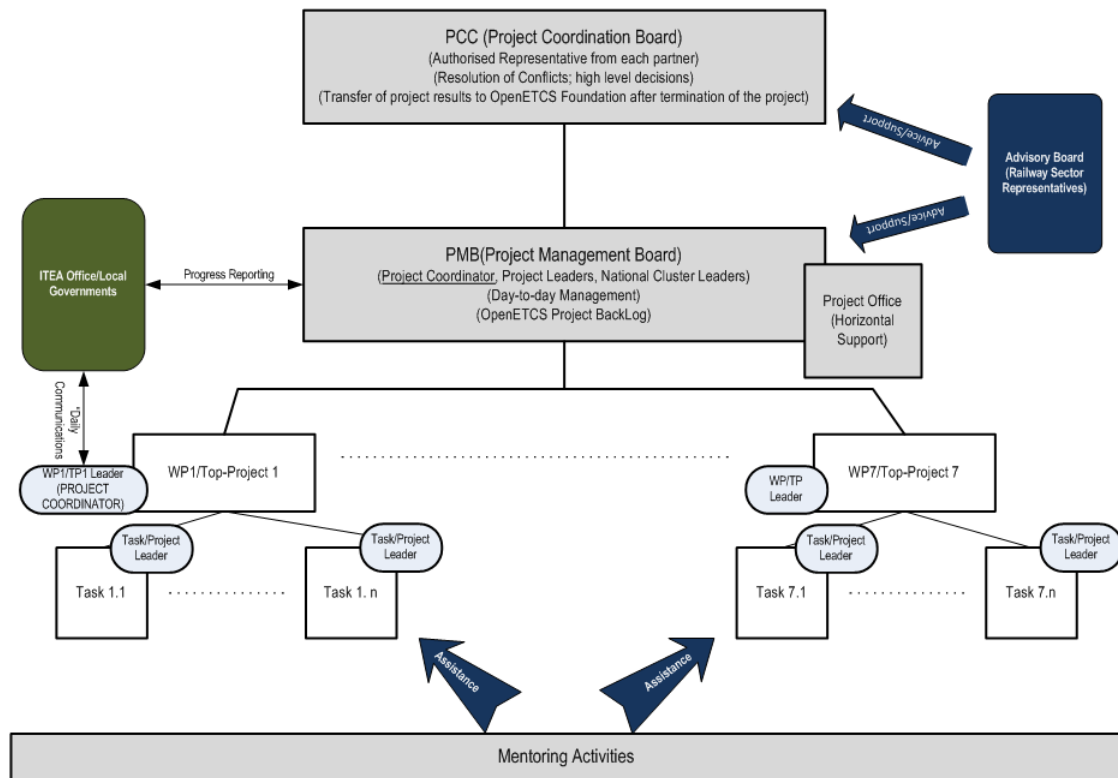


Figure 1. OpenETCS Project Structure

### 2.1.1 Compliance with ITEA Requirements

Compliance to ITEA Requirements is achieved by means of:

- The appointment of a Project Coordinator (DB, WP1, supported by the Project Office) who leads the project and is responsible for the communications with the ITEA representatives.
- The appointment of a Local Coordinator per country, National Cluster Leader, who reports to the corresponding National Authorities of the progress of the local partners
- A signed PCA where cooperation rules and principles and working structures are agreed by all the partners.
- An OpenETCS Foundation NV which guarantees sustainability of the project results once the project is finished.

### 2.1.2 Compliance with Open Source Principles

Compliance to the Open Source Principles and related objectives is achieved by means of:

- An OpenETCS IP Policy and Procedures [? ]
- An OpenETCS Development Process [? ] [Wiki] based in the Eclipse Development Process [? ], designed to promote dynamism in the development and openness. All the guidelines are maintained and available at the OpenETCS Ecosystem project [XX]:



- The OpenETCS project is conceived as a project of projects organized in a hierarchical manner, where the WorkPackages, as defined within the WorkProgramme [? ], are considered Top-Level Projects with their own charter. The so-called Tasks are projects, sub-projects of the corresponding Top-Level Project.
- Anyhow, new projects can be launched, if needed and approved; existing projects can be archived, if they become inactive. Therefore the final structure of the OpenETCS project will very much depend on its evolution.
- The list of OpenETCS projects with information on their status is available in [XX]
- Any project (independently to its position in the hierarchy, and type) has its project leader, scope and maintains its own resources. The project leader is not only responsible to guarantee progress towards the scope of the project but to promote that the most appropriate community is engaged in the project life-cycle with openness and transparency. This community includes committers, contributors, users and adopters.
- Every Top-project/WP has its own repository under the responsibility of the Top-Project/WP Leader. Agreements and principles on the repository structure and content can be found in [XX]
- The PMB (Project Management Board) is responsible for maintaining and assuring the implementation of the OpenETCS Development Process and for ensuring the required “coordination” among the projects.
- The Mentoring board (composed of XXX) is responsible for mentoring projects and advising.
- The Project Office is responsible for the administrative tasks around the OpenETCS Development Process and maintains the OpenETCS Ecosystem project [XX]
- The tools to support the OpenETCS Development Process are open source tools. A relation of the tools approved by the consortium is [XX]
- The engagement of the OpenETCS Advisory Group will not only provide valuable technical insights but visibility of the project within the railway community.

### 2.1.3 Compliance with SCRUM Requirements

Compliance to SCRUM Requirements is achieved by means of

- Each Work Package/Top-Project Leader is the SCRUM Owner of the corresponding WP/Top-Project results and maintains the corresponding backlog
- Each Project/Task Leader is the SCRUM Owner of the corresponding Tasks results and maintains the corresponding backlog
- The Project Coordinator is the SCRUM Product Owner of the project results and maintains the project results backlog.
- Weekly meetings are maintained to assess progress, promote cross-collaboration, plan next steps and therefore, maintain the corresponding backlog.
  - At WP/Project level, the registered committers, contributors, users and adopters are invited to participate
  - At Open ETCS project level, the components of the PMB( Project Management Board) are invited.

- There is a SCRUM Development Team for the each WP/Project composed by the accepted committers.
- A SCRUM master (WP1) is responsible for ensuring SCRUM is understood and enacted

#### 2.1.4 Compliance with software management and organisation according to EN50128:2011

In principle, two of the OpenETCS project results (Software and Tool Chain) are to be CENELEC SIL 4 certifiable. These are two of the results from WP3 and WP7. The following mechanisms, at organizational level, will help the corresponding project leader to provide evidence of compliance with chapters 5.1 [?] and 5.2. Anyhow, evidence that requirements imposed are met will have to be provided for each of the two software projects on a project by project basis.

- Every partner in the consortium is ISO9001 Certified or will be in the position to provide evidence of a quality management process in accordance to ISO9001
- Every partner maintains an updated CV of the staff/experts involved in OpenETCS
- A Required Competence Matrix (RCM) per role and project will be maintained (*Chapter 4*).
- A database with the participants per role and task/project will be maintained by the task/project leader.
- Overall, the independence required to develop certifiable results is promoted by the Work Programme which is structured into the following “independent” WorkPackages/Top-Projects, each lead by a different organization.
  - WP2, focused on Requirements Specification is led by SNCF.
  - WP3, focused on the Software Implementation taking as input WP2 and WP7 results is led by Alstom France.
  - WP4 focused on the specification of the V&V structure, is led by DLR
  - WP5 focused on demonstrating applicability/validity of WP3 and WP7 results is led by ERSA
  - WP7 focused on the development of the Tool Chain is led by DLR taking as input WP2 and WP4 inputs
  - For the purpose of validating/adapting technical approaches, tools and concepts before they are taken into consideration, three Use Cases will be engaged.
  - The Open Development Process facilitates the creation of the necessary projects required to achieve the OpenETCS project results.
- For each assessable result, CENELEC required software roles will be covered by experts from different WPs. Incompatibilities can be controlled and monitored as active participation to the different projects has to be granted, accepted and is appropriately registered (*Chapter 2.2*). Evidence of competence can be provided by comparing the CV of each expert with the RCM for the role assigned.
- For each assessable result, if possible, the role of the assessor will be selected from the external community of the project. Meanwhile, an internal independent assessor will be appointed. The role and profile of this assessor is detailed in OpenETCS/internal-assessment [?] [[wiki pages](#)]

One of the mechanisms to guarantee the availability of competence staff when needed will be the design and implementation of a training programme. The training programme will be managed by the Project Office. The identification of needs will be performed by the project leaders, the PMB and the Quality Manager. The training process is detailed in [XX]

## 2.2 Committers assignment and responsibilities

Each Top-Project/WP leader is responsible for establishing and publishing the specific required competence matrix for the Top-Project/WP (*Chapter 4*). This matrix will be updated in response to the demands imposed by the evolution of the project. The competence matrix template [?] is provided in [XX]

Each Top-Project/WP leader is responsible for developing the most appropriate communities of users, adopters, contributors and committers as required by the Top-Project/WP. A database will be maintained and assessed periodically by the Top-Project/WP Leader. This database will contain the coordinates of the expert, his/her role in the project and a basic explanation of adequacy. The expert database template is provided in [XX]

The required core competences as well as the expected contribution of each of the identified communities are described in Chapter 4.

Only committers have write-access to the project resources. Becoming a committer requires of the acceptance of the project leader and of the rest of the project committers. Guidelines on how to become a committer can be found in [\[ecosystem wiki pages\]](#).

- It is the responsibility of the Project Leader to make sure the required competence to develop a task is covered by the engaged committers.
- It is the responsibility of the Open ETCS Project Leader to guarantee the required competence for the project is covered by the effective committers.

Contributors have read-access to the project resources, and acceptance is not required. Guidelines on how to become a contributor can be found in [\[ecosystem wiki pages\]](#).

An expert can contribute to different projects with different roles. The data from different project will be integrated and analysed to detect potential incompatibilities, if applicable. This activity will be done by the QA Manager. The guideline on how to select expert is detailed in [XX].

## 2.3 Project QA Management

QA activities will be under the responsibility of the QA Manager, who reports to the Project Coordinator.

The QA Manager will be responsible for the identification, supervision and control of all the processes, methods and tools required to meet the quality targets of the project. It is also the responsibility of the QA manager to provide the necessary evidence that such activities have been developed.

The activities of the QA Manager will be:

- To maintain the QA Plan and associated procedures and guidelines.

- A QA Plan Backlog will be maintained, implemented and published
- To participate in the OpenETCS Ecosystem project in cooperation with the Project Office
- To perform periodical audits of the maturity of the different on-going projects; propose improvement actions, if necessary.
- To participate in the review processes of the different work products.
- To collaborate with the Project Office in the identification of gaps and in the development of the corresponding Training Programme.
- To perform quantitative and qualitative analysis at process and product levels. To maintain a set of metrics for all the processes.
- To produce and publish the corresponding quality reports.

### 3 Life Cycle

JW: A short (two sentences) introduction how these two life cycles are related.

IT: OK

#### 3.1 Project Life Cycle

The project Life Cycle is implemented through a set of WPs broken down into Tasks. In response of the nature of the project, these WPs are grouped into three purpose driven categories. The first category (WP2, WP4) addresses the specification of the work to be developed and the validation of the results to be obtained; the second category (WP3, WP7, WP5) addresses the development itself and the demonstration of the software and the tool chain developed and the third category (WP1, WP6) addresses the project management, the quality assurance and the dissemination of the project. This structure permits both the development and the integration of conceptual (R&D) and implementation activities to achieve innovative, validated and fit-for-purpose results. The detailed description of the Work Package description and overview plan is covered by [FPP].

#### 3.2 Product Life Cycle

JW: Not to long, just short introduction, please.

IT: OK

*Guidance: Refer to a separate document that describes the life cycle. Consider EN50126 and EN50129 Requirements, include Deployment and Maintenance, include activities to "adapt" the generic/abstract software to a concrete implementation. In this chapter, if applicable, include justification to "potential deviations" to CENELEC standards.*

<To be discussed>

##### 3.2.1 Life Cycle of the OpenETCS Software

The software development life-cycle of the OpenETCS project has to comply with CEN50128. Requirements imposed by the standard are analyzed and shown in detail in D2.2. The software development life-cycle is described in Deliverable 2.3 and D2.X.

##### 3.2.2 Life Cycle of the OpenETCS Tools chain

The development of the Tool Chain has to comply with EN50128. Requirements imposed by the standard are analyzed and shown in detail in D2.2. The software development life-cycle is described in Deliverable 7.XXXX.

### 3.3 QA Management

*Guidance: Refer to the procedures to implement the QA activities identified within the above mentioned development life-cycle.*

CC: The parts §2.3 (Project QA management) and 3.3 (QA management) could be both in the same part (2 or 3). For us, the Quality Assurance has to refer to both project life-cycle and Software life-cycle.

IT: In chapter 2.2, the idea is to introduce the QA Organisation Roles (both project and software, as you say). In chapter 3.3 we will explain the QA activities

## 4 Roles

### 4.1 OpenETCS Roles

In view of the nature of the project, roles are grouped into three independent categories:

- CAT1: Open Source Development Process Roles
- CAT2: SCRUM Roles
- CAT3: CENELEC Roles

Therefore, any participant will always adopt a role within CAT1, a role within CAT2 and if he/she is involved in the development of a CENELEC assessable product, a third role in CAT3.

As already mentioned, OpenETCS is a project of projects. An expert can participate to different projects with different roles. Therefore an expert will have a CAT1, CAT2 and/or CAT3 role per project.

In the Annexes A, B, C and D, the responsibilities and the core competences required by each role are detailed. It is the responsibility of the QA Manager to keep them updated

In the case of CAT 1 roles, specific technical competence will be required depending on the scope of the project. For this reason a new column has been added. In this column, specific technical competences for each project and role are to be included. It is the responsibility of each project leader to provide this information.

According to the open development process followed by Open ETCS, the QA process is also a project. For this reason the QA Manager will have to meet the competences of a Project Leader and the specific competences imposed by CENELEC and the OpenETCS project to the Quality Manager activities. When needed, specific responsibilities imposed by a project to a role will be detailed too.

As project results affected by CENELEC are already identified, both core and specific required competence per CAT 3 role are included in Annexes C and D.

### 4.2 Roles within the Development process of the openETCS Software

See Annex C

### 4.3 Roles within the Development process of the openETCS Tools Chain

See Annex D

### 4.4 QA Activities

The QA Manager will be in charge of:

- Maintaining the Requirements Competence Matrices updated in response to the evolution of the OpenETCS project
- Performing periodical audits of the participants' database per project; trace database with the RCM (Required Competence Matrix) for such project
- Identify training needs and provide the required support to the Project Office in the definition and organization of the corresponding training activities.
- In the case of CENELEC related project, provide the necessary evidence of competence and independency between roles. If this is not possible, propose the necessary solutions and support the projects in its implementation

## 5 Methods, measures and tools for quality assurance (product + open ETCS software + Tools chain)

In this chapter, the methods and tools used in each phase of the software development life-cycle process of both the application software and the tool chain are identified. A brief justification of compliance to CENELEC is included.

This chapter has to be read in conjunction with OpenETCS project work products listed in the Table below. The relevance of each deliverable for the scope of this chapter is also indicated:

Deliverable	Content of Relevance for this Chapter
D2.2: Report on CENELEC Standards	CENELEC requirements to be fulfilled and the approach followed by the project to provide evidence[XX]
XX	XX

In Annexes F, G and H the methods, techniques and tools used are identified.

### 5.1 Methods, measures and tools for quality assurance OpenETCS Application Software

It is assumed that the OpenETCS application software will be SIL4 compliant. Therefore, the methods, techniques and tools shall be suitable to SIL 4.

### 5.2 Methods, measures and tools for quality assurance openETCS Tools chain

The Tool Chain will be composed of a set of tools with different levels of interaction. The document [XX] provides a description of the Tool Chain architecture, jointly with a description of the constituent tools. Following CENELEC criteria, each tool belongs to one of the following classes: T1, T2 and T3. Only Class 3 Tools are obliged to follow specific development methods, techniques and tools. Therefore, Annex XX applies to the following tools: Tool 1,...

*[To be further developed]*

### 5.3 Quality Control and Monitoring Activities

*Guidance: Describe the measures to monitor the appropriate implementation of the selected methods and tools.*

JW: This is a broad topic, the main issues will be covered by the verification, validation and safety plan. This aspect should introduce the general principals and tools and then reference those documents.

IT: OK. I think there is an error in the template. Instead of QA Activities, it is Quality Control and Monitoring Activities.

## 6 Documentation

The documentation structure of the OpenETCS project is composed of:

- Deliverables, which constitute the official outcomes of the different Top-Projects/WPs
  - The relation and scope of the deliverables to be produced along OpenETCS can be found in the FPP [].
  - The updated status of development of each Deliverable can be found in [\[State-of-Deliverables Wiki\]](#).
  - The approved and therefore valid version of each Deliverables can be found in the repository of the Top-Project/WP it belongs to.
- Contractual documents, with the Commission and among the project partners
  - The status of development of each contractual document can be found under the repository of Management (WP1).
  - The last approved and therefore valid version of each contractual document can be found under the repository of Management (WP1).
- Periodic Progress Reports, to show progress to ITEA and EC representatives.
  - The state of each Periodic Report can be found under repository of Management (WP1).
  - The last approved and therefore valid version of each Periodic Progress Report can be found under the repository of Management (WP1).
- Supporting Documents, in the form of Templates and Procedures
  - The procedures and templates applicable to a specific Top-Project/WP can be found in the repository of the corresponding TP/WP.
  - The procedures and templates applicable to the whole project can be found in the repository of Governance.
- Internal Reports, in the form of Meeting Minutes
  - The minutes of the weekly scrum meetings are found in the repository of Governance.

The nomenclature used for the naming of the different documents is provided in [XX-to be developed].

For each TP/WP the relation of existing documents is provided in the form of a list [\[Wiki\]](#). This list includes a direct access to the valid version of each document.



## 6.1 Documentation Structure within the development process of the openETCS Software

As a SIL4 software, the documentation structure has to comply with CENELEC requirements. The following table shows the document structure required by CENELEC for a SIL4 development and the corresponding documents produced in the OpenETCS project.

Documentation Structure within the development process of the openETCS Software				
Phase	SIL4	Document	WP/Task	Document
Planning	HR	Software Quality Assurance Plan Software Quality Assurance Verification Report Software Configuration Management Plan Software Verification and Validation Plan	(to be defined)	(to be defined)
Software Requirements	HR	Software Requirements Specification Software Requirements Test Specification Software Requirements Verification Report	(to be defined)	(to be defined)
Architecture and design	HR	Software Architecture Specification Software Design Specification Software Interface Specification Software Integration Test Specification Software/Hardware Integration Test Specification Software Architecture and design verification report	(to be defined)	(to be defined)
Component Design	HR	Software Component design specification Software Component Test Specification Software Component design verification report	(to be defined)	(to be defined)
Component Implementation and Testing	HR	Software source code and supporting documentation Software source code verification report Software Component Test Report	(to be defined)	(to be defined)
Integration	HR	Software Integration Test Report Software/Hardware Integration Test Report Software Integration Verification Report	(to be defined)	(to be defined)
Overall Software Testing/Final validation	HR	Overall Software Test Report Software Validation Report Tools Validation Report Release Note	(to be defined)	(to be defined)

Software Requirements Specification Phase				
Systems configured by Application Data/algorithms	HR	Application Requirements Specification Application Preparation Plan Application Test Specification Application Architecture and Design Application Preparation Verification Report Application Test Report Source Code of Application Data/Algorithms Application Data/Algorithms Verification Report	(to be defined)	(to be defined)
Software Deployment	HR	Software Release and Deployment Plan Software Deployment Manual Release Notes Deployment Records Deployment Verification Report	(to be defined)	(to be defined)
Software Maintenance	HR	Software Maintenance Plan Software Change Records Software Maintenance Records Software Maintenance Verification Report	(to be defined)	(to be defined)
Software Assessment	HR	Software Assessment Plan Software Assessment Report	(to be defined)	(to be defined)

## 6.2 Documentation Structure within the development process of the openETCS Tools chain

*Guidance: See Chapter 6.1*

## 6.3 Quality Control and Monitoring Activities

*Guidance: Describe the methods to review the documentation structure*

JW: For me this should not be the review of the documentation structure, but the documentation quality control activities. These are looked at in detail over the next to chapters, therefore this should be a general overview.

IT: OK

## 7 Documentation Control

*Guidance: Refer to Control Process Document where the function develop by authors, reviewers is provider*

JW: This sentence is hard to understand. From my point of view the three section make no sense since there should be the same process for all kinds of documents. This section should name the main control activities (review, approval, dissemination, archiving) and the main tools used for this. Then it should refer do the respective documents (like the great review process).

IT: OK, we will clarify this sentence.

### 7.1 Documentation Control within the Development process of the openETCS Software

*Guidance: Refer to the list of active documents of the openETCS software*

### 7.2 Documentation Control within the Development process of the openETCS Tools chain

*Guidance: Refer to the list of active documents of the openETCS tools chain*

### 7.3 Quality Control and Monitoring Activities

*Guidance: Describe the methods to monitor both the control and process*

## 8 Tracking and tracing of deviation

### 8.1 Traceability (openETCS software + Tools chain)

*Guidance: Provide a description of traceability requirements, as well as how the traceability will be achieved, implement, maintained and verified. At this stage, exceptions if they exist should be justified.*

### 8.2 Configuration Management

*Guidance: Refer to SCMP (System Configuration Management Plan). Overview table with the summary of main features of SCMP.*

JW: SCMP has to be written. This mainly includes an explanation of the proper github working processes.

IT: OK, it will be included in the backlog we are preparing.

*Describe the QA activities*

### 8.3 Fault Management

ISTQB define a defect as "a flaw in a component or system that can cause the component or system to fail to perform its required function". A defect can be random or systematic. A defect, if encountered during execution, may cause a failure of the component or system". From the ISTQ glossary bug, fault and problem are defined to be the same as a defect.

A failure is a deviation of the component or system from its expected delivery, service or result. A failure is the consequence of a fault or error in a system but not all faults result in failures.

Faults, failures and errors encountered during the review activities (QA. Verification, Validation, Assessment) planned in the software development life-cycle, problems reported by users and customers as well as change requests initiated by any of the system stakeholders will be reported and managed following the Change/Problem Management Process [?] detailed in [XX] and through the Change/Problem Management Tool. This tool will be integrated with the Configuration management tool *GIT* and will be configured to implement and record all the information generated during the process.

The integration with the Configuration management tool *GIT* will permit:

- Traceability between Change/Problem Requests and the configuration items where the problem was located.
- Traceability between the configuration items modified and the corresponding Change/problem request.

The implementation of the workflow will permit:

- A complete history trail of the Change Request/Problem Report

The purpose of the Change/Problems Management implementation at OpenETCS project is to ensure that standardized methods and procedures are used for efficient and prompt handling of all changes/problems associated with the OpenETCS products, in order to minimize the number and impact of any related changes/problems. Changes/problems in the products may arise reactively in response to incidents, or proactively from seeking improved efficiency and effectiveness, as well as to enable or reflect OpenETCS initiatives, or products improvements.

The QA Manager will be in charge of:

- perform periodical audits and quality assessments of the bugs received
  - Audits to verify the process itself
  - Quality Assessments to verify the evolution of the product quality
- Assist in determining QA impacts
- Support Problem owner in analysis

## 8.4 Grievance Handling

*Guidance: Refer to the specific procedure.*

*Describe the QA activities*

## 8.5 Modification and change control

A change is the addition, modification, or removal of a configuration item (CI), product, or product component, and/or its associated elements

The change requests initiated by any of the system stakeholders will be reported and managed following the Change/Problem Management Process [?] detailed in [\[governance\]](#) and through the Change/Problem Management Tool.

The Change/problem Management process aims to evaluate and plan the change/problem process to ensure that, if a change is made, it is done in the most efficient way possible, following the established procedures and ensuring the quality and continuity of the OpenETCS project and products at all times.

The QA Manager will be in charge of:

- perform periodical audits and quality assessments of the change request received
  - Audits to verify the process itself
  - Quality Assessments to verify the evolution of the product quality
- Assist in determining QA impacts
- Support Change owner in analysis

## 9 Supplier Control

*Guidance: Requirements to external suppliers and how they will be verified*

JW: What are the suppliers in OpenETCs and what activities are needed here?

IT: It is only to be considered if any supplier is needed

*describe the QA activities to be developed.*

JW: Im missing sections for the Quality Assurance during the product maintenance and the deployment of the software and the tool chain.

IT: Product Maintenance and deployment phased will be covered in Chapter 3.2

**ANNEXES**

**10.1 ANNEX A -CAT1: Open Source Development Process Roles and Competence Matrix-**

CAT1: Open Source Development Process Roles/Competences				
Code	Role	Responsibilities (To be revised)	Core Competences	Specific Competences/ Responsibilities per project
OPL	OpenETCS project Leader	Responsible to guarantee progress Promote that the most appropriate community is engaged in the project life-cycle Ensure that all personnel involved in all phases of the software, tool chain (products) and project life-cycle, including management activities, have the appropriate training, experience and qualifications Make sure the required competence to develop a task is covered by the engaged committers	(To be fulfilled)	(To be fulfilled per project)
WPL	WP Leader/Top-level project leader	To ensure that all personnel who have responsibilities for the software are competent to discharge those responsibilities Ensure that the parties involved throughout the product life-cycle are independent, to the extent required by the software safety integrity level, in accordance with cenelec	(To be fulfilled)	(To be fulfilled per project)
TL	Task Leader/ project leader	Maintains the corresponding backlog	(To be fulfilled)	(To be fulfilled per project) Project: QA activities responsible for the identification, supervision and control of all the processes, methods and tools required to meet the quality targets of the project
US	User	Not Applicable	(To be fulfilled)	(To be fulfilled per project)



CAT1: Open Source Development Process Roles/Competences				
Code	Role	Responsibilities ( <b>To be revised</b> )	Core Competences	Specific Competences/ Responsibilities per project
AD	Adopter	Reuse of the frameworks (within the companies that are contributing to the project and outside of the project), Reuse of the tools (within the companies that are contributing to the project and outside of the project), Contribute content, code, fixes, tests, documentation, or other work that is part of the Project Provide feedback Help new users Test, report or fix bugs Request new features Write or update documentation Write and update software	(To be fulfilled)	(To be fulfilled per project)
CTB	Contributor	Have the exclusive right to elect new Committers to their Project—no other group, including a parent Project, can force a Project to accept a new Committer. Monitor and contribute to the mailing lists Proactively report problems in the task tracking system, and annotating problem reports with status information, explanations, clarifications, or requests for more information from the submitter	(To be fulfilled)	(To be fulfilled per project)
CMT	Committer		(To be fulfilled)	(To be fulfilled per project)

## 10.2 ANNEX B -CAT2: SCRUM Roles and Competence Matrix-

CAT2: SCRUM Roles/Competences			
Code	Role	Responsibilities (To be revised)	Core Competences
POw	Product Owner	Managing and prioritizing the Product Backlog Planning the release Software and Tool chain acceptance Understand the value of the project	(To be fulfilled)
ScM	Scrum Master	Planning the Sprints Prioritizing the sprint backlog Team leader Manage the development process Prepare Burndown charts Identify and eliminate obstacles that prevent the team from achieving their goals Ensures that the team is fully functional and productive Enables close cooperation across all roles and functions Ensure clear communication among everyone involved in the project	(To be fulfilled)

CAT2: SCRUM Roles/Competences			
Code	Role	Responsibilities (To be revised)	Core Competences
ScT	Scrum Team	Self organizing (organizes itself and its work) Identify obstacles and informing the Scrum Master Development to achieve sprint goals. Implementing test cases Unit and initial Acceptance testing	(To be fulfilled)

10.3 ANNEX C -CAT3: CENELEC Roles and Competence Matrix for OpenETCS software product-

CAT3: CENELEC Roles/Competences for OpenETCS application software project		
Code	Role	Responsibilities (To be revised)
PM	OpenETCS project Manager	Guarantee the required competence for the project is covered by the effective committers Identify which roles are needed for the project Verify that at least one person has been identified per project role Ensure the independence of the roles according to CENELEC Ensure compliance with the quality management system Responsible to guarantee progress according to scheduled plans Devote sufficient resources to perform the task, including security tasks Responsible for the delivery and implementation of the software Ensure the compliance and the delivery of security requirements Provide enough time for proper implementation and enforcement of security tasks Approve full and partial products to be delivered by the development process Ensure that records and traceability are maintained throughout the decision making and project Ensure that it has appointed an appropriate validator for the project according to cenelec
		Competences
		(To be fulfilled)

CAT3: CENELEC Roles/Competences for OpenETCS application software project			
Code	Role	Responsibilities (To be revised)	Competences
RQM	Requirement manager	<p>Responsible for the Software requirement specification</p> <p>Establishes and maintain traceability to and from the system-level requirements</p> <p>Ensure that software and derived specifications requirements are under system configuration and changes management control.</p> <p>Ensure consistency and completeness of the software requirements specification</p> <p>Develop and maintain documents related to software requirements</p>	(To be fulfilled: core and specific competences)
DES	Designer	<p>Transform software requirements on acceptable solutions</p> <p>Derive the requirements for the system and software architecture</p> <p>Identify the key design issues that must be resolved to support successful development of the software</p> <p>Allocate the software and derived requirements to the chosen architecture components and interfaces</p> <p>Maintain requirement traceability for the software architecture's requirements, and to and from software requirements</p> <p>Identify suitable derived requirements that address the effectiveness and cost of life-cycle phases following development, such as production and operation</p> <p>Develop and maintain design documentation</p> <p>Ensure that the design documents are under system configuration and changes management control.</p> <p>Design or select design methods and support tools</p> <p>Apply principles and suitable design standards</p> <p>Develop component specifications if it is applicable</p>	

CAT3: CENELEC Roles/Competences for OpenETCS application software project			
Code	Role	Responsibilities (To be revised)	Competences
IMP	Implementer	<p>Transform design solutions in data, source code, models and / or other design representations</p> <p>Apply design principles</p> <p>Apply specific rules for data preparation/codification</p> <p>Perform analysis to verify intermediate results</p> <p>Develop and maintain implementing documents comprising the methods, types of data, models and listings applied</p> <p>Maintain traceability to and from the design</p> <p>Maintain the generated or modified data/codes/models under system configuration and changes management control.</p>	(To be fulfilled)
TST	Tester	<p>Ensure the test activities planning</p> <p>Develop tests specification (goals and cases)</p> <p>Ensure traceability of test objectives to specified software requirements</p> <p>Ensure traceability of test cases to the specified tests objectives</p> <p>Ensure that the planned tests are implemented and performed</p> <p>Identify deviations from the expected results and record in the test reports</p> <p>Communicate deviation to the authority in charge of the changes management for evaluation and decision making</p> <p>Record the results reports</p> <p>Select the equipment for testing the software</p>	(To be fulfilled)

CAT3: CENELEC Roles/Competences for OpenETCS application software project			
Code	Role	Responsibilities (To be revised)	Competences
INT	Integrator	<p>Manage the integration process using software baselines</p> <p>Develop sw and sw /hw integration test specification for sw components based on the specifications and on the designer's components architecture</p> <p>Develop and maintain records of the integration activities</p> <p>Identify integration anomalies; record them and communicate them to the authority in charge of the changes management for evaluation and decision making</p> <p>Develop a report of components and the overall system integration covering the integration results</p> <p>Develop a SW Verification Plan</p>	(To be fulfilled)
VER	Verifier	<p>Check the documented test suitability (completeness, coherency, relevance, traceability) with the verification objectives</p> <p>Identify anomalies, evaluate in terms of the risk, record them and communicate them to the authority in charge of the changes management for evaluation and decision making</p> <p>Manage the verification process (revision, integration and testing) and ensure the independence of the activities as needed</p> <p>Develop a verification report with the results of the verification activities</p>	(To be fulfilled)
VAL	Validator	<p>Develop a Validation Plan specifying the main tasks and activities for the sw validation</p> <p>Agree on the Validation Plan with the assessor</p> <p>Review Sw requirements in relation to their intended use/environment</p> <p>Ensure sw fulfil all sw requirements</p> <p>Evaluate the assessment of the software process and of the software according to CENELEC requirements and the assigned SIL</p> <p>Review the verification and tests correctness, consistency and suitability</p> <p>Check the correctness, consistency and suitability of the test cases and executed tests</p> <p>Ensure that all validation plan activities are carried out</p> <p>Review and classify deviations, evaluate in terms of the risk, record them and communicate them to the authority in charge of the changes management for evaluation and decision making</p> <p>Provide recommendation about sw suitability</p> <p>Record Validation Plan deviations</p> <p>Conduct audits, inspections or reviews of the overall project at various stages of development as may be appropriate</p> <p>Review and analyse validation reports of the previous sw</p> <p>Check whether the developed solutions are traceable to the sw requirements</p> <p>Ensure that records associated hazardous situations and nonconformances are reviewed</p> <p>Ensure that all dangerous situations are appropriately resolved</p> <p>Develop a Validation Report</p>	(To be fulfilled)

CAT3: CENELEC Roles/Competences for OpenETCS application software project		
Code	Role	Responsibilities (To be revised)
ASR	Assessor	<p>Develop an evaluation Plan</p> <p>Evaluate the assessment of the software process and of the software according to CENELEC requirements and the assigned SIL</p> <p>Assess the project team and the organization competences for the sw development</p> <p>Evaluate the Verification &amp; Validation activities and the supporting evidences</p> <p>Evaluate quality management systems adopted for the sw development</p> <p>Evaluate the changes management and the Configuration Management Systems and their use</p> <p>Identify and assess risk in terms of any deviation from the sw requirements in the evaluation report</p> <p>Ensure the evaluation Plan is implemented</p> <p>Performs independent checks of: The development process (audits) and the products safety functions (spot checks) during different development phases.</p> <p>Should perform audits, based on the Safety plan, of the Quality and Safety management systems of the Supplier, the Infrastructure owner and the Operator and be convinced that these systems works</p> <p>The Assessor can also perform spot checks on detailed technical issues to see that safety functions are correctly implemented. The safety functions key documentation (Hazard Log, Safety Requirements and Safety Case) should be examined too.</p> <p>Give an opinion on the validity of sw developed for its intended use</p> <p>Develop an evaluation report and maintain records about the evaluation process</p>
		Competences

(To be fulfilled)



CAT3: CENELEC Roles/Competences for OpenETCS application software project			
Code	Role	Responsibilities ( <b>To be revised</b> )	Competences
CM	Configuration Manager	Responsible for the configuration management plan [?]   System configuration management owner Establish that all sw components are clearly identified and have independent versions within the system configuration management Prepare the published release notes mentioning incompatible versions of sw components	<b>(To be fulfilled)</b>

10.4 ANNEX D -CAT3: CENELEC Roles and Competence Matrix for OpenETCS Tool Chain product-

CAT3: CENELEC Roles/Competences for OpenETCS Tool Chain product		
Code	Role	Responsibilities (To be revised)
PM	OpenETCS project Manager	Guarantee the required competence for the project is covered by the effective committers Identify which roles are needed for the project Verify that at least one person has been identified per project role ensure the independence of the roles according to CENELEC ensure compliance with the quality management system Responsible to guarantee progress according to scheduled plans devote sufficient resources to perform the task, including security tasks responsible for the delivery and implementation of the software ensure the compliance and the delivery of security requirements provide enough time for proper implementation and enforcement of security tasks approve full and partial products to be delivered by the development process ensure that records and traceability are maintained throughout the decision making and project ensure that it has appointed an appropriate validator for the project according to cenelec
		Competences
		(To be fulfilled)

CAT3: CENELEC Roles/Competences for OpenETCS Tool Chain product			
Code	Role	Responsibilities (To be revised)	Competences
RQM	Requirement manager	<p>Responsible for the Software requirement specification</p> <p>Establishes and maintain traceability to and from the system-level requirements</p> <p>ensure that tool chain and derived specifications requirements are under system configuration and changes management control.</p> <p>ensure consistency and completeness of the tool chain requirements specification</p> <p>develop and maintain documents related to tool chain requirements</p>	(To be fulfilled)
DES	Designer	<p>Transform software requirements on acceptable solutions</p> <p>Derive the requirements for the system and software architecture</p> <p>Identify the key design issues that must be resolved to support successful development of the software</p> <p>Allocate the tool chain and derived requirements to the chosen architecture components and interfaces</p> <p>Maintain requirement traceability for the software architecture's requirements, and to and from software requirements</p> <p>Identify suitable derived requirements that address the effectiveness and cost of life-cycle phases following development, such as production and operation</p> <p>Develop and maintain design documentation</p> <p>Ensure that the design documents are under system configuration and changes management control.</p> <p>Design or select design methods and support tools</p> <p>Apply principles and suitable design standards</p> <p>Develop component specifications if it is applicable</p>	(To be fulfilled)

CAT3: CENELEC Roles/Competences for OpenETCS Tool Chain product			
Code	Role	Responsibilities (To be revised)	Competences
IMP	Implementer	<p>Transform design solutions in data, source code, models and / or other design representations</p> <p>Apply design principles</p> <p>Apply specific rules for data preparation/codification</p> <p>Perform analysis to verify intermediate results</p> <p>Develop and maintain implementing documents comprising the methods, types of data, models and listings applied</p> <p>Maintain traceability to and from the design</p> <p>Maintain the generated or modified data/codes/models under system configuration and changes management control.</p>	(To be fulfilled)
TST	Tester	<p>Ensure the test activities planning</p> <p>Develop tests specification (goals and cases)</p> <p>Ensure traceability of test objectives to specified software requirements</p> <p>Ensure traceability of test cases to the specified tests objectives</p> <p>Ensure that the planned tests are implemented and performed</p> <p>Identify deviations from the expected results and record in the test reports</p> <p>Communicate deviation to the authority in charge of the changes management for evaluation and decision making</p> <p>Record the results reports</p> <p>Select the equipment for testing the software</p>	(To be fulfilled)

CAT3: CENELEC Roles/Competences for OpenETCS Tool Chain product			
Code	Role	Responsibilities (To be revised)	Competences
INT	Integrator	<p>Manage the integration process using software baselines</p> <p>Develop sw and sw /hw integration test specification for sw components based on the specifications and on the designer's components architecture</p> <p>Develop and maintain records of the integration activities</p> <p>Identify integration anomalies; record them and communicate them to the authority in charge of the changes management for evaluation and decision making</p> <p>Develop a report of components and the overall system integration covering the integration results</p> <p>Develop a SW Verification Plan</p>	(To be fulfilled)
VER	Verifier	<p>Check the documented test suitability (completeness, coherency, relevance, traceability) with the verification objectives</p> <p>Identify anomalies, evaluate in terms of the risk, record them and communicate them to the authority in charge of the changes management for evaluation and decision making</p> <p>Manage the verification process (revision, integration and testing) and ensure the independence of the activities as needed</p> <p>Develop a verification report with the results of the verification activities</p>	(To be fulfilled)
VAL	Validator	<p>Develop a Validation Plan specifying the main tasks and activities for the sw validation</p> <p>Agree on the Validation Plan with the assessor</p> <p>Review Sw requirements in relation to their intended use/environment</p> <p>Ensure sw fulfil all sw requirements</p> <p>Evaluate the assessment of the software process and of the software according to CENELEC requirements and the assigned SIL</p> <p>Review the verification and tests correctness, consistency and suitability</p> <p>Check the correctness, consistency and suitability of the test cases and executed tests</p> <p>Ensure that all validation plan activities are carried out</p> <p>Review and classify deviations, evaluate in terms of the risk, record them and communicate them to the authority in charge of the changes management for evaluation and decision making</p> <p>Provide recommendation about sw suitability</p> <p>Record Validation Plan deviations</p> <p>Conduct audits, inspections or reviews of the overall project at various stages of development as may be appropriate</p> <p>Review and analyse validation reports of the previous sw</p> <p>Check whether the developed solutions are traceable to the sw requirements</p> <p>Ensure that records associated hazardous situations and nonconformances are reviewed</p> <p>Ensure that all dangerous situations are appropriately resolved</p> <p>Develop a Validation Report</p>	(To be fulfilled)

CAT3: CENELEC Roles/Competences for OpenETCS Tool Chain product		
Code	Role	Responsibilities (To be revised)
ASR	Assessor	<p>Develop an evaluation Plan</p> <p>Evaluate the assessment of the software process and of the software according to CENELEC requirements and the assigned SIL</p> <p>Assess the project team and the organization competences for the sw development</p> <p>Evaluate the Verification &amp; Validation activities and the supporting evidences</p> <p>Evaluate quality management systems adopted for the sw development</p> <p>Evaluate the changes management and the Configuration Management Systems and their use</p> <p>Identify and assess risk in terms of any deviation from the sw requirements in the evaluation report</p> <p>Ensure the evaluation Plan is implemented</p> <p>Performs independent checks of: The development process (audits) and the products safety functions (spot checks) during different development phases.</p> <p>Should perform audits, based on the Safety plan, of the Quality and Safety management systems of the Supplier, the Infrastructure owner and the Operator and be convinced that these systems works</p> <p>The Assessor can also perform spot checks on detailed technical issues to see that safety functions are correctly implemented. The safety functions key documentation (Hazard Log, Safety Requirements and Safety Case) should be examined too.</p> <p>Give an opinion on the validity of sw developed for its intended use</p> <p>Develop an evaluation report and maintain records about the evaluation process</p>
		<b>(To be fulfilled)</b>

CAT3: CENELEC Roles/Competences for OpenETCS Tool Chain product			
Code	Role	Responsibilities (To be revised)	Competences
CM	Configuration Manager	Responsible for the configuration management plan [?]   System configuration management owner Establish that all sw components are clearly identified and have independent versions within the system configuration management Prepare the published release notes mentioning incompatible versions of sw components	(To be fulfilled)

## 10.5 ANNEX E - Methods & Tools for Application Software

Software Requirements Specification Phase				
Code	Method/Technique	SIL 4	Applied (Yes/No)	Details and References
1	Formal Methods	HR	Yes	<i>Include details and references to external documents when if necessary</i>
2	Modelling	HR	Yes	<i>Include details and references to external documents when if necessary</i>
3	Structured Methodology	HR	Yes	<i>Include details and references to external documents when if necessary</i>
4	Decision Table	HR	Yes	<i>Include details and references to external documents when if necessary</i>
<b>Justification: (To be fulfilled)</b>				
<i>Justification how Methods &amp; Techniques are compliance with CENELEC</i>				

Software Architecture Phase				
Code	Method/Technique	SIL 4	Applied (Yes/No)	Details and References
1	Defensive Programming	HR	Yes	<i>Include details and references to external documents when if necessary</i>
2	Fault Detection & Diagnosis	HR	Yes	<i>Include details and references to external documents when if necessary</i>
3	Error Correcting Codes	-	Yes	<i>Include details and references to external documents when if necessary</i>
4	Error Detecting Codes	HR	Yes	<i>Include details and references to external documents when if necessary</i>
5	Assertion Programming	HR	Yes	<i>Include details and references to external documents when if necessary</i>
6	Safety Bag Techniques	R	Yes	<i>Include details and references to external documents when if necessary</i>
7	Diverse Programming	HR	Yes	<i>Include details and references to external documents when if necessary</i>



Software Architecture Phase				
Code	Method/Technique	SIL 4	Applied (Yes/No)	Details and References
8	Recovery Block	R	Yes	<i>Include details and references to external documents when if necessary</i>
9	Backward Recovery	NR	No	<i>Include details and references to external documents when if necessary</i>
10	Forward Recovery	NR	No	<i>Include details and references to external documents when if necessary</i>
11	Re-try Fault Recovery Mechanisms	R	Yes	<i>Include details and references to external documents when if necessary</i>
12	Memorising Executed Cases	HR	Yes	<i>Include details and references to external documents when if necessary</i>
13	Artificial Intelligence - Fault Correction	NR	No	<i>Include details and references to external documents when if necessary</i>
14	Dynamic Reconfiguration of software	NR	No	<i>Include details and references to external documents when if necessary</i>
15	Software Error Effect Analysis	HR	Yes	<i>Include details and references to external documents when if necessary</i>
16	Fault Tree Analysis	HR	Yes	<i>Include details and references to external documents when if necessary</i>
17	Information Hiding	-	Yes	<i>Include details and references to external documents when if necessary</i>
18	Information Encapsulation	HR	Yes	<i>Include details and references to external documents when if necessary</i>
19	Fully Defined Interface	M	Yes	<i>Include details and references to external documents when if necessary</i>
20	Formal Methods	HR	Yes	<i>Include details and references to external documents when if necessary</i>
21	Modelling	HR	Yes	<i>Include details and references to external documents when if necessary</i>

Software Architecture Phase				
Code	Method/Technique	SIL 4	Applied (Yes/No)	Details and References
22	Structured Methodology	HR	Yes	<i>Include details and references to external documents when if necessary</i>
23	Modelling supported by computer aided design and specification tools	HR	Yes	<i>Include details and references to external documents when if necessary</i>
Justification: <b>(To be fulfilled)</b>				
<i>Justification how Methods &amp; Techniques are compliance with CENELEC</i>				

Software Design and Implementation Phase				
Code	Method/Technique	SIL 4	Applied (Yes/No)	Details and References
1	Formal Methods	HR	Yes	<i>Include details and references to external documents when if necessary</i>
2	Modelling	HR	Yes	<i>Include details and references to external documents when if necessary</i>
3	Structured Methodology	HR	Yes	<i>Include details and references to external documents when if necessary</i>
4	Modular Approach	M	Yes	<i>Include details and references to external documents when if necessary</i>
5	Components	HR	Yes	<i>Include details and references to external documents when if necessary</i>
6	Design and Coding Standards	M	Yes	<i>Include details and references to external documents when if necessary</i>
7	Analysable Programs	HR	Yes	<i>Include details and references to external documents when if necessary</i>
8	Strongly Typed Programming Language	HR	Yes	<i>Include details and references to external documents when if necessary</i>
9	Structured Programming	HR	Yes	<i>Include details and references to external documents when if necessary</i>

Software Design and Implementation Phase				
Code	Method/Technique	SIL 4	Applied (Yes/No)	Details and References
10	Programming Language	HR	Yes	<i>Include details and references to external documents when if necessary</i>
11	Language Subset	HR	Yes	<i>Include details and references to external documents when if necessary</i>
12	Object Oriented Programming	R	Yes	<i>Include details and references to external documents when if necessary</i>
13	Procedural Programming	HR	Yes	<i>Include details and references to external documents when if necessary</i>
14	Metaprogramming	R	Yes	<i>Include details and references to external documents when if necessary</i>
<b>Justification: (To be fulfilled)</b>				
<i>Justification how Methods &amp; Techniques are compliance with CENELEC</i>				

Verification and Testing Phase				
Code	Method/Technique	SIL 4	Applied (Yes/No)	Details and References
1	Formal Proof	HR	Yes	<i>Include details and references to external documents when if necessary</i>
2	Static Analysis	HR	Yes	<i>Include details and references to external documents when if necessary</i>
3	Dynamic Analysis and Testing	HR	Yes	<i>Include details and references to external documents when if necessary</i>
4	Metrics	R	Yes	<i>Include details and references to external documents when if necessary</i>
5	Traceability	M	Yes	<i>Include details and references to external documents when if necessary</i>
6	Software Error Effect Analysis	HR	Yes	<i>Include details and references to external documents when if necessary</i>
7	Test Coverage for code	HR	Yes	<i>Include details and references to external documents when if necessary</i>

Verification and Testing Phase				
Code	Method/Technique	SIL 4	Applied (Yes/No)	Details and References
8	Functional/ Black-box Testing	M	Yes	<i>Include details and references to external documents when if necessary</i>
9	Performance Testing	HR	Yes	<i>Include details and references to external documents when if necessary</i>
10	Interface Testing	HR	Yes	<i>Include details and references to external documents when if necessary</i>
Justification: <b>(To be fulfilled)</b>				
<i>Justification how Methods &amp; Techniques are compliance with CENELEC</i>				

Integration Phase				
Code	Method/Technique	SIL 4	Applied (Yes/No)	Details and References
1	Functional and Black-box Testing	HR	Yes	<i>Include details and references to external documents when if necessary</i>
2	Performance Testing	HR	Yes	<i>Include details and references to external documents when if necessary</i>
Justification: <b>(To be fulfilled)</b>				
<i>Justification how Methods &amp; Techniques are compliance with CENELEC</i>				

Overall Software Testing Phase				
Code	Method/Technique	SIL 4	Applied (Yes/No)	Details and References
1	Performance Testing	M	Yes	<i>Include details and references to external documents when if necessary</i>
2	Functional and Black-box Testing	M	Yes	<i>Include details and references to external documents when if necessary</i>
3	Modelling	R	Yes	<i>Include details and references to external documents when if necessary</i>
Justification: <b>(To be fulfilled)</b>				
<i>Justification how Methods &amp; Techniques are compliance with CENELEC</i>				

Software Analysis Techniques Phase				
Code	Method/Technique	SIL 4	Applied (Yes/No)	Details and References
1	Static Software Analysis	HR	Yes	<i>Include details and references to external documents when if necessary</i>
2	Dynamic Software Analysis	HR	Yes	<i>Include details and references to external documents when if necessary</i>
3	Cause Consequence Diagrams	R	Yes	<i>Include details and references to external documents when if necessary</i>
4	Event Tree Analysis	R	Yes	<i>Include details and references to external documents when if necessary</i>
5	Software Error Effect Analysis	HR	Yes	<i>Include details and references to external documents when if necessary</i>
<b>Justification: (To be fulfilled)</b>				
<i>Justification how Methods &amp; Techniques are compliance with CENELEC</i>				

Software Quality Assurance Phase				
Code	Method/Technique	SIL 4	Applied (Yes/No)	Details and References
1	Accredited to EN ISO 9001	HR	Yes	<i>Include details and references to external documents when if necessary</i>
2	Compliant with EN ISO 9001	M	Yes	<i>Include details and references to external documents when if necessary</i>
3	Compliant with ISO/IEC 90003	R	Yes	<i>Include details and references to external documents when if necessary</i>
4	Company Quality System	M	Yes	<i>Include details and references to external documents when if necessary</i>
5	Software Configuration Management	M	Yes	<i>Include details and references to external documents when if necessary</i>
6	Checklists	HR	Yes	<i>Include details and references to external documents when if necessary</i>
7	Traceability	M	Yes	<i>Include details and references to external documents when if necessary</i>

Software Quality Assurance Phase				
8	Data Recording and Analysis	M	Yes	<i>Include details and references to external documents when if necessary</i>
Justification: <b>(To be fulfilled)</b>				
<i>Justification how Methods &amp; Techniques are compliance with CENELEC</i>				

Software Maintenance Phase				
Code	Method/Technique	SIL 4	Applied (Yes/No)	Details and References
1	Impact Analysis	M	Yes	<i>Include details and references to external documents when if necessary</i>
2	Data Recording and Analysis	M	Yes	<i>Include details and references to external documents when if necessary</i>
Justification: <b>(To be fulfilled)</b>				
<i>Justification how Methods &amp; Techniques are compliance with CENELEC</i>				

Data Preparation Techniques Phase				
Code	Method/Technique	SIL 4	Applied (Yes/No)	Details and References
1	Tabular Specification Methods	R	Yes	<i>Include details and references to external documents when if necessary</i>
2	Application specific language	R	Yes	<i>Include details and references to external documents when if necessary</i>
3	Simulation	HR	Yes	<i>Include details and references to external documents when if necessary</i>
4	Functional testing	M	Yes	<i>Include details and references to external documents when if necessary</i>
5	Checklists	M	Yes	<i>Include details and references to external documents when if necessary</i>
6	Fagan inspection	R	Yes	<i>Include details and references to external documents when if necessary</i>
7	Formal design reviews	HR	Yes	<i>Include details and references to external documents when if necessary</i>

Data Preparation Techniques Phase				
Code	Method/Technique	SIL 4	Applied (Yes/No)	Details and References
8	Formal proof of correctness (of data)	HR	Yes	<i>Include details and references to external documents when if necessary</i>
9	Walkthrough	HR	Yes	<i>Include details and references to external documents when if necessary</i>
Justification: <b>(To be fulfilled)</b>				
<i>Justification how Methods &amp; Techniques are compliance with CENELEC</i>				

Quality mechanisms for Safe deployment	Technique & Approach
Software Self-identification Mechanisms (9.1.4.11)	<b>(To be fulfilled)</b>
Error detection and/or avoidance mechanisms during deployment process (store, transfer, transmission and/or duplication of code operations) (9.1.4.20)	<b>(To be fulfilled)</b>
Automatic detection and safe management of incompatible components/versions (9.1.4.8, 9.1.4.9)	<b>(To be fulfilled)</b>
Provision of appropriate and accurate diagnostic information	<b>(To be fulfilled)</b>
Safe Roll back capabilities	<b>(To be fulfilled)</b>

## 10.6 ANNEX F -Class T3 Tools

## 10.7 ANNEX G - Methods & Tools for Tool Chain