KNÜVENERMACKERT
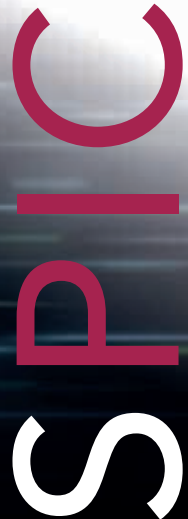## ACCEPTED PROCESSES FOLLOW EASY RULES

SPICE BOOKLET

7th Edition 2022

SPICE

- INTRODUCTION TO AUTOMOTIVE SPICE®
- AUTOMOTIVE SPICE® V3.1 (extended VDA scope)
- GUIDELINE RULES AND RECOMMENDATION IDS
- RATING CONSISTANCY DIAGRAMS
- AUTOMOTIVE SPICE® FOR CYBERSECURITY V1.0

- AGILE SPICE™ V1.1
- HARDWARE ENGINEERING SPICE V2.0
- MECHANICAL ENGINEERING SPICE V1.8
- ASSESSMENT GUIDE

[1] **VDA scope**   [2] **extended VDA scope**   [3] **with assessment guideline for rating consistency**   [4] **Automotive SPICE for Cybersecurity**

MECHANICAL ENGINEERING SPICE PROCESSES

CAPABILITY LEVEL

ASSESSMENT GUIDE

[1] **VDA scope** [2] **extended VDA scope** [3] **with assessment guideline for rating consistency** [4] **Automotive SPICE for Cybersecurity**

How to read this SPICE Guide

This Knüvener Mackert SPICE Guide offers a wealth of basic and detailed information to help you achieve maximum benefit from Automotive SPICE®.

In the following sections, **red is reserved for the management and supporting processes, black is used for the system level, blue for the subdomain level, and green for the component level.**

This Knüvener Mackert SPICE Guide contains the following sections:
1. An **introduction** to the goals and added value of effective processes and a typical approach to process improvement.
2. An **introduction to Automotive SPICE®** and its application together with agile methods and concepts for functional safety and cyber safety.
3. The processes of **Automotive SPICE®v3.1.**
   3a. For each practice of the VDA scope the pages and IDs of the related VDA Guideline (1st edition 2017) and recommendations are listed.
   3b. For each process of the VDA scope and for the process attributes of level 2 and 3 the rating consistency diagrams from the VDA Guideline (1st edition 2017) are copied.
4. The process of **Automotive SPICE® for Cybersecutity v1.0.**
5. An **introduction to Agile SPICE™** and the process AGL.1-AGL.3
6. The processes of **Hardware Engineering SPICE** v2.0
7. The processes of **Mechanical Engineering SPICE** v1.8
8. The process attributes and **generic practices** for capability levels 1 to 5
9. Various instructions for conducting an **assessment** with templates, guidelines and requirements

You can obtain the VDA Automotive Spice Guideline in the VDA QMC webshop: https://webshop.vda.de/qmc/en/

Legend

Practices and process attributes are displayed in boxes.

- For practices of the considered process, the boxes are blue.
- For practices of other processes, the boxes are green.

Dependencies between practices are displayed as arrows from the dependent practice to the other practice

- For dependencies within a process blue lines are displayed
- For dependencies between elements of different process green lines are displayed
- If the dependency is based on a rule (RL), a solid line is displayed
- If the dependency is based on a recommendation (RC), a dashed line is displayed
- An Arrow may have two points if it represents a bidirectional dependency
- If the arrows visualize defined rules (RL) or recommendations (RC), the corresponding numbers (postfixes of the IDs) are listed

Example 1: the solid blue arrow visualizes the rule that the rating of one BP depends on another BP of the process under consideration.

Example 2: the dotted green arrow visualizes a recommendation that the rating of one BP should depend on another BP which is outside the process under consideration.

Automotive SPICE® Guidelines – Rules and Recommendations

The VDA ("Verband der Automobilindustrie") has published rules and recommendations in the VDA Automotive SPICE® Guideline (1st edition 2017). These rules and recommendations are used as rating guidelines in an assessment. They are structured according to

- specific terms (traceability and consistency (TAC), summarize and communicate (SAC), verification criteria (VEC), strategy and plan (SAP)),
- application in specific environments (model-based development (MBD), agile environments (AGE), distributed development (DID), management of third-party software (TPS), management of platform and legacy software (PLS), application parameters (APA)),
- specific processes (VDA scope) or process attributes (level 1 to 3).

All relevant rules and recommendations for a specific practice of the VDA scope are divided into up to 6 different chapters and even more different sections. To facilitate the overview of the rules and recommendations relevant to a practice, this SPICE Booklet guide lists the page numbers and IDs of the rules (RL) and recommendations (RC) under the practice, e.g., for MAN.3.BP1 on page 64 (DID.RL.1), page 72 (PLS.RC.1) and on page 198 (MAN.3.RL.1, MAN.3.RL.2, MAN.3.RL.3, MAN.3.RC.1, MAN.3.RC.2).

BP 1 **Define the scope of work.** Identify the project's goals, motivation and boundaries. [OUTCOME 1]

64: DID.RL.1
72: PLS.RC.1
198: MAN.3.RL.1-3, MAN.3.RC.1-2

INTRODUCTION TO PROCESS QUALITY

Why process quality?
Automotive SPICE® supports the quality of your daily processes

✓ **Increase quality**
- Work products (WPs) are based on qualified input
- WPs are verified and validated based on criteria
- WPs are produced as planned and scheduled
- Organizational Learning due to improved standards

✓ **Reduce cost**
- Early identification and correction of lacks
- Proven processes and templates; experienced team
- Transparent and smooth progress
- Do it right the first time
- Less duplicated work, re-work and extra work
- Productivity increase

✓ **Manage risks and complexity**
- Manage risks effectively and in time
- Develop increasing functionality in reduced time

✓ **Meet customers expectation – current and future business**
- Avoid penalty (payments and/or 'high' awareness)
- Win quotations (positive supplier ranking, flexibility)

✓ **For your own sake**
- Less priority hopping
- Clear responsibilities
- Pride in one's own work
- Less discussions
- No double work
- <please add your personal points here>
- …

How to invest in quality and cost saving
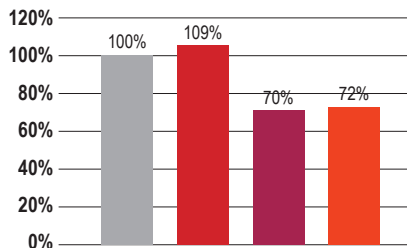
- 100% = Development without Automotive SPICE
- With Automotive SPICE: 9% more initial development costs
- With Automotive SPICE: 30% less bugs
- With Automotive SPICE: 28% less effort for maintenance

Source: Paolo Panaroni, Luca Fogli, Why Automotive SPICE?, IntecsSolutions 2017

Provided example:
Realization of one complex function

- 280 errors of A or B priority in a C sample costs 2.184.000 US$.
  Saving by Automotive SPICE (30%): 655.000 US$

- 80 open of A or B priority in SOP costs 6.760.000 US$.
  Saving by Automotive SPICE (30%): 2.028.000 US$

Source: Frank Lenkeit (K-GQX-S/2), Volkswagen AG,
17 Jahre Automotive SPICE ohne Fortschritt? Gate4SPICE – Berlin 12.06.2018

Cost of error correction

Concept phase:	$1.300,00	SOP:	$ 84.500,00
A Sample:	$4.550,00	Production:	$104.000,00
B Sample :	$5.200,00	Ahead of customer:	$117.000,00
C Sample:	$7.800,00		

"Source: Study Audi, BMW, Daimler, Porsche and Volkswagen; Seidler,
Southworth, ASPICE Made Easy-Case Studies and Lessons Learned,
IBM Rational Automotive Engineering Symposium 2013"

WHAT MATCHES BEST?

Reduction of quality cost ▪ Fewer quality issues and lower warranty cost ▪ Early error identification and correction ▪ Global learning and prevention	☐ or ☐	▪ Increasing number of quality issues ▪ Poor rectification of root causes ▪ Checks are late or incomplete ▪ Poor / unknown product component mature
Managed risks ▪ Early risk identification ▪ Systemic risk tracking and mitigation ▪ Certifications are easy to achieve	☐ or ☐	▪ Problems appear ‚suddenly' ▪ Reputation drops ▪ Certifications are missing or at risk ▪ New bids are hard to win (e.g. for Safety)
Increase of productivity ▪ People concentrate on their tasks efficiently ▪ Templates and tools are aligned to standards ▪ Limited maintenance cost for standard tools	☐ or ☐	▪ Fire fighting ▪ Unclear responsibilities ▪ Priority hopping ▪ Poor tool alignment to specific ways of working
Customer Satisfaction ▪ Flexibility within distributed development ▪ Detailed insight into progress and status ▪ Easy adaption of products, standards, and tools to project and culture needs	☐ or ☐	▪ Internal and external deliverables are late, incomplete, or of poor quality ▪ Deliveries are difficult to integrate ▪ Needed flexibility results in extraordinary cost

How to benefit from Automotive SPICE®

- Identification of development risks and capabilities associated with suppliers of mechatronic systems

- Identification of risks and capabilities in your own development

- Benchmarking for strengths and potentials of development processes of a project or an organizational unit

- Evaluation of implemented process changes

- Improve transparency, quality and productivity by clarifying and tracking the responsibilities within the development
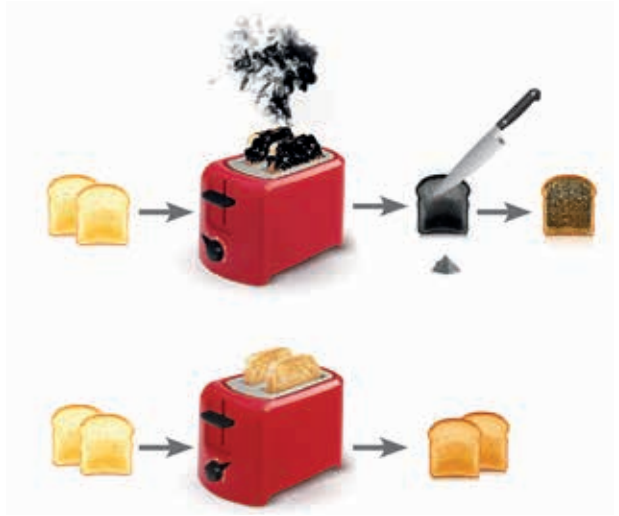
FIX THE PROCESS TO ACHIEVE QUALITY

How organizations learn systematically

Organizations learn only by improving the standard
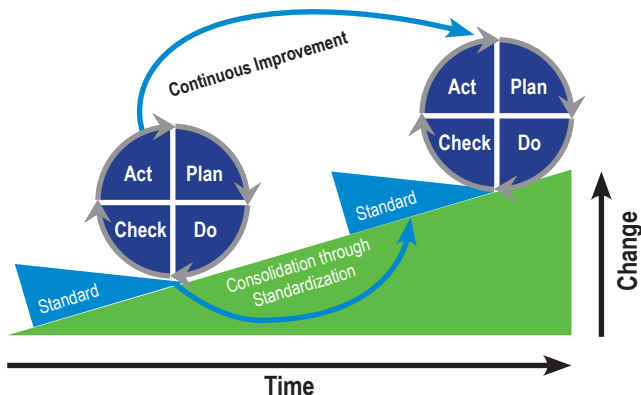
By Johannes Vietze - Own work, CC BY-SA 3.0, wikimedia,...

Plan:
- Inform about Automotive SPICE and define goal
- Analyze where you are
- Plan the roadmap for improvement
- Enable persons and infrastructure for change

Do:
- Make the management commitment continuously visible
- Define and agree on process interfaces
- Develop the process solution steps with the people

Check:
- Try the new process solution step-by-step
- Check and improve the process and templates

Act:
- Plan and execute the process trainings and roll-out

INTRODUCTION TO AUTOMOTIVE SPICE®

Automotive SPICE® Scope and Plug-In Concept

Automotive SPICE® is a standard used for improving and evaluating development processes of mechatronic systems. It is a framework which applies to traditional or agile developments. It supports the engineering of products which are critical according to safety or security. With the "Plug-in concept" of Automotive SPICE® version 3.x the processes for development of mechanical and EE parts are more and more in focus.

MAN.3   MAN.5   REU.2   ACQ.4   SUP.1   SUP.4   SUP.7   SUP.8   SUP.9   SUP.10

SYS System Engineering
HWE Hardware Engineering
SWE Software Engineering
MSE Mechanical System Engineering
MCE Mechanical Component Engineering

SYS.1
SYS.2   SYS.5
SYS.3   SYS.4

SYSTEM LEVEL

HWE.1   HWE.4
HWE.2   HWE.3

SWE.1   SWE.6
SWE.2   SWE.5

MSE.1   MSE.4
MSE.2   MSE.3

DOMAIN SUB-SYSTEM LEVEL

SWE.3   SWE.4

MCE.1   MCE.5
MCE.2   MCE.4
MCE.3

COMPONENT LEVEL

UNIT LEVEL

Engineering processes defined in Hardware Engineering SPICE (an intacs add-on to Automotive SPICE)

Engineering processes defined in Automotive SPICE®

Engineering processes defined in Mechanical Engineering SPICE (an intacs add-on to Automotive SPICE)

The concept of process capability determination by using the Automotive SPICE® assessment model is based on a two-dimensional framework. The framework consists of a process dimension and a capability dimension.

Capability dimension
- Capability levels
- Process attributes
- Rating
  - Scale
  - Rating method
  - Aggregation method
- Process capability level model

Capability levels

Process 1 2 3...n

Process dimension
- Domain and scope
- Processes with purpose and outcomes

Automotive SPICE® Process Reference Model – Overview

Acquisition Process Group (ACQ)

- **ACQ.2** Supplier Request and Selection
- **ACQ.3** Contract Agreement
- **ACQ.4** Supplier Monitoring
- **ACQ.11** Technical Requirements
- **ACQ.12** Legal and Administrative Requirements
- **ACQ.13** Project Requirements
- **ACQ.14** Request for Proposals
- **ACQ.15** Supplier Qualification

Supply Process Group (SPL)

- **SPL.1** Supplier Tendering
- **SPL.2** Product Release

System Engineering Process Group (SYS)

- **SYS.1** Requirements Elicitation
- **SYS.2** System Requirements Analysis
- **SYS.3** System Architectural Design
- **SYS.5** System Qualification Test
- **SYS.4** System Integration and Integration Test

Software Engineering Process (SWE)

- **SWE.1** Software Requirements Analysis
- **SWE.2** Software Architectural Design
- **SWE.3** Software Detailed Design and Unit Construction
- **SWE.6** Software Qualification Test
- **SWE.5** Software Integration and Intergration Test
- **SWE.4** Software Unit Verification

- **SEC.1** Cybersecurity Requirements Elicitation
- **SEC.2** Cybersecurity Implementation
- **SEC.3** Risk Treatment Verification
- **SEC.4** Risk Treatment Validation

Supporting Process Group (SUP)

- **SUP.1** Quality Assurance
- **SUP.2** Verification
- **SUP.4** Joint review
- **SUP.7** Documentation
- **SUP.8** Configuration Management
- **SUP.9** Problem Resolution Management
- **SUP.10** Change Request Management

Management Process Group (MAN)

- **MAN.3** Project Management
- **MAN.5** Risk Management
- **MAN.6** Measurement
- **MAN.7** Cybersecurity Risk Management

Reuse Process Group (REU)

- **REU.2** Reuse Programm Management

Process Improvement Process Group (PIM)

- **PIM.3** Process Improvement

Primary Life Cycle Processes	Supporting Life Cycle Processes	Organizational Life cycle Processes

Explanation: Scope Automotive SPICE for Cybersecurity | Red frame = processes of VDA scope

Automotive SPICE® Capability Dimension

Investing in process improvement led by the OU-wide quantitative feedback and causal analysis resolution.

Capability Level 5 Innovating
PA.5.1 Process Innovation
PA.5.2 Process Innovation Implementation

Quantitative data about process performance is measured, recorded and statistically analysed to allow objective decisions.

Capability Level 4 Predictable
PA.4.1 Process Measurement
PA.4.2 Process Control

A set of specific standard processes for the organization is used. The organization learns by improving the standards.

Capability Level 3 Established
PA.3.1 Process Definition
PA.3.2 Process Deployment

FIRST STABLE LEVEL*

Capability Level 2 Managed
PA.2.1 Performance Management
PA.2.2 Work Product Management

Performance is controlled (planned, monitored, adjusted) and responsibilities are defined. Results are quality checked and managed.

Capability Level 1 Performed
PA.1.1 Process Performance

Process outcomes are achieved.

Capability Level 0 Incomplete

Process results are incomplete or inappropriate.

* By experience, lower Capability Levels are not stable i.e. either increase or decrease over a period of about 18 months.

Organization SPICE

In addition to capability evaluations of single pro-cesses, the capability level of an entire organization may be evaluated. One refers to Organizational Maturity Levels (OML) in this case.

Project assessments dominate currently, but the interest in Organizational Maturity Assessments is growing because of the desire to reduce the effort needed for assessments.

Organizational assessments examine the entire company, including a majority of its projects. Ultimately, it is the organization that makes it possible for the employees in the projects to apply processes effectively.

These organizational assessments evaluate the capability and maturity of the company, to deliver quality systematically. The basis for this assessment is ISO / IEC 15504-7, which defines the concept of "Organizational Maturity Model". In assessments multiple process instances are investigated.

Level	Name
5	Innovating
4	Predictable
3	Established
2	Managed
1	Performed
0	Incomplete

The ISO/IEC 15504-7 Organizational Maturity Levels
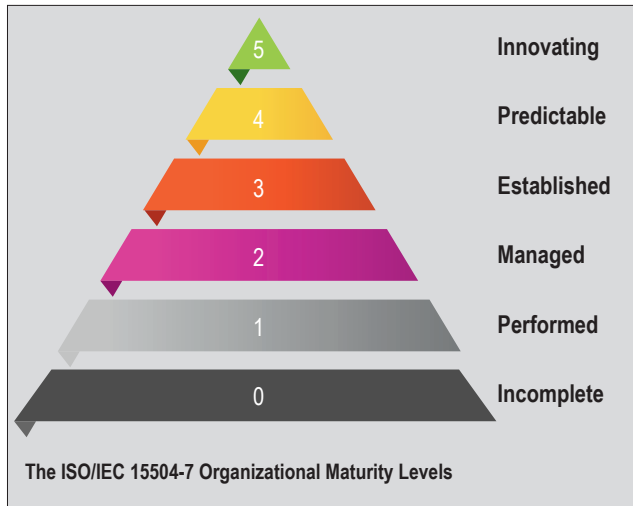
Organization SPICE Processes

Basic Process Set: VDA Scope
- SYS.2-5   System Engineering
- SWE.1-6   Software Engineering
- MAN.3   Project Management
- ACQ.4   Supplier Monitoring
- SUP.1   Quality Assurance
- SUP.8   Configuration Management
- SUP.9   Problem Resolution Management
- SUP.10   Change Request Management

Extended Process Set Level 2:
- SYS.1   Requirements Elicitation
- MAN.5   Risk Management
- MAN.6   Measurement
- ACQ.3   Contract Agreement
- SUP.4   Joint Review
- SPL.2   Product Release

Extended Process Set Level 3:
- ORG.1   Process Establishment
- ORG.4   Skill development
- PIM.3   Process Improvement
- REU.2   Reuse Program Management (recommended)

Extended Process Set Level 4 and 5:
- QNT.1   Quantitative Performance Management (Level 4)
- QNT.2   Quantitative Process Improvement (Level 5)

Selected processes

Capability Level vs Processes chart with maturity levels ML1–ML5.

Horizontal axis groups: Basic set: VDA Scope | Extended Set Level 2 | Extended Set Level 3 | Extended Set Level 4 & 5
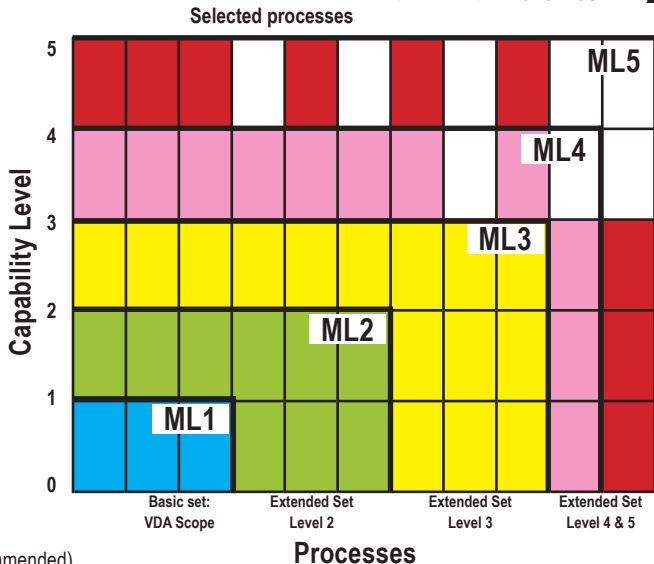
ISO/IEC TR 15504-7 Figure 2 - Rules for deriving maturity levels (ML) from capability levels "Equivalent Staging".

AUTOMOTIVE SPICE® KEY CONCEPTS

1. Use qualified input to aim qualified output

Each expert shall perform the work using **qualified input** and shall provide **qualified output** to the next one in the value chain. *Hints:*

- Divide the work into small tasks (e.g. < 40h)
- Get the tasks 'done' continuously one after another
- Qualify and approve the work products continuously
- Use clear criteria and efficient methods to qualify

2. Agree and summarize

Engineering processes:

- **Agree** on requirements and design
- **Summarize** results of step-by-step verification

Management and support processes:

- **Agree** on strategies, plans and schedules
- **Summarize** the results and report to relevant parties

3. Divide and control

On system, domain, sub-domain and component level:

1. **Specify** and **design** the solution.
2. **Delegate to lower level** OR
   implement solution on unit level.
3. **Integrate** and **verify integration** against the design before **qualifying** the solution against the specification.

4. Traceability

Each item (requirement, design element, implementation, test case / result, finding, scheduled activity, …) has to have a **reference to its source and to its verification.**

The traceability is used ...
… to check for **consistency**,
… to analyze its **impact** and
… to show **completeness**.

Qualification Test *Versus* Integration Test

Some processes have similar purpose, but differ in their level of detail:

Left: In requirements processes the problem is specified; In design processes the planned solutions, their structure elements, interfaces and dynamic behavior are specified

Right: Tests verify the test object either versus the related specification (dark red) or versus the related design (light red)
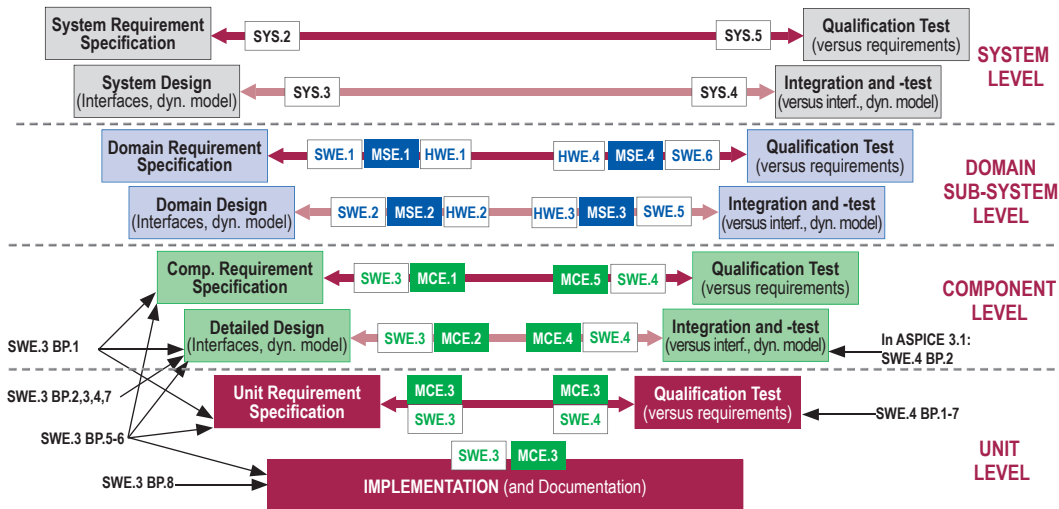
Bidirectional Traceability and Consistency

Blue: bidirectional tracebility   Red: consistency

Stakeholder requirements

SYS.2 BP6
SYS.2 BP7

SWE.1 BP6
SWE.1 BP7

System requirements

SYS.3 BP6
SYS.3 BP7

System architecture

SWE.1 BP6
SWE.1 BP7

Software requirements

SWE.2 BP7
SWE.2 BP8

Software architecture

SWE.3 BP5
SWE.3 BP6

SWE.3 BP5
SWE.3 BP6

Software detailed design

Software units

Change requests

SYS.5 BP5
SYS.5 BP6

System qualification test specification — test cases

SYS.5 BP5

System qualification test results

SYS.4 BP7
SYS.4 BP8

System integration test specification — test cases

SYS.4 BP7

System integration test results

SWE.6 BP5
SWE.6 BP6

Software qualification test specification — test cases

SWE.6 BP5

Software qualification test results

SWE.5 BP7
SWE.5 BP8

Software integration test specification — test cases

SWE.5 BP7

Software integration test results

SWE.4 BP5
SWE.4 BP6

Unit test specification

SWE.4 BP5

Unit test results

SWE.4 BP5

Static verification results

To affected work products
SUP.10 BP8

SYSTEM LEVEL

DOMAIN SUB-SYSTEM

COMPONENT LEVEL

UNIT LEVEL

Agree, Summarize and Communicate

- **"Communicate agreed"** – there is a joint understanding between affected parties of what is meant by the content of the work product.
- **"Summarize and communicate"** refers to abstracted information resulting from test executions made available to all relevant parties.
- *Note:* both concepts do *not* mean formal approval or confirmation (this would be GP 2.1.7 at CL 2).
- *Note:* a part of a specification or design is called **"Element"** (left); a part of the product is called **"Item"** (right)

„Communicate agreed …." / „elements"	„Summarize and communicate…." / „item"	
SYS.2: System Requirements Analysis	SYS.5: System Qualification Test	**SYSTEM LEVEL**
SYS.3: System Architectural Design	SYS.4: System Integration and Integration Test	
SWE.1: Software Requirements Analysis	SWE.6: Software Qualification Test	**DOMAIN SUB-SYSTEM LEVELL**
SWE.2: Software Architectural Design	SWE.5: Software Integration and Integration Test	
SWE.3: Software Detailed Design & Unit Construction	SWE.4: Software Unit Verification	**COMPONENT LEVEL**

Evaluation, Verification Criteria and Compliance

SYSTEM LEVEL

SYS.2 BP.5: Verification criteria

SYS.2: System Requirements Analysis

SYS.5: System Qualification Test

SYS.5 BP.2: Compliance

SYS.3: System Architectural Design

SYS.4: System Integration and Integration Test

SUP.2: Verification

SYS.4 BP.3: Compliance

SYS.3 BP.5: Evaluate

DOMAIN SUB-SYSTEM LEVEL

SWE.1 BP.5: Verification criteria

SWE.1: Software Requirements Analysis

SWE.6: Software Qualification Test

SWE.6 BP.2: Compliance

SWE.2 BP.6: Evaluate

SWE.2: Software Architectural Design

SWE.5: Software Integration and Integration Test

SWE.5 BP.3: Compliance

COMPONENT/ UNIT LEVEL

SWE.3 BP.4: Evaluate

SWE.3: Software Detailed Design & Unit Construction

SWE.4: Software Unit Verification

SWE.4 BP.2: Criteria for unit verification

An interpretation of the main Automotive SPICE® management and support processes

Claim, Bug, Issue

Stakeholder Change Request

SUP.1: Quality Assurance

- Develop quality strategy & plan
- Measure product quality
- Measure process quality
- Report progress & trends vs plan
- Adjust & escalate

SUP.9: Problem Resolution Management

- Record non-conformities
- Follow emergency plan if needed
- Initiate CR or corrective action
- Report progress & trends vs plan
- Adjust & escalate

SUP.10: Change Request Management

- Record change requests
- Analyze impact
- Approve change requests
- Report progress & trends vs plan
- Adjust & escalate

MAN.3: Project Management

- Define scope
- Define life cycle
- Estimate effort
- Check feasibility
- Ensure resources
- Schedule tasks
- Report progress & trends vs plan
- Adjust & escalate

MAN.5: Risk Management

- Define risk strategy
- Identify risks sources & risks
- Analyze & rate risks
- Define mitigation actions
- Report progress & trends vs plan
- Adjust & escalate

New function

Change Request

Finding

Task

Task

Task

SUP.8: Configuration Management

… for process improvement?　　　　　　　　　　　　　.... in an assessment?

What benefit does this process offer?

To which degree is the purpose achieved?

What are the typical results?

Do the outputs provide sufficient evidence?

What are typical artefacts?

Do the work products provide complete information?

What are the expected practices to achieve the purpose?

How effective is the implementation of these practices?

REU.2 Reuse Program Management

The purpose of the Reuse Program Management Process is to plan, establish, manage, control, and monitor an organization's reuse program and to systematically exploit reuse opportunities.

Process outcomes – as a result of successful implementation of this process

1. the reuse strategy, including its purpose, scope, goals and objectives, is defined;
2. each domain is assessed to determine its reuse potential;
3. the domains in which to investigate reuse opportunities, or in which it is intended to practice reuse, are identified;
4. the organization's systematic reuse capability is assessed;
5. reuse proposals are evaluated to ensure the reuse product is suitable for the proposed application;
6. reuse is implemented according to the reuse strategy;
7. feedback, communication, and notification mechanisms are established, that operate between affected parties; and
8. the reuse program is monitored and evaluated.

Output work products

04-02 Domain architecture	[OUTCOME 2]	13-04 Communication record	[OUTCOME 7]
04-03 Domain model	[OUTCOME 2]	15-07 Reuse evaluation report	[OUTCOME 5, 6, 8]
08-17 Reuse plan	[OUTCOME 5, 6]	15-13 Assessment/audit report	[OUTCOME 3, 4]
09-03 Reuse policy	[OUTCOME 1]	19-05 Reuse strategy	[OUTCOME 1]
12-03 Reuse proposal	[OUTCOME 4]		

REU.2 with 8 Base practices

BP 1   **Define organizational reuse strategy.** Define the reuse program and necessary supporting infrastructure for the organization. [Outcome 1]

BP 2   **Identify domains for potential reuse.** Identify set(s) of systems and their components in terms of common properties that can be organized into a collection of reusable assets that may be used to construct systems in the domain. [OUTCOME 2]

BP 3   **Assess domains for potential reuse.** Assess each domain to identify potential use and applications of reusable components and products. [OUTCOME 3]

BP 4   **Assess reuse maturity.** Gain an understanding of the reuse readiness and maturity of the organization, to provide a baseline and success criteria for reuse program management. [OUTCOME 4]

BP 5   Evaluate reuse proposals. Evaluate suitability of the provided reusable components and product(s) to proposed use. [OUTCOME 5]

BP 6   **Implement the reuse program.** Perform the defined activities identified in the reuse program. [OUTCOME 6]

BP 7   **Get feedback from reuse.** Establish feedback, assessment, communication and notification mechanism that operate between affected parties to control the progress of reuse program. [OUTCOME 7, 8]
   ❶ *Affected parties may include reuse program administrators, asset managers, domain engineers, developers, operators, and maintenance groups.*

BP 8   **Monitor reuse.** Monitor the implementation of the reuse program periodically and evaluate its suitability to actual needs. [OUTCOME 6, 8]
   ❷ *The quality requirements for re-use work products should be defined.*

Work product characteristics in Annex B of AUTOMOTIVE SPICE® v3.1

WP ID

An identifier number for the work product which is used to reference the work product.

WP Name

Provides an example of a typical name associated with the work product characteristics. Organizations may call these work products by different names and may have several equivalent work products which contain the characteristics defined in one work product type. The formats for the work products can vary. It is up to the assessor and the organizational unit coordinator to map the actual work products produced in their organization to the examples given here.

WP Characteristics

Provides examples of the potential characteristics associated with the work product types. The assessor may look for these in the samples provided by the organizational unit. For Capability Level 2 or higher, each process-specific "Plan" (WP 08-nn) inherits the work product characteristics represented by the Generic Plan (WP 08-00). This means that for a process-specific "Plan" both the process-specific characteristics (WP 08-nn) and the generic characteristics (WP 08-00) apply.

WP ID	WP Name	WP Characteristics
04-00	Design	▪ Describes the overall product/system structure
		▪ Identifies the required product/system elements
		▪ Identifies the relationship between the elements
		▪ Consideration is given to:
		- any required performance characteristics
		- any required interfaces
		- any required security characteristics

WP ID	WP Name	WP Characteristics
04-04	Software architectural design	▪ Describes the overall software structure ▪ Describes the operative system including task structure ▪ Identifies inter-task/inter-process communication ▪ Identifies the required software elements ▪ Identifies own developed and supplied code ▪ Identifies the relationship and dependency between software elements ▪ Identifies where the data (such as application parameters or variables) are stored and which measures (e.g. checksums, redundancy) are taken to prevent data corruption ▪ Describes how variants for different model series or configurations are derived ▪ Describes the dynamic behavior of the software (Start-up, shutdown, software update, error handling and recovery, etc.) ▪ Describes which data is persistent and under which conditions ▪ Consideration is given to: - any required software performance characteristics - any required software interfaces - any required security characteristics required - any database design requirements

Automotive SPICE applications can benefit by agile methods, e.g. in project management.
Automotive SPICE is a framework for agility.

Open Points

Approved
feature
increments

Approved
stakeholder
change
requests

Problem
reports with
approved
correction
plan

Backlog of
Open Points
which are
assigned to
deliveries

Backlog of
derived Work
Packages for
the upcoming
delivery assigned
to its domain

Backlog of
derived tasks,
which are
assigned to
the upcoming
iteration

**Delivery
Cycle**

**Iteration
Cycle**

Sys
Eng.

Domain
Eng.

Sys
Test

Analysis,
implementation,
integration and quali-
fication is managed in
small iteration cycles of
fixed time slots

Verified
Open Points

An Example for A Functional Safety Implementation

Prepare

- Initiate Safety-Life-Cycle → Create Safety-Plan → Create Technical-Safety-Concept
- Generate Tool-Qualification-Report

Input for
- Project Manual
- Project Schedule

Execute

- Analyze Safety → Generate Confirmation Measure-Report
- Carry out Functional-Safety-Audit → Generate Confirmation Measure-Report

Continuous analysis, auditing and reporting for ongoing progress

Approve

- Generate Safety-Case → Carry out Functional-Safety-Assessment

Smooth Approval

Automotive SPICE			ISO 26262	
MAN.3	Project Management	++	Safety management during the concept phase and the product development	
		+++	Item definition (top level)	
		++	Initiation of the safety lifecycle	
		++	Initiation of product development at the system level	
		++	Initiation of product development at the hardware level	
		++	Initiation of product development at the software level	
ACQ.4	Supplier Monitoring	++	Interfaces within distributed developments	
SUP.1	Quality Assurance	++	Safety management during the concept phase and the product development	
		+++	Functional safety assessment	
SUP.2	Verification	+++	Verification	
SUP.7	Documentation	+++	Documentation	
SUP.8	Configuration Management	++	Configuration Management	
SUP.10	Change Request Management	++	Change Management	
SPL.2	Product Release	+++	Release for production	

A successful application of Automotive SPICE supports the compliance to ISO 26262.

The related Automotive SPICE process provides weak / medium / strong (+/++/+++) support to the related chapter in ISO 26262.

Automotive SPICE			ISO 26262
SYS.1	Requirements Elicitation	+++	Item definition (detailed level)
SYS.2	System Requirements Analysis	+	Functional safety concept
		+	Specification of the technical safety requirements
		++	Specification and management of safety requirements
SYS.3	System Architectural Design	++	System design
SYS.4	System Integration and Integration Test	++	Item integration and testing
SWE.1	Software Requirements Analysis	++	Specificaiton of software safety requirements
SWE.2	Software Architectural Design	++	Software architectural design
SWE.3	Software Detailed Design and Unit Construction	++	Software unit design and implementation
SWE.4	Software Unit Verification	++	Software unit testing
SWE.5	Software Integration and Integration Tests	++	Software integration and testing
SWE.6	Software Qualification Testing	++	Verification of software safety requirements

> If compliance to ISO 26262 is required, the related chapters shall be considered during application of Automotive SPICE.

AUTOMOTIVE SPICE® PROCESSES

MAN.3 Project Management

The purpose of the Project Management Process is to identify, establish, and control the activities and resources necessary for a project to produce a product, in the context of the project's requirements and constraints.

Process outcomes – as a result of successful implementation of this process

1. the scope of the work for the project is defined;
2. the feasibility of achieving the goals of the project with available resources and constraints is evaluated;
3. the activities and resources necessary to complete the work are sized and estimated;
4. interfaces within the project, and with other projects and organizational units, are identified and monitored;
5. plans for the execution of the project are developed, implemented and maintained;
6. progress of the project is monitored and reported; and
7. corrective action is taken when project goals are not achieved, and recurrence of problems identified in the project is prevented.

Output work products

08-12 Project plan	[OUTCOME 1, 3, 4, 5]	14-06 Schedule	[OUTCOME 3, 5]
13-04 Communication record	[OUTCOME 4, 6]	14-09 Work breakdown structure	[OUTCOME 3,4,5]
13-16 Change request	[OUTCOME 7]	14-50 Stakeholder groups list	[OUTCOME 4]
13-19 Review record	[OUTCOME 2,7]	15-06 Project status report	[OUTCOME 4,6]
14-02 Corrective action register	[OUTCOME 7]		

BP 1

Define the scope of work. Identify the project's goals, motivation and boundaries. [OUTCOME 1]

64: DID.RL.1
72: PLS.RC.1
198: MAN.3.RL.1-3, MAN.3.RC.1-2

BP 2

Define project life cycle. Define the life cycle for the project, which is appropriate to the scope, context, magnitude and complexity of the project. [OUTCOME 2]

1 *This typically means that the project life cycle and the customer's development process are consistent with each other.*

60: AGE.RC.2
201: MAN.3.RC.11-12
208: MAN.3.RC.18

BP 3

Evaluate feasibility of the project. Evaluate the feasibility of achieving the goals of the project in terms of technical feasibility within constraints with respect to time, project estimates, and available resources. [OUTCOME 2]

198: MAN.3.RC.2, MAN.3.RL.3
206: MAN.3.RC.15-17
208: MAN.3.RC.19
210: MAN.3.RC.30

BP 4   **Define, monitor and adjust project activities.** Define, monitor and adjust project activities and their dependencies according to defined project life cycle and estimations. Adjust activities and their dependencies as required. [OUTCOME 3, 5, 7]

  2 *A structure and a manageable size of the activities and related work packages support an adequate progress monitoring.*

  3 *Project activities typically cover engineering, management and supporting processes.*

59: AGE.RC.1
64: DID.RL.3
199: MAN.3.RC.3-5
201f: MAN.3.RC.11-13, MAN.3.RL.4-9
204: MAN.3.RL.11-15
208: MAN.3.RC.20

BP 5 **Define, monitor and adjust project estimates and resources.** Define, monitor and adjust project estimates of effort and resources based on project's goals, project risks, motivation and boundaries. [OUTCOME 2, 3, 7]

4 *Appropriate estimation methods should be used.*

5 *Examples of necessary resources are people, infrastructure (such as tools, test equipment, communication mechanisms...) and hardware/materials.*

6 *Project risks (using MAN.5) and quality criteria (using SUP.1) may be considered.*

7 *Estimations and resources typically include engineering, management and supporting processes.*

61: AGE.RC.4
64: DID.RL.3
66: TPS.RC.1
68: TPS.RC.7
94: SYS.2.RC.6
125: SWE.1.RC.7
198: MAN.3.RC.2, MAN.3.RL.3
200f: MAN.3.RC.6-13, MAN.3.RL.4-9
206: MAN.3.RC.15-17
208: MAN.3.RC.21-24
209: MAN.3.RC.28
224: CL2.RC.4-6

BP 6

Ensure required skills, knowledge, and experience. Identify the required skills, knowledge, and experience for the project in line with the estimates and make sure the selected individuals and teams either have or acquire these in time. [OUTCOME 3, 7]

⑧ *In the case of deviations from required skills and knowledge trainings are typically provided.*

206: MAN.3.RC.15-17
225: CL2.RC.7

BP 7

Identify, monitor and adjust project interfaces and agreed commitments. Identify and agree interfaces of the project with other (sub-) projects, organizational units and other affected stakeholders and monitor agreed commitments. [OUTCOME 4, 7]

⑨ *Project interfaces relate to engineering, management and supporting processes.*

70: TPS.RC.13
72: PLS.RC.3
78: APA.RC.1
201: MAN.3.RC.13, MAN.3.RL.4-9
204: MAN.3.RL.11-15
209: MAN.3.RC.29
225: CL2.RC.8

BP 8

Define, monitor and adjust project schedule. Allocate resources to activities, and schedule each activity of the whole project. The schedule has to be kept continuously updated during lifetime of the project. [OUTCOME 3, 5, 7]

10 *This relates to all engineering, management and supporting processes.*

198: MAN.3.RC.2, MAN.3.RL.3	204: MAN.3.RL.11-15
199: MAN.3.RC.3-5	208: MAN.3.RL.17, MAN.3.RC.25
201f: MAN.3.RC.11-13, MAN.3.RL.4-9	

BP 9

Ensure consistency. Ensure that estimates, skills, activities, schedules, plans, interfaces, and commitments for the project are consistent across affected parties. [OUTCOME 3, 4, 5, 7]

39: TAC.RL.1	201f: MAN.3.RC.13, MAN.3.RL.4-9
59: AGE.RC.1	205: MAN.3.RC.14-5
64: DID.RL.2	

BP 10

Review and report progress of the project. Regularly review and report the status of the project and the fulfillment of activities against estimated effort and duration to all affected parties. Prevent recurrence of problems identified. [OUTCOME 6, 7]

11 *Project reviews may be executed at regular intervals by the management. At the end of a project, a project review contributes to identifying e.g. best practices and lessons learned.*

43: SAC.RC.1-2
180: SUP.8.RC.9
201f: MAN.3.RC.13, MAN.3.RL.4-10
209: MAN.3.RC.26-27
210: MAN.3.RC.31

MAN.3 Consistency Diagram

BP2 Define project life cycle

BP1 Define the scope of work

RC.18: is appropriate for

BP6 Ensure required skills knowledge, and experience

BP3 Evaluate feasibility of the project

BP10 Review and report progress of the project

BP4 Define, monitor and adjust project activities

BP5 Define, monitor an adjust project estimates and resources

BP7 Identify, monitor and adjust project interfaces and agreed commitments

BP8 Define, monitor and adjust project schedule

BP9 Ensure consistency

Pro.y Other Processes (see following figures)

RC.20: according to

RC.26

RC.19: with respect to

RC.21: based on

RC.24: to make available resources

RC.22: with respect to

RC.27

RC.23: comparsion against each other

according to

schedules activities

RC.25

RL.17: allocates to resources

consistent with each other

based on

MAN.5 Risk Management

The purpose of the Risk Management Process is to identify, analyze, treat and monitor the risks continuously.

Process outcomes – as a result of successful implementation of this process

1. the scope of the risk management to be performed is determined;
2. appropriate risk management strategies are defined and implemented;
3. risks are identified as they develop during the conduct of the project;
4. risks are analyzed and the priority in which to apply resources to treatment of these risks is determined;
5. risk measures are defined, applied, and assessed to determine changes in the status of risk and the progress of the treatment activities; and
6. appropriate treatment is taken to correct or avoid the impact of risk based on its priority, probability, and consequence or other defined risk threshold.

Output work products

07-07 Risk measure	[OUTCOME 5]	14-02 Corrective action register	[OUTCOME 6]
08-14 Recovery plan	[OUTCOME 4, 6]	14-08 Tracking system	[OUTCOME 5, 6]
08-19 Risk management plan	[OUTCOME ALL]	15-08 Risk analysis report	[OUTCOME 4]
08-20 Risk mitigation plan	[OUTCOME 3, 4, 5, 6]	15-09 Risk status report	[OUTCOME 4, 5]
13-20 Risk action request	[OUTCOME 1, 2, 6]		

MAN.5 with 7 Base practices

BP 1 **Establish risk management scope.** Determine the scope of risk management to be performed for the project, in accordance with organizational risk management policies. [OUTCOME 1]

1 *Risks may include technical, economic and timing risks.*

BP 2 — **Define risk management strategies.** Define appropriate strategies to identify risks, mitigate risks and set acceptability levels for each risk or set of risks, both at the project and organizational level. [OUTCOME 2]

BP 3 — **Identify risks.** Identify risks to the project both initially within the project strategy and as they develop during the conduct of the project, continuously looking for risk factors at any occurrence of technical or managerial decisions. [OUTCOME 2, 3]

> 2 *Examples of risk areas that are typically analyzed for potential risk reasons or risks factors include: cost, schedule, effort, resource, and technical.*
>
> 3 *Examples of risk factors may include: unsolved and solved trade-offs, decisions of not implementing a project feature, design changes, lack of expected resources.*

BP 4 — **Analyze risks.** Analyze risks to determine the priority in which to apply resources to mitigate these risks. [OUTCOME 4]

> 4 *Risks are normally analyzed to determine their probability, consequence and severity.*
>
> 5 *Different techniques may be used to analyze a system in order to understand if risks exist, for example, functional analysis, simulation, FMEA, FTA etc.*

BP 5 — **Define risk treatment actions.** For each risk (or set of risks) define, perform and track the selected actions to keep/reduce the risks to acceptable level. [OUTCOME 5, 6]

BP 6 — **Monitor risks.** For each risk (or set of risks) define measures (e.g. metrics) to determine changes in the status of a risk and to evaluate the progress of the mitigation activities. Apply and assess these risk measures. [OUTCOME 5, 6]

> 6 *Major risks may need to be communicated to and monitored by higher levels of management.*

BP7 — **Take corrective action.** When expected progress in risk mitigation is not achieved, take appropriate corrective action to reduce or avoid the impact of risk. [OUTCOME 6]

> 7 *Corrective actions may involve developing and implementing new mitigation strategies or adjusting the existing strategies.*

MAN.5

MAN.7 Cybersecurity Risk Management

The purpose of the Cybersecurity Risk Management Process is to identify, prioritize, and analyze risks of damage to relevant stakeholders as well as monitor and control respective risk treatment options continuously.

Process outcomes – As a result of successful implementation of this process

1. the scope of the risk management to be performed is determined,
2. appropriate risk management practices are defined and implemented,
3. potential risks are identified as they evolve,
4. potential risks are prioritized initially for estimated damage and impact,
5. potential risks are analyzed and risks are evaluated,
6. risk treatment options are determined,
7. risks are continuously monitored and identified for relevant changes, and
8. corrective actions are performed on relevant changes.

Output work products

07-07 Risk measure	[OUTCOME 6]	14-51 Cybersecurity scenario register	[OUTCOME 1, 3, 5]
08-14 Recovery plan	[OUTCOME 6, 7,8]	14-52 Asset library	[OUTCOME 1, 3]
08-19 Risk management plan	[OUTCOME 1, 2, 4, 5, 6, 7, 8]	15-08 Risk analysis report	[OUTCOME 5, 6]
13-20 Risk action request	[OUTCOME 6, 7, 8]	15-09 Risk status report	[OUTCOME 6, 7, 8]
14-08 Tracking system	[OUTCOME 4, 5, 6, 7, 8]		

BP 1

Determine cybersecurity risk management scope. Determine the scope of the cybersecurity risk management to be performed including project and project assets with cybersecurity properties, damage scenarios, relevant stakeholders, impact categories and related product phases.
Determine the scope in accordance with its operational environment and organizational risk management policies.
[OUTCOME 1]

1 *Cybersecurity properties of assets include confidentiality, integrity and availability.*

2 *Typical impact categories are safety, financial, operational and privacy.*

BP 2

Define cybersecurity risk management practices. Define appropriate practices to manage the cybersecurity risks according to the defined scope including:
- Potential risk identification
- Risk analysis
- Risk evaluation
- Risk determination
- Risk treatment decision
  [OUTCOME 2]

3 *Relevant risk assessment practices may be included from established standards covering practices such as FMEA, TARA, HARA, FTA.*

BP 3
Identify potential risks. Identify potential risks within the project scope initially and during the conduct of the project, continuously looking for risk factors at any occurrence of technical or managerial decisions. [OUTCOME 3]

4 *The identification of potential risks shall include the determination of threat scenarios that impose a specific risk to initiate a damage scenario with impact on relevant stakeholders for all related properties and assets within the scope.*

BP 4
Prioritize potential risks initially for damage. Prioritize potential risks with respect to damage and impact on the relevant category and stakeholder. [OUTCOME 4]

5 *The potential risks prioritization may be consistent with the scope of risk assessment.*

BP 5
Analyze potential risks and evaluate risks. Analyze potential risks to determine the probability, consequence, and severity of risks. [OUTCOME 5]

6 *Risks are analyzed based on identified attack paths that realize a threat scenario and the ease with which identified attack paths can be conducted.*

7 *Different techniques for evaluation of metrics, rating and scoring scheme may be used to analyze a system, e.g., functional analysis, simulation, FMEA, FTA, ATA etc.*

BP 6
Define risk treatment option. For each risk (or set of risks) define the selected treatment option to accept, reduce, avoid or share (transfer) the risks. [OUTCOME 6]

8 *Typically accepted and shared risks define cybersecurity claims.*

BP 7

Monitor risks. For each risk (or set of risks) determine changes in the status of a risk and evaluate the progress of the treatment activities. [OUTCOME 7]

9 *Major risks may need to be communicated to and monitored by higher levels of management.*

10 *Risk treatment decisions may be revised for changed conditions or arise from new and updated estimations and analysis results.*

BP 8

Take corrective action. When relevant changes to risks are identified, take appropriate corrective action. [OUTCOME 8]

11 *Corrective actions may involve a reevaluation of risks, developing and implementing new risk treatment practices or adjusting existing practices.*

BP1 Determine cybersecurity risk management scope

BP4 Prioritize potential risks initially for damage

BP7 Monitor risks

according to

according to

according to

according to

BP3 Identify potenal risks

according to

BP2 Define cybersecurity risk management practices

BP8 Take corrective action

according to

according to

according to

BP5 Analyze poten al risks and evaluate risks

investigate

BP6 Define risk treatment op on

MAN.7

REU.2 Reuse Program Management

The purpose of the Reuse Program Management Process is to plan, establish, manage, control, and monitor an organization's reuse program and to systematically exploit reuse opportunities.

Process outcomes – as a result of successful implementation of this process

1. the reuse strategy, including its purpose, scope, goals and objectives, is defined;
2. each domain is assessed to determine its reuse potential;
3. the domains in which to investigate reuse opportunities, or in which it is intended to practice reuse, are identified;
4. the organization's systematic reuse capability is assessed;
5. reuse proposals are evaluated to ensure the reuse product is suitable for the proposed application;
6. reuse is implemented according to the reuse strategy;
7. feedback, communication, and notification mechanisms are established, that operate between affected parties; and
8. the reuse program is monitored and evaluated.

Output work products

04-02 Domain architecture	[OUTCOME 2]	13-04 Communication record	[OUTCOME 7]
04-03 Domain model	[OUTCOME 2]	15-07 Reuse evaluation report	[OUTCOME 5, 6, 8]
08-17 Reuse plan	[OUTCOME 5, 6]	15-13 Assessment/audit report	[OUTCOME 3, 4]
09-03 Reuse policy	[OUTCOME 1]	19-05 Reuse strategy	[OUTCOME 1]
12-03 Reuse proposal	[OUTCOME 4]		

REU.2 with 8 Base practices

BP 1 **Define organizational reuse strategy.** Define the reuse program and necessary supporting infrastructure for the organization. [OUTCOME 1]

BP 2 **Identify domains for potential reuse.** Identify set(s) of systems and their components in terms of common properties that can be organized into a collection of reusable assets that may be used to construct systems in the domain. [OUTCOME 2]

BP 3 **Assess domains for potential reuse.** Assess each domain to identify potential use and applications of reusable components and products. [OUTCOME 3]

BP 4 **Assess reuse maturity.** Gain an understanding of the reuse readiness and maturity of the organization, to provide a baseline and success criteria for reuse program management. [OUTCOME 4]

BP 5 **Evaluate reuse proposals.** Evaluate suitability of the provided reusable components and product(s) to proposed use. [OUTCOME 5]

BP 6 **Implement the reuse program.** Perform the defined activities identified in the reuse program. [OUTCOME 6]

BP 7 **Get feedback from reuse.** Establish feedback, assessment, communication and notification mechanism that operate between affected parties to control the progress of reuse program. [OUTCOME 7, 8]

1. *Affected parties may include reuse program administrators, asset managers, domain engineers, developers, operators, and maintenance groups.*

BP 8 **Monitor reuse.** Monitor the implementation of the reuse program periodically and evaluate its suitability to actual needs. [OUTCOME 6, 8]

2. *The quality requirements for re-use work products should be defined.*

ACQ.2 Supplier request and selection

The purpose of supplier request and selection process is to award a supplier for a contract/agreement based on relevant criteria.

Process outcomes – as a result of successful implementation of this process

1. evaluation criteria are established for suppliers,
2. suppliers are evaluated against the defined criteria,
3. a request for quotation is issued to supplier candidates, and
4. contract, action, and risk mitigation plans are agreed. The supplier is contracted in consideration of the evaluation result.

Output work products

02-00 Contract	[OUTCOME 4]	14-02 Corrective action register	[OUTCOME 3, 4]
02-01 Commitment/agreement	[OUTCOME 4]	14-05 Preferred supplier register	[OUTCOME 2]
02-50 Interface agreement	[OUTCOME 4]	15-21 Supplier evaluation report	[OUTCOME 2]
08-20 Risk mitigation plan	[OUTCOME 4]	18-50 Supplier evaluation criteria	[OUTCOME 1]
12-01 Request for quotation	[OUTCOME 3]		

BP 1

Establish supplier evaluation criteria. Analyze relevant requirements to define evaluation criteria for supplier's capabilities. [OUTCOME 1]

1 *Criteria may consider:*
- *Functional and non-functional requirements*
- *Technical evaluation regarding cybersecurity capabilities of the supplier, including cybersecurity concepts and methods (threat analysis and risk assessment, attack models, vulnerability analysis, etc.)*
- *The organization's capability of the supplier concerning cybersecurity (e.g., cybersecurity best practices from the development, post-development, governance, quality, and information security)*
- *Continuous operation, including cybersecurity*
- *Supplier capability and performance evidence in terms of cybersecurity obtained by supplier monitoring in previous projects*

BP 2

Evaluate potential suppliers. Collect information about the supplier's capabilities and evaluate it against the established evaluation criteria. Short-list the preferred suppliers and document the results. [OUTCOME 2]

2 *The evaluation of potential suppliers may be supported by:*
- *Summaries of previous Automotive SPICE for Cybersecurity assessments*
- *Evidence of the organizational cybersecurity management system (e.g., organizational audit results if available)*
- *Evidence of an information security management system*
- *Evidence of the organization's quality management system appropriate/capable of supporting cybersecurity engineering*

ACQ.2

BP 3

Prepare and execute request for quotation (RFQ). Identify supplier candidates based on the evaluation. Prepare and issue a request for quotation including a corrective action plan for identified deviations. [OUTCOME 3,4]

3 *The request for quotation may include:*
- *A formal request to conform with all customer relevant and legal standards*
- *Cybersecurity responsibilities of the supplier*
- *The scope of work regarding cybersecurity, including the cybersecurity goals or the set of relevant cybersecurity requirements and their attributes, depending on what the supplier is quoting for*
- *Action plan for identified deviations and risks*

BP 4

Negotiate and award the contract/agreement. Establish a contract based on the evaluation of the request for quotation results, covering the relevant requirements and the agreed corrective actions. [OUTCOME 4]

4 *Distributed cybersecurity activities may be specified within a cybersecurity interface agreement considering all relevant aspects (e.g., contacts, tailoring, responsibilities, information share, milestones, timing).*

5 *In case of deliverables without any support (e.g. free and open source software), an interface agreement is not required.*

BP1
Establish supplier evaluaon criteria

against

BP2
Evaluate potenal suppliers

based on

BP3
Prepare and execute request for quotaon

based on

BP4
Negoate and award the contract/agreement

ACQ.4 Supplier Monitoring
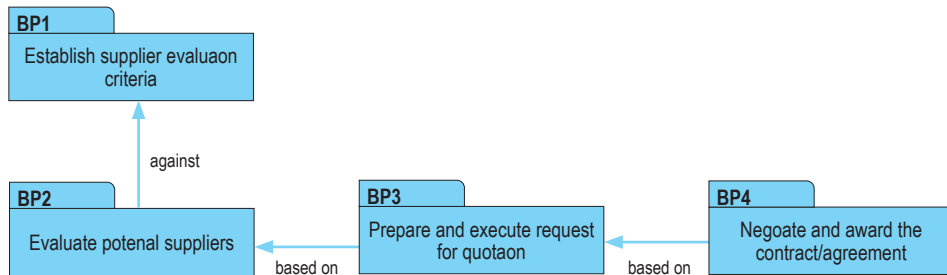
The purpose of the Supplier Monitoring Process is to track and assess the performance of the supplier against agreed requirements.

Process outcomes – as a result of successful implementation of this process

1. joint activities, as agreed between the customer and the supplier, are performed as needed;
2. all information, agreed upon for exchange, is communicated regularly between the supplier and customer;
3. performance of the supplier is monitored against the agreements; and
4. changes to the agreement, if needed, are negotiated between the customer and the supplier and documented in the agreement.

Output work products

02-01 Commitment/agreement	[OUTCOME 4]	13-16 Change request	[OUTCOME 4]
13-01 Acceptance record	[OUTCOME 3]	13-19 Review record	[OUTCOME 2]
13-04 Communication record	[OUTCOME 1, 2]	14-02 Corrective action register	[OUTCOME 4]
13-09 Meeting support record	[OUTCOME 1]	15-01 Analysis report	[OUTCOME 3]
13-14 Progress status record	[OUTCOME 2]		

BP 1

Agree on and maintain joint processes, joint interfaces, and information to be exchanged. Establish and maintain an agreement on information to be exchanged and on joint processes and joint interfaces, responsibilities, type and frequency of joint activities, communications, meetings, status reports and reviews. [OUTCOME 1, 2, 4]

1. *Joint processes and interfaces usually include project management, requirements management, change management, configuration management, problem resolution, quality assurance and customer acceptance.*

2. *Joint activities to be performed should be mutually agreed between the customer and the supplier.*

3. *The term customer in this process refers to the assessed party. The term supplier refers to the supplier of the assessed party.*

69f: TPS.RC.8-11, 13
83: ACQ.4.RL.2
84: ACQ.4.RC.1
86: ACQ.4.RC.3

BP 2

Exchange all agreed information. Use the defined joint interfaces between customer and supplier for the exchange of all agreed information. [OUTCOME 1, 2, 3]

4. *Agreed information should include all relevant work products.*

43: SAC.RC.1-2
67: TPS.RC.2-3
85: ACQ.4.RL.3

BP 3

Review technical development with the supplier. Review development with the supplier on the agreed regular basis, covering technical aspects, problems and risks and also track open items to closure. [OUTCOME 1, 3, 4]

85f: ACQ.4.RL.3-4

BP 4

Review progress of the supplier. Review progress of the supplier regarding schedule, quality, and cost on the agreed regular basis. Track open items to closure and perform risk mitigation activities. [OUTCOME 1, 3, 4]

70: TPS.RC.12
85: ACQ.4.RL.3
86: ACQ.4.RL.5

BP 5

Act to correct deviations. Take action when agreed objectives are not achieved to correct deviations from the agreed project plans and to prevent reoccurrence of problems identified. Negotiate changes to objectives and document them in the agreements. [OUTCOME 4]

86: ACQ.4.RC.2

ACQ.2 / BP4 — Negoate and award the contract/agreement

SUP.10 — Change Request Management
SYS.1 — Requirements Elicitation
MAN.3 — Project Management
AI processes with scope

BP1 — Agree on and maintain joint processes

BP3 — Review technical development with the supplier

BP2 — Exchange all agreed information

BP4 — Review progress of the supplier

BP5 — Act to correct deviations

SUP.9 / PA1.1 — Problem Resolution Management

related to — uses — consistent with — based on — related to — consistent with

ACQ.4

SUP.1 Quality Assurance

The purpose of the Quality Assurance Process is to provide independent and objective assurance that work products and processes comply with predefined provisions and plans and that non-conformances are resolved and further prevented.

Process outcomes – as a result of successful implementation of this process

1. a strategy for performing quality assurance is developed, implemented, and maintained;
2. quality assurance is performed independently and objectively without conflicts of interest;
3. non-conformances of work products, processes, and process activities with relevant requirements are identified, recorded, communicated to the relevant parties, tracked, resolved, and further prevented;
4. conformance of work products, processes and activities with relevant requirements is verified, documented, and communicated to the relevant parties;
5. authority to escalate non-conformances to appropriate levels of management is established; and
6. management ensures that escalated non-conformances are resolved.

Output work products

08-13 Quality plan	[OUTCOME 1,2]	13-19 Review record	[OUTCOME 2, 3, 4]
13-04 Communication record	[OUTCOME 3, 4, 5]	14-02 Corrective action register	[OUTCOME 3, 5, 6]
13-07 Problem record	[OUTCOME 3, 5]	18-07 Quality criteria	[OUTCOME 1]
13-18 Quality record	[OUTCOME 2, 3, 4]		

BP 1 **Develop a project quality assurance strategy.** Develop a strategy in order to ensure that work product and process quality assurance is performed at project level independently and objectively without conflicts of interest. [OUTCOME 1, 2]

1 *Aspects of independence may be financial and/or organizational structure.*

2 *Quality assurance may be coordinated with, and make use of, the results of other processes such as verification, validation, joint review, audit and problem management.*

3 *Process quality assurance may include process assessments and audits, problem analysis, regular check of methods, tools, documents and the adherence to defined processes, reports and lessons learned that improve processes for future projects.*

4 *Work product quality assurance may include reviews, problem analysis, reports and lessons learned that improve the work products for further use.*

51ff: SAP.RL.1-4
62: AGE.RC.10
165ff: SUP.1.RL.1-5
167f: SUP.1.RC.1-2
232: CL2.RC.12

BP 2

Assure quality of work products. Perform the activities according to the quality assurance strategy and the project schedule to ensure that the work products meet the defined work product requirements and document the results. [OUTCOME 2, 3, 4]

5 *Relevant work product requirements may include requirements from applicable standards.*

6 *Non-conformances detected in work products may be entered into the problem resolution management process (SUP.9) to document, analyze, resolve, track to closure and prevent the problems.*

62: AGE.RC.11
79: APA.RL.7
167f: SUP.1.RL.6-7
170: SUP.1.RC.3
171: SUP.1.RC.6
172: SUP.1.RC.9
233: CL2.RC.17

BP3

Assure quality of process activities. Perform the activities according to the quality assurance strategy and the project schedule to ensure that the processes meet their defined goals and document the results. [OUTCOME 2, 3, 4]

7 *Relevant process goals may include goals from applicable standards.*

8 *Problems detected in the process definition or implementation may be entered into a process improvement process (PIM.3) to describe, record, analyze, resolve, track to closure and prevent the problems.*

167f: SUP.1.RL.6-7
170: SUP.1.RC.3
171: SUP.1.RC.7

BP 4 | **Summarize and communicate quality assurance activities and results.** Regularly report performance, deviations, and trends of quality assurance activities to relevant parties for information and action according to the quality assurance strategy. [OUTCOME 3, 4]

43: SAC.RC.1-2
171: SUP.1.RC.4-5

BP 5 | **Ensure resolution of non-conformances.** Deviations or non-conformance found in process and product quality assurance activities should be analyzed, tracked, corrected, and further prevented. [OUTCOME 3, 6]

168f: SUP.1.RL.8-9
171: SUP.1.RC.4-5
172: SUP.1.RC.8

BP 6 | **Implement an escalation mechanism.** Establish and maintain an escalation mechanism according to the quality assurance strategy that ensures that quality assurance may escalate problems to appropriate levels of management and other relevant stakeholders to resolve them. [OUTCOME 5, 6]

65: DID.RL.9
171: SUP.1.RC.4-5
172: SUP.1.RC.8

SUP.1

SUP.8 / BP8: Verified the information about configured items

BP1: Develop a project quality assurance strategy

BP2: Assure quality of work products

BP4: Summarize and communicate quality assurance activities & results

BP3: Assure quality of process activities

BP5: Ensure resolution of non-conformances

SUP.9 / PA1.1: Problem Resolution Management

BP6: Implement an escalation mechanism

RC.6: according to
RC.7: according to
according to
RC.9: includes aspects of
according to
RC.4: based on
RC.5: based on
RC.4: related to
RC.5: related to
RC.5: related to
RC.8: treated as problems
RC.8: treated as problems
RC.4: related to

SUP.2 Verification

The purpose of the Verification Process is to confirm that each work product of a process or project properly reflects the specified requirements.

Process outcomes – as a result of successful implementation of this process

1. a verification strategy is developed, implemented and maintained;
2. criteria for verification of all required work products are identified;
3. required verification activities are performed;
4. defects are identified, recorded and tracked; and
5. results of the verification activities are made available to the customer and other involved parties.

Output work products

13-04 Communication record	[OUTCOME 5]	14-02 Corrective action register	[OUTCOME 4]
13-07 Problem record	[OUTCOME 3, 4, 5]	18-07 Quality criteria	[OUTCOME 2]
13-25 Verification results	[OUTCOME 2, 3, 4, 5]	19-10 Verification strategy	[OUTCOME 1]

BP 1   **Develop a verification strategy.** Develop and implement a verification strategy, including verification activities with associated methods, techniques, and tools; work product or processes under verification; degrees of independence for verification and schedule for performing these activities. [OUTCOME 1]

1   *Verification strategy is implemented through a plan.*

2   *Software and system verification may provide objective evidence that the outputs of a particular phase of the software development life cycle (e.g. requirements, design, implementation, testing) meet all of the specified requirements for that phase.*

3   *Verification methods and techniques may include inspections, peer reviews (see also SUP.4), audits, walkthroughs and analysis.*

BP 2   **Develop criteria for verification.** Develop the criteria for verification of all required technical work products. [OUTCOME 2]

BP 3   **Conduct verification.** Verify identified work products according to the specified strategy and to the developed criteria to confirm that the work products meet their specified requirements. The results of verification activities are recorded. [OUTCOME 3]

BP 4   **Determine and track actions for verification results.** Problems identified by the verification should be entered into the problem resolution management process (SUP.9) to describe, record, analyze, resolve, track to closure and prevent the problems. [OUTCOME 4]

BP 5   **Report verification results.** Verification results should be reported to all affected parties. [OUTCOME 5]

SUP.4 Joint Review

The purpose of the Joint review process is to maintain a common understanding with the stakeholders of the progress against the objectives of the agreement and what should be done to help ensure development of a product that satisfies the stakeholders. Joint reviews are at both project management and technical levels and are held throughout the life of the project.

Process outcomes – as a result of successful implementation of this process

1. management and technical reviews are held based on the needs of the project;
2. the status and products of an activity of a process are evaluated through joint review activities between the stakeholders;
3. review results are made known to all affected parties;
4. action items resulting from reviews are tracked to closure; and
5. problems are identified and recorded.

1 *Joint review should be performed at specific milestones during project/product development. The scope and the goals of joint review may be different depending on project/product development phase (for example, in the early stage of a project joint review may be „conceptual" in order to analyze the customer requirements; in later stages joint review may be concerned with the implementation).*

2 *Joint review should be performed to verify different aspects (for example: hardware resources utilization; the introduction of new requirements and new technologies; modification to the working team structure; technology changes).*

Output work products

13-04 Communication record	[OUTCOME 3]	14-02 Corrective action register	[OUTCOME 3, 4, 5]
13-05 Contract review record	[OUTCOME 1, 2, 3]	14-08 Tracking system	[OUTCOME 3, 4, 5]
13-07 Problem record	[OUTCOME 3, 5]	15-01 Analysis report	[OUTCOME 3, 5]
13-09 Meeting support record	[OUTCOME 1,2]	15-13 Assessment/audit report	[OUTCOME 1,2]
13-19 Review record	[OUTCOME ALL]	15-16 Improvement opportunity	[OUTCOME 3, 4]

BP 1   **Define review elements.** Based on the needs of the project, identify the schedule, scope and participants of management and technical reviews, agree all resources required to conduct the reviews (this includes personnel, location and facilities) and establish review criteria for problem identification, resolution and agreement. [OUTCOME 1]

BP 2   **Establish a mechanism to handle review outcomes.** Establish mechanisms to ensure that review results are made available to all affected parties that problems detected during the reviews are identified and recorded and that action items raised are recorded for action. [OUTCOME 3]

BP 3   **Prepare joint review.** Collect, plan, prepare and distribute review material as appropriate in preparation for the review. [OUTCOME 1]

> 1   *The following items may be addressed: Scope and purpose of the review; Products and problems to be reviewed; Entry and exit criteria; Meeting agenda; Roles and participants; Distribution list; Responsibilities; Resource and facility requirements; Used tools (checklists, scenario for perspective based reviews etc.).*

BP 4   **Conduct joint reviews.** Conduct joint management and technical reviews as planned. Record the review results. [OUTCOME 1, 2]

BP 5   **Distribute the results.** Document and distribute the review results to all the affected parties. [OUTCOME 3]

BP 6   **Determine actions for review results.** Analyze the review results, propose actions for resolution and determine the priority for actions. [OUTCOME 4]

BP 7 **Track actions for review results.** Track actions for resolution of identified problems in a review to closure. [OUTCOME 4]

BP 8 **Identify and record problems.** Identify and record the problems detected during the reviews according to the established mechanism. [OUTCOME 5]

SUP.7 Documentation

The purpose of the Documentation Process is to develop and maintain the recorded information produced by a process.

Process outcomes – as a result of successful implementation of this process

1. a strategy identifying the documentation to be produced during the life cycle of the product or service is developed;
2. the standards to be applied for the development of the documentation are identified;
3. documentation to be produced by the process or project is identified;
4. the content and purpose of all documentation is specified, reviewed and approved;
5. documentation is developed and made available in accordance with identified standards; and
6. documentation is maintained in accordance with defined criteria.

Output work products

08-26 Documentation plan	[OUTCOME 1,2]	14-01 Change history	[OUTCOME 5, 6]
13-01 Acceptance record	[OUTCOME 4, 5]	14-11 Work product list	[OUTCOME 3]
13-19 Review record	[OUTCOME 4, 5]		

SUP.7 with 8 Base practices

BP 1

Develop a documentation management strategy. Develop a documentation management strategy which addresses where, when and what should be documented during the life cycle of the product/service.[OUTCOME 1]

1 *A documentation management strategy may define the controls needed to approve documentation for adequacy prior to issue; to review and update as necessary and re-approve documentation; to ensure that changes and the current revision status of documentation are identified; to ensure that relevant versions of documentation are available at points of issue; to ensure that documentation remain legible and readily identifiable; to ensure the controlled distribution of documentation; to prevent unintended use of obsolete documentation ; and may also specify the levels of confidentiality, copyright or disclaimers of liability for the documentation.*

BP 2 | **Establish standards for documentation.** Establish standards for developing, modifying and maintaining documentation. [OUTCOME 2]

BP 3 | **Specify documentation requirements.** Specify requirements for documentation such as title, date, identifier, version history, author(s), reviewer, authorizer, outline of contents, purpose, and distribution list. [OUTCOME 2]

BP 4 | **Identify the relevant documentation to be produced.** For any given development life cycle, identify the documentation to be produced. [OUTCOME 3]

BP 5 | **Develop documentation.** Develop documentation at required process points according to established standards and policy, ensuring the content and purpose is reviewed and approved as appropriate. [OUTCOME 4, 5]

BP 6 | **Check documentation**. Review documentation before distribution, and authorize documentation as appropriate before distribution or release. [OUTCOME 5]

2 *The documentation intended for use by system and software users should accurately describe the system and software and how it is to be used in clear and useful manner for them.*

3 *Documentation should be checked through verification or validation process.*

BP 7 | **Distribute documentation**. Distribute documentation according to determined modes of distribution via appropriate media to all affected parties, confirming delivery of documentation, where necessary. [OUTCOME 5]

BP 8 | **Maintain documentation.** Maintain documentation in accordance with the determined documentation strategy. [OUTCOME 6]

4 *If the documentation is part of a product baseline or if its control and stability are important, it should be modified and distributed in accordance with process SUP.8 Configuration management.*

SUP.8 Configuration Management

The purpose of the Configuration Management Process is to establish and maintain the integrity of all work products of a process or project and make them available to affected parties.

Process outcomes – as a result of successful implementation of this process

1. a configuration management strategy is developed;
2. all configuration items generated by a process or project are identified, defined and baselined according to the configuration management strategy;
3. modifications and releases of the configuration items are controlled;
4. modifications and releases are made available to affected parties;
5. the status of the configuration items and modifications is recorded and reported;
6. the completeness and consistency of the baselines is ensured; and
7. storage of the configuration items is controlled.

Output work products

06-02 Handling and storage guide	[OUTCOME 3, 4, 5, 7]	13-10 Configuration management record	[OUTCOME 2, 5, 7]]
08-04 Configuration management	[OUTCOME 1, 2, 7]	14-01 Change history	[OUTCOME 3]
08-14 Recovery plan	[OUTCOME 1,7]	16-03 Configuration management system	[OUTCOME 1, 3, 4]
13-08 Baseline	[OUTCOME 2, 3, 4, 5, 6]		

BP 1

Develop a configuration management strategy. Develop a configuration management strategy, including
• responsibilities;
• tools and repositories;
• criteria for configuration items;
• naming conventions;
• access rights;
• criteria for baselines;
• merge and branch strategy;
• the revision history approach for configuration items [OUTCOME 1]

1 *The configuration management strategy typically supports the handling of product/software variants which may be caused by different sets of application parameters or by other causes.*

2 *The branch management strategy specifies in which cases branching is permissible, whether authorization is required, how branches are merged, and which activities are required to verify that all changes have been consistently integrated without damage to other changes or to the original software.*

51ff: SAP.RL.1-4
174: SUP.8.RL.1-5
175: SUP.8.RC.1

BP 2

Identify configuration items. Identify and document configuration items according to the configuration management strategy. [OUTCOME 2]

③ *Configuration control is typically applied for the products that are delivered to the customer, designated internal work products, acquired products, tools and other configuration items that are used in creating and describing these work products.*

78: APA.RL.4
179: SUP.8.RL.14
232: CL2.RC.13

BP 3

Establish a configuration management system. Establish a configuration management system according to the configuration management strategy. [OUTCOME 1, 2, 3, 4, 6, 7]

177f: SUP.8.RL.11-14
233: CL2.RC.15

BP 4

Establish branch management. Establish branch management according to the configuration management strategy where applicable for parallel developments that use the same base. [OUTCOME 1, 3, 4, 6, 7]

176: SUP.8.RL.9-10
179: SUP.8.RL.14

BP 5

Control modifications and releases. Establish mechanisms for control of the configuration items according to the configuration management strategy, and control modifications and releases using these mechanisms. [OUTCOME 3, 4, 5]

179: SUP.8.RL.14, SUP.8.RC.3
233: CL2.RC.15

BP 6

Establish baselines. Establish baselines for internal purposes and for external delivery according to the configuration management strategy. [OUTCOME 2]

④ *For baseline issues refer also to the product release process SPL.2.*

| 175: SUP.8.RL.6-8 |
| 176: SUP.8.RC.2 |
| 179: SUP.8.RL.14 |
| 233: CL2.RC.15 |

BP 7

Report configuration status. Record and report status of configuration items to support project management and other relevant processes. [OUTCOME 5]

⑤ *Regular reporting of the configuration status (e.g. how many configuration items are currently under work, checked in, tested, released, etc.) supports project management activities and dedicated project phases like software integration.*

| 179: SUP.8.RC.3 |

BP 8

Verify the information about configured items. Verify that the information about configured items, and their baselines is complete and ensure the consistency of baselines. [OUTCOME 6]

⑥ *A typical implementation is performing baseline and configuration management audits.*

| 175: SUP.8.RL.6-8 |
| 176: SUP.8.RC.2, SUP.8.RL.9-10 |
| 179: SUP.8.RC.3-4 |
| 233: CL2.RC.18 |

BP9

Manage the storage of configuration items and baselines. Ensure the integrity and availability of configuration items and baselines through appropriate scheduling and resourcing of storage, archiving (long term storage) and backup of the used CM systems. [OUTCOME 4, 5, 6, 7]

7 *Backup, storage and archiving may need to extend beyond the guaranteed lifetime of available storage media. Relevant configuration items affected may include those referenced in* 2 *and* 3 *. Availability may be specified by contract requirements.*

| 177: SUP.8.RL.11-13 |
| 179: SUP.8.RC.3, 5-6 |

SUP.8 Consistency Diagram

BP5 — Control modifications and releases

BP4 — Establish branch management strategy

MAN.3 / BP10 — Review and report progress of the project

BP1 — Develop a configuration management strategy

SPL.2 / BP3 — Establish a product release classification and numbering scheme

BP7 — Report configuration status

BP2 — Indentify configuration items

BP8 — Verify the information about configured items

SPL.2 / BP13 — Deliver the release to the intended customer

BP3 — Establish a configuration management system

BP9 — Manage the storage of configuration items and baselines

BP6 — Establish baselines

RL.14: according to
RC.7: reflects
RC.3: for
RC.9: support to
RC.3: for
RC.3: for
RC.3: for
RL.14: according to
RC.5: for
RC.8: support external elivery
RC.6: using
RC.4: using

SUP.8

SUP.9 Problem Resolution Management

The purpose of the Problem Resolution Management Process is to ensure that problems are identified, analyzed, managed and controlled to resolution.

Process outcomes – as a result of successful implementation of this process

1. a problem resolution management strategy is developed;
2. problems are recorded, uniquely identified and classified;
3. problems are analyzed and assessed to identify an appropriate solution;
4. problem resolution is initiated;
5. problems are tracked to closure; and
6. the status of problems and their trend are known.

Output work products

08-27 Problem management plan	[OUTCOME 1]	15-05 Evaluation report	[OUTCOME 3]
13-07 Problem record	[OUTCOME 2, 3, 4, 5]	15-12 Problem status report	[OUTCOME 6]
15-01 Analysis report	[OUTCOME 3]		

BP 1

Develop a problem resolution management strategy. Develop a problem resolution management strategy, including problem resolution activities, a status model for the problems, alert notifications, responsibilities for performing these activities and an urgent resolution strategy. Interfaces to affected parties are defined and definitions are maintained. [OUTCOME 1]

1 *Problem resolution activities can be different during the product life cycle, e.g. during prototype construction and series development.*

| 51ff: SAP.RL.1-4 |
| 182: SUP.9.RL.1-2 |
| 184: SUP.9.RL.7-8, SUP.9.RC.1 |

BP 2

Identify and record the problem. Each problem is uniquely identified, described and recorded. Supporting information should be provided to reproduce and diagnose the problem. [OUTCOME 2]

2 *Supporting information typically includes the origin of the problem, how it can be reproduced, environmental information, by whom it has been detected, etc.*

3 *Unique identification supports traceability to changes made.*

| <no rule; no recommendation> |

BP 3

Record the status of problems. A status according to the status model is assigned to each problem to facilitate tracking. [OUTCOME 6]

| 184: SUP.9.RL.7-8, SUP.9.RC.1 |
| 186: SUP.9.RL.9, SUP.9.RC.2 |

BP 4

Diagnose the cause and determine the impact of the problem. Investigate the problem and determine its cause and impact in order to categorize the problem and to determine appropriate actions. [OUTCOME 2, 3]

4 *Problem categorization (e.g. A, B, C, light, medium, severe) may be based on severity, impact, criticality, urgency, relevance for the change process, etc.*

| 183: SUP.9.RL.3-6 |
| 186: SUP.9.RC.3 |

BP 5

Authorize urgent resolution action. If according to the strategy a problem requires an urgent resolution, authorization shall be obtained for immediate action also according to the strategy. [OUTCOME 4]

| 186: SUP.9.RL.9-10 |

BP 6

Raise alert notifications. If according to the strategy the problem has a high impact on other systems or other affected parties, an alert notification needs to be raised also according to the strategy. [OUTCOME 4]

| 183: SUP.9.RL.3-6 |
| 186: SUP.9.RL.9, SUP.9.RC.4 |

BP 7

Initiate problem resolution. Initiate appropriate actions according to the strategy to resolve the problem including review of those actions, or initiate a change request. [OUTCOME 4]

5 *Appropriate actions may include the initiating of a change request. See SUP.10 for managing of change requests.*

6 *The implementation of process improvements (to prevent problems) is done in the process improvement process (PIM.3). The implementation of generic project management improvements (e.g. lessons learned) are part of the project management process (MAN.3). The implementation of generic work product related improvements are part of the quality assurance process (SUP.1).*

| 186: SUP.9.RL.9, SUP.9.RC.5 |
| 195: SUP.10.RC.16 |

BP 8

Track problems to closure. Track the status of problems to closure including all related change requests. A formal acceptance has to be authorized before closing the problem. [OUTCOME 5, 6]

| 184: SUP.9.RL.7-8, SUP.9.RC.1 |
| 186: SUP.9.RL.11 |

BP 9

Analyze problem trends. Collect and analyze problem resolution management data, identify trends, and initiate project related actions, according to the strategy. [OUTCOME 6]

7 *Collected data typically contains information about where the problems occurred, how and when they were found, what were their impacts, etc.*

| 186: SUP.9.RL.9 |

SUP.9 Consistency Diagram

BP3
Record the status of the problems

RL.9: according to

BP1
Develop a problem resolution management strategy

RC.2: assigned to

BP5
Autorize urgent resolution action

RL.9: according to

RL.10: based on determined actions

BP2
Identify and record the problem

BP6
Raise alert notifications

RL.9: according to

RC.3: investigate

BP4
Diagnose the cause and determine the impact of the problem

RC.4: based on determined actions

BP7
Initiate problem resolution

RL.9: according to

RC.5: based on determined actions

BP8
Track problems to closure

RL.11: based on

BP9
Analyze problem trends

RL.9: according to

RC.6: initiate

SUP.10 **BP2**
Identify and record the change requests

RC.7: including related

SUP.10 **BP7**
Track change request to closure

SUP.10 Change Request Management

The purpose of the Change Request Management Process is to ensure that change requests are managed, tracked and implemented.

Process outcomes – as a result of successful implementation of this process

1. a change request management strategy is developed;
2. requests for changes are recorded and identified;
3. dependencies and relationships to other change requests are identified;
4. criteria for confirming implementation of change requests are defined;
5. requests for change are analyzed, and resource requirements are estimated;
6. changes are approved and prioritized on the basis of analysis results and availability of resources;
7. approved changes are implemented and tracked to closure;
8. the status of all change requests is known; and
9. bidirectional traceability is established between change requests and affected work products..

Output work products

08-28 Change management plan	[OUTCOME 1]	13-19 Review record	[OUTCOME 7]
13-16 Change request	[OUTCOME 2, 3, 4, 5, 6, 7]	13-21 Change control record	[OUTCOME 8,9]

BP 1

Develop a change request management strategy. Develop a change request management strategy, including change request activities, a status model for the change requests, analysis criteria, and responsibilities for performing these activities. Interfaces to affected parties are defined and maintained. [OUTCOME 1]

1 *A status model for change requests may contain: open, under investigation, approved for implementation, allocated, implemented, fixed, closed, etc.*

2 *Typical analysis criteria are: resource requirements, scheduling issues, risks, benefits, etc.*

3 *Change request activities ensure that change requests are systematically identified, described, recorded, analyzed, implemented, and managed.*

4 *The change request management strategy may cover different proceedings across the product life cycle, e.g. during prototype construction and series development.*

51ff: SAP.RL.1-4
79: APA.RL.6
189: SUP.10.RL.1

BP 2

Identify and record the change requests. Each change request is uniquely identified, described, and recorded according to the strategy, including the initiator and reason of the change request. [OUTCOME 2, 3]

187: SUP.9.RC.6
194: SUP.10.RL.8
233: CL2.RC.16

BP 3

Record the status of change requests. A status according to the status model is assigned to each change request to facilitate tracking. [OUTCOME 8]

192ff: SUP.10.RL.6-7-8, SUP.10.RC.7-10
233: CL2.RC.16

BP 4

Analyze and assess change requests. Change requests are analyzed according to the strategy including their dependencies to affected work products and other change requests. Assess the impact of the change requests and establish criteria for confirming implementation. [OUTCOME 3, 4, 5, 9]

73: PLS.RC.6
79: APA.RL.5
191: SUP.10.RL.4-5, SUP.10.RC.5-6
194: SUP.10.RL.8, SUP.10.RC.11-12

BP 5

Approve change requests before implementation. Change requests are prioritized based on analysis results and availability of resources before implementation and approved according to the strategy. [OUTCOME 6]

5 *A Change Control Board (CCB) is a common mechanism used to approve change requests.*

6 *Prioritization of change requests may be done by allocation to releases.*

190: SUP.10.RL.3, SUP.10.RC.4
194: SUP.10.RL.8-9

BP 6

Review the implementation of change requests. The implementation of change requests is reviewed before closure to ensure that their criteria for confirming implementation are satisfied, and that all relevant processes have been applied. [OUTCOME 7, 8]

| 191: SUP.10.RL.4-5, SUP.10.RC.5-6 |
| 194: SUP.10.RC.13 |

BP 7

Track change requests to closure. Change requests are tracked until closure. Feedback to the initiator is provided. [OUTCOME 7, 8]

| 187: SUP.9.RC.7 |
| 192: SUP.10.RL.6-7, SUP.10.RC.7 |
| 195: SUP.10.RL.10 |
| 233: CL2.RC.16 |

BP 8

Establish bidirectional traceability. Establish bidirectional traceability between change requests and work products affected by the change requests. In case that the change request is initiated by a problem, establish bidirectional traceability between change requests and the corresponding problem reports. [OUTCOME 9]

7 *Bidirectional traceability supports consistency, completeness and impact analysis.*

| 36ff: TAC.RC.1-3 |
| 195: SUP.10.RL.11 |

SUP.10 Consistency Diagram

SUP.9 | **BP7**
Initiate problem resolution (corresponding problem reports)

RC.16: establish

BP8
Establish bidirectional tracebility

RC.17: establish

PA1.1
Process performance (of all relevant processes) (affected work products)

RL.11: establish

RC.12: uses dependencies of

RC.14: dependencies to

RC.15: to ensure application

BP1
Develop a change request management strategy

RL.8: according to

BP2
Identify and record the change requests

dependencies to

BP4
Analyze and assess change requests

RC.9: assigned to

RC.8

BP3
Record the status of change requests

RC.11: based on

RL.9: based on

BP5
Approve change requests before implementation

RL.8: according to

RL.10: based on

BP7
Track change requests to closure

RC.13: to ensure criteria for confirming implementation

BP6
Review the implementation of change requests

RL.8: according to

RL.8: according to

SPL.2 Product Release

The purpose of the Product Release Process is to control the release of a product to the intended customer.

Process outcomes – as a result of successful implementation of this process

1. the contents of the product release are determined;
2. the release is assembled from configured items;
3. the release documentation is defined and produced;
4. the release delivery mechanism and media are determined;
5. release approval is effected against defined criteria;
6. the product release is made available to the intended customer; and
7. confirmation of release is obtained.

Output work products

08-16 Release plan	[OUTCOME 1, 3]	13-06 Delivery record	[OUTCOME 6,7]
11-03 Product release information	[OUTCOME 1, 3, 4, 6]	13-13 Product release approval record	[OUTCOME 5]
11-04 Product release package	[OUTCOME 2, 3, 6]	15-03 Configuration status report	[OUTCOME 2]
11-07 Temporary solution	[OUTCOME 6]	18-06 Product release criteria	[OUTCOME 5, 7]

BP 1

Define the functional content of releases. Establish a plan for releases that identifies the functionality to be included in each release. [OUTCOME 1, 3]

1 *The plan should point out which application parameters influencing the identified functionality are effective for which release.*

BP 2

Define release products. The products associated with the release are defined. [OUTCOME 1]

2 *The release products may include programming tools where these are stated. In automotive terms a release may be associated with a sample e.g. A, B, C.*

BP 3

Establish a product release classification and numbering scheme. A product release classification and numbering scheme are established based upon the intended purpose and expectations of the release(s). [OUTCOME 2]

3 *A release numbering implementation may include*
  • *the major release number*
  • *the feature release number*
  • *the defect repair number*
  • *the alpha or beta release*
  • *the iteration within the alpha or beta release*

BP 4

Define the build activities and build environment. A consistent build process is established and maintained. [OUTCOME 2]

4 *A specified and consistent build environment should be used by all parties.*

BP 5

Build the release from configured items. The release is built from configured items to ensure integrity. [OUTCOME 2]

5 *Where relevant the software release should be programmed onto the correct hardware revision before release.*

BP 6

Communicate the type, service level and duration of support for a release. The type, service level and duration of support for a release are identified and communicated. [OUTCOME 3]

BP 7

Determine the delivery media type for the release. The media type for product delivery is determined in accordance with the needs of the customer. [OUTCOME 4]

6 *The media type for delivery may be intermediate (placed on an adequate media and delivered to customer), or direct (such as delivered in firmware as part of the package) or a mix of both. The release may be delivered electronically by placement on a server. The release may also need to be duplicated before delivery.*

BP 8

Identify the packaging for the release media. The packaging for different types of media is identified. [OUTCOME 4]

7 *The packaging for certain types of media may need physical or electronic protection for instance specific encryption techniques.*

BP 9

Define and produce the product release documentation/release notes. Ensure that all documentation to support the release is produced, reviewed, approved and available. [OUTCOME 3]

BP 10

Ensure product release approval before delivery. Criteria for the product release are satisfied before release takes place. [OUTCOME 5]

BP 11

Ensure consistency. Ensure consistency between software release number, paper label and EPROM-Label (if relevant). [OUTCOME 5]

BP 12

Provide a release note. A release is supported by information detailing key characteristics of the release. [OUTCOME 6]

8 *The release note may include an introduction, the environmental requirements, installation procedures, product invocation, new feature identification and a list of defect resolutions, known defects and workarounds.*

BP 13

Deliver the release to the intended customer. The product is delivered to the intended customer with positive confirmation of receipt. [OUTCOME 6, 7]

9 *Confirmation of receipt may be achieved by hand, electronically, by post, by telephone or through a distribution service provider.*

10 *These practices are typically supported by the SUP.8 Configuration Management Process.*

SYS.1 Requirements Elicitation

The purpose of the Requirements Elicitation Process is to gather, process, and track evolving stakeholder needs and requirements throughout the lifecycle of the product and/or service so as to establish a requirements baseline that serves as the basis for defining the needed work products.

Process outcomes – as a result of successful implementation of this process

1. continuing communication with the stakeholder is established;
2. agreed stakeholder requirements are defined and baselined;
3. a change mechanism is established to evaluate and incorporate changes to stakeholder requirements into the baselined requirements based on changing stakeholder needs;
4. a mechanism is established for continuous monitoring of stakeholder needs;
5. a mechanism is established for ensuring that customers can easily determine the status and disposition of their requests; and
6. changes arising from changing technology and stakeholder needs are identified, the associated risks assessed and their impact managed.

Output work products

08-19 Risk management plan	[OUTCOME 6]	13-21 Change control record	[OUTCOME 3, 4]
08-20 Risk mitigation plan	[OUTCOME 6]	15-01 Analysis report	[OUTCOME 2, 3, 6]
13-04 Communication record	[OUTCOME 1, 4]	17-03 Stakeholder Requirements	[OUTCOME 1, 2]
13-19 Review record	[OUTCOME 4, 5]		

BP 1

Obtain stakeholder requirements and requests. Obtain and define stakeholder requirements and requests through direct solicitation of customer input and through review of customer business proposals (where relevant), target operating and hardware environment, and other documents bearing on customer requirements. [OUTCOME 1, 4]

1 *Requirements elicitation may involve the customer and the supplier.*

2 *The agreed stakeholder requirements and evaluation of any change may be based on feasibility studies and/or cost and time analyzes.*

3 *The information needed to keep traceability for each customer requirement has to be gathered and documented.*

BP 2

Understand stakeholder expectations. Ensure that both supplier and customer understand each requirement in the same way. [OUTCOME 2]

4 *Reviewing the requirements and requests with the customer supports a better understanding of customer needs and expectations. Refer to the process SUP.4 Joint Review.*

BP 3

Agree on requirements. Obtain an explicit agreement from all relevant parties to work on these requirements. [OUTCOME 2]

BP 4

Establish stakeholder requirements baseline. Formalize the stakeholder's requirements and establish them as a baseline for project use and monitoring against stakeholder needs. The supplier should determine the requirements not stated by the stakeholder but necessary for specified and intended use and include them in the baseline. [OUTCOME 2,3]

SYS.1

BP5

Manage stakeholder requirements changes. Manage all changes made to the stakeholder requirements against the stakeholder requirements baseline to ensure enhancements resulting from changing technology and stakeholder needs are identified and that those who are affected by the changes are able to assess the impact and risks and initiate appropriate change control and mitigation actions. [OUTCOME 3, 6]

5 *Requirements change may arise from different sources as for instance changing technology and stakeholder needs, legal constraints.*

6 *An information management system may be needed to manage, store and reference any information gained and needed in defining agreed stakeholder requirements.*

BP6

Establish customer-supplier query communication mechanism. Provide means by which the customer can be aware of the status and disposition of their requirements changes and the supplier can have the ability to communicate necessary information, including data, in a customer-specified language and format. [OUTCOME 5]

7 *Any changes should be communicated to the customer before implementation in order that the impact, in terms of time, cost and functionality can be evaluated.*

8 *This may include joint meetings with the customer or formal communication to review the status for their requirements and requests; Refer to the process SUP.4 Joint Review.*

9 *The formats of the information communicated by the supplier may include computer-aided design data and electronic data exchange.*

SYS.2 System Requirements Analysis

The purpose of the System Requirements Analysis Process is to transform the defined stakeholder requirements into a set of system requirements that will guide the design of the system.

Process outcomes – As a result of successful implementation of this process

1. a defined set of system requirements is established;
2. system requirements are categorized and analyzed for correctness and verifiability;
3. the impact of system requirements on the operating environment is analyzed;
4. prioritization for implementing the system requirements is defined;
5. the system requirements are updated as needed;
6. consistency and bidirectional traceability are established between stakeholder requirements and system requirements;
7. the system requirements are evaluated for cost, schedule and technical impact; and
8. the system requirements are agreed and communicated to all affected parties.

Output work products

13-04 Communication record	[OUTCOME 8]	15-01 Analysis report	[OUTCOME 2, 3, 4, 7]
13-19 Review record	[OUTCOME 6]	17-08 Interface requirements specification	[OUTCOME 1, 3]
13-21 Change control record	[OUTCOME 1]	17-12 System requirements specification	[OUTCOME 1, 5]
13-22 Traceability record	[OUTCOME 6]	17-50 Verification criteria	[OUTCOME 2]

BP 1

Specify system requirements. Use the stakeholder requirements and changes to the stakeholder requirements to identify the required functions and capabilities of the system. Specify functional and non-functional system requirements in a system requirements specification. [OUTCOME 1, 5, 7]

1 *Application parameter influencing functions and capabilities are part of the system requirements.*

2 *For changes to the stakeholder's requirements SUP.10 applies.*

76f: APA.RL.1, 3
88: SYS.2.RL.1-3
94: SYS.2.RC.5

BP 2

Structure system requirements. Structure the system requirements in the system requirements specification by e.g.
  • grouping to project relevant clusters,
  • sorting in a logical order for the project,
  • categorizing based on relevant criteria for the project,
  • prioritizing according to stakeholder needs.
  [OUTCOME 2, 4]

3 *Prioritizing typically includes the assignment of functional content to planned releases. Refer to SPL.2.BP1*

88f: SYS.2.RL.4-5, SYS.2.RC.1
94: SYS.2.RL.9

SYS.2

BP 3

Analyze system requirements. Analyze the specified system requirements including their interdependencies to ensure correctness, technical feasibility and verifiability, and to support risk identification. Analyze the impact on cost, schedule and the technical impact. [OUTCOME 1, 2, 7]

④ *The analysis of impact on cost and schedule supports the adjustment of project estimates. Refer to MAN.3.BP5.*

60: AGE.RC.3
89: SYS.2.RL.6, SYS.2.RC.2
94: SYS.2.RL.9

BP 4

Analyze the impact on the operating environment. Identify the interfaces between the specified system and other elements of the operating environment. Analyze the impact that the system requirements will have on these interfaces and the operating environment. [OUTCOME 3, 7]

90: SYS.2.RC.3-4
94: SYS.2.RL.9

BP5

Develop verification criteria. Develop the verification criteria for each system requirement that define the qualitative and quantitative measures for the verification of a requirement. [OUTCOME 2, 7]

⑤ *Verification criteria demonstrate that a requirement can be verified within agreed constraints and is typically used as the input for the development of the system test cases or other verification measures that ensures compliance with the system requirements.*

⑥ *Verification which cannot be covered by testing is covered by SUP.2.*

48: VEC.RL.1-2
91: SYS.2.RL.7
94: SYS.2.RL.9

BP6

Establish bidirectional traceability. Establish bidirectional traceability between stakeholder requirements and system requirements. [OUTCOME 6]

[7] *Bidirectional traceability supports coverage, consistency and impact analysis.*

36ff: TAC.RC.1-4
41: TAC.RL.2-3
94: SYS.2.RL.9, SYS.2.RC.8

BP7

Ensure consistency. Ensure consistency between stakeholder requirements and system requirements. [OUTCOME 6]

[8] *Consistency is supported by bidirectional traceability and can be demonstrated by review records.*

39ff: TAC.RL.1-3, TAC.RC.4
92ff: SYS.2.RL.8-9, SYS.2.RC.9
233: CL2.RC.18

BP8

Communicate agreed system requirements. Communicate the agreed system requirements and updates to system requirements to all relevant parties. [OUTCOME 8]

44: SAC.RL.1
46: SAC.RC.4-6
94: SYS.2.RL.9
225: CL2.RC.9

SYS.2

SYS.2 Consistency Diagram

BP2 — Structure system requirements

BP4 — Analyze the impact on the operating environment

BP8 — Communicate agreed system requirements

MAN.5 / BP3 — Identify risks

MAN.3 / BP5 — Define, monitor and adjust project estimates and resources

BP3 — Analyze system requirements

BP5 — Develop verification criteria

BP1 — Specify system requirements

BP6 — Establish bidirectional traceability

BP7 — Ensure consistency

SYS.1 / PA1.1 — Requirements Elicitation

RL.9: communicates
RL.9: analyzes the impact
RC.7: uses
RC.6: uses
RL.9: uses
RL.9: structures
RL.9: analyzes
RL.9: uses
RC.5: uses
RL.9: uses
RC.8: establish between
RC.9: ensure between

SYS.3 System Architectural Design

The purpose of the System Architectural Design Process is to establish a system architectural design and identify which system requirements are to be allocated to which elements of the system, and to evaluate the system architectural design against defined criteria.

Process outcomes – As a result of successful implementation of this process

1. a system architectural design is defined that identifies the elements of the system;
2. the system requirements are allocated to the elements of the system;
3. the interfaces of each system element are defined;
4. the dynamic behavior of the system elements is defined;
5. consistency and bidirectional traceability are established between system requirements and system architectural design; and
6. the system architectural design is agreed and communicated to all affected parties.

Output work products

04-06 System architectural design	[OUTCOME 1, 2, 3, 4, 5]	13-22 Traceability record	[OUTCOME 5]
13-04 Communication record	[OUTCOME 6]	17-08 Interface requirements specification	[OUTCOME 3]
13-19 Review record	[OUTCOME 5]		

BP 1

Develop system architectural design. Develop and document the system architectural design that specifies the elements of the system with respect to functional and non-functional system requirements. [OUTCOME 1]

1 *The development of system architectural design typically includes the decomposition into elements across appropriate hierarchical levels.*

97: SYS.3.RL.1-2
103: SYS.3.RC.2

BP 2

Allocate system requirements. Allocate the system requirements to the elements of the system architectural design. [OUTCOME 2]

98: SYS.3.RL.3
103: SYS.3.RL.7

BP 3

Define interfaces of system elements. Identify, develop and document the interfaces of each system element. [OUTCOME 3]

99: SYS.3.RL.4
103: SYS.3.RL.7

BP 4

Describe dynamic behavior. Evaluate and document the dynamic behavior of the interaction between system elements. [OUTCOME 4]

2 *Dynamic behavior is determined by operating modes (e.g. start-up, shutdown, normal mode, calibration, diagnosis, etc.).*

99: SYS.3.RL.5
103: SYS.3.RL.7

SYS.3

BP 5

Evaluate alternative system architectures. Define evaluation criteria for the architecture. Evaluate alternative system architectures according to the defined criteria. Record the rationale for the chosen system architecture. [OUTCOME 1]

3 *Evaluation criteria may include quality characteristics (modularity, maintainability, expandability, scalability, reliability, security realization and usability) and results of make-buy-reuse analysis.*

101ff: SYS.3.RL.6-7, SYS.3.RC.1

BP6

Establish bidirectional traceability. Establish bidirectional traceability between system requirements and elements of the system architectural design. [OUTCOME 5]

4 *Bidirectional traceability covers allocation of system requirements to the elements of the system architectural design.*

5 *Bidirectional traceability supports coverage, consistency and impact analysis.*

36ff: TAC.RC.1-4
41: TAC.RL.2-3
103: SYS.3.RL.7-8, SYS.3.RC.3

BP7

Ensure consistency. Ensure consistency between system requirements and the system architectural design.
[OUTCOME 1, 2, 5, 6]

6 *Consistency is supported by bidirectional traceability and can be demonstrated by review records.*

7 *System requirements typically include system architectural requirements. Refer to BP5.*

39: TAC.RL.1
40: TAC.RC.4
41: TAC.RL.2-3
103: SYS.3.RL.7, SYS.3.RC.4
233: CL2.RC.18

BP8

Communicate agreed system architectural design. Communicate the agreed system architectural design and updates to system architectural design to all relevant parties. [OUTCOME 6]
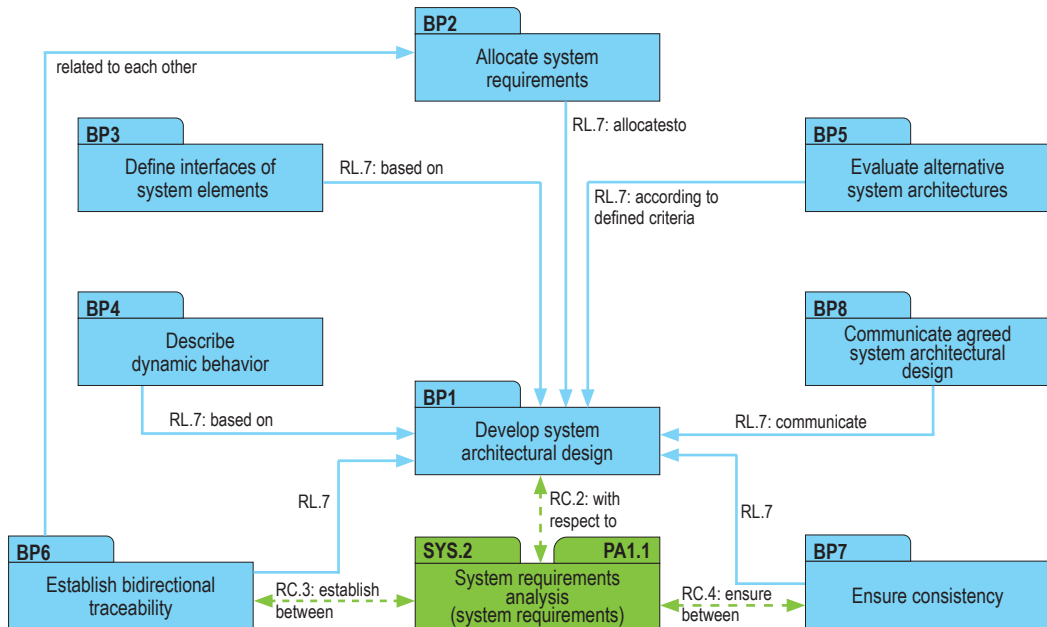
44: SAC.RL.1
46: SAC.RC.4-6
103: SYS.3.RL.7
225: CL2.RC.9

SYS.3

SYS.3 Consistency Diagram

SYS.4 System Integration and Integration Test

The purpose of the System Integration and Integration Test Process is to integrate the system items to produce an integrated system consistent with the system architectural design and to ensure that the system items are tested to provide evidence for compliance of the integrated system items with the system architectural design, including the interfaces between system items.

Process outcomes – **As a result of successful implementation of this process**

1. a system integration strategy consistent with the project plan, the release plan and the system architectural design is developed to integrate the system items;
2. a system integration test strategy including the regression test strategy is developed to test the system item interactions;
3. a specification for system integration test according to the system integration test strategy is developed that is suitable to provide evidence for compliance of the integrated system items with the system architectural design, including the interfaces between system items;
4. system items are integrated up to a complete integrated system according to the integration strategy;
5. test cases included in the system integration test specification are selected according to the system integration test strategy and the release plan;
6. system item interactions are tested using the selected test cases and the results of system integration testing are recorded;
7. consistency and bidirectional traceability between the elements of the system architectural design and test cases included in the system integration test specification and bidirectional traceability between test cases and test results is established; and
8. results of the system integration test are summarized and communicated to all affected parties.

08-50 Test specification	[OUTCOME 3, 5]	13-19 Review record	[OUTCOME 7]
08-52 Test plan	[OUTCOME 1, 2]	13-22 Traceability record	[OUTCOME 7]
11-06 System	[OUTCOME 4]	13-50 Test result	[OUTCOME 6, 8]
13-04 Communication record	[OUTCOME 8]		

SYS.4 with 9 Base practices

BP 1

Develop system integration strategy. Develop a strategy for integrating the system items consistent with the project plan and the release plan. Identify system items based on the system architectural design and define a sequence for integrating them. [OUTCOME 1]

51ff: SAP.RL.1-4
65: DID.RL.10
104: SYS.4.RL.1
111: SYS.4.RC.2-3

BP 2

Develop system integration test strategy including regression test strategy. Develop a strategy for testing the integrated system items following the integration strategy. This includes a regression test strategy for re-testing integrated system items if a system item is changed. [OUTCOME 2]

51ff: SAP.RL.1-4
81: APA.RL.8
106: SYS.4.RL.2-3

SYS.4

BP3

Develop specification for system integration test. Develop the test specification for system integration test including the test cases for each integration step of a system item according to the system integration test strategy. The test specification shall be suitable to provide evidence for compliance of the integrated system items with the system architectural design. [OUTCOME 3]

1 *The interface descriptions between system elements are an input for the system integration test cases.*

2 *Compliance to the architectural design means that the specified integration tests are suitable to prove that the interfaces between the system items fulfill the specification given by the system architectural design.*

3 *The system integration test cases may focus on*
   • *the correct signal flow between system items*
   • *the timelines and timing dependencies of signal flow between system items*
   • *the correct interpretation of signals by all system items using an interface*
   • *the dynamic interaction between system items*

4 *The system integration test may be supported using simulation of the environment (e.g. Hardware-in-the-Loop simulation, vehicle network simulations, digital mock-up).*

| 106: SYS.4.RL.4 |
| 110: SYS.4.RL.9, 11 |
| 111: SYS.4.RC.4 |

BP 4

Integrate system items. Integrate the system items to an integrated system according to the system integration strategy. [OUTCOME 4]

5 *The system integration can be performed step wise integrating system items (e.g. the hardware elements as prototype hardware, peripherals (sensors and actuators), the mechanics and integrated software) to produce a system consistent with the system architectural design.*

110: SYS.4.RL.12

BP5

Select test cases. Select test cases from the system integration test specification. The selection of test cases shall have sufficient coverage according to the system integration test strategy and the release plan. [OUTCOME 5]

| 107: SYS.4.RL.5, SYS.4.RC.1 |
| 110: SYS.4.RL.9, 13-14 |
| 111: SYS.4.RC.5 |

BP6

Perform system integration test. Perform the system integration test using the selected test cases. Record the integration test results and logs. [OUTCOME 6]

6 *See SUP.9 for handling of non-conformances.*

| 107f: SYS.4.RL.6-8 |
| 110: SYS.4.RL.15 |

SYS.4

BP7

Establish bidirectional traceability. Establish bidirectional traceability between elements of the system architectural design and test cases included in the system integration test specification.
Establish bidirectional traceability between test cases included in the system integration test specification and system integration test results. [OUTCOME 7]

7 *Bidirectional traceability supports coverage, consistency and impact analysis.*

36ff: TAC.RC.1-4
111: SYS.4.RC.6

BP8

Ensure consistency. Ensure consistency between elements of the system architectural design and test cases included in the system integration test specification. [OUTCOME 7]

8 *Consistency is supported by bidirectional traceability and can be demonstrated by review records.*

39: TAC.RL.1
40: TAC.RC.4
111: SYS.4.RC.7
233: CL2.RC.18

BP9

Summarize and communicate results. Summarize the system integration test results and communicate them to all affected parties. [OUTCOME 8]

9 *Providing all necessary information from the test case execution in a summary enables other parties to judge the consequences*

43ff: SAC.RC.1-6
225: CL2.RC.10

SYS.4 Consistency Diagram

BP4
Integrate system items

RL.12: according to

BP1
Develop system intergration strategy

RC.3: consistent with

BP8
Ensure consistency

RC.2: consistent with

RL.10: according to

RL.9, 14: according to

BP2
Develop system intergration test strategy including regression test strategy

MAN.3 **PA1.1**
Project management

SPL.2 **PA1.1**
Product release (release plan)

RL.9, 11: according to

RC.7: ensure between

no RC

BP3
Develop spedification for system integration test

RC.4: provide evidence for compliance with

SYS.3 **PA1.1**
System architectural design (system architecture)

RL.13: select from

no RC

BP5
Select test cases

RC.5: according to

RC.6: establish between

BP9
Summarize and communicate results

summarize test results

BP6
Perform system integration test

RL.15: using

establish between

BP7
Establish bidirectional traceability

SYS.4

SYS.5 System Qualification Test

The purpose of the System Qualification Test Process is to ensure that the integrated system is tested to provide evidence for compliance with the system requirements and that the system is ready for delivery.

Process outcomes – As a result of successful implementation of this process

1. a system qualification test strategy including regression test strategy consistent with the project plan and release plan is developed to test the integrated system;
2. a specification for system qualification test of the integrated system according to the system qualification test strategy is developed that is suitable to provide evidence for compliance with the system requirements;
3. test cases included in the system qualification test specification are selected according to the system qualification test strategy and the release plan;
4. the integrated system is tested using the selected test cases and the results of system qualification test are recorded;
5. consistency and bidirectional traceability are established between system requirements and test cases included in the system qualification test specification and between test cases and test results; and
6. results of the system qualification test are summarized and communicated to all affected parties.

Output work products

08-50 Test specification	[OUTCOME 2, 3]	13-19 Review record	[OUTCOME 5]
08-52 Test plan	[OUTCOME 1]	13-22 Traceability record	[OUTCOME 5]
13-04 Communication record	[OUTCOME 6]	13-50 Test result	[OUTCOME 4, 6]

BP 1

Develop system qualification test strategy including regression test strategy. Develop a strategy for system qualification test consistent with the project plan and the release plan. This includes a regression test strategy for re-testing the integrated system if a system item is changed. [OUTCOME 1]

51ff: SAP.RL.1-4
81: APA.RL.8
113: SYS.5.RL.1-2
117: SYS.5.RC.2
125: SWE.1.RC.5-6

BP2

Develop specification for system qualification test. Develop the specification for system qualification test including test cases based on the verification criteria according to the system qualification test strategy. The test specification shall be suitable to provide evidence for compliance of the integrated system with the system requirements. [OUTCOME 2]

113: SYS.5.RL.3
117: SYS.5.RL.9, SYS.5.RC.3

BP3

Select test cases. Select test cases from the system qualification test specification. The selection of test cases shall have sufficient coverage according to the system qualification test strategy and the release plan. [OUTCOME 3]

114: SYS.5.RL.4, SYS.5.RC.1
117: SYS.5.RL.10-11
118: SYS.5.RC.4

BP4

Test integrated system. Test the integrated system using the selected test cases. Record the system qualification test results and logs. [OUTCOME 4]

🛈 *See SUP.9 for handling of non-conformances.*

114ff: SYS.5.RL.5-8, 12

SYS.5

BP5

Establish bidirectional traceability. Establish bidirectional traceability between system requirements and test cases included in the system qualification test specification. Establish bidirectional traceability between test cases included in the system qualification test specification and system qualification test results. [OUTCOME 5]

2 *Bidirectional traceability supports coverage, consistency and impact analysis.*

36ff: TAC.RC.1-4
118: SYS.5.RC.5

BP6

Ensure consistency. Ensure consistency between system requirements and test cases included in the system qualification test specification. [OUTCOME 5]

3 *Consistency is supported by bidirectional traceability and can be demonstrated by review records.*

39: TAC.RL.1
40: TAC.RC.4
118: SYS.5.RC.6
233: CL2.RC.18

BP7

Summarize and communicate results. Summarize the system qualification test results and communicate them to all affected parties. [OUTCOME 6]

4 *Providing all necessary information from the test case execution in a summary enables other parties to judge the consequences.*

43ff: SAC.RC.1-6
225: CL2.RC.10

SYS.5 Consistency Diagram

MAN.3 / **PA1.1**
Project management

SPL.2 / **PA1.1**
Product release
(release plan)

RC.2:
consistent with

BP1
Develop system qualification
test strategy including
regression test strategy

BP6
Ensure consistency

RL.8, 11:
according to

RL.8, 9:
according to

RC.6:
ensure
between

RC.4:
according
to

BP3
Select test cases

RL.10:
select from

BP2
Develop spedficication for
system qualification test

RC.5:
ensure
between

SYS.2 / **PA1.1**
System requirements
analysis

RL.12: using

BP4
Test integrated system

no RC

BP7
Summarize and
communicate results

summarize
test results

establish
between

RC.5:
ensure
between

BP5
Establish bidirectional
traceability

SYS.5

SWE.1 Software Requirements Analysis

The purpose of the Software Requirements Analysis Process is to transform the software related parts of the system requirements into a set of software requirements.

Process outcomes – As a result of successful implementation of this process

1. the software requirements to be allocated to the software elements of the system and their interfaces are defined;
2. software requirements are categorized and analyzed for correctness and verifiability;
3. the impact of software requirements on the operating environment is analyzed;
4. prioritization for implementing the software requirements is defined;
5. the software requirements are updated as needed;
6. consistency and bidirectional traceability are established between system requirements and software requirements; and consistency and bidirectional traceability are established between system architectural design and software requirements;
7. the software requirements are evaluated for cost, schedule and technical impact; and
8. the software requirements are agreed and communicated to all affected parties.

Output work products

13-04 Communication record	[OUTCOME 8]	15-01 Analysis report	[OUTCOME 2, 3, 4, 7]
13-19 Review record	[OUTCOME 6]	17-08 Interface requirements specification	[OUTCOME 1, 3]
13-21 Change control record	[OUTCOME 5,7]	17-11 Software requirements specification	[OUTCOME 1]
13-22 Traceability record	[OUTCOME 1,6]	17-50 Verification criteria	[OUTCOME 2]

BP 1

Specify software requirements. Use the system requirements and the system architecture and changes to system requirements and architecture to identify the required functions and capabilities of the software. Specify functional and nonfunctional software requirements in a software requirements specification. [OUTCOME 1, 5, 7]

1 *Application parameter influencing functions and capabilities are part of the system requirements.*

2 *In case of software development only, the system requirements and the system architecture refer to a given operating environment (see also 5). In that case, stakeholder requirements should be used as the basis for identifying the required functions and capabilities of the software as well as for identifying application parameters influencing software functions and capabilities.*

| 73: PLS.RC.4-5 |
| 76f: APA.RL.1, 3 |
| 120: SWE.1.RL.1-3 |

BP 2

Structure software requirements. Structure the software requirements in the software requirements specification by e.g.
  • grouping to project relevant clusters,
  • sorting in a logical order for the project,
  • categorizing based on relevant criteria for the project,
  • prioritizing according to stakeholder needs.
  [OUTCOME 2, 4]

3 *Prioritizing typically includes the assignment of software content to planned releases. Refer to SPL.2.BP1.*

| 120: SWE.1.RL.4-5 |
| 121: SWE.1.RC.1 |
| 125: SWE.1.RL.10 |

BP 3   **Analyze software requirements.** Analyze the specified software requirements including their interdependencies to ensure correctness, technical feasibility and verifiability, and to support risk identification. Analyze the impact on cost, schedule and the technical impact. [OUTCOME 2, 7]

4   *The analysis of impact on cost and schedule supports the adjustment of project estimates. Refer to MAN.3.BP5.*

60: AGE.RC.3
121: SWE.1.RL.6, SWE.1.RC.2
125: SWE.1.RL.10

BP 4   **Analyze the impact on the operating environment.** Analyze the impact that the software requirements will have on interfaces of system elements and the operating environment. [OUTCOME 3, 7]

5   *The operating environment is defined as the system in which the software executes (e.g. hardware, operating system, etc.).*

122: SWE.1.RC.3-4
125: SWE.1.RL.10

BP 5

Develop verification criteria. Develop the verification criteria for each software requirement that define the qualitative and quantitative measures for the verification of a requirement. [OUTCOME 2, 7]

6 *Verification criteria demonstrate that a requirement can be verified within agreed constraints and is typically used as the input for the development of the software test cases or other verification measures that should demonstrate compliance with the software requirements.*

7 *Verification which cannot be covered by testing is covered by SUP.2.*

48: VEC.RL.1-2
74: PLS.RC.8
123: SWE.1.RL.7
125: SWE.1.RL.10

BP 6

Establish bidirectional traceability. Establish bidirectional traceability between system requirements and software requirements. Establish bidirectional traceability between the system architecture and software requirements. [OUTCOME 6]

8 *Redundancy should be avoided by establishing a combination of these approaches that covers the project and the organizational needs.*

9 *Bidirectional traceability supports coverage, consistency and impact analysis.*

36ff: TAC.RC.1-4
41: TAC.RL.2-3
123ff: SWE.1.RL.8-10
125: SWE.1.RC.9-10

BP 7

Ensure consistency. Ensure consistency between system requirements and software requirements. Ensure consistency between the system architecture and software requirements. [OUTCOME 6]

10 *Consistency is supported by bidirectional traceability and can be demonstrated by review records.*

11 *In case of software development only, the system requirements and system architecture refer to a given operating environment (see also* 2 *). In that case, consistency and bidirectional traceability have to be ensured between stakeholder requirements and software requirements.*

39f: TAC.RL.1, 4
41: TAC.RL.2-3
123ff: SWE.1.RL.8-12
233: CL2.RC.18

BP 8

Communicate agreed software requirements. Communicate the agreed software requirements and updates to software requirements to all relevant parties. [OUTCOME 8]
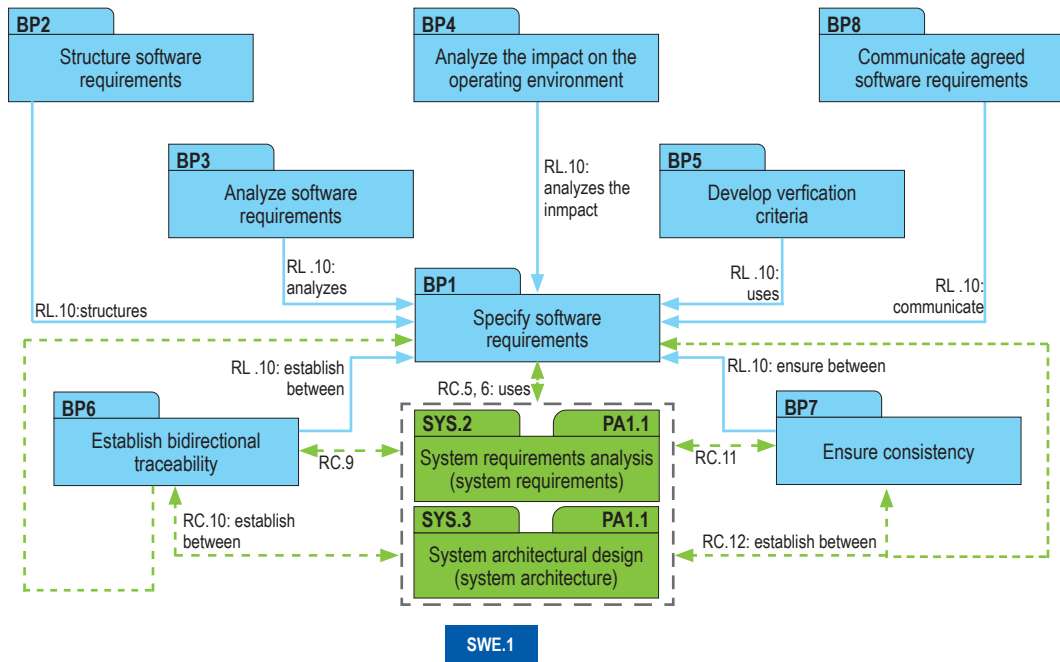
44: SAC.RL.1
46: SAC.RC.4-6
67: TPS.RC.2-3
125: SWE.1.RL.10
225: CL2.RC.9

SWE.1 Consistency Diagram

SWE.1

SWE.2 Software Architectural Design

The purpose of the Software Architectural Design Process is to establish an architectural design and to identify which software requirements are to be allocated to which elements of the software, and to evaluate the software architectural design against defined criteria.

Process outcomes – As a result of successful implementation of this process

1. a software architectural design is defined that identifies the elements of the software;
2. the software requirements are allocated to the elements of the software;
3. the interfaces of each software element are defined;
4. the dynamic behavior and resource consumption objectives of the software elements are defined;
5. consistency and bidirectional traceability are established between software requirements and software architectural design; and
6. the software architectural design is agreed and communicated to all affected parties.

Output work products

04-04 Software architectural design	[OUTCOME 1, 2, 3, 4, 5]	13-22 Traceability record	[OUTCOME 5]
13-04 Communication record	[OUTCOME 6]	17-08 Interface requirements specification	[OUTCOME 3]
13-19 Review record	[OUTCOME 5]		

BP1 **Develop software architectural design.** Develop and document the software architectural design that specifies the elements of the software with respect to functional and non-functional software requirements. [OUTCOME 1]

1 *The software is decomposed into elements across appropriate hierarchical levels down to the software components (the lowest level elements of the software architectural design) that are described in the detailed design.*

61: AGE.RC.5-6
68: TPS.RC.4, 6
72: PLS.RC.2
128: SWE.2.RL.1-2
134: SWE.2.RC.3

BP2 **Allocate software requirements.** Allocate the software requirements to the elements of the software architectural design. [OUTCOME 2]

129: SWE.2.RL.3
134: SWE.2.RL.8

BP3 **Define interfaces of software elements.** Identify, develop and document the interfaces of each software element. [OUTCOME 3]

68: TPS.RC.5
129: SWE.2.RL.4
134: SWE.2.RL.8

BP4

Describe dynamic behavior. Evaluate and document the timing and dynamic interaction of software elements to meet the required dynamic behavior of the system. [OUTCOME 4]

2 *Dynamic behavior is determined by operating modes (e.g. start-up, shutdown, normal mode, calibration, diagnosis, etc.), processes and process intercommunication, tasks, threads, time slices, interrupts, etc.*

3 *During evaluation of the dynamic behavior the target platform and potential loads on the target should be considered.*

| 130: SWE.2.RL.5 |
| 134: SWE.2.RL.8 |

BP5

Define resource consumption objectives. Determine and document the resource consumption objectives for all relevant elements of the software architectural design on the appropriate hierarchical level. [OUTCOME 4]

4 *Resource consumption is typically determined for resources like Memory (ROM, RAM, external / internal EEPROM or Data Flash), CPU load, etc.*

| 131: SWE.2.RL.6 |
| 134: SWE.2.RL.8 |

BP6

Evaluate alternative software architectures. Define evaluation criteria for the architecture. Evaluate alternative software architectures according to the defined criteria. Record the rationale for the chosen software architecture. [OUTCOME 1, 2, 3, 4, 5]

5 *Evaluation criteria may include quality characteristics (modularity, maintainability, expandability, scalability, reliability, security realization and usability) and results of make-buy-reuse analysis.*

| 132: SWE.2.RC.1 |
| 134: SWE.2.RL.8 |

BP7 **Establish bidirectional traceability.** Establish bidirectional traceability between software requirements and elements of the software architectural design. [OUTCOME 5]

6 *Bidirectional traceability covers allocation of software requirements to the elements of the software architectural design.*

7 *Bidirectional traceability supports coverage, consistency and impact analysis.*

36ff: TAC.RC.1-4
41: TAC.RL.2-3
134: SWE.2.RL.8-9, SWE.2.RC.4

BP8 **Ensure consistency.** Ensure consistency between software requirements and the software architectural design. [OUTCOME 1, 2, 5, 6]

8 *Consistency is supported by bidirectional traceability and can be demonstrated by review records.*

39: TAC.RL.1
40: TAC.RC.4
41: TAC.RL.2-3
134: SWE.2.RL.8, SWE.2.RC.5
233: CL2.RC.18

BP9 **Communicate agreed software architectural design.** Communicate the agreed software architectural design and updates to software architectural design to all relevant parties. [OUTCOME 6]

44: SAC.RL.1
46: SAC.RC.4-6
225: CL2.RC.9

SWE.2 Consistency Diagram

BP2
Allocate software requirements

BP4
Discribe dynamic behavior

RL.8: allocates to

RL.8: basesd on

BP3
Define interfaces of software elements

RL.8: basesd on

BP5
Define resource consumption objectives

RL.8: basesd on

BP6
Evaluate alternative software architectures

BP9
Communicate agreed software architectural design

BP1
Develop software architectural design (→ software elements)

RL .8: communicate

RL.8: according to defined criteria

RL.9: related to each other

RL .8

RC.3: with respect to

BP7
Establish bidirectional tracebility

SWE.1 **PA1.1**
Software requirements analysis (software requirements)

RL .8

BP8
Ensure consistency

RC.4: establish between

RC.5: ensure between

SWE.3 Software Detailed Design and Unit Construction

The purpose of the Software Detailed Design and Unit Construction Process is to provide an evaluated detailed design for the software components and to specify and to produce the software units.

Process outcomes – As a result of successful implementation of this process

1. a detailed design is developed that describes software units;
2. interfaces of each software unit are defined;
3. the dynamic behavior of the software units is defined;
4. consistency and bidirectional traceability are established between software requirements and software units; and consistency and bidirectional traceability are established between software architectural design and software detailed design; and consistency and bidirectional traceability are established between software detailed design and software units;
5. the software detailed design and the relationship to the software architectural design is agreed and communicated to all affected parties; and
6. software units defined by the software detailed design are produced.

Output work products

04-05 Software detailed design	[OUTCOME 1, 2, 3]	13-19 Review record	[OUTCOME 4]
11-05 Software unit	[OUTCOME 6]	13-22 Traceability record	[OUTCOME 4]
13-04 Communication record	[OUTCOME 5]		

BP1

Develop software detailed design. Develop a detailed design for each software component defined in the software architectural design that specifies all software units with respect to functional and non-functional software requirements. [OUTCOME 1]

76: APA.RL.2
137: SWE.3.RL.1-2
143: SWE.3.RC.2-3

BP2

Define interfaces of software units. Identify, specify and document the interfaces of each software unit. [OUTCOME 2]

138: SWE.3.RL.3
143: SWE.3.RL.7

BP3

Describe dynamic behavior. Evaluate and document the dynamic behavior of and the interaction between relevant software units. [OUTCOME 3]

1 *Not all software units have dynamic behavior to be described.*

139: SWE.3.RL.4
143: SWE.3.RL.7

BP4

Evaluate software detailed design. Evaluate the software detailed design in terms of interoperability, interaction, criticality, technical complexity, risks and testability. [OUTCOME 1,2,3,4]

2 *The results of the evaluation can be used as input for software unit verification.*

141: SWE.3.RL.5, SWE.3.RC.1
143: SWE.3.RL.7

SWE.3

BP5

Establish bidirectional traceability. Establish bidirectional traceability between software requirements and software units. Establish bidirectional traceability between the software architectural design and the software detailed design. Establish bidirectional traceability between the software detailed design and software units. [OUTCOME 4]

3 *Redundancy should be avoided by establishing a combination of these approaches that covers the project and the organizational needs.*

4 *Bidirectional traceability supports coverage, consistency and impact analysis.*

36ff: TAC.RC.1-4
41: TAC.RL.2-3
143: SWE.3.RL.7, SWE.3.RC.4-5

BP6

Ensure consistency. Ensure consistency between software requirements and software units. Ensure consistency between the software architectural design, the software detailed design and software units. [OUTCOME 4]

5 *Consistency is supported by bidirectional traceability and can be demonstrated by review records.*

39: TAC.RL.1
40: TAC.RC.4
41: TAC.RL.2-3
57: MBD.RL.6
143: SWE.3.RL.7, SWE.3.RC.6-7
233: CL2.RC.18

BP7 | **Communicate agreed software detailed design.** Communicate the agreed software detailed design and updates to the software detailed design to all relevant parties. [OUTCOME 5]

| 44: SAC.RL.1 |
| 46: SAC.RC.4-6 |
| 143: SWE.3.RL.7 |
| 225: CL2.RC.9 |

BP8 | **Develop software units.** Develop and document the executable representations of each software unit according to the software detailed design. [OUTCOME 6]

| 141ff: SWE.3.RL.6-7 |

BP2
Define interfaces of software units

BP3
Describe dynamic behavior

BP4
Evaluate software detailed design

BP1
Develop software detailed design (→ software elements)

BP7
Communicate agreed software detailed design

BP8
Develop software units

RL.7: basesd on

RL.7: communicates

RL.7: basesd on

RL.7: according to

RL.7: based on

RL.7

RC.2, 3: based on

RL.7

(no RC)

(no RC)

BP5
Establish bidirectional traceability

SWE.1 **PA1.1**
Software requirements analysis (software requirements)

SWE.2 **PA1.1**
Software architectural design (software architectural)

BP6
Ensure consistency

RC.4: establish between

RC.6: ensure between

RC.7: establish between

RC.5: establish between

SWE.4 Software Unit Verification

The purpose of the Software Unit Verification Process is to verify software units to provide evidence for compliance of the software units with the software detailed design and with the non-functional software requirements.

Process outcomes – As a result of successful implementation of this process

1. a software unit verification strategy including regression strategy is developed to verify the software units;
2. criteria for software unit verification are developed according to the software unit verification strategy that are suitable to provide evidence for compliance of the software units with the software detailed design and with the non-functional software requirements;
3. software units are verified according to the software unit verification strategy and the defined criteria for software unit verification and the results are recorded;
4. consistency and bidirectional traceability are established between software units, criteria for verification and verification results; and
5. results of the unit verification are summarized and communicated to all affected parties.

Output work products

08-50 Test specification E	[OUTCOME 2]	13-22 Traceability record	[OUTCOME 4]
08-52 Test plan	[OUTCOME 1]	13-25 Verification results	[OUTCOME 3, 5]
13-04 Communication record	[OUTCOME 5]	13-50 Test result	[OUTCOME 3, 5]
13-19 Review record	[OUTCOME 3, 4]	15-01 Analysis report	[OUTCOME 3]

BP1 **Develop software unit verification strategy including regression strategy.** Develop a strategy for verification of the software units including regression strategy for re-verification if a software unit is changed. The verification strategy shall define how to provide evidence for compliance of the software units with the software detailed design and with the non-functional requirements. [OUTCOME 1]

1 *Possible techniques for unit verification include static/dynamic analysis, code reviews, unit testing etc.*

51ff: SAP.RL.1-4
62: AGE.RC.7
81: APA.RL.8
145: SWE.4.RL.1-2

BP2 **Develop criteria for unit verification.** Develop criteria for unit verification that are suitable to provide evidence for compliance of the software units, and their interactions within the component, with the software detailed design and with the non-functional requirements according to the verification strategy. For unit testing, criteria shall be defined in a unit test specification. [OUTCOME 2]

2 *Possible criteria for unit verification include unit test cases, unit test data, static verification, coverage goals and coding standards such as the MISRA rules.*

3 *The unit test specification may be implemented e.g. as a script in an automated test bench.*

148: SWE.4.RL.7
149: SWE.4.RC.1-2

SWE.4

BP3

Perform static verification of software units. Verify software units for correctness using the defined criteria for verification. Record the results of the static verification. [OUTCOME 3]

4 *Static verification may include static analysis, code reviews, checks against coding standards and guidelines, and other techniques.*

5 *See SUP.9 for handling of non-conformances.*

57: MBD.RL.7-8, 10
62: AGE.RC.11
145: SWE.4.RL.3-6
148: SWE.4.RL.8

BP4

Test software units. Test software units using the unit test specification according to the software unit verification strategy. Record the test results and logs. [OUTCOME 3]

6 *See SUP.9 for handling of non-conformances.*

57: MBD.RL.9, 11
145ff: SWE.4.RL.3-7, 9

BP5

Establish bidirectional traceability. Establish bidirectional traceability between software units and static verification results. Establish bidirectional traceability between the software detailed design and the unit test specification. Establish bidirectional traceability between the unit test specification and unit test results. [OUTCOME 4]

7 *Bidirectional traceability supports coverage, consistency and impact analysis.*

36ff: TAC.RC.1-4
149: SWE.4.RC.3

BP6

Ensure consistency. Ensure consistency between the software detailed design and the unit test specification. [OUTCOME 4]

8 *Consistency is supported by bidirectional traceability and can be demonstrated by review records.*

39: TAC.RL.1
40: TAC.RC.4
149: SWE.4.RC.4
233: CL2.RC.18

BP7

**Summarize and communicate results.** Summarize the unit test results and static verification results and communicate them to all affected parties. [OUTCOME 5]

9 *Providing all necessary information from the test case execution in a summary enables other parties to judge the consequences.*

43ff: SAC.RC.1-6
148: SWE.4.RL.10-11
225: CL2.RC.10

SWE.4

SWE.4 Consistency Diagram

SWE.5 Software Integration and Integration Test
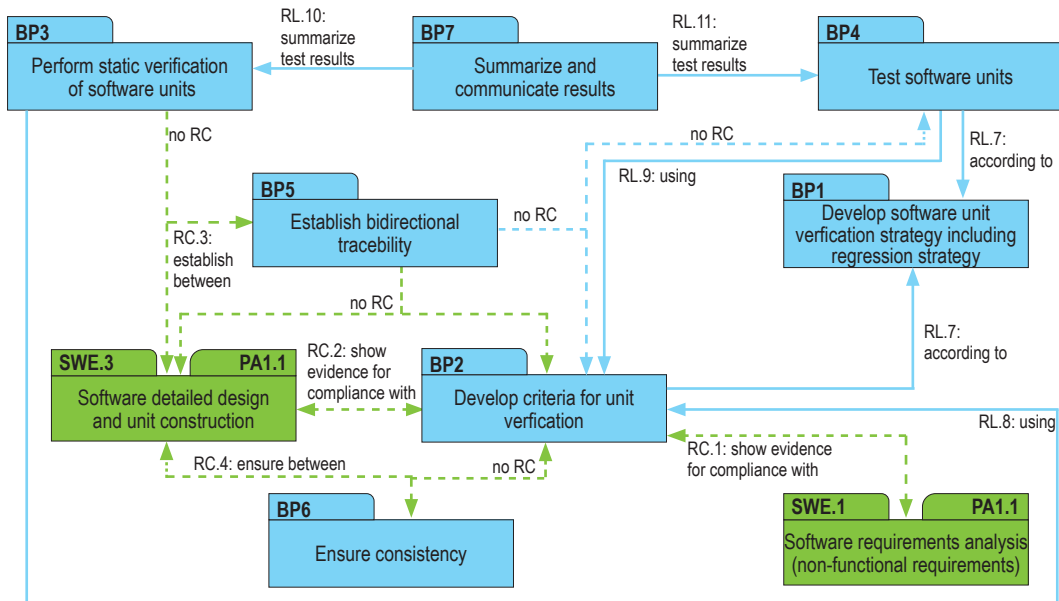
The purpose of the Software Integration and Integration Test Process is to integrate the software units into larger software items up to a complete integrated software consistent with the software architectural design and to ensure that the software items are tested to provide evidence for compliance of the integrated software items with the software architectural design, including the interfaces between the software units and between the software items.

Process outcomes – As a result of successful implementation of this process

1. a software integration strategy consistent with the project plan, release plan and the software architectural design is developed to integrate the software items;
2. a software integration test strategy including the regression test strategy is developed to test the software unit and software item interactions;
3. a specification for software integration test according to the software integration test strategy is developed that is suitable to provide evidence for compliance of the integrated software items with the software architectural design, including the interfaces between the software units and between the software items;
4. software units and software items are integrated up to a complete integrated software according to the integration strategy;
5. test cases included in the software integration test specification are selected according to the software integration test strategy, and the release plan;
6. integrated software items are tested using the selected test cases and the results of software integration test are recorded;
7. consistency and bidirectional traceability are established between the elements of the software architectural design and the test cases included in the software integration test specification and between test cases and test results; and
8. results of the software integration test are summarized and communicated to all affected parties.

01-03 Software item	[OUTCOME 4]	13-19 Review record	[OUTCOME 7]
01-50 Integrated software	[OUTCOME 4]	13-22 Traceability record	[OUTCOME 7]
08-50 Test specification	[OUTCOME 3,5]	13-50 Test result	[OUTCOME 6, 8]
08-52 Test plan	[OUTCOME 1,2]	17-02 Build list	[OUTCOME 4, 7]
13-04 Communication record	[OUTCOME 8]		

SWE.5 with 9 Base practices

BP1

Develop software integration strategy. Develop a strategy for integrating software items consistent with the project plan and release plan. Identify software items based on the software architectural design and define a sequence for integrating them. [OUTCOME 1]

51ff: SAP.RL.1-4
62: AGE.RC.8
65: DID.RL.10
150: SWE.5.RL.1
157: SWE.5.RC.2-3

BP2

Develop software integration test strategy including regression test strategy. Develop a strategy for testing the integrated software items following the integration strategy. This includes a regression test strategy for re-testing integrated software items if a software item is changed. [OUTCOME 2]

51ff: SAP.RL.1-4
81: APA.RL.8
152: SWE.5.RL.2-3

SWE.5

BP3

Develop specification for software integration test. Develop the test specification for software integration test including the test cases according to the software integration test strategy for each integrated software item. The test specification shall be suitable to provide evidence for compliance of the integrated software items with the software architectural design. [OUTCOME 3]

1 *Compliance to the architectural design means that the specified integration tests are suitable to prove that the interfaces between the software units and between the software items fulfill the specification given by the software architectural design.*

2 *The software integration test cases may focus on*
   • *the correct dataflow between software items*
   • *the timelines and timing dependencies of dataflow between software items*
   • *the correct interpretation of data by all software items using an interface*
   • *the dynamic interaction between software items*
   • *the compliance to resource consumption objectives of interfaces*

70: TPS.RC.11
152: SWE.5.RL.4
156: SWE.5.RL.9, SWE.5.RL.11
157: SWE.5.RC.4

BP4

Integrate software units and software items. Integrate the software units to software items and software items to integrated software according to the software integration strategy. [OUTCOME 4]

156: SWE.5.RL.12

BP5 **Select test cases.** Select test cases from the software integration test specification. The selection of test cases shall have sufficient coverage according to the software integration test strategy and the release plan. [OUTCOME 5]

153: SWE.5.RL.5
153: SWE.5.RC.1
156: SWE.5.RL.9
156: SWE.5.RL.13-14
157: SWE.5.RC.5

BP6 **Perform software integration test.** Perform the software integration test using the selected test cases. Record the integration test results and logs. [OUTCOME 6]

3 *See SUP.9 for handling of non-conformances.*

4 *The software integration test may be supported by using hardware debug interfaces or simulation environments (e.g. Software-in-the-Loop-Simulation).*

70: TPS.RC.12
153f: SWE.5.RL.6-8
156: SWE.5.RL.15

BP7 **Establish bidirectional traceability.** Establish bidirectional traceability between elements of the software architectural design and test cases included in the software integration test specification. Establish bidirectional traceability between test cases included in the software integration test specification and software integration test results. [OUTCOME 7]

5 *Bidirectional traceability supports coverage, consistency and impact analysis.*

36ff: TAC.RC.1-4
157: SWE.5.RC.6

SWE.5

BP8

Ensure consistency. Ensure consistency between elements of the software architectural design and test cases included in the software integration test specification. [OUTCOME 7]

6 *Consistency is supported by bidirectional traceability and can be demonstrated by review records.*

39: TAC.RL.1
40: TAC.RC.4
157: SWE.5.RC.7
233: CL2.RC.18

**BP9**

Summarize and communicate results. Summarize the software integration test results and communicate them to all affected parties. [OUTCOME 8]

7 *Providing all necessary information from the test case execution in a summary enables other parties to judge the consequences.*

43ff: SAC.RC.1-6, SAC.RL.2
225: CL2.RC.10

SWE.5 Consistency Diagram

SWE.6 Software Qualification Test
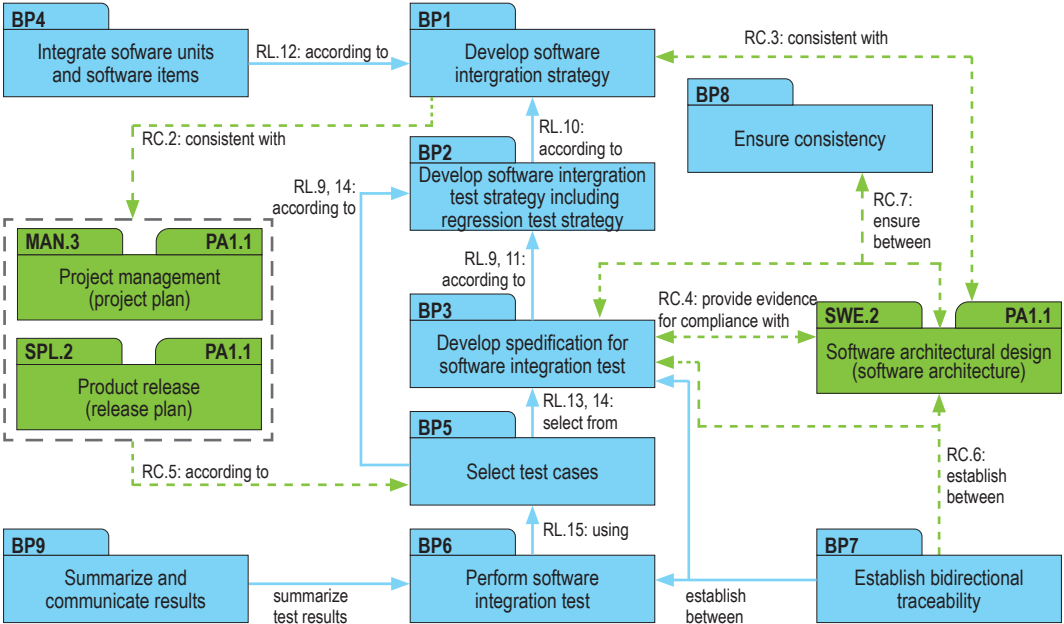
The purpose of the Software Qualification Test Process is to ensure that the integrated software is tested to provide evidence for compliance with the software requirements.

Process outcomes – As a result of successful implementation of this process

1. a software qualification test strategy including regression test strategy consistent with the project plan and release plan is developed to test the integrated software;
2. a specification for software qualification test of the integrated software according to the software qualification test strategy is developed that is suitable to provide evidence for compliance with the software requirements;
3. test cases included in the software qualification test specification are selected according to the software qualification test strategy and the release plan;
4. the integrated software is tested using the selected test cases and the results of software qualification test are recorded;
5. consistency and bidirectional traceability are established between software requirements and software qualification test specification including test cases and between test cases and test results; and
6. results of the software qualification test are summarized and communicated to all affected parties.

Output work products

08-50 Test specification	[OUTCOME 2, 3]	13-19 Review record	[OUTCOME 5]
08-52 Test plan	[OUTCOME 1]	13-22 Traceability record	[OUTCOME 5]
13-04 Communication record	[OUTCOME 6]	13-50 Test result	[OUTCOME 4, 6]

BP1

Develop software qualification test strategy including regression test strategy. Develop a strategy for software qualification testing consistent with the project plan and the release plan. This includes a regression test strategy for re-testing the integrated software if a software item is changed. [OUTCOME 1]

51ff: SAP.RL.1-4
62: AGE.RC.9
74: PLS.RC.7
81: APA.RL.8
159: SWE.6.RL.1-2
163: SWE.6.RC.2

BP2

Develop specification for software qualification test. Develop the specification for software qualification test including test cases based on the verification criteria, according to the software test strategy. The test specification shall be suitable to provide evidence for compliance of the integrated software with the software requirements. [OUTCOME 2]

159: SWE.6.RL.3
163: SWE.6.RL.8-9
164: SWE.6.RC.3

BP3

Select test cases. Select test cases from the software test specification. The selection of test cases shall have sufficient coverage according to the software test strategy and the release plan. [OUTCOME 3]

160: SWE.6.RL.4, SWE.6.RC.1
163: SWE.6.RL.8, 10-11
164: SWE.6.RC.4

SWE.6

BP4

Test integrated software. Test the integrated software using the selected test cases. Record the software test results and logs. [OUTCOME 4]

① *See SUP.9 for handling of non-conformances.*

160f: SWE.6.RL.5-7
163: SWE.6.RL.12

BP5

Establish bidirectional traceability. Establish bidirectional traceability between software requirements and test cases included in the software qualification test specification. Establish bidirectional traceability between test cases included in the software qualification test specification and software qualification test results. [OUTCOME 5]

② *Bidirectional traceability supports coverage, consistency and impact analysis.*

36ff: TAC.RC.1-4
164: SWE.6.RC.5

BP6

Ensure consistency. Ensure consistency between software requirements and test cases included in the software qualification test specification. [OUTCOME 5]

③ *Consistency is supported by bidirectional traceability and can be demonstrated by review records.*

39: TAC.RL.1
40: TAC.RC.4
164: SWE.6.RC.6
233: CL2.RC.18

BP7

Summarize and communicate results. Summarize the software qualification test results and communicate them to all affected parties. [OUTCOME 6]

4 *Providing all necessary information from the test case execution in a summary enables other parties to judge the consequences*

| 43ff: SAC.RC.1-6 |
| 225: CL2.RC.10 |

AUTOMOTIVE SPICE® CYBERSECURITY Version1.0

Bidirectional traceability and Consistency for Cybersecurity

Threat scenarios

SEC.1 BP.2
SEC.1 BP.3

Cybersecurity goals

SEC.4 BP.4
SEC.4 BP.5

Validation specification

SEC.4 BP.4

Validation results

SEC.1 BP.2
SEC.1 BP.3

System Level — Cybersecurity requirements

SEC.3 BP.4
SEC.3 BP.5

SYS.3.BP7
SYS.2.BP8

System Level — Architectural Design

SEC.3 BP4
SEC.3.BP5

SEC.2.BP8
SEC.2.BP9

HW/SW Level — Cybersecurity requirements

SEC.3 BP4
SEC.3.BP5

SWE.2.BP7
SWE.2.BP8

HW/SW Level — Architectural Design

SEC.3 BP4
SEC.3.BP5

SEC.2 BP.8
SEC.2 BP.9

HW/SW Component Level — Software detailed design

SEC.3 BP.5

SWE.3 BP5
SWE.3 BP6

Software units

Risk treatment verification specification

test cases

SEC.3 BP.4

Verification results

Blue: bidirectional tracebility
Red: consistency
Black: PAM3.1 relation

- Regulation R155

UN

ISO

- ISO 21434 Cybersecurity
- ISO 24086 Software updates
- ISO DPAS 5112 Audit

- EU: Cybersecurity Act
- China: Cybersecurity Law
- USA: NHTSA Cybersecrity Guidelines

Local Law

VDA QMC

- ACSMS Audit
- Automotive SPICE for Cybersecurity

Timeline

| 2018 | 2020 | 2022 | 2024 | 2026 |

2021-Q1:
UNECE R155
Cybersecurity regulation

2022-Q3:
Compliance for all new vehicle types

2024-Q3:
Complinace for all vehicles

22nd Jan. 2021

7th July 2022

7th July 2024

Cybersecurity Processes at a Glance

TARA – MAN.7

1. Asset Identification — BP1 BP3

2. Threat Scenario Identification — BP3

3. Impact Rating — BP3 BP4

4. Attack Path Analysis — BP5

5. Attack Feasibility Rating — BP5

6. Risk Determination — BP5

7. Risk Treatment Decision — BP6

derive goals →

SEC.1 CS Requirements Elicitation

Cybersecurity Goals

Cybersecurity Requirements

implement

SEC.2 CS Implementation

Architecture

SW Detail Design

SW Units

SEC.4 Risk Treatment Validation

validate

Goal validation specification

verify

Risk treatment verification specification

SEC.3 Risk Treatment Verification

Cybersecurity Management System (Organizational Level)

Monitoring CS Claim

Sub Supplier

Vulnerability DB

TARA – Threat Analyses and Risk Assessment
Precondition: The Scope of TARA is defined

① Identify all Assets (anything worth protecting) within the scope (below is an example of one asset)   **②**   **③**

Asset	Security Property	Damage	Threat Scenario	Stakeholder Impact Rating					
				Road User				OEM	
				Safety	Financial	Operational	Privacy	Safety	Financial
Function: Synchronization between Bluetooth connected phone and internal phone number storage	*Authenticity*	*falsified phone data due to spoofed identity*	*Synchronization with a spoofed phone, unknown phone spoofs a known phone*	0	1	0	1	1	0
	Integrity	*falsified phone data due to corrupted messages*	*Tampering: Man in the middle attack allows corruption of messages*	0	1	0	1	1	0
	Non-repudiation	*falsified phone data see Authenticity*	*see Authenticity and Integrity*	0	1	0	1	1	0
	Confidentiality	*violation of privacy due to exposition of confidential data*	*Information Disclosure: a) unknown phone spoofs a known phone to access data b) man in the middle attack forwards data to attacker c) eavesdropping*	0	2	0	3	2	0
	Availability	*synchronization failure due to failed connection*	*a) man in the middle attack blocks communication b) Denial of Service attack overloads connection*	0	0	0	0	0	0
	Authortization	*loss of data due to inappropriate access rights*	*Elevation of Privileges: connected phone can access unauthorized Bluetooth profiles*	0	1	0	1	1	0

TARA – Threat Analyses and Risk Assessment

(4)   **(5)**

Security Property	Attack Path Analysis	Attack feasibility assessment								
		Elapsed Time	Specialist Expertise	Elapsed Time	Elapsed Time	Elapsed Time	Elapsed Time	Elapsed Time	Elapsed Time	Elapsed Time
Authenticity	'1. attackers phone must emulate a paired device (CVE-2020-9770) 2. establish connection with vehicle 3. trigger synchronisation	≤ 1 month	Expert	Public information	Easy	Standard	4	6	0	1
Integrity	'1. verify bluetooth vulnerability (CVE-2018-5383, CVE-2020-15802) 2. establish connection with man in the middle device 3. tamper with the data as desired	≤ 1 month	Expert	Public information	Easy	Standard	4	6	0	1
Non-repudiation	see Authenticity and Integrity	≤ 1 month	Expert	Public information	Easy	Standard	4	6	0	1
Confidentiality	'1. gather encryption key during reconnection process 2. eavesdrop on communication, collect data 3. copy data and use as desired	≤ 1 month	Expert	Public information	Easy	Standard	4	6	0	1
Availability	'1. send a flood of buetooth requests to occupy/overload receiver	≤ 1 month	Expert	Public information	Easy	Standard	1	6	0	1
Authorization	'1. attackers phone must emulate a paired device (CVE-2020-9770) 2. establish connection with vehicle 3. switch to an unauthorized bluetooth profile 4. perform unauthorized action	≤ 1 month	Expert	Public information	Easy	Standard	4	6	0	1

TARA – Threat Analyses and Risk Assessment

Security Property	Stakeholder Impact Rating							Attack ⑥		Stakeholder Risk Value ⑦						
	Road User				OEM					Road User				OEM		
	Safety	Financial	Operational	Privacy	Safety	Financial	Operational	Total Value	Attack feasibility Value	Safety	Financial	Operational	Privacy	Safety	Financial	Operational
Authenticity	0	1	0	1	1	0	0	11	High	0	2	0	2	2	0	0
Integrity	0	1	0	1	1	0	0	11	High	0	2	0	2	2	0	0
Non-repudiation	0	1	0	1	1	0	0	11	High	0	2	0	2	2	0	0
Confidentiality	0	2	0	3	2	0	0	11	High	0	3	0	4	3	0	0
Availability	0	0	0	0	0	0	0	8	High	0	0	00	0	0	0	0
Authortization	0	1	0	1	1	0	0	11	High	0	2	0	2	2	0	0

Criteria for road user impact rating				
Impact rating	Financial	Operational	Privacy	Safety
Severe	**F3: The financial damage leads to catastrophic consequences which the affected road user might not overcome.**	**O3: The operational damage leads to the loss or impairment of a core vehicle function.**	**P3: The privacy damage leads to significant or even irreversible impact to the road user.**	**S3: Life-threatening injuries (survival uncertain), fatal injuries**
Major	**F2: The financial damage leads to substantial consequences which the affected road user will be able to overcome.**	**O2: The operational damage leads to the loss or impairment of an important vehicle function**	**P2: The privacy damage leads to serious impact to the road user.**	**S2: Severe and life-threatening injuries (survival probable)**
Moderate	**F1: The financial damage leads to inconvenient consequences which the affected road user will be able to overcome with limited resources.**	**O1: The operational damage leads to partial degradation of a vehicle function.**	**P1: The privacy damage leads to inconvenient consequences to the road user.**	**S1: Light and moderate injuries**
Negligible	**F0: The financial damage leads to no effect, negligible consequences or is irrelevant to the road user.**	**O0: The operational damage leads to no impairment or non-perceivable impairment of a vehicle function.**	**P0: The privacy damage leads to no effect or, negligible consequences or is irrelevant to the road user.**	**S0: No injuries**

Criteria for OEM impact rating			
Impact rating	Financial	Operational	Privacy
Severe	**F3: The financial damage leads to catastrophic consequences which the affected stakeholder might not overcome.**	**O3: The operational damage leads to a service not working, from non-intended operation up to the service being non-operational.**	**"P3: The privacy damage leads to significant or even irreversible impact to the service user OR the number of affected PII principals is very high."**
Major	**F2: The financial damage leads to substantial consequences which the affected stakeholder will be able to overcome.**	**O2: The operational damage leads to the loss of a Service function.**	**"P2: The privacy damage leads to serious impact to the service user OR the number of affected PII principals is high."**
Moderate	**F1: The financial damage leads to inconvenient consequences which the affected stakeholder will be able to overcome with limited resources.**	**O1: The operational damage leads to partial degradation of a service function or performance.**	**"P1: The privacy damage leads to significant inconveniences to the service user AND the number of affected PII principals is limited."**
Negligible	**F0: The financial damage leads to no effect, negligible consequences or is irrelevant to the stakeholder.**	**O0: The operational damage leads to no effect or indiscernible degradation of a service function or performance.**	**P0: The privacy damage leads to no effect or can create few inconveniencies to the service user AND the number of affected PII principals is very limited.**

Attack feasibility - Definitions and values			
Attack Feasibility Category	**Definition**	**Enumerate**	**Value**
Elapsed Time	The total amount of time taken by an attacker to identify that a particular potential vulnerability may exist, to develop an attack method and to sustain the effort required in mounting the attack.	≤ 1 day	0
		≤ 1 week	1
		≤ 1 month	4
		≤ 6 months	10
		> 6 months	19
Specialist Expertise	The required level of generic knowledge of the underlying principles, product types or attack methods.	Layman	0
		Proficient	3
		Expert	6
		Multiple experts	8
Knowledge of the item	This refers to specific expertise in relation to the item under investigation. This is distinct from generic expertise, but not unrelated to it.	Public information	0
		Restricted information	3
		Confidential information	7
		Strictly confidential information	11
Window of opportunity	This has a relationship to the Elapsed time. Identification and exploitation of a vulnerability may require considerable amounts of access to a system that may increase the likelihood of detection of the attack. Some attack methods may require considerable effort off-line, and only brief access to the target to exploit. Access may also need to be continuous or over a number of sessions.	Unlimited	0
		Easy	1
		Moderate	4
		Difficult	10
Equipment	This refers to the equipment required to identify and exploit a vulnerability.	Standard	0
		Specialized	4
		Bespoke	7
		Multiple bespoke	9

SEC.1 Cybersecurity Requirements Elicitation

The purpose of the Cybersecurity Requirements Elicitation Process is to derive cybersecurity goals and requirements from the outcomes of risk management, and ensure consistency between the risk assessment, cybersecurity goals and cybersecurity requirements.

Process outcomes – As a result of successful implementation of this process

1. cybersecurity goals are defined,
2. cybersecurity requirements are derived from cybersecurity goals,
3. consistency and bidirectional traceability are established between cybersecurity requirements and goals and between the cybersecurity goals and the threat scenarios, and
4. the cybersecurity requirements are agreed and communicated to all affected parties.

Output work products

13-04 Communication record	[OUTCOME 4]	17-11 Software requirements specification	[OUTCOME 1, 2]
13-19 Review record	[OUTCOME 3]	17-12 System requirements specification	[OUTCOME 1, 2]
13-22 Traceability record	[OUTCOME 3]	17-51 Cybersecurity goals	[OUTCOME 1]
15-01 Analysis report	[OUTCOME 1, 2]		

BP1

Derive cybersecurity goals and cybersecurity requirements. Derive cybersecurity goals for those threat scenarios, where the risk treatment decision requires risk reduction. Specify functional and non-functional cybersecurity requirements for the cybersecurity goals, including criteria for the achievement of the cybersecurity goals. [OUTCOME 1, 2]

1. *This includes the refinement of requirements during iterations of this process.*
2. *This includes requirements for post-development phases which may include production, operation, maintenance and decommissioning.*

BP2

Establish bidirectional traceability. Establish bidirectional traceability between the cybersecurity requirements and the cybersecurity goals. Establish bidirectional traceability between the cybersecurity goals and the threat scenarios. [OUTCOME 3]

BP3

Ensure consistency. Ensure consistency between the cybersecurity requirements and the cybersecurity goals. Ensure consistency between the cybersecurity goals and the threat scenarios. [OUTCOME 3]

BP4

Communicate agreed cybersecurity requirements. Communicate agreed cybersecurity goals and cybersecurity requirements to all affected parties. [OUTCOME 4]

SYS2 | **BP1**
Specify system requirements

BP4
Communicate agreed cybersecurity requirements

— uses →

SWE.1 | **BP1**
Specify software requirements

— uses →

BP1
Derive cybersecurity goals and cybersecurity requirements

communicates

BP3
Ensure consistency

based on

ensure between

BP2
Establish bidireconal traceability

establish between

MAN.7 | **BP6**
Define risk treatment option

SEC.2 Cybersecurity Implementation

The purpose of the Cybersecurity Implementation Process is to allocate the cybersecurity requirements to the elements of the system and software and ensure they are implemented.

Process outcomes – As a result of successful implementation of this process

1. architectural design is refined,
2. cybersecurity requirements are allocated to elements of the architectural design,
3. appropriate cybersecurity controls are selected,
4. vulnerabilities are analyzed,
5. detailed design is refined,
6. software units are developed,
7. consistency and bidirectional traceability are established between architectural design and detailed design, and
8. the cybersecurity risk treatment implementation is agreed upon and communicated to all affected parties.

Output work products

04-04 Software architectural design	[OUTCOME 1]	13-19 Review record	[OUTCOME 7]
04-05 Software detailed design	[OUTCOME 5]	13-22 Traceability record	[OUTCOME 2, 7]
04-06 System architectural design	[OUTCOME 1]	15-50 Vulnerability analysis report	[OUTCOME 4]
11-05 Software unit	[OUTCOME 6]	17-52 Cybersecurity controls	[OUTCOME 3]
13-04 Communication record	[OUTCOME 8]		

BP1 — **Refine the details of the architectural design.** The architectural design is refined based on cybersecurity goals and cybersecurity requirements. [OUTCOME 1]

1. *Refinement could be on system and software level architecture.*
2. *Refinement here means to add, adapt or rework elements of the architecture.*

BP2 — **Allocate cybersecurity requirements.** Allocate the cybersecurity requirements to one or more elements of the architectural design. [OUTCOME 2]

3. *Cybersecurity requirements could be on system and software level.*

BP3 — **Select cybersecurity controls.** Select appropriate cybersecurity controls to achieve or support the cybersecurity requirements. [OUTCOME 3]

4. *Typically, cybersecurity controls are technical or other solutions to avoid, detect, counteract or mitigate cybersecurity risks.*

BP4 — **Refine interfaces.** Refine and describe cybersecurity related interfaces between the elements of the architectural design and operating environment. [OUTCOME 1]

BP5 — **Analyze architectural design.** Analyze the architectural design to identify and analyze vulnerabilities. [OUTCOME 4]

BP6 — **Refine the details of the detailed design**. The detailed design is refined based on architectural design. [OUTCOME 5]

5. *Refinement here means toadd, adapt or rework components of the detailed design.*

SEC.2

BP7

Develop software units. Implement the software using appropriate modeling or programming languages. [OUTCOME 6]

6 *Criteria for appropriate modeling and programming languages for cybersecurity can include the use of language subsets, enforcement of strong typing and/or the use of defensive implementation techniques.*

7 *Example to cover the defined criteria above could be the use of a coding guideline or an appropriate development environment.*

BP8

Establish bidirectional traceability. Establish bidirectional traceability between the refined architectural design and the detailed design. [OUTCOME 2, 7]

BP9

Ensure consistency. Ensure consistency between the refined architectural design and the detailed design. [OUTCOME 7]

BP10

Communicate agreed results of cybersecurity implementation. Communicate the agreed results of the cybersecurity implementation to all affected parties including stakeholders from post-development phases. [OUTCOME 8]

8 *The communicated contents may include both results of the cybersecurity implementation and vulnerabilities identified within the architectural design analysis.*

SEC2. Consistency Diagram

BP10 Communicate agreed results of cybersecurity implementation

based on

communicates vulnerabilities

SEC.1 — **BP1** Derive cybersecurity goals and cybersecurity requirements

BP7 Develop software units

BP5 Analyze architectural design

communicates

according to

BP2 Allocate cybersecurity requirements

BP6 Refine the details of the detailed design

BP3 Select cybersecurity controls

based on

BP4 Refine interfaces

BP9 Ensure consistency

ensure between

uses

BP8 Establish bidirectional traceability

establish between

BP1 Refine the details of the architectural design

uses

SEC.2

SEC.3 Risk Treatment Verification

The purpose of the Risk Treatment Verification Process is to confirm that the implementation of the design and integration of the components comply with the cybersecurity requirements, the refined architectural design and detailed design.

Process outcomes – As a result of successful implementation of this process

1. a risk treatment verification and integration strategy are developed, implemented, and maintained,
2. a specification for risk treatment verification is developed according to the risk treatment verification strategy suitable to provide evidence of compliance in implementing cybersecurity requirements as well as the refined architectural and detailed design,
3. identified work products are verified according to the risk treatment verification strategy for risk treatment verification. The implementation of the design and the integration of the components is tested using the defined test cases. Verification and test results are recorded,
4. bidirectional traceability between the cybersecurity requirements and risk treatment verification specification (including test cases), and bidirectional traceability between the refined architectural design (including detailed design) and the risk treatment verification specification (including test cases), and between the test cases included in the risk treatment verification specification, and verification results is established,
5. consistency between the cybersecurity requirements and risk treatment verification specification (including test cases) and consistency between the refined architectural design (including detailed design) and the risk treatment verification specification (including test cases) is established, and
6. results of the verification are summarized and communicated to all affected parties.

Output work products

08-50 Test specification	[OUTCOME 2]	13-22 Traceability record	[OUTCOME 4]
08-52 Test plan	[OUTCOME 1]	13-25 Verification results	[OUTCOME 3, 6]
13-04 Communication record	[OUTCOME 6]	13-50 Test result	[OUTCOME 3, 6]
13-19 Review record	[OUTCOME 3, 5]	19-10 Verification strategy	[OUTCOME 1]

BP1   **Develop a risk treatment verification and integration strategy.** Develop and implement a risk treatment verification and integration strategy, including a regression strategy. This contains:
- activities with associated methods, techniques and tools,
- work products or processes under verification,
- degree of independence for verification for performing these activities, and
- verification criteria. [OUTCOME 1]

1   *The risk treatment verification may provide objective evidence that the outputs of a particular phase of the system and software development lifecycle (e.g., requirements, design, implementation, testing) meet the specified requirements for that phase.*

2   *The risk treatment verification strategy may include*
- *requirements-based testing and interface testing on system and software level,*
- *check for any unspecified functionalities,*
- *resource consumption evaluation,*
- *control flow and data flow verification, and*
- *static analysis; for software: static code analysis e.g. industry recognized security-focused coding standards.*

3   *The risk treatment verification methods and techniques may include*
- *network tests simulating attacks (non-authorized commands, signals with wrong hash key, flooding the connection with messages, etc.), and*
- *simulating brute force attacks.*

4   *The risk treatment verification methods and techniques may also include audits, inspections, peer reviews, walkthroughs, code reviews, and other techniques.*

SEC.3

BP2

Develop specification for risk treatment verification. Develop the specification for risk treatment verification (including test cases) according to the risk treatment verification strategy. It shall be suitable to provide evidence of compliance of the implementation with the cybersecurity requirements and the refined architectural design and detailed design. [OUTCOME 2]

5 *Methods of deriving test cases may include*
- *analysis of requirements,*
- *generation and analysis of equivalence classes,*
- *boundary values analysis, and/or*
- *error guessing based on knowledge or experience.*

BP3

Perform verification activities. Verify identified work products according to the specified strategy in order to confirm that the work products meet their specified requirements.
Test the implementation of the design and component integration according to the risk treatment verification specification.
Record the risk treatment verification results and logs. [OUTCOME 3]

BP4

Establish bidirectional traceability. Establish bidirectional traceability between the cybersecurity requirements and risk treatment verification specification, including test cases comprised in the risk treatment verification specification.
Establish bidirectional traceability between the refined architectural design, detailed design, software units and the risk treatment verification specification.
Establish bidirectional traceability between the test cases included in the risk treatment verification specification, and verification results. [OUTCOME 4]

6 *Bidirectional traceability supports coverage, consistency, and impact analysis.*
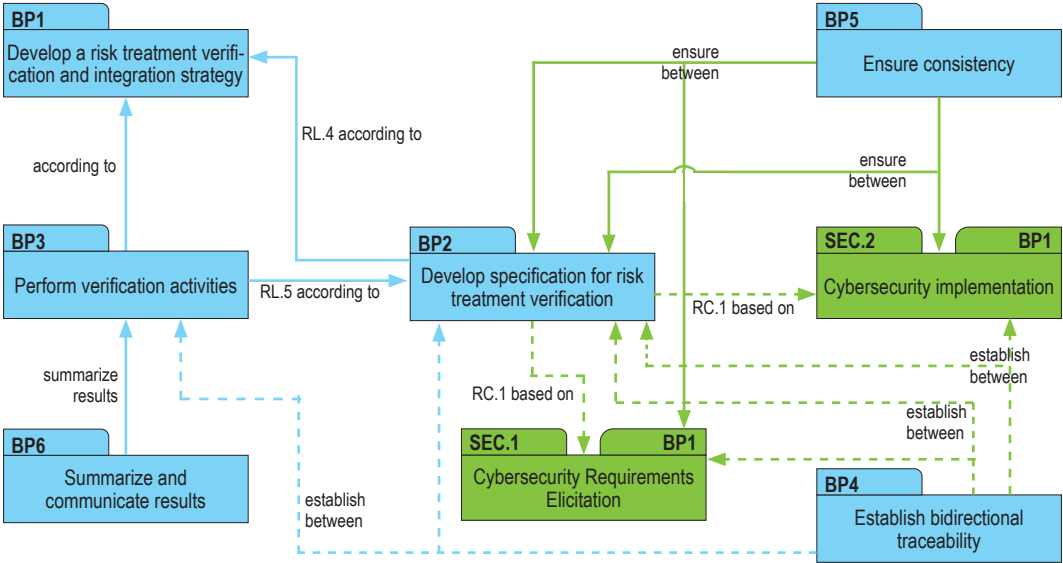
BP5

Ensure consistency. Ensure consistency between the cybersecurity requirements and the risk treatment verification specification, including test cases comprised in the risk treatment verification specification.
Ensure consistency between the refined architectural and detailed design and the risk treatment verification specification. [OUTCOME 5]

7 *Consistency is supported by bidirectional traceability and can be demonstrated by review records.*

BP6

Summarize and communicate results. Summarize the risk treatment verification results and communicate them to all affected parties. [OUTCOME 6]

8 *Providing all necessary information from the risk treatment verification execution in a summary enables other parties to judge the consequences.*

SEC.3

BP1 Develop a risk treatment verification and integration strategy

BP3 Perform verification activities

BP6 Summarize and communicate results

BP2 Develop specification for risk treatment verification

SEC.1 BP1 Cybersecurity Requirements Elicitation

BP4 Establish bidirectional traceability

BP5 Ensure consistency

SEC.2 BP1 Cybersecurity implementation

RL.4 according to
according to
RL.5 according to
summarize results
establish between
RC.1 based on
RC.1 based on
ensure between
ensure between
establish between
establish between

SEC.4 Risk Treatment Validation

The purpose of the Risk Treatment Validation Process is to confirm that the integrated system achieves the associated cybersecurity goals.

Process outcomes – As a result of successful implementation of this process

1. a risk treatment validation strategy is developed, implemented and agreed upon with relevant stakeholders and maintained suitably to provide evidence that the implementation achieves the associated cybersecurity goals,
2. the implemented design and integrated components are validated according to the defined risk treatment validation strategy,
3. validation activities are documented and the results are recorded,
4. bidirectional traceability between the cybersecurity goals, risk treatment validation specification and validation results is established,
5. consistency between the cybersecurity goals and the risk treatment validation specification is established, and
6. results of the validation are summarized and communicated to all affected parties.

Output work products

08-50 Test specification	[OUTCOME 2]	13-22 Traceability record	[OUTCOME 4]
13-04 Communication record	[OUTCOME 6]	13-24 Validation results	[OUTCOME 3]
13-19 Review record	[OUTCOME 2, 5]	19-11 Validation strategy	[OUTCOME 1]

SEC.4 with 6 Base practices

BP1 **Develop a risk treatment validation strategy.** Develop and implement a validation strategy. [OUTCOME 1]

1. *Risk treatment validation methods and techniques typically include cybersecurity-relevant methods to detect unidentified vulnerabilities (e.g., penetration testing).*
2. *Risk treatment validation examines whether the associated cybersecurity goals are achieved.*

BP2

Develop specification for risk treatment validation. Develop the specification for risk treatment validation (including test cases) according to the risk treatment validation strategy. It shall be suitable to provide evidence of achievement of the associated cybersecurity goals. [OUTCOME 2]

3 *Methods of deriving test cases may include*
- *analysis of requirements,*
- *generation and analysis of equivalence classes,*
- *boundary values analysis, and/or*
- *error guessing based on knowledge or experience.*

BP3

Perform and document risk treatment validation activities. Validate the implemented design and the integrated components according to the defined risk treatment validation strategy.
The risk treatment validation activities are documented, and the results are recorded. [OUTCOME 2, 3]

4 *See SUP.9 for handling of non-conformances and vulnerabilities.*

BP4

Establish bidirectional traceability. Establish bidirectional traceability between the cybersecurity goals and the risk treatment validation specification. Establish bidirectional traceability between the risk treatment validation specification and the validation results. [OUTCOME 4]

5 *Bidirectional traceability supports coverage, consistency and impact analysis.*

BP5

Ensure consistency. Ensure consistency between the cybersecurity goals and the risk treatment validation specification. [OUTCOME 5]

6 *Consistency is supported by bidirectional traceability and can be demonstrated by review records.*

BP6

Summarize and communicate results. Summarize the risk treatment validation results and communicate them to all affected parties. [OUTCOME 3, 6]

7 *This includes typically information from the risk treatment validation activities and important findings concerning additional vulnerabilities that enables other parties to judge the consequences.*
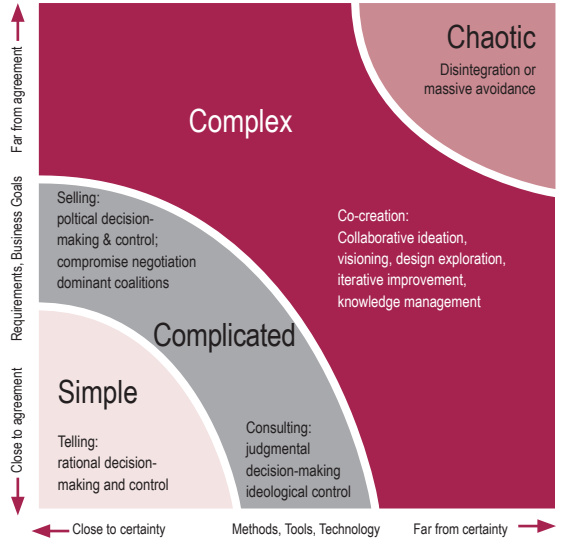
SEC.4

BP1
Develop a risk treatment verification and integration strategy

BP4
Establish bidirectional traceability

BP2
Develop specification for risk treatment validation

SEC.1 **BP1**
Derive cybersecurity goals and cybersecurity requirements

BP3
Perform and document risk treatment validation activities

BP6
Summarize and communicate results

BP5
Ensure consistency

according to

ensure
between

RC.1 based on

according to

establish
between

summarize
results
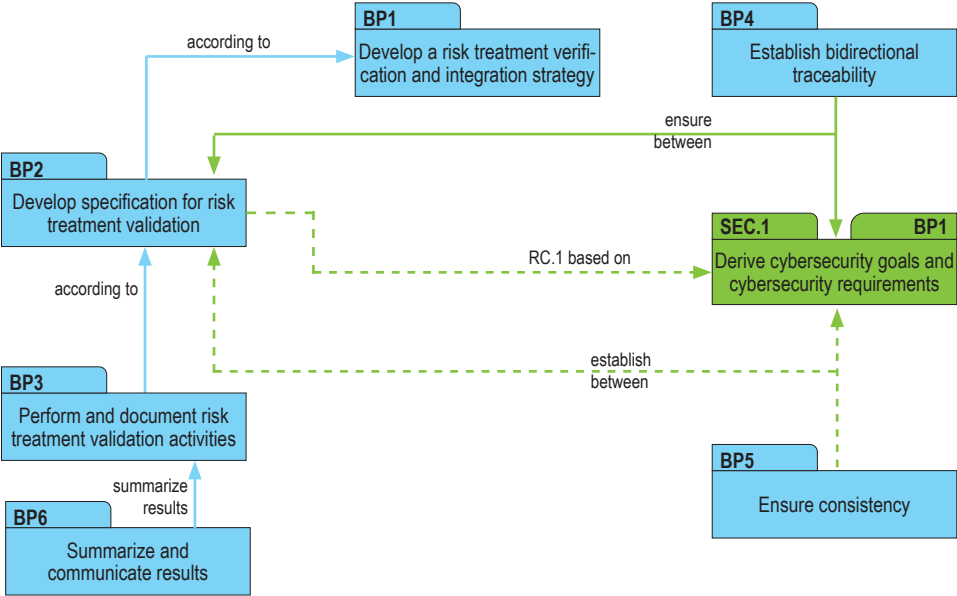
AGILE SPICE™ Version 1.1

- Growing complexity and faster changes during development drive increased use of agile approaches.
- OEMs ensure the overall quality and safety/security of those products, leading to increased pressure to show SPICE capabilities.
- SPICE as is can be applied and interpreted for any kind of development.
- However, both agile organizations and those in an agile transition struggle in implementing and interpreting SPICE.
- There is a need to reduce misunderstandings and help to interpret the terminology for both sides.
- This bridge shall …
  - reduce the variation in interpretation of assessors,
  - increase the acceptance of SPICE in the agile community.

Requirements, Business Goals

Far from agreement

Close to agreement

Chaotic
Disintegration or massive avoidance

Complex

Selling:
poltical decision-making & control;
compromise negotiation
dominant coalitions

Co-creation:
Collaborative ideation, visioning, design exploration, iterative improvement, knowledge management

Complicated

Simple

Telling:
rational decision-making and control

Consulting:
judgmental
decision-making
ideological control

Close to certainty ⟵ Methods, Tools, Technology Far from certainty ⟶

Viewpoint from an agile organization

- Driving acceptance of process capability requirements in agile environments especially in automotive industry
- Practices describing „what" is expected not the „how"
  - Avoiding discussions about specific agile approaches
  - Ensuring expected process capability by automotive industry
- Helping in both implementing agile good practices and achieving Automotive SPICE expectations at the same time
- Resolving past misunderstandings of how to implement and assess relevant Base Practices in agile environments
- Providing a "SPICE bridge" to agile approaches

Viewpoint a conventional organization

- How to keep existing capability while moving toward agile approaches?
- Learning about agile terminology
- Avoiding typical pitfalls in an agile transformation (e.g., how to ensure a minimum of governance)

Viewpoint of an assessor

- Very broad interpretations of existing SPICE processes in agile organizations
- Lack of common terminology for assessing agile
- Need a mapping of ratings between classical and agile approaches
- Requires comparability of ratings of agile and classical approaches to development work

Wishful thinking in the long run: Use of Agile SPICE™ as a bridge to other PAMs.

Agile SPICE™ Assumptions

- Providing agile practices for the what and not the how
- Condensing existing best agile practices without favoring a specific one (e.g., Scrum, Kanban, SAFe, LeSS, Nexus, Scrum of Scrums….)
- Practice is within the guiding principles of the agile manifesto and our definition of agility
- Bridging existing PAM processes and outcomes (do their intentions match?)
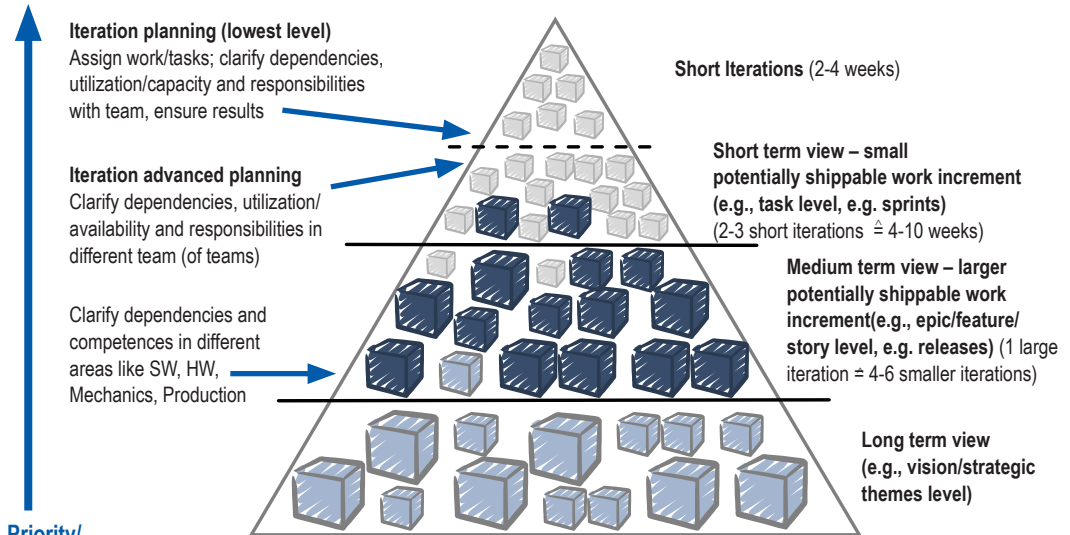- Retaining existing process attributes / generic practices (capability dimension) on CL2-5

Agility is the timely adaption of an organization (or team) to an ever-changing environment while continuously delivering value to their customers at sustainable pace.

Definition by Kugler Maag Cie and Knüvener Mackert GmbH.

Agile Principles for Automotive*

1. Our highest priority is to satisfy our customers through early and continuous delivery of valuable and usable system functions.

2. Requirement changes are mastered, prioritized and systematically integrated into our continuous development work. Agile processes make use of changes to the competitive advantage of the customer.

3. We deliver regularly usable and enhanced system features, preferring shorter time periods within a few weeks or months.

4. Experts from all domains should collaborate intensively during product development.

5. We organize the product development around motivated individuals. We design an environment and support to achieve maximum value. In doing so, we trust that the individuals do their jobs independently and in the best possible way.

6. The most efficient and effective way to communicate information to and within a development team is face-to-face.

7. Usable and extended system functions are the most important measure of progress. Agile processes promote sustainable development.

8. Clients, developers and users should be able to maintain a steady pace for an unlimited period of time.

9. Continuous attention to technical excellence and good design promotes agility.

10. Simplicity - the art of maximizing the amount of work not done - is essential.

11. The best architectures, requirements and designs are created by self-organized teams.

12. At regular intervals, the team reflects on how it can become more effective and adjusts its behavior accordingly

* Adapted by Kugler Maag Cie

Granularity of planning

Iteration planning (lowest level)
Assign work/tasks; clarify dependencies, utilization/capacity and responsibilities with team, ensure results

Iteration advanced planning
Clarify dependencies, utilization/availability and responsibilities in different team (of teams)

Clarify dependencies and competences in different areas like SW, HW, Mechanics, Production

Short Iterations (2-4 weeks)

Short term view – small potentially shippable work increment (e.g., task level, e.g. sprints) (2-3 short iterations $\hat{=}$ 4-10 weeks)

Medium term view – larger potentially shippable work increment(e.g., epic/feature/ story level, e.g. releases) (1 large iteration ≠ 4-6 smaller iterations)

Long term view (e.g., vision/strategic themes level)

Priority/ Level of detail

Picture by Kugler Maag Cie GmbH 2019

AGILE

AGL.1 Agile Work Management

The purpose of Agile Work Management is to collaboratively manage the work of a team (of teams) to develop iteratively within work boundaries, vision and strategic themes to generate business and customer value.

Agile Process Outcomes

1. the product vision and strategic themes are jointly defined and kept up to date;
2. the right set of competencies and adequate resources are planned and adapted as needed;
3. a work approach is defined and continuously improved;
4. dependencies, interfaces, stakeholders and their commitment are planned for and monitored;
5. the needed infrastructure and work environment is planned and operationalized;
6. the feasibility is evaluated for critical elements;
7. the backlog is estimated and prioritized as basis for both for short term and long term planning;
8. the content of iterations and (potentially) shippable work increment is planned and realized;
9. progress and status of work completion is made transparent and impacts on strategic themes and vision are managed to ensure consistency;
10. impediments are identified and resolved when planned work or vision and strategic themes are significantly affected; recurrence of selected issues is prevented.

DRAFT - READY FOR PILOTING - FEEDBACK WELCOME

AGL.1 Agile Work Management (AWM) – Practice Summary

BP.1 **Identify Demand and Work Boundaries.** Identify the customer demand and work boundaries collaborating closely with stakeholders. Derive the vision and strategic themes to achieve business and customer value. Keep demand, boundaries, vision, and strategic themes up to date.

BP.2 **Build Team.** Form, empower and enable a team (of teams) fitting to the vision and work boundaries. Ensure the right skill and experience set within each team (of teams).

BP.3 **Define Work Approach.** Establish, record and keep the work approach of the team (of teams) up to date. Ensure that the work approach reflects the given level of complexity, fulfils the work boundaries and defines team policies, iteration cycles, agile events, artefacts, and roles.

BP.4 **Manage Stakeholders and Interfaces.** Stakeholders, interfaces and dependencies within and outside the team (of teams) are identified, planned for, recorded, and involved.

BP.5 **Plan Infrastructure.** Identify, plan for and keep the needed work and development infrastructure up to date.

BP.6 **Evaluate feasibility.** Evaluate and act on the feasibility of critical elements.

BP.7 **Estimate Work.** Perform a high level estimate on all backlog items. Estimate and prioritize work for the upcoming iteration cycle to ensure a common understanding of the work content within the team (of teams). Refine and adapt estimates to continuously improve team collaboration and the quality of the product backlog.

BP.8 **Work Planning.** Plan and realize the content of the upcoming iteration cycles based on estimates, team capacity, and definitions of ready and done.

BP.9 **Inspect and Adapt.** Inspect, measure and visualize the status and progress of work. Adapt as needed to ensure consistency and to manage impacts on strategic themes and vision.

BP.10 **Manage Impediments.** Identify, monitor, and resolve impediments within and across iteration cycles by teams (of teams).

BP.11 **Improve Work App roach.** Inspect and adapt the work approach based on short learning cycles within the team (of teams).

AGL.1

BP1

Identify Demand and Work Boundaries. Identify the customer demand and work boundaries collaborating closely with stakeholders. Derive the vision and strategic themes linked to business and customer value. Keep demand, boundaries, vision, and strategic themes up to date. [OUTCOME 1]

Notes & Definitions:

- *Collaboration can be internal and external as well as across organizations; e.g., within a program, product line or organization, and together with (multiple) customers and suppliers.*
- *A customer demand is a recorded customer requirement or statement on the problem to be solved.*
- *A vision defines the product capabilities potentially leading to a successful solution.*
- *Strategic themes are unique selling propositions related both to vision of the product and its quality criteria. They typically run across iterations and address a mid and long term perspective.*
- *Vision and strategic themes are typically the result of requirements engineering activities.*
- *A customer can be a stakeholder within (e.g., product management) or external to the organization (an individual customer)*
- *Boundaries can include out of scope, system context, solution space, link to feasibility, organizational constraints and business objectives, platform and product line constraints as well as regulatory requirements.*
- *Ensure agreement with stakeholders on change mechanism for changes to the demand and boundaries.*

Agile Work Products: Product backlog, Demand statement (e.g. includes agreed stakeholder goals), Boundaries, Vision and strategic themes

Supporting Agile Principles *1, 2, 4, 10, 11*

DRAFT - READY FOR PILOTING - FEEDBACK WELCOME

BP2

Build Team. Form, empower and enable a team (of teams) fitting to the vision and work boundaries. Ensure the right skill and experience set within each team (of teams). [OUTCOME 2]

Notes & Definitions:

- *Self organization is a guiding principle for founding an agile team (of teams) and their efficient performance.*
- *Teams of teams are used for larger scopes using a fitting agile scaling approach for teams.*
- *In scaling approaches all teams need to agree on ground rules to ensure a common purpose.*
- *Best performing teams are typically stable in composition and are working at a sustainable pace.*
- *Team building includes defined ground rules for collaboration within a team (of teams).*
- *Empowerment is a conscious delegation of decision authority to a team (of teams).*
- *Enablement ensures the right skills and experience set within a team (of teams) including needed training.*
- *Responsibility for technical releases and product liability must be defined.*

Agile Work Products: Team setup, Work approach, Training plans and records, Skill profiles
Supporting Agile Principles 4, 5, 6, 8, 9, 11, 12

DRAFT - READY FOR PILOTING - FEEDBACK WELCOME

AGL.1

BP3

Define work approach. Establish, record and keep the work approach of the team (of teams) up to date. Ensure that the work approach reflects the given level of complexity, fulfils the work boundaries and defines team policies, iteration cycles, agile events, artefacts, and roles. [OUTCOME 3]

Notes & Definitions:

- *Typically, agility is based on the pull principle as well as on limiting the amount of work in progress and on reducing multi tasking.*
- *The Definition of Done (DoD) is a build in quality measure containing minimum, agreed to and recorded set of criteria upon which a task or increment is considered to be done.*
- *The Definition of Ready (DoR) is a build in quality measure containing minimum, agreed to and recorded set of criteria upon which a content is considered as ready to be pulled.*
- *Typical team (of teams) policies include Definitions of Ready and Done based on quality criteria.*
- *Stakeholder requirements for DoD and DoR include quality requirements, and possibly regulatory requirements imposed by safety or security considerations.*
- *An agile approach often encompasses a whole product lifecycle and a clear alignment with the customer work approach.*
- *Typically, there is an agreement in place with the customer on the chosen agile approach and how delivered work is accepted for each shippable work increment.*
- *If an iteration based approach has been chosen, iterations must be in line with t he chosen agile approach and is influenced by the customer and technical feasibility as well as safety and security aspects.*

Agile Work Products: *Work approach, Definition of Done (DoD), Definition of Ready (DoR)*
Supporting Agile Principles *2, 4, 5, 7, 8, 9, 10, 11*

DRAFT - READY FOR PILOTING - FEEDBACK WELCOME

BP4

Manage Stakeholders and interfaces. Stakeholders, interfaces and dependencies within and outside the team (of teams) are identified, planned for, recorded and involved. [OUTCOME 4]

Notes & Definitions:

- Dependencies and interfaces include both technical and organizational ones:
  - technical: e.g., among major architectural elements or safety/security related activities/roles;
  - organizational: e.g., to other teams/stakeholders and between different iteration cycles;
  - Supplied products or services: e.g. from suppliers or from customers.
- *Critical dependencies should be identified from the start, their sequence identified, and their status tracked across multiple iteration cycles. The elements of the backlog typically contain a path to address them.*
- *Stakeholder involvement includes tracking the commitment of involved and affected parties as well as ensuring the active involvement of stakeholders.*
- *Maintain communication records for all interfaces. Continuously verify the necessity of all interfaces and remove unnecessary interfaces.*
- *In case of mixed agile and classical approaches, e.g., on system and other discipline level, clearly define how different approaches integrate and synchronize.*
- *Agile practitioners are typically organized in communities of practice (CoP, self organizing networks).*

Agile Work Products: Agile work approach (containing e.g. communication and meeting mechanisms, technical and organizational interfaces and dependencies), Product backlog

Supporting Agile Principles *2, 4, 5, 12*

DRAFT - READY FOR PILOTING - FEEDBACK WELCOME

AGL.1

BP5

Plan Infrastructure. Identify, plan for and keep the needed work and development infrastructure up to date.
[OUTCOME 5]

Notes & Definitions:

- Infrastructure typically includes but is not limited to an engineering tool chain, ticketing and backlog database, verification and integration environment, communication and collaboration tools, physical and online workspaces, work environment, licensing, etc.
- Align infrastructure needed for the interfaces to all stakeholders within and outside the organization.
- Agile approaches typically focus on as much automation of processes as possible, e.g. for ticketing, development, continuous integration and deployment, and transparency of status.

Agile Work Products: *Work environment, Product backlog*
Supporting Agile Principles *3, 6, 10*

BP6

Evaluate feasibility. Evaluate and act on the feasibility of critical elements. [OUTCOME 6]
Notes & Definitions:
- Criticality is related to fundamental and conscious decisions during the complete product lifecycle.
- Critical elements address contents related to e.g. product risks, architectural challenges, key features, key technology decisions, key supplied features, relevant safety and security contents.
- The identification, prioritization and monitoring of critical elements is a continuous activity.
- Critical elements should be addressed by potentially shippable work increments.
- Many agile approaches are built for adapting to uncertainty in early stages of development (see MAN.5 for risk mamagement).

Agile Work Products: Prototypes, Potentially shippable work increment, Product backlog (e.g., contents characterized as critical elements), Impediments (Risks)
Supporting Agile Principles 1, 2, 4, 7, 9, 10, 11

DRAFT - READY FOR PILOTING - FEEDBACK WELCOME

BP7

Estimate Work. Perform a high-level estimate on all backlog items. Estimate and prioritize work for the upcoming iteration cycles to ensure a common understanding of the work content within the team (of teams). Refine and adapt estimates to continuously improve team collaboration and the quality of the product backlog. [OUTCOME 7]

Notes & Definitions:
- A high level estimate helps to gauge the overall feasibility of vision and strategic themes.
- Work estimation requires sufficiently small backlog items fitting within the upcoming iteration cycle, i.e., satisfying a DoR and considering (potential) impediments.
- The selection of work items for estimation should be driven by priority and business value.
- Typically, agile estimation is based on experts discussing estimates to achieve a shared understanding and consensus.
- Appropriate estimation method and recorded estimation data from previous estimates should be used, i.e., based on estimating complexity, relative size, historical data or analogy.
- Usually, the estimation method is continuously evaluated and refined.

Agile Work Products: *Product backlog, Tasks*
Supporting Agile Principles *3, 7, 8, 10, 12*

BP8

Work Planning. Plan and realize the content of the upcoming iteration cycles based on estimates and definitions of ready and done.[OUTCOME 8]

Notes & Definitions:

- Typically, there are different levels of planning related to iteration cycles depending on the complexity of the product and team of teams (e.g., sprints and releases).
- In general, work planning should consider actual team member capacity, availability and velocity as well as the recorded work approach, dependencies and feasibility.
- Planning is usually based on selecting (pulling) content from the prioritized product backlog meeting DoR criteria, estimates, overall vision and strategic themes.
- Typically, planned work for each level is the result of a planning workshop for the upcoming iteration cycles by focusing on the near and known future.
- Typically, the team decides on the work distribution mechanisms within the team (of teams), e.g., principles like push, pull, round robin.
- Typically, work is planned to avoid multitasking and by limiting the amount of work in progress; i.e. interruption and segmentation of activities is reduced to a minimum.
- Typically, one or multiple iterations form a potentially shippable work increment (SWI)= Release. Being potentially shippable does not mean the results have to be delivered to customers. Shipping is a recorded business decision and should provide customer value and feedback.
- The term "sample" is often used in automotive for a larger shippable work increment containing results of multiple iteration cycles and disciplines.

Agile Work Products: Product backlog, Tasks (e.g., part of the backlog), Plan for the upcoming activities in a task list, Shippable work increment (SWI) = Release

Supporting Agile Principles 1, 3, 4, 5, 7, 8, 9, 10, 11, 12

AGL.1

BP9

Inspect and Adapt. Inspect, measure and visualize the status and progress of work. Adapt as needed to ensure consistency and to manage impacts on strategic themes and vision. [OUTCOME 9]

Notes & Definitions:
- Intervals and events to inspect the status depend on the complexity of the product and team of teams (e.g., small iterations on team level and larger increments on team of teams or program level).
- Typically, progress and status of work of a team is visible and reviewed daily.
- Measurements are typically related to team (of teams) capacity, velocity, and rate of completion based on agreed to Definition of Ready and Definition of Done.
- The status is usually visible on demand at any time by physical or online team boards or charts.
- Transparency supports achieving consistency among current and overall planning, product backlog, team skills and team capacity to ensure a sustainable pace.

Agile Work Products: *Reporting, Tasks, (updated) Product backlog, (updated) Vision and strategic themes*
Supporting Agile Principles *1, 5, 6, 7, 8*

BP10

Manage Impediments. Identify, monitor, and resolve impediments within and across iteration cycles by teams (of teams). [OUTCOME 10]

Notes & Definitions:

- An impediment is any issue or risk towards either achieving current iteration/increment goals or likely affecting planned work or visions and strategic themes (potential impediment = risk).
- Managing impediments supports consistency among current planning and vision, product backlog, and team capacity to ensure a sustainable pace.
- Impediments are typically identified by the team (of teams) while reviewing the progress of work. Addressing them helps in adapting work planning as well as vision and strategic themes.
- Work resulting from impediments is typically managed as backlog item.

Agile Work Products: Implementation backlog, Tasks, (updated) Backlog, (updated) Vision and strategic themes
Supporting Agile Principles 1, 5, 6, 7, 8

DRAFT - READY FOR PILOTING - FEEDBACK WELCOME

AGL.1

BP11

Improve Work Approach.
Inspect and adapt the work approach based on short learning cycles within the team (of teams). [OUTCOME 3]
Notes & Definitions:
- The way of working in the team (of teams) is regularly discussed to identify improvements to the recorded work approach.
- Typically current processes, interfaces, and work products are inspected as part of the work approach and adapted at least per iteration cycle and event driven.
- Improvement work from identified improvements is typically managed as part of the backlog.

Agile Work Products: (updated) Work Approach, (updated) Definition of Done (DoD), (updated) Definition of Ready (DoR), Tasks
Supporting Agile Principles 5, 6, 12

DRAFT - READY FOR PILOTING - FEEDBACK WELCOME

AGL.1

The purpose of the Partner Collaboration Management Process is to achieve common project goals in collaboration with a partner.

Agile Process Outcomes

1. Information is shared as agreed between partners;
2. The collaboration model is documented in the collaboration agreement and up to date;
3. Transparency is established by continuous alignment and synchronization between partners;
4. Risks and impediments are managed collaboratively;
5. Technical approach and content are in line with shared Product Vision; and
6. Progress of all partners is continuously and jointly inspected.

BP1 **Establish a collaboration model.** Establish and maintain an agreement on how partners collaborate, how and how often they align and synchronize, and which information is shared among the partners.

BP2 **Share information.** Establish communication to share all agreed information between partners.

BP3 **Establish a technical approach.** A technical approach is jointly developed, agreed upon and kept up to date on a regular basis as documented in the collaboration agreement.

BP4 **Review joint technical content.** Perform reviews on jointly developed technical content with regard to Acceptance Criteria and Definition of Done on regular basis as agreed in the collaboration model.

BP5 **Inspect joint progress.** Measure, visualize, and inspect joint progress continuously with regard to quality, effort, cost and schedule against plan. Identify technical and business risks, impediments, and deviations from desired status collaboratively.

BP6 **Act on risks, impediments, and deviations.** Mitigate technical and business risks, impediments, and deviations from desired status collaboratively.

AGL.2

BP1

Establish a collaboration model. Establish and maintain an agreement on how partners collaborate, how and how often they align and synchronize, and which information is shared among the partners. [OUTCOME 1, 2, 3]

Notes & Definitions:

- *Ensure that the collaboration model is based on a common understanding regarding roles, meetings, and artifacts.*
- *While cooperation is a loosely coupled group work, agile collaboration is characterized by a teamwork with a common goal, continuous alignment and synchronization.*
- *A Collaboration Agreement typically includes e.g., communication mechanisms with escalation paths and urgent problem resolution, meeting structure, technical and organizational interfaces, infrastructure, roles including skills and responsibility split, and ownership of artifacts.*

Agile Work Products: Collaboration agreement, Product vision, Definition of Done
Supporting Agile Principles *4, 6, 11*

BP2

Share information. Establish communication to share all agreed information between partners.
[OUTCOME 1, 2, 3]

Notes & Definitions:

- *In agile context, a suitable meeting structure may encompass Queue Replenishment, Product Backlog Refinement, Iteration Planning, Stand up, Iteration Review, Retrospective. These collaborative activities highly depend on self organization of the team (of teams).*
- *Information to be shared may include technical content, acceptance criteria, status, risks, impediments, and open points.*
- *Collaboration in an agile environment requires a common Definition of Ready and Definition of Done. It is up to the team (of teams) to complement the agreed minimum set by own criteria.*

Agile Work Products: Collaboration agreement, Product vision, Product roadmap, Product backlog, Open item list, Risk list, Definition of Ready, Definition of Done, Impediment backlog

Supporting Agile Principles *4, 6, 8, 12*

DRAFT - READY FOR PILOTING - FEEDBACK WELCOME

AGL.2

BP3

Establish a technical approach. A technical approach is jointly developed, agreed upon and kept up to date on a regular basis as documented in the collaboration agreement. [OUTCOME 1, 3, 4, 5]

Notes & Definitions:
- *Constraints , risks , assumptions , and open items are , considered.*
- *The technical approach is aligned with the agile work approach (see AGL.1).*

Agile Work Products: Product vision, Product backlog, Impediment backlog, Definition of Done / Definition of Ready, Review record, Open item list, Risk list

Supporting Agile Principles *2, 4, 5, 6, 9, 10, 11, 12*

BP4 **Review joint technical content.** Perform reviews on jointly developed technical content with regard to Acceptance Criteria and Definition of Done on regular basis as agreed in the Collaboration Agreement. [OUTCOME 1, 2, 3, 5]

Notes & Definitions:

- *If rework is required, prioritize, plan and track work packages to closure. Ensure that the joint technical content is in line with shared Product Vision.*
- *Acceptance Criteria are applicable to individual work packages.*
- *Definition of Done is to be considered for the work packages of the same type.*

Agile Work Products: Product vision, Product roadmap, Product backlog, Iteration backlog, Definition of Done, Review record, Open item list

Supporting Agile Principles *1, 2, 3, 4, 6, 7, 9, 10, 11, 12*

BP5

Inspect joint progress. Measure, visualize, and inspect joint progress continuously with regard to quality, effort, cost and schedule against plan. Identify technical and business risks, impediments, and deviations from desired status collaboratively. [OUTCOME 1, 3, 4, 6]

Notes & Definitions:
- *Quality, effort, cost, and schedule can be monitored by metrics and KPIs agreed by the partners.*
- *Inspect is the ability of a team (of teams) to detect deviations from desired status.*

Agile Work Products: Iteration/release burndown chart or cumulative flow diagram, Velocity chart, Open item list, Risk list, Impediment backlog

Supporting Agile Principles *4, 5, 6, 7, 8, 12*

BP6

Act on risks, impediments, and deviations. Mitigate technical and business risks, impediments, and deviations from desired status collaboratively. [OUTCOME 1, 4]

Notes & Definitions:
- *Prioritize, plan and track open points to closure. In case of deviations from the desired status, jointly identify root causes, introduce countermeasures and prevent reoccurrence.*
- *Adaption is the ability of a team (of teams) to timely adjust to an everchanging environment.*

Agile Work Products: Collaboration agreement, Product vision, Product roadmap, Product backlog, Definition of Done, Open item list, Risk list, Impediment backlog

Supporting Agile Principles *1, 2, 3, 4, 5, 9, 10, 11*

DRAFT - READY FOR PILOTING - FEEDBACK WELCOME

AGL.3 Agile Quality Assurance – Purpose and Outcomes

The purpose of Agile Quality Assurance is to independently identify, track to closure, escalate and further prevent impediments affecting the achievement of quality objectives.

Agile Process Outcomes

1. quality objectives in line with work boundaries, vision, strategic themes, work approach and governance criteria are collaboratively identified;
2. a quality assurance strategy to identify and independently communicate impediments in achieving quality objectives is jointly defined and kept up to date;
3. conformance of actual work products and processes to agreed work approach and applicable governance criteria is ensured;
4. impediments affecting quality objectives are recorded and communicated to relevant stakeholders;
5. impediments affecting quality objectives are tracked to closure and their re-occurrence is prevented;
6. mechanisms and authority to escalate non resolution of impediments within and beyond the agile team (of teams) are established and effective.

DRAFT - READY FOR PILOTING - FEEDBACK WELCOME

BP 1 **Identify quality objectives.** Collaboratively identify and agree on quality objectives in line with work boundaries, vision, strategic themes, work approach, and governance criteria.

BP 2 **Define a quality assurance strategy.** Jointly define and record a quality assurance strategy to identify and independently communicate impediments in achieving quality objectives.

BP 3 **Ensure conformance.** Ensure the conformance of actual work products and processes as implemented by the agile team (of teams) to agreed work approach and applicable governance criteria.

BP 4 **Record impediments.** Record impediments affecting the achievement of quality objectives and communicate them to relevant stakeholders.

BP 5 **Resolve impediments.** Track impediments affecting the achievement of quality objectives to closure and prevent their re occurrence.

BP 6 **Establish escalation mechanisms.** Establish mechanisms and authority to escalate non resolution of impediments within and beyond the agile team (of teams).

BP 7 **Ensure effective escalation.** Ensure the resolution of escalated impediments by adequate governance and decision making bodies.

BP 8 **Inspect and adapt.** Inspect and adapt the quality assurance strategy based on short learning cycles within the agile team (of teams).

DRAFT - READY FOR PILOTING - FEEDBACK WELCOME

AGL.3

BP1 **Identify quality objectives.** Collaboratively identify and agree on quality objectives in line with work boundaries, vision, strategic themes, work approach and governance criteria. [OUTCOME 1]

Notes & Definitions:
- *Quality objectives*
  - *encompass the work approach selected by the agile team (of teams) as well as the relevant governance processes of the organization,*
  - *are agreed collaboratively,*
  - *are achieved by the agile team (of teams) across the iterations.*
- *Quality objectives lead to the establishment of suitable work processes and quality characteristics for the work products.*
- *Among other, criteria for contents definition, structure, review, approval of work products as well as any other criterion derived from standards are part of the quality objectives.*

Agile Work Products: Quality objectives
Supporting Agile Principles *1, 3, 4*

BP2

Define a quality assurance strategy. Jointly define and record a quality assurance strategy to identify and independently communicate impediments in achieving quality objectives. [OUTCOME 2]

Notes & Definitions:
- *The agile team (of teams) is jointly responsible for the quality of their processes and work products.*
- *The strategy encompasses the quality of work processes and developed products.*
- *The strategy includes the quality assurance of supplier deliverables.*
- *The strategy addresses methods to identify, track to closure, escalate and further prevent impediments affecting the achievement of quality objectives.*
- *The strategy includes the communication of impediments independently from the development team.*
- *Agile quality assurance may make use of the results of other processes such as e g iteration reviews and retrospectives, problem analysis, reports.*
- *The strategy is agreed to, recorded and communicated.*

Agile Work Products: Agile quality strategy, Quality plan
Supporting Agile Principles *2, 4, 6, 12*

BP3

Ensure conformance. Ensure the conformance of actual work products and processes as implemented by the agile team (of teams) to agreed work approach and applicable governance criteria. [OUTCOME 2, 3]

Notes & Definitions:

- *Typically, criteria for the quality of processes and work product are defined, e g in a DoR and DoD.*
- *Quality assurance activities are planned, e g as part of the backlog and iteration planning.*
- *Quality assurance checks objectively for each release that work products and processes are aligned with the work approach and the applicable governance criteria.*
- *The agile methodology followed by the agile team (of teams) is also verified.*

Agile Work Products: Review record
Supporting Agile Principles *1, 3, 5*

BP4 **Record impediments.** Ensure the conformance of actual work products and processes as implemented by the agile team (of teams) to agreed work approach and applicable governance criteria. [OUTCOME 4]

Notes & Definitions:
- *Record impediments that affect the achievement of quality objectives.*
- *Communicate regularly with the team (of teams) regarding impediments and desired performance. This can happen at various levels, during daily stand ups, during iteration reviews and retrospectives, etc.*
- *The agile team (of teams) plans in the backlog the corrective actions necessary to resolve the recorded impediments.*
- *Communication can include metrics, risks, qualitative feedback, etc.*
- *Metrics relevant to process and product quality can be present. This can include(but not limited to) velocity forecasts, defect trends, increments released per gate, etc.*
- *Communication should be based on the perspective relevant for the recipient agile team (of teams), management, customer.*

Agile Work Products: Impediment backlog, Backlog, Communication record
Supporting Agile Principles *6, 7, 12*

DRAFT - READY FOR PILOTING - FEEDBACK WELCOME

AGL.3

BP5

Resolve impediments. Track impediments affecting the achievement of quality objectives to closure and prevent their re-occurrence. [OUTCOME 5]

Notes & Definitions:
- *Ensure that impediments are correctly understood by relevant stakeholders.*
- *Ensure that resolving and closing of impediments are planned by the agile team(of teams).*
- *Track and verify the closure of impediments.*
- *Analyse and communicate root causes of re-occurring impediments.*
- *Support the agile team (of teams) to avoid impediment re occurrence.*

Agile Work Products: Impediment backlog, Backlog, Communication record
Supporting Agile Principles *6, 8, 12*

BP6

Establish escalation mechanisms. Establish mechanisms and authority to escalate non resolution of impediments within and beyond the agile team(of teams). [OUTCOME 6]

Notes & Definitions:

- *The escalation path is known by each team member and those that contribute to the team.*
- *The escalation path begins with the team as the starting point Typically, the path ends with the highest authority in the organisation.*
- *The escalation path is typically recorded e g by an organigram.*
- *The escalation path is accessible to anyone in the organisation.*
- *The impediment backlog is visible at least to anyone in the escalation path and the team (of teams).*

Agile Work Products: Escalation path, Communication record, Impediment backlog
Supporting Agile Principles *1, 3, 4, 7, 8, (9)*

DRAFT - READY FOR PILOTING - FEEDBACK WELCOME

AGL.3

BP7

Ensure effective escalation. Ensure the resolution of escalated impediments by adequate governance and decision-making bodies. [OUTCOME 6]

Notes & Definitions:
- *Primarily, the agile team (of teams) is jointly responsible for resolving impediments and collaborates closely with the person who tracks their impediments to closure*
- *Each member in the escalation path maintains seamless communication to its lower and its upper partners in the path*
- *The agile quality assurance responsible acts as 'escalation guard' and is empowered to involve higher authorities of the escalation path, if necessary*
- *Any escalation rationale, decision, action and effect is recorded in the impediment backlog*

Agile Work Products: Escalation record, Communication record, Impediment backlog
Supporting Agile Principles *1, 3, 4, 7, 8, (9)*

BP8

Inspect and adapt. Inspect and adapt the quality assurance strategy based on short learning cycles within the agile team (of teams). [OUTCOME 1, 2]
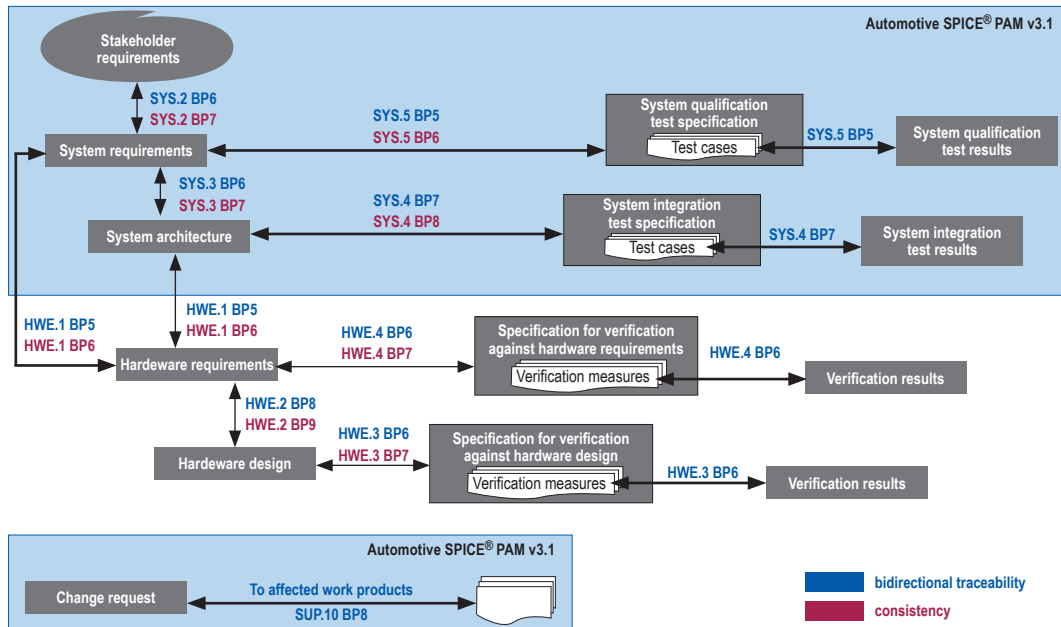
Notes & Definitions:
- *The quality strategy typically considers different organizational levels of development*
- *Inspect and adapt events take place regularly in a collaborative way with the agile team (of teams) and relevant stakeholders*
- *The learning aspects consider multiple views, including management, teams and customer*
- *The adaptations of quality strategy and/or objectives are consistent with the organisation strategy and reflect customer quality needs*
- *The adaptations and learnings are reflected and made visible, e g in retrospectives by maintaining DoD and DoR criteria*

Agile Work Products: Quality plan, Agile quality strategy, Quality objectives, Meeting records
Supporting Agile Principles *4, 8, 12*

DRAFT - READY FOR PILOTING - FEEDBACK WELCOME

AGL.3

HARDWARE ENGINEERING SPICE Version 2.0

Automotive SPICE® PAM v3.1

Stakeholder requirements

SYS.2 BP6
SYS.2 BP7

System requirements

SYS.5 BP5
SYS.5 BP6

System qualification test specification
Test cases

SYS.5 BP5

System qualification test results

SYS.3 BP6
SYS.3 BP7

System architecture

SYS.4 BP7
SYS.4 BP8

System integration test specification
Test cases

SYS.4 BP7

System integration test results

HWE.1 BP5
HWE.1 BP6

HWE.1 BP5
HWE.1 BP6

Hardware requirements

HWE.4 BP6
HWE.4 BP7

Specification for verification against hardware requirements
Verification measures

HWE.4 BP6

Verification results

HWE.2 BP8
HWE.2 BP9

Hardware design

HWE.3 BP6
HWE.3 BP7

Specification for verification against hardware design
Verification measures

HWE.3 BP6

Verification results

Automotive SPICE® PAM v3.1

Change request

To affected work products
SUP.10 BP8

bidirectional traceability

consistency

HWE 1

HWE.1 Hardware Requirements Analysis

The purpose of the Hardware Requirements Analysis process is to transform the hardware-related system requirements or stakeholder requirements, and hardware-related system architectural design, into a set of hardware requirements.

Process outcomes – as a result of successful implementation of this process

1. The hardware requirements to be allocated to the hardware elements of the system and their interfaces are defined.
2. Hardware requirements are categorized and analysed.
3. The impact of hardware requirements on the operating environment is analysed.
4. Prioritization of hardware requirements is defined.
5. The hardware requirements are updated as needed.
6. Consistency and bidirectional traceability are established between system requirements and hardware requirements. Consistency and bidirectional traceability are established between system architectural design and hardware requirements.
7. The hardware requirements are evaluated for cost, schedule and
8. The hardware requirements are agreed and communicated to all affected parties.

Output work products

13-04 Communication record	[OUTCOME 8]	15-01 Analysis report	[OUTCOME 2, 3, 4, 7]
13-19 Review record	[OUTCOME 6]	17-08 Interface requirements specification	[OUTCOME 1, 3]
13-21 Change control record	[OUTCOME 5, 7]	17-HW01 Hardware requirements specification	[OUTCOME 1]
13-22 Traceability record	[OUTCOME 1, 6]		

BP 1

Specify hardware requirements. Use the stakeholder and system requirements, and the system architecture including interface definitions, as well as changes to these, to identify the required functions and capabilities of the hardware. Specify hardware requirements including hardware interface requirements in a hardware requirements specification according to state-ofthe- art characteristics for requirements. [OUTCOME 1,5]
[ISO 26262-5:2018, clauses 6.4.1, 6.4.2, 6.4.5]

1. *A single requirement usually needs both 'functional' and 'nonfunctional' information in it, acc. to the definition of this terms in ISO IEC IEEE 29148 [25] or IREB CPRE [26]. For further information see Rationale 5 – No Usage of Terms Functional and Non-functional Requirement.*

2. *Characteristics of requirements are defined in standards such as ISO IEEE 29148 clause 5.2, or ISO 26262-8:2018 clause 6.4.2.4. According to these standards characteristics of an individual requirement include being: Typical analysis criteria are: resource requirements, scheduling issues, risks, benefits, etc. Change request activities ensure that change requests are systematically identified, described, recorded, analyzed, implemented, and managed. The change request management strategy may cover different proceedings across the product life cycle, e.g. during prototype construction and series development.*
   - *verifiable*
   - *design-free/implementation-free (see Section 3.6 here)*
   - *unambiguous*
   - *comprehensible*
   - *consistent in itself*
   - *complete in itself*
   - *not contradicting any other requirement*
   - *atomic/singular*
   - *defined through language criteria and sentence structure supporting the above characteristics*

HWE 1

BP 1

③ *In case of hardware development only, the system requirements and the system architecture refer to a given operating environment (see also Note 14). In that case, stakeholder requirements should be used as the basis for identifying the required functions and capabilities of the hardware.*

④ *Hardware requirements specify particular desired characteristics of the hardware and can include*
- *lifetime and mission profile, lifetime robustness (as, in contrast to software, hardware characteristics are impacted by physical influences which may change the hardware's characteristics over time)*
- *maximum price*
- *storage and transportation requirements*
- *functional behaviour of analog or digital circuits and logic*
- *quiescent current, voltage impulse responsiveness to crank, start-stop, drop-out, load dump*
- *temperature, maximum hardware heat dissipation*
- *power consumption depending on the operating state such as sleepmode, start-up, reset conditions*
- *frequencies, modulation, signal delays, filters, control loops*
- *power-up and power-down sequences, accuracy and precision of signal acquisition or signal processing time*
- *computing resources such as memory space and CPU clock tolerances*
- *maximum abrasive wear and shearing forces for e.g. pins or soldering joints*
- *requirements resulting from lessons learned [ISO 26262-2:2018, clause 5.4.2.6]*
- *safety related requirements derived from the technical safety concept [ISO 26262-5:2018, clauses 6.4.1, 6.4.2]*

BP 1

5 *Some numerical values, to be mentioned in complete requirements statements, may only be determined in an evolutionary way by means of e.g. measurements, prototype testing. Incomplete or underspecified aspects should be considered as a risk in HWE.1.BP3*

EXAMPLE: *Radio connection at system level Sender and receiver, 400m away from each other. Both components will require a max. signal-to-noise ratio. However, these values can only be determined in an empirical way. Therefore, exact hardware requirements cannot be defined in the first place.*

6 *Hardware requirements are often integrated in superordinate requirements specifications, or spread across several work products, such as customer requirements, system requirements, and industry standards.*

7 *Reasons for an update may be e.g.*
- *change requests,*
- *results of safety analyses [ISO 26262-9, clauses 8.4.3 and 8.4.4] and analysis of dependent failures [ISO 26262-9 clause 7.4]*

HWE 1

BP 2

Structure hardware requirements. Structure the hardware requirements in the hardware requirements specification [OUTCOME 2, 4, 8]

8 *In regards to classifying requirements into 'funcional' and 'nonfunctional', acc. to the definition of this terms in ISO IEC IEEE 29148 [25] or IREB CPRE [26], see Rationale 5 – No Usage of Terms Functional and Nonfunctional Requirement.*

9 *Structuring supports the comprehensibility and the managing of requirements, and can be done by e.g.*
- *grouping according to HW functionalities*
- *grouping according to hardware components, e.g. the hardware requirements are restructured depending on the allocation in the hardware architecture*
- *categorising based on relevant criteria for the project such as organisational, technical, legal, and internal topics.*
- *categorizing according to planned variants of the product.*
- *labelling with ASIL attribute [ISO 26262-8:2018, clause 6.4.2.5c)]*
- *sorting in a logical order for the project*
- *prioritizing according to stakeholder needs*
- *prioritizing through the assignment of hardware content to planned samples or series releases.*
  Refer to Automotive SPICE® SPL.2.BP1.

BP 3

Analyse hardware requirements. Analyse the specified hardware requirements including their interdependencies to ensure correctness, technical feasibility, and to support risk identification. Determine the impact on cost, schedule, and the technical impact. [OUTCOME 2, 7]

10 *The analysis of impact on cost and schedule supports the adjustment of project estimates. Refer to Automotive SPICE® MAN.3.BP5 and MAN.3.BP8. For risk identification refer to Automotive SPICE® MAN.5.BP3.*

BP 4

Analyse the impact on the operating environment. Analyse the impact that the hardware requirements will have on interfaces of the system elements and the operating environment. [OUTCOME 3, 7]

11 *Aspects of the operation environment may be e.g.*
- *the mounting space and position*
- *temperature*
- *humidity*
- *mechanical stress*
- *EMC/EMI, or ESD*

12 *Interfaces to the system elements may be e.g.*
- *connector*
- *cable harness*
- *optical/illumination*
- *voltage/currents*
- *power supply*
- *heat dissipation*

The system level (e.g. SYS.3 in Automotive SPICE®) is responsible for deciding on the connection technology of the interfaces of system elements (crimping, soldering, pressing, etc.).

BP 5

Establish bidirectional traceability. Establish bidirectional traceability between a single hardware requirement and system requirements. Establish bidirectional traceability between a single hardware requirement and the system architecture. [OUTCOME 6]

13 *For a particular hardware requirement traceability redundancy should be avoided by establishing a combination of these approaches that covers the project and the organisational needs.*

14 *Bidirectional traceability supports coverage, consistency, and impact analysis.*

BP 6

Ensure consistency. *Ensure consistency between system requirements and hardware requirements. Ensure consistency between the system architecture and hardware requirements.* [OUTCOME 6] [ISO 26262-5:2018, clause 6.4.9]

15 *Consistency is supported by bidirectional traceability and can be demonstrated by review records.*

16 *In case of hardware development only, the system requirements and system architecture refer to a given operating environment (see also note 13). In that case, consistency and bidirectional traceability have to be ensured between stakeholder requirements and hardware requirements.*

17 *Safety related requirements shall be compliant with system architectural constraints such as*
  • *Fault tolerant time interval [ISO 26262-5:2018, clause 6.4.7]*
  • *Fault handling time interval [ISO 26262-5:2018, clause 6.4.7]*
  • *Multiple-point fault detection interval [ISO 26262-5:2018, clause 6.4.8]*

BP 7

Communicate agreed hardware requirements. Communicate the agreed hardware requirements and updates to hardware requirements to all relevant parties. [OUTCOME 8]

RL1 — *If the hardware requirements specification does not reflect latest changes, the indicator BP1 must not be rated higher than L.*

RL2 — *If hardware requirements are not derived from system requirements and system architecture but from another reasonable source (e.g. platform requirements, HW being a SEooC according to ISO 26262) according to a reuse strategy the indicator BP1 must not be downrated.*

RL3 — *If hardware requirements are not verifiable, the indicator BP1 must not be rated higher than P.*

RL4 — *In case of hardware development only, if the traceability from hardware requirements to stakeholder requirements is established, the indicator BP5 must not be downrated.*

RL5 — *In case of hardware development only, if the consistency from hardware requirements to stakeholder requirements is ensured, the indicator BP6 must not be downrated.*

RL6 — *If the specification of hardware requirements (BP1) is rated P or lower, PA 1.1 shall be downrated.*

RC1 — *If there is no evidence for prioritization but a release plan consistently maps hardware functionality to future releases the indicator BP2 should not be downrated.*

RC2 — *If the analysis of correctness and technical feasibility is covered by risk management this should not be used to downrate the indicator BP3.*

RC3

[HWE.1.RC.3] If the analysis of hardware requirements impact on cost and schedule is covered by the estimation of work packages in the project planning this should not be used to downrate the indicator BP3.

RC4

[HWE.1.RC.4] If PA 1.1 for SYS.2 is downrated, this should be in line with the rating of the indicator BP1.

RC5

[HWE.1.RC.5] If PA 1.1 for SYS.3 is downrated, this should be in line with the rating of the indicator BP1.

RC6

[HWE.1.RC.6] If the indicator BP3 is downrated, this should be in line with the rating of the indicators 'determine, monitor and adjust project estimates and resources' (Automotive SPICE® MAN.3.BP5) and 'determine, monitor and adjust project schedule (Automotive SPICE® MAN.3.BP8)'.

RC7

[HWE.1.RC.7] If the indicator BP3 is downrated, this should be in line with the rating of the indicator 'evaluate feasibility of the project' (Automotive SPICE® MAN.5.BP3).

RC8

[HWE.1.RC.8] If Automotive SPICE® SYS.2 BP1 is downrated, this should be in line with the rating of the indicator BP5.

RC9

[HWE.1.RC.9] If Automotive SPICE® SYS.3 BP1 is downrated, this should be in line with the rating of the indicator BP5.

RC10

[HWE.1.RC.10] If Automotive SPICE® SYS.2 BP1 is downrated, this should be in line with the rating of the indicator BP6.

RC11

[HWE.1.RC.11] If Automotive SPICE® SYS.3 BP1 is downrated, this should be in line with the rating of the indicator BP6.

HWE.2 Hardware Design

The purpose of the Hardware Design process is to provide an evaluated design, that is suitable for manufacturing, and to derive production-relevant data.

Process outcomes – as a result of successful implementation of this process

1. A HW architecture and HW detailed design is developed.
2. The HW requirements are allocated to the hardware components or their interfaces.
3. The interfaces between the HW elements are defined.
4. The dynamic behaviour of the HW elements is defined.
5. The HW architecture and the HW detailed design are evaluated.
6. Consistency and bidirectional traceability are established between hardware requirements and hardware components.
7. Hardware production data is derived from the HW detailed design and communicated to the affected parties.
8. Information for production test is derived from the HW detailed design and communicated to the affected parties.
9. Special characteristics are identified and communicated to all affected parties.
10. The hardware architecture and the hardware detailed design are communicated to all affected parties.

Output work products

04-HW01 Hardware architecture	[OUTCOME 1, 2, 3, 4]	11-HW02 Special characteristics	[OUTCOME 9]
04-HW02 Hardware detailed design description	[OUTCOME 1, 3, 4, 5]	13-04 Communication record	[OUTCOME 7, 8, 9, 10]
04-HW03 Schematics	[OUTCOME1, 3]	13-19 Review record	[OUTCOME 6]
04-HW04 Bill of materials	[OUTCOME 1]	13-22 Traceability record	[OUTCOME 6]
04-HW05 Layout	[OUTCOME 1]	15-01 Analysis report	[OUTCOME 5]
11-HW01 Hardware production data	[OUTCOME 7, 8]	17-08 Interface requirement specification	[OUTCOME 3]

BP 1

Develop hardware architecture. Develop the hardware architecture that identifies the hardware components. Describe the rationale for the defined hardware architecture. [OUTCOME 1]

1. *Hardware design typically starts at an abstract level, using e.g. recursively decomposed block diagrams that identify the HW components.*

2. *One purpose of a hardware architectural design is to provide motivation, reasoning, and explanatory context information to other subject matter experts in the hardware domain and product domain, respectively.*

3. *The appropriate level of architectural detail is driven by e.g.*
   - *the need for integration of reused hardware components*
   - *the complexity of the hardware components*
   - *the allocation of requirements to hardware components*
   - *the intent for future reuse of hardware components*
   - *the intent for adaptability of hardware components*

4. *The hardware architecture may include a ground concept, supply concept, EMC concept.*

5. *Hardware elements might inherit the highest ASIL of corresponding requirements, unless the criteria for coexistence in accordance with ISO 26262- 9:2018, clause 6 are met. [ISO 26262-5:2018 clause 7.4.1.4]*

BP 2

Develop hardware detailed design. Develop a hardware detailed design based on components of the hardware architecture. Identify all hardware parts based on the related requirements. Describe the detailed design for intended hardware variants. [OUTCOME 1]

6 *A HW detailed design typically comprises schematics, RTL design, PCB characteristics, layouts, bill of materials (BOM), and a sufficiently comprehensive description.*

7 *The identification of hardware parts and their suppliers may be subject to a pre-defined repository. For supplier selection see ACQ.2 in ISO/IEC 33060; see also IATF 16949:2016, clause 8.4.1.2.*

8 *Hardware design may be subject to constraints such as*
   - *availability of hardware parts on the market*
   - *hardware design rules, layout rules*
   - *creepage and clearance distances*
   - *compliance of HW parts with industry standards such as AEC-Q, REACH*

9 *Hardware elements might inherit the highest ASIL of corresponding requirements, unless the criteria for coexistence in accordance with ISO26262- 9:2018, clause 6 are met. [ISO 26262-5:2018 clause 7.4.1.4]*

10 *In the case of safety-related development, the hardware detailed design should consider the results of safety analyses [ISO 26262-9:2018, clauses 8.4.3 and 8.4.4] and analysis of dependent failures. [ISO 26262-9:2018 clause 7.4.2]*

BP 3

Define interfaces of the hardware elements. Specify and document the interfaces between the hardware elements. [OUTCOME 1, 2, 3]

11 *A hardware element interface is typically defined by output, input, type, and electrical characteristics including signal tolerances.*

12 *Examples of interfaces are*
- *high level interfaces like SPI, I2C, CAN, LIN, Ethernet*
- *electrical interconnections*
- *thermal interfaces between hardware parts (heat dissipation)*

BP 4

Describe dynamic behaviour. Evaluate and document the dynamic behaviour of the relevant hardware elements and the interaction between them. [OUTCOME 1, 4]

13 *Examples are*
- *transitions between electrical states of hardware parts*
- *power-up and power-down sequences*
- *frequencies, modulations*
- *signal delays*
- *debounce times*
- *filters*
- *short circuit behaviour*
- *self-protection*

14 *Not all hardware elements have dynamic behaviour that needs to be described.*

15 *Particular views of the architecture may require a description of the dynamic behaviour of the complete hardware.*

BP 5 — **Allocate hardware requirements.** Allocate the hardware requirements to the hardware elements and interfaces of the hardware architecture.[OUTCOME 2] *[ISO 26262-5:2018 clauses 6.4.1, 7.4.1.2]*

16 *This allocation typically reflects one direction of bidirectional traceability addressed by HWE.2.BP8.*

17 *Allocation might be done based on single requirements or cluster of requirements.*

18 *Allocation should be on appropriate level of granularity, at least to single hardware components.*

BP 6 — **Evaluate the hardware architecture and the hardware detailed design**. Analyse and evaluate the hardware architecture and detailed design against defined quantitative or qualitative criteria, including risks, manufacturability, and verifiability. Identify special characteristics. [OUTCOME 5, 9] *[ISO 26262-5:2018 clause 10.4.3, clause 7.4.5 and clause 9.4.1.2 NOTE 2]*

19 *Examples for risk evaluation are*
  - *prototype testing*
  - *simulations*
  - *calculations such as 'Weibull distribution', WCCA*
  - *qualitative or quantitative analyses such as FMEA, FMEDA/FMECA, ETA, FTA, DFA*
  - *identification of interference such as temperature, vibrations, water, dust, EMI, noise factor, crosstalk*
    [ISO 26262-5:2018 clause 7.4.1.7]

20 *Example for manufacturability are*
  - *evidence for conformity with production constraints*
  - *evidence of availability for all hardware parts*
  - *appropriate knowledge of production technology and their availability*

21 *The results of the evaluation can be used as input for the verification of the physical hardware against the hardware design (HWE.3).*

BP 6

22. In case of safety-related development hardware design evaluation might include checking the criteria for coexistence of elements as explained in ISO 26262- 9:2018 clauses 6.4.2, 6.4.3, and 6.4.4.

23. In case of safety-related development, hardware design evaluation might also include safety analysis in order to
    • identify faults, or failures, and their potential causes, that can lead to the violation of a safety goal, or a safety requirement, respectively
    • identify hardware-related hazards not yet considered in the hazard analysis and risk assessment above the hardware level
    [ISO 26262-5:2018 clauses 6.4.3, 6.4.4 and 6.4.8], [ISO 26262-9:2018 clauses 8.1 and 8.4.5]

24. In case of safety-related development, hardware design evaluation might also include dependent failure analysis in order to confirm that sufficient independence is achieved. *[ISO 26262-9:2018, clauses 7.1 and 7.4]*

25. In case of safety-related development, hardware design evaluation by means of quantitative safety analyses might also include the consideration of 'dedicated measures' such as hardware part over-design (e.g. electrical or thermal stress rating) or physical separation (e.g. spacing of contacts on a printed circuit board) *[ISO 26262-5:2018 clauses 9.4.2]*

26. Even in case of reuse of hardware elements, the suitability for the current application shall be evaluated.

27. Evaluation may also include the checking of application notes and erratas.

28. If an application review is performed with the suppliers of hardware parts (e.g. SBC) refer to SUP.4 or ACQ.4 in Automotive SPICE®.

29. In the semiconductor context, design evaluation typically includes pre-silicon verification, and may include subsequent steps. Still, the purpose of such verification activities in the context of HWE.2 is to critically review the design specification itself but not the physical product sample.

BP 7

Establish bidirectional traceability. *Establish bidirectional traceability between hardware elements.* [OUTCOME 6] *[ISO 26262-5:2018 clause 7.4.1.5]*

30 *Bidirectional traceability supports coverage, consistency and impact analysis.*

31 *Traceability should be on appropriate level of granularity, at least to single hardware components.*

BP 8

Ensure consistency. *Ensure consistency between hardware requirements and hardware components of the hardware architecture. Ensure consistency between hardware components of the hardware architecture and the hardware parts of the hardware detailed design.* [OUTCOME 6]

32 *Consistency is supported by bidirectional traceability and can be demonstrated by review records.*

33 *A typical solution that supports the consistency between hardware detailed design and hardware architecture is to draw frames around those hardware parts in the schematic that represent a hardware component.*

34 *Ensure safety requirements are considered in hardware architecture. [ISO 26262-5:2018 clauses 7.4.1.1]*

BP 9

Communicate all information needed to relevant parties. *Communicate the hardware architecture and hardware detailed design and all updates of hardware architecture and hardware detailed design to all relevant parties. Provide relevant production data and special characteristics to the affected parties.* [OUTCOME 7, 8, 9, 10]

35 *Interface definitions (e.g. the hardware software interface or interfaces to mechanical elements) might be impacted by hardware architecture and hardware design adaptations. Refer to Automotive SPICE® SYS.3 and SUP.10, respectively. [ISO 26262-5:2018 clause 6.4.10]*

36 *If hazards are identified by the hardware design not yet reflected in the hazard analysis and risk assessment, they need to be communicated to all relevant parties. [ISO 26262-5:2018 clause 7.4.3.6]*

BP 9

37 *Production data typically includes the bill of materials (BOM), GERBER data, placement data, mask data (GDS2), and input to e.g. ICT, AOI, AXI, EOL, wafer- or package level test.*

38 *Information for EOL test might include loads to be used.*

39 *Production processes are not in the scope of this HWE PRM/PAM. See Rationale 1 – No Production Process*

HWE.2 Rating Guidelines with Rules and Recommendations

RL1

[HWE.2.RL.1] If manufacturability is not evaluated in the context of the indicator BP6, then PA 1.1 shall be downrated.

RL2

[HWE.2.RL.2] If the allocation of the hardware requirements to elements of the hardware architecture BP3 is downrated, the indicator BP8 shall be downrated.

RC1

[HWE.2.RC.1] If HWE.1.PA.1.1 is downrated, this should be in-line with the rating of the indicator BP1.

HWE 2

HWE.3 Verification against Hardware Design

The purpose of the Verification against Hardware Design process is to ensure that the hardware is verified to provide evidence for compliance with the hardware design.

Process outcomes – as a result of successful implementation of this process

1. A strategy for the verification against hardware design is defined, including a regression strategy consistent with the project plan and release plan, as well as suitable measurement and verification equipment.
2. Hardware design-compliant samples are received according to the strategy for the verification against hardware design.
3. A verification specification is developed according to the strategy for the verification against hardware design that is suitable to provide evidence for compliance with the hardware design.
4. Verification measures included in the specification are selected according to the verification strategy and the release plan.
5. Verification is performed using the selected verification measures, and verification results are recorded.
6. Consistency and bidirectional traceability are established between hardware elements and verification measures; bidirectional traceability is established between verification measures and verification results.
7. Verification results are summarized and communicated to all affected parties.

Output work products

08-HW01 Verification plan	[OUTCOME 1]	13-19 Review record	[OUTCOME 6]
08-HW02 Verification specification	[OUTCOME 3, 4]	13-22 Traceability record	[OUTCOME 6]
13-01 Acceptance record	[OUTCOME 2]	13-HW01 Verification result	[OUTCOME 5, 7]
13-04 Communication record	[OUTCOME 7]		

BP 1

Develop a strategy for the verification against hardware design. Develop a strategy for the verification against hardware design including

   a) a definition of the verification scope *[ISO 26262-8:2018 clause 9.4.1.1 b)]*

   b) the identification of the hardware variants to be verified

   c) a definition of suitable measurement and verification equipment *[ISO 26262-8:2018 clause 9.4.1.1 f)]*

   d) a regression strategy for verifying the hardware *[ISO 26262-8:2018 clause 9.4.1.1 i)]*.

   e) a definition of the criteria to select verification measures including
   - the coverage of new or changed requirements
   - the coverage of change requests
   - the coverage of changes to the device under test
   - the consideration of dependencies, based on the analysis of changes
   - the selection of appropriate verification measures forregression verification

   f) a definition of the methods for verification measure development including criteria for selection
   [ISO 26262-8:2018 clause 9.4.1.1 c)]

   g) a definition of how specific requirements regarding verification (e.g. test-specific stakeholder requirements,
   [ISO 26262-8:2018 clauses 10.4.5 and 10.4.6] are covered

   h) required sequences of verification steps

   i) an approach for the handling of failed verification *[ISO 26262-8:2018 clause 9.4.1.1 h)]*

   j) an approach for verification measure data handling [OUTCOME 1]

1. *The reason for the existence of aspects a) to i) is given in Section 2 on 'Noseparate guideline document'.*

2. *Hardware design includes hardware architecture and hardware detailed design.*

3. *If HW parts are used, which are not or not yet qualified for the intended use, the HW design verification strategy should include the verification of the calculated or simulated results.*

BP 1

4 *The suitability of measurement and verification equipment may be dependent on e.g. the release stage such as the EMC measurement of early samples intended to be done by non-certified labs.*

5 *Suitability also addresses special test-software as test environment running on the hardware.*

6 *For semiconductor development, the verification strategy should explain which verification activities*
- *are done in the context of design creation addressed by HWE.2 (i.e. pre-silicon verification)*
- *or otherwise are done at the post-silicon level addressed by HWE.3*

BP 2

Develop specification for the verification against hardware design. Develop the verification specification according to the defined strategy. The verification specification shall be suitable to provide evidence for compliance of the hardware with the hardware design. [OUTCOME 3]

7 *This typically includes pass/fail criteria for each verification measure.*

8 *Measuring points can be used for stepwise testing of hardware items.*

9 *The objective is to verify the sole hardware, i.e. without software/mechanical functionality. Further, hardware-software-interface testing is a system architectural design concern outside HWE.3.*
However, for the purpose of HWE.3 software/mechanical elements might be needed as a test environment.

10 *The requirement of using HW parts in the HW design which meet certain characteristics defined e.g. in standards such as AEC-Q ('pre-qualification') does not necessarily provide evidence that the hardware is compliant with the design in the context of HWE.3. [ISO 26262-5:2018 clause 10.4.3]*

11 *In the case of safety-related development, additional safety-related test cases should be determined by using results of the safety analysis including faults and failure mode information [ISO 26262-9:2018, clause 8.4.7], see also HWE.2.BP6 Notes 22 and 23.*

12 *In case of safety-related development, 'dedicated measures' might need to be considered such as burn-in tests [ISO 26262-5:2018 clauses 9.4.1.2 NOTE 2]*

BP 3

Ensure use of compliant samples. Ensure that the samples used for verification against hardware design are compliant with the corresponding production data, including special characteristics. [OUTCOME 2]

13 Received evidence can be e.g. sample reports, record of visual inspection, ICT report.

14 Bill of materials-compliance alone does not automatically mean full production data compliance, i.e. design compliance.

15 Parties from which samples are obtained can be production, prototype and sample construction/workshops, or build-2print-suppliers.

16 A produced hardware may have imperfections which can be identified e.g. by means of visual or X-ray inspections, such as footprint/pitch error, incorrect locations of HW parts etc.

17 If samples have deviations, or need to be reworked or modified, this information needs to be recorded.

18 Production processes themselves are not in the scope of HWE PRM/PAM; the assumption is that the production process itself is done correctly; for the purpose of getting correct samples, only process interfaces to the production processes are in scope. See Section 3.2 for a detailed rationale.

BP 4

Select verification measures. Select verification measures from the verification specification according to the defined strategy. The selection of verification measures shall

    a) have sufficient coverage according to the strategy for the verification against hardware design and the release plan

    b) consider the intended use of the deliverable item (e.g. for EMV testing, for supporting software testing)

    c) be implemented according to the selection criteria (as defined in the strategy)

    d) be adequately documented

    e) list the adopted criteria [OUTCOME 4]

BP4

(19) *Criteria for selection may be e.g.*
- *maturity of a requirements implementation*
- *regression strategy*
- *prioritization of requirements*

BP5

Verify hardware design. Verify the hardware design using the selected verification measures according to the defined strategy. Record the verification results including pass/fail status and corresponding verification measure data. [OUTCOME 5]

(20) *See Automotive SPICE® SUP.9 for handling of non-conformances.*

(21) *Results could support the update of simulation models.*

BP6

Establish bidirectional traceability. Establish bidirectional traceability between the hardware elements and verification measures. Establish bidirectional traceability between the verification measures and verification results. [OUTCOME 6]

(22) *Bidirectional traceability supports coverage, consistency and impact analysis.*

BP7

Ensure consistency. Ensure consistency between hardware elements and the verification measures. [OUTCOME 6]

(23) *Consistency is supported by bidirectional traceability and can be demonstrated by review records.*

BP8

Summarize and communicate results. Summarize the verification results and communicate them to all affected parties. [OUTCOME 7]

(24) *In the case large amounts of verification data is generated (e.g. automated tests) then a meaningful summary of the verification data as adequate evidence for each verification result can be provided.*

RL1

If the strategy for verification against hardware design does not cover all aspects in BP1, the indicator BP1 must not be rated F.

RL2

If the test implementation using automation does not cover the following aspect, the indicator BP5 must not be rated F: Correctness, completeness, and consistency of test scripts and test programs with respect to the test cases assigned to an automated test in the verification specification.

RL3

If the verification results contain only a pure passed/failed information without supporting verification measure data, the indicator BP5 must not be rated higher than P.

HWE.4 Verification against Hardware Requirements

The purpose of the Verification against Hardware Requirements process is to ensure that the complete hardware is verified to provide evidence for compliance with the hardware requirements.

Process outcomes – as a result of successful implementation of this process

1. A strategy for verification against hardware requirements including regression strategy consistent with the project plan and release plan is developed, and suitability of measurement and verification equipment is ensured.
2. A specification for verifying the hardware according to the strategy for verification against hardware is developed that is suitable to provide evidence for compliance with the hardware requirements.
3. Hardware design-compliant samples are received according to the strategy for verification against hardware.
4. Verification measures included in the verification specification are selected according to the verification strategy and the release plan.
5. The hardware is verified using the selected verification measures and the results of hardware requirements verifications are recorded.
6. Consistency and bidirectional traceability are established between verification measures and hardware requirements. Consistency and bidirectional traceability are established between verification measures and verification results.
7. Results of the verifications are summarized and communicated to all affected parties.

Output work products

08-HW01 Verification plan	[OUTCOME 1]	13-19 Review record	[OUTCOME 6]
08-HW02 Verification specification	[OUTCOME 2,4]	13-22 Traceability record	[OUTCOM 6]
13-01 Acceptance record	[OUTCOME 3]	13-HW01 Verification result	[OUTCOME 5,7]
13-04 Communication record	[OUTCOME 7]		

BP 1 **Develop a strategy for the verification against hardware requirements.** Develop a strategy for the verification against hardware requirements consistent with the project plan and the release plan including

a) a definition of the verification scope *[ISO 26262-8:2018 clause 9.4.1.1 b)]*

b) identification of the hardware variants to be verified

c) definition of suitable measurement and verification equipment *[ISO 26262-8:2018 clause 9.4.1.1 f)]*

d) a regression strategy for verifying the hardware *[ISO 26262-8:2018 clause 9.4.1.1 i)]*,

e) a definition of the criteria to select verification measures including

  - the coverage of new or changed requirements

  - the coverage of change requests

  - the coverage of changes to the device under test

  - the consideration of dependencies, based on the analysis of changes

  - the selection of appropriate verification measures for regression verification

f) a definition of the methods for verification measure development including criteria for selection *[ISO 26262-8:2018 clause 9.4.1.1 c)]*

g) a definition of how specific requirements regarding verification (e.g. test-specific stakeholder requirements) are covered

h) required sequences of verification steps

i) an approach for the handling of failed verification *[ISO 26262- 8:2018 clause 9.4.1.1 h)]*

j) an approach for verification measure data handling

1 *The reason for the existence of aspects a) to f) is given in Section 2 on 'No separate guideline document'.*

2 *Hardware regression verification means verifying that a hardware item, which has not been changed, is not influenced by a change of another hardware item.*

BP 1

3 *A predefined number of verification measures to be repeated on any change might be defined in the regression strategy as well, e.g. all safety relevant test cases.*

4 *The objective is to verify discrete hardware functionality, i.e. without software/mechanical functionality. However, for that purpose mechanical elements, or suitable special test-software running on the hardware, might be needed as the verification environment.*

5 *The suitability of measurement and verification equipment may be dependent on e.g. the release stage such as the EMC measurement of early samples intended to be done by non-certified labs.*

6 *For semiconductor development the strategy typically covers both Pre- and Post-Silicon verification against hardware requirements.*

BP 2

Develop specification for the verification against hardware requirements. Develop the verification specification according to the defined strategy. The verification specification shall
  a) be suitable to provide evidence for compliance of the hardware with the hardware requirements
  b) include a definition of entry and exit criteria for the verification [OUTCOME 2]

7 *This typically includes pass/fail criteria for each verification measure.*

8 *For safety-related aspects the durability and robustness of hardware against environmental and operational stress factors should be verified [ISO 26262-5:2018 clause 10.4.6]*

9 *In the case of safety-related development, additional safety-related verification measures should be determined by using results of the safety analysis including faults and failure mode information [ISO 26262-9:2018, clause 8.4.7], see also HWE.2 BP6 Note 22*

BP 3

Ensure use of compliant samples. Ensure that the samples used for the verification against hardware requirements are compliant with the corresponding production data, including special characteristics, provided by hardware design. [OUTCOME 3]

⑩ *Received evidence can be e.g. sample reports, record of visual inspection, ICT report.*

⑪ *Bill of materials-compliance alone does not automatically mean full production data compliance.*

⑫ *The party from which samples are obtained can be production, prototype and sample construction or build2print-suppliers.*

⑬ *If samples have deviations, or need to be reworked or modified, this information needs to be documented.*

⑭ *Production processes themselves are not in the scope of HWE PRM/PAM; the assumption is that the production process itself is done correctly; for the purpose of getting correct samples, only process interfaces to the production processes are in scope.*

BP 4

Select verification measures. Select verification measures from the verification specification according to the defined strategy. The selection of verification measures shall
b) consider the intended use of the deliverable item (e.g. for EMV testing, for supporting software testing)
c) document the used selection criteria (as defined in the strategy)
d) be documented [OUTCOME 4]

⑮ *Criteria for selection may be e.g.*
  • *maturity of implementation of requirements*
  • *regression strategy*
  • *prioritization of requirements*

⑯ *Calculations and simulations are considered hardware design evaluation activities, see HWE.2 BP6*

BP 5

Verify hardware. *Verify the hardware using the selected verification measures according to the defined strategy. Record the verification results including pass/fail status and corresponding verification measure data.* [OUTCOME 5]

17 *See Automotive SPICE® SUP.9 for handling of non-conformances*

BP 6

Establish bidirectional traceability. *Establish bidirectional traceability between hardware requirements and verification measures. Establish bidirectional traceability between verification measures and verification results.* [OUTCOME 6]

18 *Bidirectional traceability supports coverage, consistency and impact analysis.*

BP 7

Ensure consistency. *Ensure consistency between hardware requirements and verification measures.* [OUTCOME 6]

19 *Consistency is supported by bidirectional traceability and can be demonstrated by review records.*

BP 8

Summarize and communicate results. Summarize the verification results and communicate them to all affected parties. [OUTCOME 7]

20 *Providing all necessary information from the verification measures in a summary supports other parties in taking appropriate measures.*

21 *In the case large amounts of verification data may be generated (e.g. automated tests) then a meaningful summary of the verification data as adequate evidence for each verification result can be provided.*

RL1 *[HWE.4.RL.1] If the strategy for verification against hardware requirements does not cover all aspects in BP1, the indicator BP1 must not be rated F.*

RL2 *[HWE.4.RL.2] If the test implementation using automation does not cover the following aspect, the indicator BP5 must not be rated F:*

- *Correctness, completeness, and consistency of test scripts and test programs with respect to the test cases assigned to an automated test in the verification specification.*
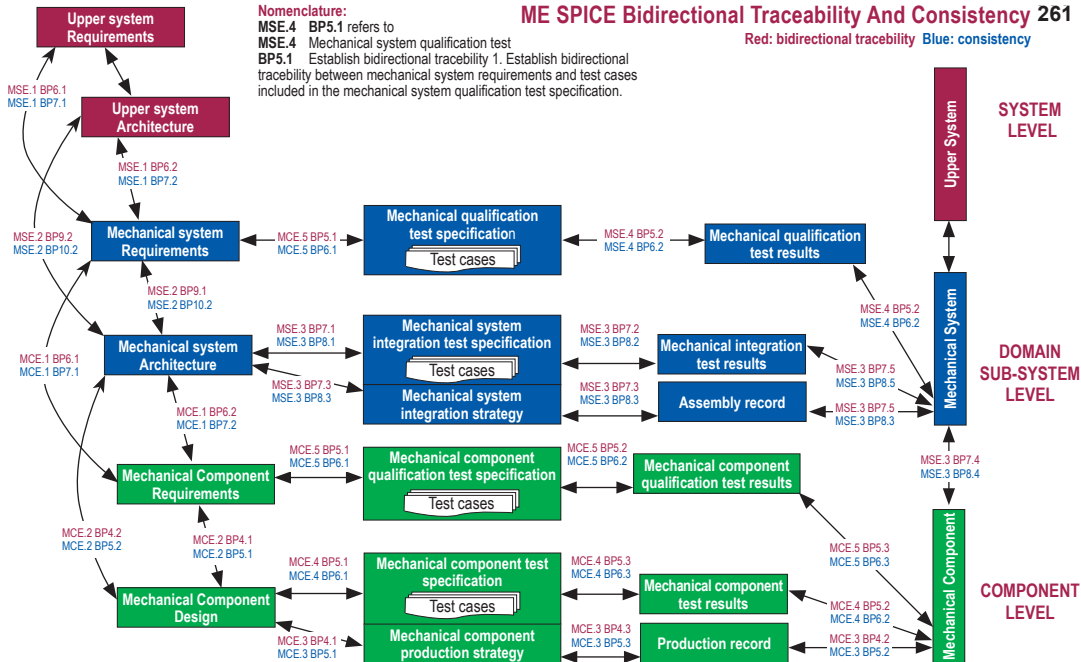
RL3 *[HWE.4.RL.3] If the verification results contain only a pure pass/fail information without supporting verification measure data, the indicator BP5 must not be rated higher than P.*

MECHANICAL ENGINEERING SPICE Version v1.8

Nomenclature:
MSE.4 BP5.1 refers to
MSE.4   Mechanical system qualification test
BP5.1   Establish bidirectional traceability 1. Establish bidirectional traceability between mechanical system requirements and test cases included in the mechanical system qualification test specification.

Red: bidirectional tracebility   Blue: consistency

Upper system Requirements

Upper system Architecture

MSE.1 BP6.1
MSE.1 BP7.1

MSE.1 BP6.2
MSE.1 BP7.2

Mechanical system Requirements

MSE.2 BP9.2
MSE.2 BP10.2

Mechanical qualification test specification
Test cases

MCE.5 BP5.1
MCE.5 BP6.1

MSE.4 BP5.2
MSE.4 BP6.2

Mechanical qualification test results

MSE.2 BP9.1
MSE.2 BP10.2

Mechanical system Architecture

MCE.1 BP6.1
MCE.1 BP7.1

MSE.3 BP7.1
MSE.3 BP8.1

Mechanical system integration test specification
Test cases

MSE.3 BP7.2
MSE.3 BP8.2

Mechanical integration test results

MSE.3 BP7.3
MSE.3 BP8.3

Mechanical system integration strategy

MSE.3 BP7.3
MSE.3 BP8.3

Assembly record

MSE.3 BP7.5
MSE.3 BP8.5

MSE.3 BP7.5
MSE.3 BP8.3

MCE.1 BP6.2
MCE.1 BP7.2

Mechanical Component Requirements

MCE.5 BP5.1
MCE.5 BP6.1

Mechanical component qualification test specification
Test cases

MCE.5 BP5.2
MCE.5 BP6.2

Mechanical component qualification test results

MSE.3 BP7.4
MSE.3 BP8.4

MCE.2 BP4.2
MCE.2 BP5.2

MCE.2 BP4.1
MCE.2 BP5.1

Mechanical Component Design

MCE.4 BP5.1
MCE.4 BP6.1

Mechanical component test specification
Test cases

MCE.4 BP5.3
MCE.4 BP6.3

Mechanical component test results

MCE.5 BP5.3
MCE.5 BP6.3

MCE.4 BP5.2
MCE.4 BP6.2

MCE.3 BP4.1
MCE.3 BP5.1

Mechanical component production strategy

MCE.3 BP4.3
MCE.3 BP5.3

Production record

MCE.3 BP4.2
MCE.3 BP5.2

Upper System — SYSTEM LEVEL

Mechanical System — DOMAIN SUB-SYSTEM LEVEL

MSE.4 BP5.2
MSE.4 BP6.2

Mechanical Component — COMPONENT LEVEL

Mechanical System Engineering

MSE.1 Mechanical System Requirements Analysis

The purpose of the Mechanical System Requirements Analysis process is to derive the mechanical system requirements from the upper system requirements together with all affected stakeholders.

Process outcomes – as a result of successful implementation of this process

1. the mechanical system requirements are derived from the upper system requirements and the upper system architecture;
2. Note: If the mechanical system is the highest system the source of these requirements are the only the stakeholders, in other cases the requirements' source is the upper system requirements and the upper system architecture.
3. the mechanical system requirements are categorized and analyzed for correctness and verifiability;
4. the impact of mechanical system requirements on the operating environment is analyzed and communicated;
5. prioritization for implementing the mechanical system requirements is defined;
6. the mechanical system requirements are updated as needed;
7. consistency and bidirectional traceability are established between upper system requirements and mechanical system requirements; and consistency and bidirectional traceability are established between upper system architecture and mechanical system requirements;
8. the mechanical system requirements are evaluated for cost, schedule and technical impact; and
9. the mechanical system requirements are agreed and communicated to all affected stakeholders.

Output work products

01-51 Application parameter	[OUTCOME 1]	15-01 Analysis report	[OUTCOME 2, 3, 4, 7]
13-04 Communication record	[OUTCOME 8]	17-08 Interface requirements specification [1]	[OUTCOME 1]
13-19 Review record	[OUTCOME 6]	17-ME01 Mechanical system requirements specification	[OUTCOME 1]
13-21 Change control record	[OUTCOME 5, 7]	17-50 Verification criteria	[OUTCOME 2]
13-22 Traceability record	[OUTCOME 1, 6]		

BP1

Specify mechanical system requirements.
Use the upper system requirements and the upper system architecture as well as changes to the upper system requirements and architecture to identify the required functions and capabilities of the mechanical system. Specify functional and non-functional mechanical system requirements in a mechanical system requirements specification. [OUTCOME 1, 5, 7]

1 *Non-functional requirements may include e.g. production, maintenance, exchangeability of systems and components in the field, logistic, packaging, sizing, weight, price per unit, producibility, environmental, design guidelines, modelling guidelines and patents.*

2 *Mechanical system requirements should include tolerances as necessary.*

BP2

Structure mechanical system requirements.
Structure the mechanical system requirements in the mechanical system requirements specification by e.g.
- grouping to project relevant clusters like architecture elements,
- sorting in a logical order for the project,
- categorizing based on relevant criteria for the project,
- prioritizing according to stakeholder needs.

[OUTCOME 2, 4]

3 *Prioritizing typically includes the assignment of mechanical content to planned releases. Refer to SPL.2 BP1.*

BP3

Analyze mechanical system requirements.
Analyze the specified mechanical system requirements including their interdependencies to ensure correctness, technical feasibility and verifiability, and to support risk identification. Analyze the impact on cost, schedule and the technical impact. [OUTCOME 2, 7]

4 *The analysis of impact on cost, schedule and quality supports the adjustment of project estimates. Refer to MAN.3 BP5.*

MSE.1

BP4

Analyze the impact on the operating environment.
Analyze the impact that the mechanical system requirements will have on upper system elements and the operating environment. [OUTCOME 3, 7]

BP5

Develop verification criteria.
Develop the verification criteria for each mechanical system requirement that define the qualitative and quantitative measures for the verification of a requirement. [OUTCOME 2, 7]

5 *Verification criteria demonstrate that a requirement can be verified within agreed constraints and is typically used as the input for the development of the test cases or other verification measures that should demonstrate compliance with the mechanical system requirements.*

6 *Verification which cannot be covered by testing is covered by SUP.2.*

BP6

Establish bidirectional traceability.
 1. Establish bidirectional traceability between upper system requirements and mechanical system requirements.
 2. Establish bidirectional traceability between the upper system architecture and mechanical system requirements.
[OUTCOME 6]

7 *Bidirectional traceability supports coverage, consistency and impact analysis.*

BP7

Ensure consistency.

1. Ensure consistency between upper system requirements and mechanical system requirements.
2. Ensure consistency between the upper system architecture and mechanical system requirements.

[OUTCOME 6]

8   *Consistency is supported by bidirectional traceability and can be demonstrated by review records.*

9   *In case of mechanical development only, the upper system requirements and upper system architecture refer to a given operating environment. In that case, consistency and bidirectional tracea-bility has to be ensured between stakeholder requirements and mechanical system requirements.*

BP8

Communicate agreed mechanical requirements.
Communicate the agreed mechanical system requirements and updates to mechanical system requirements to all relevant stakeholders. [OUTCOME 8]

MSE.2 Mechanical System Architectural Design

The purpose of the Mechanical System Architectural Design Process is to establish an architectural design and to identify which mechanical system requirements are to be allocated to which elements of the mechanic, and to evaluate the mechanical system architectural design against defined criteria.

Process outcomes – as a result of successful implementation of this process

1. a mechanical system architectural design is defined that identifies the elements of the mechanical system;
2. the mechanical system requirements are allocated to the elements of the mechanical system;
3. the interfaces of each mechanical system elements are defined;
4. the static and dynamic behaviour and design constraints of the mechanical system elements are defined;
5. consistency and bidirectional traceability are established between mechanical system requirements and mechanical system architectural design; and
6. the mechanical system architectural design is agreed and communicated to all affected stakeholders.

Output work products

04-ME01 Mechanical system architectural design [OUTCOME 1, 2, 3, 4, 5]	13-22 Traceability record	[OUTCOME 5]
13-04 Communication record [OUTCOME 6]	17-08 Interface requirement specification	[OUTCOME 3]
13-19 Review record [OUTCOME 5]	13-ME01 Characteristics classification record	[OUTCOME 1]

BP1 **Develop mechanical system architectural design.**
Develop and document the mechanical system architectural design that specifies the elements of the mechanical system with respect to functional and non-functional mechanical system requirements. [OUTCOME 1]

1 *The mechanical system is decomposed into elements across appropriate hierarchical levels down to the mechanical components (the elements on the lowest level of the mechanical system architectural design) that are described in the mechanical component design.*

2 *Consider make, buy and reuse options.*

3 *Model-based development (e.g. FEM, SysML) may facilitate the collaboration of the different engineering domains.*

BP2 **Allocate mechanical system requirements.**
Allocate all mechanical system requirements to the elements of the mechanical system architectural design. [OUTCOME 2]

BP3 **Define interfaces of mechanical elements.**
Identify, develop and document the interfaces of each mechanical system element. [OUTCOME 3]

BP4 **Identify special characteristics.**
Identify and document special characteristics of the mechanical system elements. [OUTCOME 1]

4 *The identification of special characteristics is supported by e.g. simulation, risk analysis, sizing calculations.*

BP5 **Describe dynamic and static behaviour.**
Evaluate and document the dynamic and static behaviour of and the interaction between mechanical.
system elements. [OUTCOME 4]

5 *Static and dynamic behaviour is determined by e.g. stress, force, pressure, strain, temperature, operating modes (open, closed, in motion, misuse, emergency, etc.)*

MSE.2

BP6 **Consider, determine, and document design constraints.**
Determine and document design constraints for all mechanical system elements and take them into account for creating the mechanical system architecture. [OUTCOME 4]

BP7 **Evaluate alternative mechanical system architectures.**
Define evaluation criteria for architectural design. Evaluate alternative mechanical system architectures according to the defined criteria. Record the rationale for the chosen mechanical system architecture. [OUTCOME 1, 2, 3, 4, 5]

6 *Evaluation criteria may include quality characteristics (cost, weight, packaging, modularity, maintainability, expandability, scalability, reliability, safety and usability) and results of make-buy-reuse analysis.*

BP8 **Verify mechanical system architectural design.**
Ensure that the mechanical system architectural design meets all mechanical system requirements. [Outcomes 4, 5]

7 *Verification of mechanical system architectural design may include FEA, simulation, or Product FMEA.*

BP9 **Establish bidirectional traceability.**
1. Establish bidirectional traceability between mechanical system requirements and elements of the mechanical system architectural design.
2. Establish bidirectional traceability between elements of the mechanical system architectural design and elements of the system architectural design.

[OUTCOME 5]

8 *Bidirectional traceability covers allocation of mechanical system requirements to the elements of the mechanical system architectural design.*

9 *Bidirectional traceability supports coverage, consistency and impact analysis.*

BP10

Ensure consistency.
1. Ensure consistency between mechanical system requirements and the mechanical system architectural design.
2. Ensure consistency between elements of the mechanical system architectural design and elements of the system architectural design.
[OUTCOME 1, 2, 5, 6]

10 *Consistency is supported by bidirectional traceability and can be demonstrated by review records.*

11 *Mechanical system requirements include mechanical system architectural requirements, refer to BP7.*

BP11

Communicate agreed mechanical system architectural design.
Communicate the agreed mechanical system architectural design and updates to mechanical system architectural design to all relevant stakeholders. [OUTCOME 6]

MSE.3 Mechanical System Integration and Integration Test

The purpose of the Mechanical System Integration and Integration Test Process is to integrate the mechanical items (mechanical component items and/or mechanical system items) into larger mechanical items up to a complete integrated mechanical system item consistent with the mechanical system architectural design and to ensure that the mechanical items are tested to provide evidence for compliance of the integrated mechanical items with the mechanical system architectural design, including the interfaces between the mechanical items.

Process outcomes – as a result of successful implementation of this process

1. a mechanical system integration strategy consistent with the project plan, release plan and the mechanical system architectural design is developed to integrate the mechanical items;
2. a mechanical system integration test strategy including the regression test strategy is developed to test the mechanical items interactions;
3. a specification for mechanical system integration test according to the mechanical system integration test strategy is developed that is suitable to provide evidence for compliance of the integrated mechanical items with the mechanical system architectural design, including the interfaces between the mechanical items;
4. mechanical items are integrated up to a complete integrated mechanical system according to the integration strategy;
5. test cases included in the mechanical system integration test specification are selected according to the mechanical system integration test strategy, and the release plan;
6. integrated mechanical items are tested using the selected test cases and the results of mechanical system integration testing are recorded;
7. consistency and bidirectional traceability are established between the elements of the mechanical system architectural design and the test cases included in the mechanical system integration test specification, between test cases and test results and between integrated mechanical items and recorded process data; and
8. the results of the mechanical system integration test are summarized and communicated to all affected stakeholders.

08-ME01 Sample control plan	[OUTCOME 1,2]	13-22 Traceability record	[OUTCOME 7]
17-ME02 Assembly instruction	[OUTCOME 1]	17-ME03 Bill of material (BOM, Build list)	[OUTCOME 3, 4, 7]
13-ME02 Assembly record	[OUTCOME 4]	11-ME01 Mechanical System	[OUTCOME 4]
08-50 Test specification	[OUTCOME 3,5]	13-04 Communication record	[OUTCOME 8]
13-50 Test result	[OUTCOME 6,8]	13-19 Review record	[OUTCOME 7]

MSE.3 with 9 Base practices

BP1

Develop mechanical system integration strategy.
Develop a strategy for integrating mechanical sub-systems consistent with the project plan and the release plan. Identify mechanical subsystems based on the mechanical system architectural design and define a sequence for integrating them. [OUTCOME 1]

BP2

Develop mechanical system integration test strategy including regression test strategy.
Develop a strategy for testing the integrated mechanical item following the mechanical system integration strategy. This includes a regression test strategy for retesting integrated mechanical item if a mechanical item is changed. [OUTCOME 2]

BP3

Develop specification for mechanical system integration test.
Develop the test specification for mechanical system integration test including the test cases according to the mechanical system integration test strategy for each integrated mechanical item. The test specification shall be suitable to provide evidence for compliance of the integrated mechanical items with the mechanical system architectural design. [OUTCOME 3]

1 *Compliance to the architectural design means that the specified integration tests are suitable to prove that the interfaces between the mechanical items fulfill the specification (e.g. special characteristics) given by the mechanical system architectural design.*

MSE.3

BP4 **Integrate mechanical items.**
Integrate the mechanical items to integrated mechanical system item according to the mechanical system integration strategy and record process data according to the integration strategy. [OUTCOME 4]

BP5 **Select test cases.**
Select test cases from the mechanical system integration test specification. The selection of test cases shall have sufficient coverage according to the mechanical system integration test strategy and the release plan. [OUTCOME 5]

BP6 **Perform mechanical system integration test.**
Perform the mechanical system integration test using the selected test cases. Record the integration test results and logs. [OUTCOME 6]

> 2 *See SUP.9 for handling of non-conformances*

> 3 *Capable test environment as defined in the test strategy needs to be available for performing mechanical system integration and integration test.*

BP7 **Establish bidirectional traceability.**
1. Establish bidirectional traceability between elements of the mechanical system architectural design and test cases included in the mechanical system integration test specification.
2. Establish bidirectional traceability between test cases included in the mechanical system integration test specification and mechanical system integration test results.
3. Establish bidirectional traceability between integrated mechanical items and recorded process data according to the mechanical system integration strategy.
4. Establish bidirectional traceability between integrated mechanical items and the considered mechanical system item.
5. Establish bidirectional traceability between the mechanical integration test results and the integrated mechanical systems. [OUTCOME 7]

> 4 *Bidirectional traceability supports coverage, consistency and impact analysis.*

B8

Ensure consistency.
1. Ensure consistency between elements of the mechanical system architectural design and test cases included in the mechanical system integration test specification.
2. Ensure consistency between test cases included in the mechanical system integration test speci-fication and mechanical system integration test results.
3. Ensure consistency between integrated mechanical items and recorded process data according to the mechanical system integration strategy.
4. Ensure consistency between integrated mechanical items and the considered mechanical sys-tem item.
5. Ensure consistency between the mechanical integration test results and the integrated mechan-ical systems.
[OUTCOME 7]

5 *Consistency is supported by bidirectional traceability and can be demonstrated by review records.*

BP9

Summarize and communicate results.
Summarize the mechanical system integration test results and communicate them to all affected stakeholders. [OUTCOME 8]

6 *Providing all necessary information (e.g. test results, recorded process data) from the test case execution in a summary enables stakeholders to judge the consequences.*

MSE.3

MSE.4 Mechanical System Qualification Test

The purpose of the Mechanical System Qualification Test Process is to ensure that the integrated mechanical system is tested to provide evidence for compliance with the mechanical system requirements.

Process outcomes – as a result of successful implementation of this process

1. a mechanical system qualification test strategy including regression test strategy consistent with the project plan and the release plan is developed to test the integrated mechanical system;
2. a specification for mechanical system qualification test of the integrated mechanical system according to the mechanical system qualification test strategy is developed that is suitable to provide evidence for compliance with the mechanical system requirements;
3. test cases included in the mechanical system qualification test specification are selected according to the mechanical system qualification test strategy and the release plan;
4. the integrated mechanical system is tested using the selected test cases and the results of mechanical system qualification test are recorded;
5. consistency and bidirectional traceability are established between mechanical system requirements and mechanical system qualification test specification including test cases and between test cases and test results; and
6. results of the mechanical system qualification test are summarized and communicated to all affected stakeholders.

Output work products

08-52 Test plan (DVP)	[OUTCOME 1, 2, 6]	13-22 Traceability record	[OUTCOME 5]
08-50 Test specification	[OUTCOME 2, 3]	13-04 Communication record	[OUTCOME 6]
13-50 Test result	[OUTCOME 4, 6]	13-19 Review record	[OUTCOME 5]

BP1 **Develop mechanical system qualification test strategy including a regression test strategy.**
Develop a strategy for mechanical system qualification testing consistent with the project plan and the release plan. This includes a regression test strategy for retesting the integrated mechanical system if a mechanical subsystem is changed. [OUTCOME 1]

BP2 **Develop specification for mechanical system qualification test.**
Develop the specification for mechanical system qualification testing including test cases based on the verification criteria according to the mechanical system test strategy. The test specification shall be suitable to provide evidence for compliance of the integrated mechanical system with the mechanical system requirements. [OUTCOME 2]

BP3 **Select test cases.**
Select test cases from the mechanical system qualification test specification. The selection of test cases shall have sufficient coverage according to the mechanical system qualification test strategy and the release plan. [OUTCOME 3]

BP4 **Test the integrated mechanical system.**
Test the mechanical system using the selected test cases. Record the mechanical system qualification test results and logs. [OUTCOME 4]
1 *See SUP.9 for handling of non-conformances*
2 *Capable test environment as defined in the test strategy needs to be available for performing mechanical system qualification testing.*

BP5

Establish bidirectional traceability.
1. Establish bidirectional traceability between mechanical system requirements and test cases included in the mechanical system qualification test specification.
2. Establish bidirectional traceability between test cases included in the mechanical system qualification test specification and mechanical system qualification test results.
3. Establish bidirectional traceability between the mechanical system qualification test results and the integrated mechanical systems.
[OUTCOME 5]

3 *Bidirectional traceability supports coverage, consistency and impact analysis.*

BP6

Ensure consistency.
1. Ensure consistency between mechanical system requirements and test cases included in the mechanical system qualification test specification.
2. Ensure consistency between test cases included in the mechanical system qualification test specification and mechanical system qualification test results.
3. Ensure consistency between the mechanical system qualification test results and the integrated mechanical systems.
[OUTCOME 5]

4 *Consistency is supported by bidirectional traceability and can be demonstrated by review records.*

BP7

Summarize and communicate results.
Summarize the mechanical system qualification test results and communicate them to all affected stakeholders.
[OUTCOME 6]

5 *Providing all necessary information from the test case execution in a summary enables stakeholders to judg the consequences.*

Mechanical Component Engineering

MCE.1 Mechanical Component Requirements Analysis

The purpose of the Mechanical Component Requirements Analysis process is to establish the requirements for the mechanical component.

Process outcomes – as a result of successful implementation of this process

1. the mechanical component requirements are derived from the upper system requirements and upper system architecture;
2. mechanical component requirements are categorized and analyzed for completeness, correctness, and verifiability;
3. the impact of mechanical component requirements on the operating environment is analyzed;
4. prioritization for implementing the mechanical component requirements is defined;
5. the mechanical component requirements are updated as needed;
6. consistency and bidirectional traceability are established between upper system requirements and mechanical component requirements; and consistency and bidirectional traceability are established between upper system architectural design and mechanical component requirements;
7. the mechanical component requirements are evaluated for cost, schedule and technical impact; and
8. the mechanical component requirements are agreed and communicated to all affected stakeholders.

Output work products

13-04 Communication record	[OUTCOME 8]	15-01 Analysis report	[OUTCOME 2, 3, 4, 7]
13-19 Review record	[OUTCOME 6]	17-08 Interface requirements specification	[OUTCOME 1]
13-21 Change control record	[OUTCOME 5,7]	17-ME04 Mechanical component requirements specification	[OUTCOME 1]
13-22 Traceability record	[OUTCOME 1, 6]	17-50 Verification criteria	[OUTCOME 2]

BP1

Specify mechanical component requirements.
Use the upper system requirements and the upper system architecture and changes to the upper system requirements and the upper system architecture to identify the required functions and capabilities of the mechanical component. Specify functional and non-functional mechanical component requirements in a mechanical component requirements specification. [OUTCOME 1, 5, 7]

1 *If the system requirements and the system architectural design refer to a given operating environment, then the stakeholder requirements should be used as the basis for identifying the required functions and capabilities of the mechanical component.*

2 *Non-functional requirements may include e.g. production, maintenance, logistic, environmental.*

BP2

Structure mechanical component requirements.
Structure the mechanical component requirements in the mechanical component requirements specification by e.g.
- grouping to project relevant clusters,
- sorting in a logical order for the project,
- categorizing based on relevant criteria for the project,
- prioritizing according to stakeholder needs.
[OUTCOME 2, 4]

3 *Prioritizing typically includes the assignment of mechanical content to planned releases. Refer to SPL.2 BP1.*

BP3 **Analyze mechanical component requirements.**
Analyze the specified mechanical component requirements including their interdependencies to ensure correctness, technical feasibility, producibility and verifiability, and to support risk identification. Analyze the impact on cost, schedule and the technical impact. [OUTCOME 2, 7]

4 *The analysis of impact on cost, schedule and quality supports the adjustment of project esti-mates. Refer to MAN.3 BP5.*

BP4 **Analyze the impact on the operating environment.**
Analyze the impact that the mechanical component requirements will have on interfaces of system elements and the operating environment. [OUTCOME 3, 7]

BP5 **Develop verification criteria.**
Develop the verification criteria for each mechanical component requirement that define the qualitative and quantitative measures for the verification of a requirement. [OUTCOME 2, 7]

5 *Verification criteria demonstrate that a requirement can be verified within agreed constraints and are typically used as the input for the development of the test cases or other verification measures that should demonstrate compliance with the mechanical component requirements.*

6 *Verification which cannot be covered by testing is covered by SUP.2.*

BP6 **Establish bidirectional traceability.**
1. *Establish bidirectional traceability between upper system requirements and mechanical component requirements.*
2. *Establish bidirectional traceability between the upper system architecture and mechanical component requirements.* [OUTCOME 6]

7 *Redundancy should be avoided by establishing a combination of the approaches BP6.1 and BP6.2 that covers the project and the organizational needs.*

8 *Bidirectional traceability supports coverage, consistency and impact analysis.*

BP7

Ensure consistency.
1. Ensure consistency between upper system requirements and mechanical component requirements.
2. Ensure consistency between the upper system architecture and mechanical component requirements.
[OUTCOME 6]

> 9 *Consistency is supported by bidirectional traceability and can be demonstrated by review records.*

> 10 *If the system requirements and the system architectural design refer to a given operating environment, then the stakeholder requirements should be used as the basis for identifying the required functions and capabilities of the mechanical component.*

BP8

Communicate agreed mechanical component requirements.
Communicate the agreed mechanical component requirements and updates to mechanical component requirements to all relevant stakeholders. [OUTCOME 8]

MCE.2 Mechanical Component Design

The purpose of the Mechanical Component Design process is to provide an evaluated design for the mechanical component.

Process outcomes – as a result of successful implementation of this process

1. a design is developed that describes the mechanical component;
2. interfaces of the mechanical component are defined;
3. consistency and bidirectional traceability are established between mechanical component requirements and mechanical component design; and consistency and bidirectional traceability are established between upper system architecture and mechanical component design; and
4. the mechanical component design is agreed and communicated to all affected stakeholders.

Output work products

04-ME02 Mechanical component design	[OUTCOME 1,2]	13-04 Communication record	[OUTCOME 4]
13-22 Traceability record	[OUTCOME 3]		

BP1

Develop mechanical component design.
Develop a design for the mechanical component using the functional and non-functional mechanical component requirements including interfaces. [OUTCOME 1]

While developing the mechanical component design the requirements and data relevant for production are identified and documented.

1 *Non-functional requirements may include e.g. price per unit, maintenance, logistic, packaging, size, weight, manufacturability, environmental constraints, design guidelines, modelling guidelines, failure times.*

2 *Design for Manufacturing and Design for Assembly may be used to ensure manufacturability.*

BP2

Evaluate mechanical component design.
Evaluate the mechanical component design in terms of interaction, criticality, technical complexity, risks, measurability and verifiability. [OUTCOME 1,2]

3 *The results of the evaluation can be used as input for test against mechanical component design.*

BP3

Verify mechanical component design.
Ensure that the mechanical component design meets all mechanical component requirements. [OUTCOMES 4, 5]

4 *Verification of mechanical component design may include FEA, simulation, or Product FMEA.*

BP4 **Establish bidirectional traceability.**
1. Establish bidirectional traceability between mechanical component requirements and mechanical component design.
2. Establish bidirectional traceability between the mechanical system architectural design and mechanical component design.
[OUTCOME 3]

5 *Redundancy should be avoided by establishing a combination of the approaches BP4.1 and BP4.2 that covers the project and the organizational needs.*

6 *Bidirectional traceability supports coverage, consistency and impact analysis.*

BP5 **Ensure consistency.**
1. Ensure consistency between mechanical component requirements and mechanical component design.
2. Ensure consistency between the mechanical system architectural design and mechanical component design.
[OUTCOME 3]

7 *Consistency is supported by bidirectional traceability and can be demonstrated by review records.*

BP6 **Communicate agreed mechanical component design.**
Communicate the agreed mechanical component design and updates to the mechanical component design to all relevant stakeholders. [OUTCOME 4]

MCE.3 Mechanical Component Sample Production

The purpose of the Mechanical Component Sample Production process is to produce a mechanical component item that reflects properly the mechanical component design and mechanical component production strategy.

Process outcomes – as a result of successful implementation of this process

1. a mechanical component production strategy is developed, communicated to, and agreed on with all affected stakeholders,
2. mechanical component items are produced according to the mechanical component design,
3. bidirectional traceability are established between the produced mechanical component and recorded process data according to the mechanical component production strategy; and consistency and bidirectional traceability are established between recorded process data and the mechanical component production strategy (control plan), and
4. information gathered during production is communicated to all affected stakeholders.

Output work products

11-ME02 Mechanical Component	[OUTCOME 1,2]	13-22 Traceability record [3]	[OUTCOME 3]
19-ME01 Production strategy	[OUTCOME 1]	13-04 Communication record	[OUTCOME 4]
13-ME03 Production record	[OUTCOME 2,4]	15-01 Analysis report	[OUTCOME 4]
		(Containing analyses results of e.g. suitability of chosen production method regarding effectiveness, timing, cost)	

BP1 **Develop mechanical component production strategy.**
Develop a strategy for production of the mechanical component item. The mechanical component production strategy shall be consistent with the mechanical component design, project plan (e.g. estimation of number of built items needed), release plan (e.g. definition of releases and their content), and test strategy (e.g. mapping of test methods to releases). [OUTCOME 1] The mechanical component production strategy may contain the definition of the production method(s), verification method(s) (control plan).

BP2 **Agree on mechanical component production strategy.**
Communicate the agreed mechanical component production strategy between all involved stakeholders (e.g. engineering, sample shop, production). [OUTCOME 1]

1 *The communication of the mechanical component production strategy to suppliers is handled by ACQ.4 Supplier monitoring.*

BP3 **Ensure and support production of mechanical components.**
Ensure and support production of mechanical component items according to:
• the mechanical component design
• mechanical component production strategy
• the requirements and data relevant for production.
Record process data according to the mechanical component production strategy. [OUTCOME 2, 4]

2 *Production here means only sample phases (e.g. prototype building, pre-series production) and does not cover the process of industrialization.*

MCE.3

BP4 **Establish bidirectional traceability.**
1. Establish bidirectional traceability between mechanical component production strategy and mechanical component design.
2. Establish bidirectional traceability between the produced mechanical component item and recorded process data according to the mechanical component production strategy.
3. Establish bidirectional traceability between recorded process data and mechanical component production strategy (control plan).
[OUTCOME 3]

3 *Bidirectional traceability supports coverage, consistency and impact analysis.*

BP5 **Ensure consistency.**
1. Ensure consistency between recorded process data and mechanical component production strategy (control plan).
2. Ensure consistency between produced mechanical component item and recorded process data according to the mechanical component production strategy.
3. Ensure consistency between recorded process data and mechanical component production strategy (control plan).
[OUTCOME 3]

4 *Consistency is supported by bidirectional traceability and can be demonstrated by review records.*

BP6

Provide feedback to all affected stakeholders
Communicate information gathered during the production of the mechanical component to all affected stakeholders.
[OUTCOME 4]
These information may contain:
• Capability of chosen production method
• Manufacturability of the mechanical component
• Improvement potentials for future releases
• Process data and information

5 *See SUP.9 for handling of non-conformances*

6 *The communication of information mentioned above is handled by ACQ.4 Supplier monitoring in case of production at a supplier's site.*

Affected stakeholders may be:
• Industrialization
• Series production
• Mechanical engineering
• Project management

MCE.4 Test against Mechanical Component Design

The purpose of the Test against mechanical component design process is to test the mechanical component item to provide evidence for compliance of the mechanical component item with the mechanical component design.

Process outcomes – as a result of successful implementation of this process

1. a strategy for test against mechanical component design including regression test strategy is developed;
2. a specification for test against mechanical component design is developed according to the strategy for test against mechanical component design that is suitable to provide evidence for compliance of the mechanical component item with the mechanical component design;
3. test cases included in the test specification for test against mechanical component design are selected according to the test strategy for test against the mechanical component design and the release plan;
4. the mechanical component item is tested according to the strategy for test against mechanical component design and the test specification for test against mechanical component design and the results are recorded;
5. consistency and bidirectional traceability are established between the mechanical component design and the test specification for test against mechanical component design as well as between the test specification for test against mechanical component design and test results; and
6. results of the test against mechanical component design are summarized and communicated to all affected stakeholders.

Output work products

08-50 Test specification	[OUTCOME 2]	13-19 Review record	[OUTCOME 3, 4]
08-52 Test plan	[OUTCOME 1, 6]	13-22 Traceability record	[OUTCOME 4]
13-04 Communication record	[OUTCOME 6]	13-50 Test result	[OUTCOME 3, 5, 6]

BP1

Develop strategy for test against mechanical component design including regression test strategy.
Develop a strategy for test against mechanical component design including regression test strategy for retest if the mechanical component design is changed. The test strategy shall define how to provide evidence for compliance of the mechanical component item with the mechanical component design. [OUTCOME 1]

1 *The test strategy shall contain a planning of needed items for testing and the allocation of tests to be performed within different releases. The needed amount of items for dedicated tests shall consider that random and systematic faults have to be detected.*

BP2

Develop test specification for test against mechanical component design.
Develop test specification for test against mechanical component design including test cases that are suitable to provide evidence for compliance of the mechanical component item with the mechanical component design according to the test strategy. [OUTCOME 2]

BP3

Select test cases.
Select test cases from the test specification for test against mechanical component design. The selection of test cases shall have sufficient coverage according to the test strategy for test against mechanical component design and the release plan. [OUTCOME 3]

BP4

Test mechanical component item.
Test the mechanical component item using the test specification for test against mechanical component design according to the strategy for test against mechanical component design. Record the test results and measured values. [OUTCOME 4]

2 *See SUP.9 for handling of non-conformances.*

3 *Capable test environment as defined in the test strategy needs to be available for performing test against mechanical component design.*

BP5

Establish bidirectional traceability.
1. Establish bidirectional traceability between the mechanical component design and the mechanical component test specification for test against mechanical component design.
2. Establish bidirectional traceability between the test results and tested mechanical component items.
3. Establish bidirectional traceability between test cases included in the mechanical component test specification and mechanical component test results.
[OUTCOME 5]

4 *Bidirectional traceability supports coverage, consistency and impact analysis.*

BP6

Ensure consistency.
1. Ensure consistency between the mechanical component design and the test specification for test against mechanical component design.
2. Ensure consistency between the test results and tested mechanical component items.
3. Ensure consistency between test cases included in the mechanical component test specification and mechanical component test results.
[OUTCOME 5]

5 *Consistency is supported by bidirectional traceability and can be demonstrated by review records.*

BP7

Summarize and communicate results.
Summarize the test results and communicate them to all affected stakeholders. [OUTCOME 6]

6 *Providing all necessary information from the test case execution in a summary enables stakeholders to judge the consequences.*

MCE.5 Test against Mechanical Component Requirements

The purpose of the Test against Mechanical Component Requirements process is to test the mechanical component to provide evidence for compliance of the mechanical component with the mechanical component requirements.

Process outcomes – as a result of successful implementation of this process

1. a strategy for the test against mechanical component requirements including regression test strategy consistent with the project plan and the release plan is developed;
2. a specification for the test against mechanical component requirements is developed according to the strategy for the test against mechanical component requirements that is suitable to provide evidence for compliance of the mechanical component with the mechanical component requirements;
3. test cases included in the test specification for the test against mechanical component requirements are selected according to the test strategy for the test against mechanical component requirements and the release plan
4. the mechanical component is tested according to the strategy for the test against mechanical component requirements and the test specification for the test against mechanical component requirements, and the results are recorded;
5. consistency and bidirectional traceability are established between the mechanical component requirements and the test specification for the test against mechanical component requirements as well as between the test specification for the test against mechanical component requirements and test results; and
6. results of the test against mechanical component requirements are summarized and communicated to all affected stakeholders.

Output work products

08-50 Test specification	[OUTCOME 2, 6]	13-19 Review record	[OUTCOME 3, 4]
08-52 Test plan	[OUTCOME 1, 6]	13-22 Traceability record	[OUTCOME 4]
13-04 Communication record	[OUTCOME 6]	13-50 Test result	[OUTCOME 3, 5]

BP1 **Develop strategy for the test against mechanical component requirements including regression test strategy.**
Develop a strategy for the test against mechanical component requirements consistent with the project plan and the release plan. This includes a regression test strategy for retesting the mechanical component if it has been changed. [OUTCOME 1]

1 *The test strategy shall include a plan of which items need to be tested and the allocation of tests to be performed within different releases. The needed amount of items for dedicated tests shall consider that random and systematic faults have to be detected.*

BP2 **Develop test specification for the test against mechanical component requirements.**
Develop test specification including test cases for the test against mechanical component requirements that are suitable to provide evidence for compliance of the mechanical component with the mechanical component requirements according to the test strategy. [OUTCOME 2]

BP3 **Select test cases.**
Select test cases from the test specification for the test against mechanical component requirements. The selection of test cases shall have sufficient coverage according to the test strategy for the test against mechanical component requirements and the release plan. [OUTCOME 5]

BP4 **Test the mechanical component.**
Test the mechanical component using the test specification for the test against mechanical component requirements according to the strategy for the test against mechanical component requirements. Record the test results and measured values. [OUTCOME 3]

2 *See SUP.9 for handling of non-conformances.*

3 *Capable test environment as defined in the test strategy needs to be available for performing test against mechanical component requirements.*

BP5

Establish bidirectional traceability.

1. Establish bidirectional traceability between the mechanical component requirements and the test specification for test against mechanical component requirements.
2. Establish bidirectional traceability between the test specification for the test against mechanical component requirements and test results.
3. Establish bidirectional traceability between the mechanical component qualification test results and the tested mechanical component items.

[OUTCOME 4]

4 *Bidirectional traceability supports coverage, consistency and impact analysis.*

BP6

Ensure consistency.

1. Ensure consistency between the mechanical component requirements and the test specification for the test against mechanical component requirements.
2. Ensure consistency between the test specification for the test against mechanical component requirements and test results.
3. Ensure consistency between the mechanical component qualification test results and the tested mechanical component items.

[OUTCOME 4]

5 *Consistency is supported by bidirectional traceability and can be demonstrated by review records.*

BP7

Summarize and communicate results.

Summarize the test results and communicate them to all affected stakeholders. [OUTCOME 6]

6 *Providing all necessary information from the test case execution in a summary enables stakeholders to judge the consequences.*

CAPABILITY LEVELS

Process capability Level 1: Performed process

The implemented process achieves its process purpose. The following process attribute demonstrates the achievement of this level

PA 1.1 Process performance process attribute

The process performance process attribute is a measure of the extent to which the process purpose is achieved. As a result of full achievement of this attribute:

    a) the process achieves its defined outcomes

Generic practices 1.1.1

GP 1.1.1

Achieve the process outcomes [ACHIEVEMENT a]
Achieve the intent of the base practices. Produce work products that evidence the process outcomes.

Generic resources

Resources are used to achieve the intent of process specific base practices [ACHIEVEMENT a]

Process capability Level 2: Managed process

The previously described Performed process is now implemented in a managed fashion (planned, monitored and adjusted) and its work products are appropriately established, controlled and maintained. The following process attributes, together with the previously defined process attribute, demonstrate the achievement of this level:

PA 2.1 Performance management process attribute

The performance management process attribute is a measure of the extent to which the performance of the process is managed.
As a result of full achievement of this process attribute:
a) Objectives for the performance of the process are identified;
b) Performance of the process is planned;
c) Performance of the process is monitored;
d) Performance of the process is adjusted to meet plans;
e) Responsibilities and authorities for performing the process are defined, assigned and communicated;
f) Personnel performing the process are prepared for executing their responsibilities;
g) Resources and information necessary for performing the process are identified, made available, allocated and used;
h) Interfaces between the involved parties are managed to ensure both effective communication and clear assignment of responsibility

GP 2.1.1

Identify the objectives for the performance of the process. [ACHIEVEMENT a]

Performance objectives are identified based on process requirements.

The scope of the process performance is defined.

Assumptions and constraints are considered when identifying the performance objectives.

1 *Performance objectives may include*

(1) timely production of artifacts meeting the defined quality criteria,

(2) process cycle time or frequency

(3) resource usage; and

(4) boundaries of the process.

2 *At minimum, process performance objectives for resources, effort and schedule should be stated.*

215: CL2.RL.1-4

GP 2.1.2

Plan the performance of the process to fulfill the identified objectives. [ACHIEVEMENT b]

Plan(s) for the performance of the process are developed.

The process performance cycle is defined.

Key milestones for the performance of the process are established.

Estimates for process performance attributes are determined and maintained.

Process activities and tasks are defined.

Schedule is defined and aligned with the approach to performing the process.

Process work product reviews are planned.

216: CL2.RL.5-9

223: CL2.RL.22

GP 2.1.3

Monitor the performance of the process against the plans. [ACHIEVEMENT c]

The process is performed according to the plan(s).

Process performance is monitored to ensure planned results are achieved and to identify possible deviations.

217: CL2.RL.10-12
223: CL2.RL.23

GP 2.1.4

Adjust the performance of the process. [ACHIEVEMENT d]

Process performance issues are identified.

Appropriate actions are taken when planned results and objectives are not achieved.

The plan(s) are adjusted, as necessary.

Rescheduling is performed as necessary.

218: CL2.RL.13-14
223: CL2.RL.24-26

GP 2.1.5

Define responsibilities and authorities for performing the process. [ACHIEVEMENT e]

Responsibilities, commitments and authorities to perform the process are defined, assigned and communicated.

Responsibilities and authorities to verify process work products are defined and assigned.

The needs for process performance experience, knowledge and skills are defined.

64: DID.RL.4
219: CL2.RL.15-17

PA 2.1

GP 2.1.6

Identify, prepare, and make available resources to perform the process according to plan. [ACHIEVEMENT f, g]

The human and infrastructure resources, necessary for performing the process are identified, made available, allocated and used.

The individuals performing and managing the process are prepared by training, mentoring, or coaching to execute their responsibilities.

The information necessary to perform the process is identified and made available.

64: DID.RL.5
220: CL2.RL.18-19
224: CL2.RL.27-28

GP 2.1.7

Manage the interfaces between involved parties. [ACHIEVEMENT h]

The individuals and groups involved in the process performance are determined.

Responsibilities of the involved parties are assigned.

Interfaces between the involved parties are managed.

Communication is assured between the involved parties.

Communication between the involved parties is effective.

43: SAC.RC.1
64: DID.RL.7
221: CL2.RL.20-21
224: CL2.RC.3

PA2.1 Consistency Diagram

GP2.1.1 — Identify the objectives for the performance of the process

GP2.1.2 — Plan the performance of the process to fulfill the identified objectives

GP2.1.3 — Monitor the performance of the process against plans

GP2.1.4 — Adjust the performance of the process

GP2.1.5 — Define responsibilities and authorities for performing the process

GP2.1.6 — Identify, prepare and make available resources to perform …

GP2.1.7 — Manage the interfaces between involved parties

RL.24: planned objectives are not achieved
RL.25: plans are adjusted
RL.22: to fulfil the identified objectives
RL.23: against the plans
RL.26: planned results are not achieved
RL.27: according to plan
RL.28: made available as defined

RC.5: monitor
RC.4: define
RC.6: adjust
RC.7: ensure skills
RC.3: manage as defined
RC.8: Identify, monitor and adjust project interfaces
RC.9: consider its own
RC.10: consider its own

MAN.3 — BP4 — Define, monitor and adjust project activities

MAN.3 — BP5 — Define, monitor and adjust project estimates and resources

MAN.3 — BP8 — Define, monitor and adjust project schedule

MAN.3 — BP6 — Ensure required skills, knowledge and experience

MAN.3 — BP7 — Identify, monitor and adjust project interfaces and agreed commitments.

SWE.3 — BP7
SWE.2 — BP9
SWE.1 — BP8
SYS.3 — BP8
SYS.2 — BP8 — Communicate agreed …

SWE.6 — BP7
SWE.5 — BP9
SWE.4 — BP7
SYS.5 — BP7
SYS.4 — BP9 — Summarize and communicate …

PA 2.1

The work product management process attribute is a measure of the extent to which the work products produced by the process are appropriately managed. As a result of full achievement of this process attribute:

a) Requirements for the work products of the process are defined;

b) Requirements for documentation and control of the work products are defined;

c) Work products are appropriately identified, documented, and controlled;

d) Work products are reviewed in accordance with planned arrangements and adjusted as necessary to meet requirements.

1 *Requirements for documentation and control of work products may include requirements for the identification of changes and revision status, approval and re-approval of work products, distribution of work products, and for making relevant versions of applicable work products available at points of use.*

2 *The work products referred to in this clause are those that result from the achievement of the process purpose through the process outcomes.*

Generic practices 2.2.1

GP 2.2.1
Define the requirements for the work products. [ACHIEVEMENT a]
The requirements for the work products to be produced are defined.
Requirements may include defining contents and structure.
Quality criteria of the work products are identified.
Appropriate review and approval criteria for the work products are defined.

65: DID.RL.8
227f: CL2.RL.29-33

GP 2.2.2

Define the requirements for documentation and control of the work products. [ACHIEVEMENT b]

Requirements for the documentation and control of the work products are defined. Such requirements may include requirements for

(1) distribution,

(2) identification of work products and their components and

(3) traceability.

Dependencies between work products are identified and understood.

Requirements for the approval of work products to be controlled are defined.

| 64: DID.RL.6 |
| 228: CL2.RL.34 |

GP 2.2.3

Identify, document and control the work products. [ACHIEVEMENT c]

The work products to be controlled are identified.

Change control is established for work products.

The work products are documented and controlled in accordance with requirements.

Versions of work products are assigned to product configurations as applicable.

The work products are made available through appropriate access mechanisms.

The revision status of the work products may readily be ascertained.

| 232: CL2.RL.40 |

PA 2.2

GP 2.2.4

Review and adjust work products to meet the defined requirements. [ACHIEVEMENT d]

Work products are reviewed against the defined requirements in accordance with planned arrangements.

Issues arising from work product reviews are resolved.

PA2.2 Consistency Diagram

SUP.1   **BP1**
Develop a project quality assurance strategy

SUP.1   **BP2**
Assure quality of work products

SUP.8   **BP8**
Verify the information about configured items

SUP.8   **BP2**
Identify configuration items

SUP.8   **BP1**
Develop a configuration management strategy

SUP.8   **BP6**
Establish baselines

SUP.8   **BP5**
Control modifications and releases

SUP.8   **BP3**
Establish a configuration management system

GP2.2.1
Define the requirements for the work products

GP2.2.4
Review and adjust work product to meet the defined requirements

GP2.2.2
Define the requirements for documentation and control of the work products

GP2.2.3
Identify, document and control the work products

SYS.5 **BP6**
SYS.4 **BP8**
SYS.3 **BP7**
SYS.2 **BP7**
Ensure consistency

SWE.6 **BP6**
SWE.5 **BP8**
SWE.4 **BP6**
SWE.3 **BP6**
SWE.2 **BP8**
SWE.1 **BP7**
Ensure consistency

SUP.10   **BP1**
Develop a change request management strategy

SUP.10   **BP7**
Track change request to closure

SUP.10   **BP3**
Record the status of change requests

SUP.10   **BP2**
Identify and record the change requests

RC.12: consider quality criteria

RC.17: assure

verify configured items

RC.13: define configuration management

RC.15: perform configuration management

RL.14: against defined requirements

ensure

RC.18: ensure

RC.14: develop strategy

RL.40: in accordance with the requirements

RC.16: manage changes

PA 2.2

Process capability Level 3: Established process

The previously described Managed process is now implemented using a defined process that is capable of achieving its process outcomes. The following process attributes, together with the previously defined process attributes, demonstrate the achievement of this level:

PA 3.1 Process definition process attribute

The process definition process attribute is a measure of the extent to which a standard process is maintained to support the deployment of the defined process. As a result of full achievement of this process attribute:

a) A standard process, including appropriate tailoring guidelines, is defined and maintained that describes the fundamental elements that must be incorporated into a defined process;

b) The sequence and interaction of the standard process with other processes is determined.

c) Required competencies and roles for performing the process are identified as part of the standard process;

d) Required infrastructure and work environment for performing the process are identified as part of the standard process;

e) Suitable methods and measures for monitoring the effectiveness and suitability of the process are determined.

GP 3.1.1

Define and maintain the standard process that will support the deployment of the defined process. [ACHIEVEMENT a]

A standard process is developed and maintained that includes the fundamental process elements.

The standard process identifies the deployment needs and deployment context.

Guidance and/or procedures are provided to support implementation of the process as needed.

Appropriate tailoring guideline(s) are available as needed.

| 235f: CL3.RL.1-5 |
| 244: CL3.RC.4-5 |

GP 3.1.2

Determine the sequence and interaction between processes so that they work as an integrated system of processes. [ACHIEVEMENT b]

The standard process's sequence and interaction with other processes are determined.

Deployment of the standard process as a defined process maintains integrity of processes.

| 237: CL3.RL.6 |
| 244: CL3.RC.3-5 |

GP 3.1.3

Identify the roles and competencies, responsibilities, and authorities for performing the standard process. [ACHIEVEMENT c]

Process performance roles are identified

Competencies for performing the process are identified.

Authorities necessary for executing responsibilities are identified.

| 237: CL3.RL.7 |
| 244: CL3.RC.3-5 |

PA 3.1

GP 3.1.4

Identify the required infrastructure and work environment for performing the standard process. [ACHIEVEMENT d]

Process infrastructure components are identified (facilities, tools, networks, methods, etc.).

Work environment requirements are identified.

238: CL3.RL.8
244: CL3.RC.3-5

GP 3.1.5

Determine suitable methods and measures to monitor the effectiveness and suitability of the standard process. [ACHIEVEMENT e]

Methods and measures for monitoring the effectiveness and suitability of the process are determined.

Appropriate criteria and data needed to monitor the effectiveness and suitability of the process are defined.

The need to conduct internal audit and management review is established.

Process changes are implemented to maintain the standard process.

239: CL3.RL.9

The process deployment process attribute is a measure of the extent to which the standard process is deployed as a defined process to achieve its process outcomes. As a result of full achievement of this process attribute:

a) A defined process is deployed based upon an appropriately selected and/or tailored standard process;

b) Required roles, responsibilities and authorities for performing the defined process are assigned and communicated;

c) Personnel performing the defined process are competent on the basis of appropriate education, training, and experience;

d) Required resources and information necessary for performing the defined process are made available, allocated and used;

e) Required infrastructure and work environment for performing the defined process are made available, managed and maintained;

f) Appropriate data are collected and analysed as a basis for understanding the behaviour of the process, to demonstrate the suitability and effectiveness of the process, and to evaluate where continual improvement of the process can be made.

Generic practices 3.2.1

GP 3.2.1 **Deploy a defined process that satisfies the context specific requirements of the use of the standard process.** [ACHIEVEMENT a]

The defined process is appropriately selected and/or tailored from the standard process.

Conformance of defined process with standard process requirements is verified.

240: CL3.RL.10

GP 3.2.2

Assign and communicate roles, responsibilities and authorities for performing the defined process.
[ACHIEVEMENT b]

The roles for performing the defined process are assigned and communicated.

The responsibilities and authorities for performing the defined process are assigned and communicated.

240: CL3.RL.11, CL3.RC.1
244: CL3.RL.17
246: CL3.RL.22

GP 3.2.3

Ensure necessary competencies for performing the defined process. [ACHIEVEMENT c]

Appropriate competencies for assigned personnel are identified.

Suitable training is available for those deploying the defined process.

240: CL3.RL.12-13
244: CL3.RL.18

GP 3.2.4

Provide resources and information to support the performance of the defined process. [ACHIEVEMENT d]

Required human resources are made available, allocated and used.

Required information to perform the process is made available, allocated and used.

241: CL3.RL.14
245: CL3.RL.19
246: CL3.RC.6

PA 3.2

GP 3.2.5

Provide adequate process infrastructure to support the performance of the defined process. [ACHIEVEMENT e]

Required infrastructure and work environment is available.

Organizational support to effectively manage and maintain the infrastructure and work environment is available.

Infrastructure and work environment is used and maintained.

| 241: CL3.RL.15 |
| 245: CL3.RL.20 |
| 247: CL3.RC.7 |

GP 3.2.6

Collect and analyze data about performance of the process to demonstrate its suitability and effectiveness. [ACHIEVEMENT f]

Data required to understand the behavior, suitability and effectiveness of the defined process are identified.

Data is collected and analyzed to understand the behavior, suitability and effectiveness of the defined process.

Results of the analysis are used to identify where continual improvement of the standard and/or defined process can be made.

1 *Data about process performance may be qualitative or quantitative.*

| 242: CL3.RL.16 |
| 242: CL3.RC.2 |
| 245: CL3.RL.21 |

GP3.1.1
Define and maintain in the standard process that will support the deployment of the defined process

RC.5: based on standard process

GP3.2.1
Develop s defined process that satisfies the context specific requirements of the use of the standard process

RC.3: determine interaction

GP3.1.2
Determine the sequence and interaction between processes so that they work as an integrated system of processes

GP3.2.2
Assign an communicate roles, responsbilities and authorities for performing the defined process

RC.3: identify roles

GP3.1.3
Identify the roles and competencies, responsbilities, and authorities for performing the standard porcess

RL.17: based on standard process

RL.18: based on standard process

GP3.2.3
Ensure necessary competencies for performing the defined process

RC.3: identify infrastructure

GP3.1.4
Identify the required infrastructure and work enviroment for performing the standards process

RL.19: based on standard process

GP3.2.4
Provide recources and information to the support the performance of the defined process

RL.20: based on standard process

GP3.2.5
Provide adequate process infrastructure to support the performance of the defined process

RC.4: monitor effectiveness

GP3.1.5
Determine suitable methods and measures to monitor the effectiveness and suitability of the standard process

RL.21: based on measures

GP3.2.6
Collect and analyze data about performance of the process to demonstrate its suitability and effectiveness

PA 3.2

GP2.1.5
Define resposibility and authorties for performing the process

GP3.2.2
Assign and communicate roles, responsibilities and authorities for performing the defined process

based on definition of responsibilities

GP3.2.4
Provide resources and information to support the performance of the defined process

GP2.1.6
Indentify, prepare, and make available resources to perform the process according to plan

GP3.2.5
Provide adequate process infrastructure to support the performance of the defined process

based on indentification and availability of recources

		PA 2.1	PA 2.2	PA 3.1	PA 3.2
MAN.3	Project Management	++			
MAN.5	Risk Management	+			+
REU.2	Reuse Program Management		+	+	
ACQ.4	Supplier Monitoring	+	+		
SUP.1	Quality Assurance		++		+
SUP.2	Verification		++		+
SUP.4	Joint Review		+		
SUP.7	Documentation		+	+	
SUP.8	Configuration Management		++	+	
SUP.9	Problem Resolution Management	+	+		+
SUP.10	Change Request Management		+		+
SPL.2	Product Release		+		

A +/++ entry in a cell indicates a dependency: a weakness in the process most likely corresponds to a weakness in the related Process Attribute (PA)
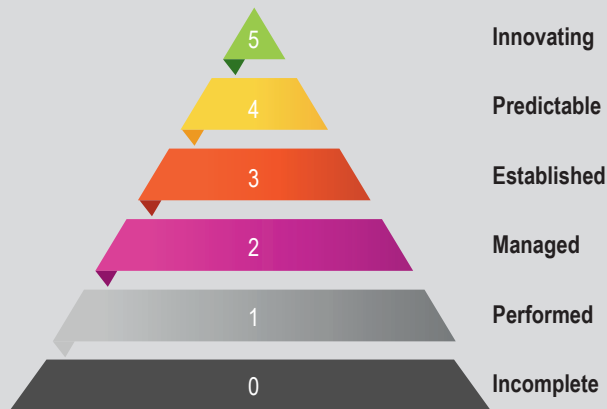
PA 3.2

Capability Level 1: The Performed Process

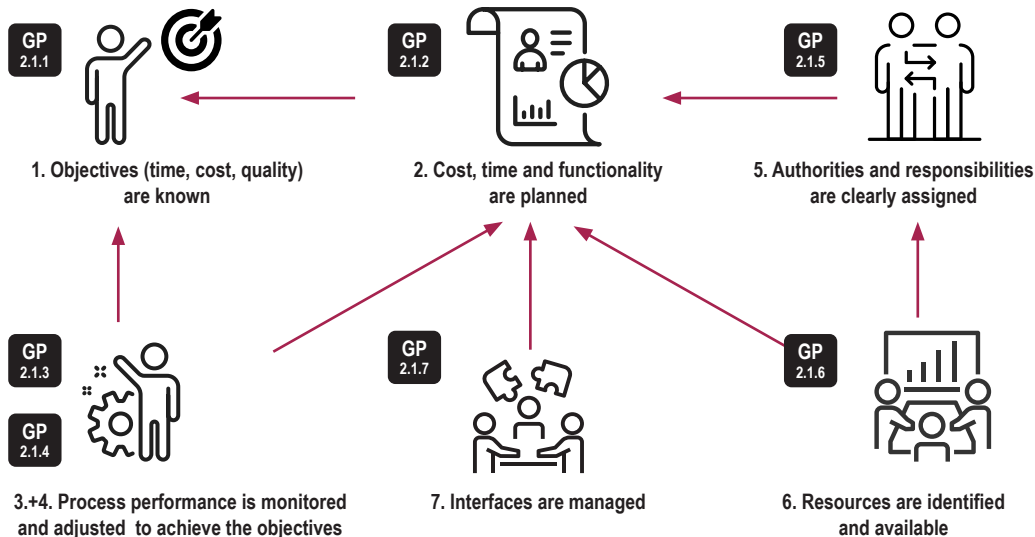**GP 1.1.1**

The process purpose and outcomes are achieved
- The intent of the base practices is achieved
- The work products are produced

Capability Level 2: The Managed Process

PA 2.1: Performance Management
GP 2.1.1 – GP 2.1.7

GP 2.1.1

1. Objectives (time, cost, quality) are known

GP 2.1.2

2. Cost, time and functionality are planned

GP 2.1.5

5. Authorities and responsibilities are clearly assigned

GP 2.1.3

GP 2.1.4

3.+4. Process performance is monitored and adjusted to achieve the objectives

GP 2.1.7

7. Interfaces are managed

GP 2.1.6

6. Resources are identified and available

Overview

Capability Level 2: The Managed Process

PA 2.2: Work Product Management
GP 2.2.1 – GP 2.2.4

GP 2.2.1

1. Requirements and approval criteria
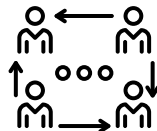   for the work products are defined

GP 2.2.2

2. Requirements for the control of the
   work products are defined

GP 2.2.4

4. Work products are verified

GP 2.2.3

3. Work products are controlled

PA 3.1: Process definition
GP 3.1.1 – GP 3.1.5

GP 3.1.1   **1. A standard process including tailoring guidelines is defined**

GP 3.1.2   **2. Sequence and interaction between processes are identified**

GP 3.1.3   **3. Roles and competencies are identified**

GP 3.1.4   **4. The infrastructure needed for the process performance is defined**

GP 3.1.5   **5. Appropriate methods for monitoring the effectiveness and suitability of the standard process are determined**

PA 3.2: Process deployment
GP 3.2.1 – GP 3.2.6

GP 3.2.1   **1. The process is established**

GP 3.2.2   **2. Tasks, competencies and responsibilities are assigned**

GP 3.2.3   **3. Necessary competencies are ensured**

GP 3.2.4   **4. Resources/ information are available**

GP 3.2.5   **5. Infrastructure is available**

GP 3.2.6   **6. Process performance data is collected**

Overview

Process capability Level 4: Predictable process

The previously described Established process now operates predictively within defined limits to achieve its process outcomes. Quantitative management needs are identified, measurement data are collected and analysed to identify assignable causes of variation. Corrective action is taken to address assignable causes of variation.

The following process attributes, together with the previously defined process attributes, demonstrate the achievement of this level:

PA 4.1 Quantitative analysis process attribute

The quantitative analysis process attribute is a measure of the extent to which information needs are defined, relationships between process elements are identified and data are collected. As a result of full achievement of this process attribute:

a) The process is aligned with quantitative business goals;

b) Process information needs in support of relevant defined quantitative business goals are established;

c) Process measurement objectives are derived from process information needs;

d) Measurable relationships between process elements that contribute to the process performance are identified;

e) Quantitative objectives for process performance in support of relevant business goals are established;

f) Appropriate measures and frequency of measurement are identified and defined in line with process measurement objectives and quantitative objectives for process performance;

g) Results of measurement are collected, validated and reported in order to monitor the extent to which the quantitative objectives for process performance are met.

1 *Information needs typically reflect management, technical, project, process or product needs.*

GP 4.1.1
Identify business goals. [ACHIEVEMENT a]
Business goals are identified that are supported by the quantitatively measured process.

GP 4.1.2
Establish process information needs. [ACHIEVEMENT a, b]
Stakeholders of the identified business goals and the quantitatively measured process, and their information needs are identified, defined and agreed.

GP 4.1.3
Derive process measurement objectives from process information needs. [ACHIEVEMENT a, c]
The process measurement objectives to satisfy the established process information needs are derived.

GP 4.1.4
Identify measurable relationships between process elements. [ACHIEVEMENT a, d]
Identify the relationships between process elements, which contribute to the derived measurement objectives.

GP 4.1.5
Establish quantitative objectives. [ACHIEVEMENT a, e]
Establish quantitative objectives for the identified measurable process elements and their relationships. Agreement with process stakeholders is established.

GP 4.1.6
Identify process measures that support the achievement of the quantitative objectives. [ACHIEVEMENT a, f]
Detailed measures are defined to support monitoring, analysis and verification needs of the quantitative objectives.
Frequency of data collection is defined.
Algorithms and methods to create derived measurement results from base measures are defined, as appropriate.
Verification mechanism for base and derived measures is defined.

1 *Typically, the standard process definition is extended to include the collection of data for process measurement.*

PA 4.1

GP 4.1.7 **Collect product and process measurement results through performing the defined process.** [ACHIEVEMENT a, g]

Data collection mechanism is created for all identified measures.

Required data is collected within the defined frequency, and recorded.

Measurement results are analyzed, and reported to the identified stakeholders.

> 2 *A product measure can contribute to a process measure, e.g. the productivity of testing characterized by the number of defects found in a given timeframe in relation to the product defect rate in the field.*

The quantitative control process attribute is a measure of the extent to which objective data are used to manage process performance that is predictable. As a result of full achievement of this process attribute:

a) Techniques for analyzing the collected data are selected;

b) Assignable causes of process variation are determined through analysis of the collected data;

c) Distributions that characterize the performance of the process are established;

d) Corrective actions are taken to address assignable causes of variation;

e) Separate distributions are established (as necessary) for analyzing the process under the influence of assignable causes of variation.

Generic practices 4.2.1 - 4.2.3

GP 4.2.1
Select analysis techniques. [ACHIEVEMENT a]
Analysis methods and techniques for control of the process measurements are defined.

GP 4.2.2
Establish distributions that characterize the process performance. [ACHIEVEMENT c]
Expected distributions and corresponding control limits for measurement results are defined.

GP 4.2.3
Determine assignable causes of process variation. [ACHIEVEMENT b]
Each deviation from the defined control limits is identified and recorded.
Determine assignable causes of these deviations by analyzing collected data using the defined analysis techniques.
All deviations and assigned causes are recorded.

GP 4.2.4 **Identify and implement corrective actions to address assignable causes.** [ACHIEVEMENT d]
Corrective actions are determined, recorded, and implemented to address assignable causes of variation.
Corrective action results are monitored and evaluated to determine their effectiveness.

GP 4.2.5 **Establish separate distributions for analyzing the process** [ACHIEVEMENT e]
Separate distributions are used to quantitatively understand the variation of process performance under the influence of assignable causes.

The previously described Predictable process is now continually improved to respond to change aligned with organizational goals. The following process attributes, together with the previously defined process attributes, demonstrate the achievement of this level:

PA 5.1 Process innovation process attribute

The process innovation process attribute is a measure of the extent to which changes to the process are identified from investigations of innovative approaches to the definition and deployment of the process. As a result of full achievement of this process attribute:

a) Process innovation objectives are defined that support the relevant business goals;

b) Appropriate data are analysed to identify opportunities for innovation;

c) Innovation opportunities derived from new technologies and process concepts are identified;

d) An implementation strategy is established to achieve the process innovation objectives.

Generic practices 5.1.1 - 5.1.2

GP 5.1.1 **Define the process innovation objectives for the process that support the relevant business goals.** [ACHIEVEMENT a]
New business visions and goals are analyzed to give guidance for new process objectives and potential areas of process innovation.

GP 5.1.2 **Analyze data of the process to identify opportunities for innovation.** [ACHIEVEMENT b]
Common causes of variation in process performance are identified and analyzed to get a quantitative understanding of their impact.Identify opportunities for innovation based on the quantitative understanding of the analyzed data.

PA 5.1

GP 5.1.3

Analyze new technologies and process concepts to identify opportunities for innovation. [ACHIEVEMENT c]
Industry best practices, new technologies and process concepts are identified and evaluated.Feedback on opportunities for innovation is actively sought.Emergent risks are considered in evaluating improvement opportunities.

GP 5.1.4

Define and maintain an implementation strategy based on innovation vision and objectives. [ACHIEVEMENT d]
Commitment to innovation is demonstrated by organizational management including the process owner(s) and other relevant stakeholders.
Define and maintain an implementation strategy to achieve identified opportunities for innovation and objectives.
Based on implementation strategy process changes are planned, prioritized based on their impact on defined innovations.
Measures that validate the results of process changes are defined to determine the expected effectiveness of the process changes and the expected impact on defined business objectives.

The process innovation process implementation attribute is a measure of the extent to which changes to the definition, management and performance of the process achieves the relevant process innovation objectives. As a result of full achievement of this process attribute:

a) Impact of all proposed changes is assessed against the objectives of the defined process and standard process;

b) Implementation of all agreed changes is managed to ensure that any disruption to the process performance is understood and acted upon;

c) Effectiveness of process change on the basis of actual performance is evaluated against the defined product requirements and process objectives.

Generic practices 5.2.1 - 5.2.2

GP 5.2.1
Assess the impact of each proposed change against the objectives of the defined and standard process.
[ACHIEVEMENT a] New business visions and goals are analyzed to give guidance for new process objectives and potential areas of process innovation. Objective priorities for process innovation are established. Specified changes are assessed against product quality and process performance requirements and goals. Impact of changes to other defined and standard processes is considered.

GP 5.2.2
Manage the implementation of agreed changes. [ACHIEVEMENT b]
A mechanism is established for incorporating accepted changes into the defined and standard process(es) effectively and completely.
The factors that impact the effectiveness and full deployment of the process change are identified and managed, such as:
• Economic factors (productivity, profit, growth, efficiency, quality, competition, resources, and capacity);
• Human factors (job satisfaction, motivation, morale, conflict/cohesion, goal consensus, participation, training, span of control);
• Management factors (skills, commitment, leadership, knowledge, ability, organizational culture and risks);

PA 5.2

GP 5.2.2

• Technology factors (sophistication of system, technical expertise, development methodology, need of new technologies)

Training is provided to users of the process.

Process changes are effectively communicated to all affected parties.

Records of the change implementation are maintained.

GP 5.2.3

Evaluate the effectiveness of process change. [ACHIEVEMENT c]

Performance and capability of the changed process are measured and evaluated against process objectives and historical data. A mechanism is available for documenting and reporting analysis results to management and owners of standard and defined process. Measures are analyzed to determine whether the process performance has improved with respect to common causes of variations. Other feedback is recorded, such as opportunities for further innovation of the predictable process.

ASSESSMENT GUIDE

Certification Level	Additional Requirements & Capability (compared to the lower assessor grade)	
"intacs™ certified **Instructor Competent Level**" (qualified for all PAMs; domain specific qualifications may apply)	• Capable of performing competent assessor trainings • Approval by a certified instructor (observation process)	
"intacs™ certified **Instructor Provisional Level**" (qualified for all PAMs; domain specific qualifications may apply)	• Capable of performing provisional assessor trainings • Proven teaching skills • Approval by a certified instructor (observation process)	
"intacs™ certified **Principal Assessor**" (qualified for all PAMs; domain specific qualifications may apply)	• Continuously and actively contributes to the international ISO/IEC 15504-5/33000xx community's knowledge & best practices • Min. 8 assessment experiences	
"intacs™ certified **Competent Assessor**" (ISO/IEC 15504-5, ISO/IEC 330xx, Automotive SPICE®, TestSPICE, ISO 20000 PAM)	• Capable of leading assessments • Approval by a certified assessor (observation process) • Min. 5 assessment experience • 2 additional trainings & one exam	
"intacs™ certified **Provisional Assessor**" (ISO/IEC 15504-5, ISO/IEC 330xx, Automotive SPICE®, TestSPICE, ISO 20000 PAM)	• Capable of acting as a co-assessor • Little or no assessment experience • Passed training course & exam	

intacs™ Experience Evidence (EE)

To be granted or have renewed an assessor grade you have to prove that you maintain technical skills and experience with using the standard by collecting Experience Evidence (EE) according to the intacs EE concept. Find more information here:
https://vdaqmc.de/en/software-processes/automotive-spice/certification/:
https://intacs.info/

EE Type	EE Name	EE Description
EE-AT	Assessment Team member	50h Co-Assessor in an ISO/IEC 15504/330xx compliant assessment
EE-AL	Assessment Leading	50h Lead Assessor in an ISO/IEC 15504/330xx compliant assessment
EE-IP	Internal Passive	6h participation in an internal SPICE event hold by intacs certified assessors
EE-EP	External Passive	6h participation in an external and intacs acknowledged SPICE event
EE-AC	Active Contribution	Contributions to the SPICE community on how to comprehend and apply SPICE
EE-CT	Course training	Delivering an intacs assessor training course

Intacs™ Requirements for Provisional Assessor Automotive SPICE™ (valid for 3 years)

	Requirements for receiving assessor certification	Requirements for assessor grade renewal
Provisional	▪ Passed provisional assessor training and examination ▪ Payment of fee (450 EUR in 2022) ▪ No assessment experience and no EE required	▪ Payment of fee (450 EUR in 2022)

A-TEAM

	Requirements for receiving assessor certification	Requirements for assessor grade renewal
Competent	▪ intacs Provisional Assessor Certification ▪ 4 years of professional experience in development of technical complex systems or quality assurance, confirmed by employer or customer ▪ Attended the course „Introduction to the VDA Automotive SPICE Guidelines" ▪ Passed competent assessor training and examination in last 12 months ▪ 5 EE-AT in last 60 months (all led by an certified Automotive SPICE assessor; at least 4 out of 5 EE-AT in Automotive) ▪ Positive assessment lead observation by an intacs certified Competent or Principal assessor ▪ Payment of fee (450 EUR in 2022)	▪ Payment of fee (450 EUR in 2022) ▪ 6 EEs in last 36 months (Only EEs gathered after the certification as Competent Assessor are valid):
Principal	▪ intacs Competent Assessor Certification ▪ 3 EE-AL gathered in at least 3 assessments plus 2 EE-AC plus one more EE (AT/AL/IP/EP/AC) ▪ All EEs have to be granted within the last 36 months and only EE gathered after the certification as Competent Assessor are valid. ▪ Payment of fee (450 EUR in 2022)	▪ Payment of fee (450 EUR in 2022) ▪ 6 EEs in last 36 months 6 EEs in last 36 months (Only EEs gathered after the certification as Principal Assessor are valid):

Competent renewal EE table:

EE Type	EE Type	EE Type	EE Type	EE Type	EE Type
AT/ AL	AL	AL	EP/AC	AT/AL/ IP/EP/ AC	AT/ AL/ IP/ EP/ AC

Principal renewal EE table:

EE Type	EE Type	EE Type	EE Type	EE Type	EE Type
AT/AL	AL	AL	AC	AC	AT/AL/IP/ EP/AC

Requirements for receiving assessor certification	Requirements for assessor grade renewal

Provisional Course

Requirements for receiving assessor certification
▪ Intacs Principal Assessor Certification
▪ Having demonstrated didactic skills, independent and objectively confirmed (for detail see intacs.info certification center)
▪ All EEs have to be granted within the last 36 months and only EE gathered after the certification as Principal Assessor are valid.
▪ Positive provisional assessor training course observation by an intacs acknowledged certified instructor
▪ Payment of fee (450 EUR in 2022).

Requirements for assessor grade renewal:

▪ Payment of fee (450 EUR in 2022)

▪ 7 EEs in last 36 months: (Only EEs gathered after the certification as Instructor Provisional Level are valid):

EE Type	EE Type	EE Type	EE Type	EE Type	EE Type	EE Type
AT/AL	AL	AL	EP or AC	AC or CT	AC or CT	CT

Competent Course

Requirements for receiving assessor certification
▪ intacs Instructor Provisional Course
▪ All EEs have to be granted within the last 36 months and only EE gathered after the certification as Principal Assessor are valid.
▪ Positive competent assessor training course observation by an intacs acknowledged certified Competent instructor
▪ Payment of fee (450 EUR in 2022)

Requirements for assessor grade renewal:

▪ Payment of fee (450 EUR in 2022)

▪ 7 EEs in last 36 months (Only EEs gathered after the certification as Instructor Competent Level are valid)::

EE Type	EE Type	EE Type	EE Type	EE Type	EE Type	EE Type
AT or AL	AL	AL	AC/CT	AC/CT	AT/AL/ IP/EP/ AC/ CT	CT

A-TEAM

Two different Automotive SPICE® assessment objectives and their impact on the rating

OBJECTIVE:
Identification of process related product risks

- Classical objective

- Typically the customer aims to identify the product risks resulting from process weaknesses

- Selected to measure completeness of process performance

- Weaknesses in one process affect all following processes

- Insufficient inputs, which should be approved according to schedule, lead to downrating

OBJECTIVE:
Evaluation of process improvement

- Improvement objective

- Typically the organization aims to identify effectiveness of process changes

- Selected to measure the capability of recently modified processes

- Weaknesses in one process do NOT affect following processes

- Insufficient inputs do NOT lead to downrating

- Focus on small subsets e.g. golden samples

→ This objective might lead to different rating results

Two different Automotive SPICE® assessment objectives and their impact on the rating

1. The assessment objective "Identification of process related product risks" is selected to measure process performance completeness

System Requirements Spec

40% of spec is available

Test Spec
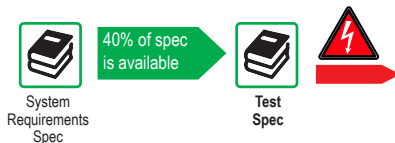
The test process can only be executed for the given 40% of the system requirements.
⟶ **rating < L; Level 0**

Idea of completeness

Good process performance with insufficient input from other processes leads to a lower rating. The argument is, that with insufficient input, the process cannot be executed without risks.

Typically the customer is interested to identify the process related product risks.

2. The assessment objective "Evaluation of process improvement" is selected to measure the capability of recently implemented processes

System Requirements Spec

40% of spec is available

Test Spec
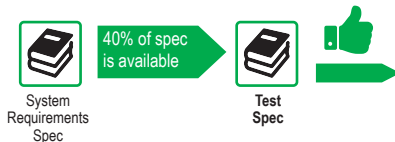
For the given 40% of the system requirements the test process is executed well ⟶ **rating F**

Idea of capability

Good process performance with insufficient input from other processes leads to a good rating (see example above).
The argument is, that the process is executed in a good way based on the available input.

A-INPUT

Roles and Assignments		
Sponsor, Position		
Local Coordinator		
Lead Assessor, Certification ID		
Co Assessor(s), Certification ID(s)		
Standards and Classifications		
Process Assessment Model version	Automotive SPICE 3.1	Assessment class	1, 2 or 3
Assessment Standard	ISO/IEC 33002	Independence category	A, B, C or D
Assessment Process	KM Assessment Process 4.1	VDA Guideline version	1st edition 2017
Application of VDA Assessment Guideline chapter 2.2: Assessing specific application environments		
2.2.1 Model based development	Yes/No	2.2.4 Management of 3rd party software	Yes/No
2.2.2 Agile environments	Yes/No	2.2.5 Management of platform and legacy software SW	Yes/No
2.2.3 Distributed development	Yes/No	2.2.6 Application parameters	Yes/No

Project & Product		
Company, Organizational Unit(s)	<Name(s) of the assessed …>	
Project(s)	<Name(s) of the assessed project(s)>	
Product(s), ASIL Level(s)	e.g., Braking Control Unit, ASIL D	
Application Domain(s)	Body Electronics, Integrated Services, Infotainment, Powertrain, Chassis Control	
Organization Unit Classification	Automotive Tier 1	Small/Medium-sized Enterprise	Yes/No
Assessment Scope		
Assessment purpose	"Evaluation of process improvement" or "Identify process related product risk"	
Process instances and locations	e.g., VDA scope incl. MAN.5, REU.2 in location A; SWE.1-5 for Basic-SW in location B; SWE.1-5 for Appl.-SW in location C;	
Target capability level	e.g., CL 3 for all assessed processes	
Process context category	A (part of product/delivery) or B (Entire product/delivery); if A, please specify e.g., "A subset of stakeholder requirements valid for a specific release" OR "All changes between two defined project milestones" OR "All software requirements implemented by improved processes"	

A-INPUT

Day 1			
Start	End	Topic	Participants
9:00	9:15	Kick off	Sponsor, Assessment Team
9.15	10:50	MAN.3 - Project Management - Project Level	
10:50	11:00	Break	
11:00	12:00	MAN.3 - Project Mngt. - Sub-Project/Teams	
12:00	12:30	Break	
12:30	13:30	Consolidation	
13:30	15:00	SUP.1 - Quality Assurance	
15:00	15:30	Consolidation	
15:30	17:00	SUP.8 - Configuration Management	
17:00	17:30	Consolidation	
Day 2			
Start	End	Topic	Participants
9:00	10:30	SYS.2 - System Requirements	
10:30	11.00	Consolidation	
11:00	12:15	SYS.3 - System Architecture	
12.15	13:00	Break	
13:00	13.30	Consolidation	
13.30	15:00	SWE.1 - SW Requirements	
15:00	15:30	Consolidation	
15:30	17:00	SWE.2 - SW Architecture	
17:00	17:30	Consolidation	

Day 3			
Start	End	Topic	Participants
9:00	10:15	SWE.3 - SW Construction	
10:15	10:45	Consolidation	
10:45	12:15	SWE.4 - SW Module Test	
12:15	13:00	Break	
13:00	13:30	Consolidation	
13:30	15:00	SWE.5 - SW Integration and Integr. Test	
15:00	15:30	Consolidation	
15:30	17:00	SWE.6 - SW Qualification	
17:00	17:30	Consolidation	
Day 4			
Start	End	Topic	Participants
9:00	10:15	SYS.4 - System Integration and Integr. Test	
10:15	10.45	Consolidation	
10:45	12:15	SYS.5 - System Qualification	
12.15	13:00	Break	
13:00	13.30	Consolidation	
13.30	14:45	SUP.9 - Problem Resolution Management	
14:45	15:15	Consolidation	
15:15	17:00	SUP.10 - Change Request Management	
17:00	17:30	Consolidation	

A-INPUT

Day 5			
Start	End	Topic	Participants
9:00	11:00	Consolidation	
11.00	12:00	Open Session	
12:00	13:00	Break	
13:00	15:00	Consolidation	
15:00	16:00	Presentation of Preliminary Results	

Assessment class:

1. 4 or more process instances per process
   If there are fewer than the required number of process instances available in the organization, all process instances shall be selected.

2. 2 or more process instances per process
   If there are fewer than … (ditto)

3. else

Example for a specific application environment:
2.2.5 Management of platform and legacy SW

No (i.e. the Management of platform and legacy software is not applied): *The assessment covers the current project and former projects in which platform and legacy software were developed. The platform and legacy software development is assessed and rated in separate instances.*

	Type A	Type B	Type C	Type D
Body performing the assessment	The body performing the assessment is independent of the organization being assessed		The body performing the assessment is part of the organization being assessed	The body performing the assessment may or may NOT be independent being assessed
Competent assessor	Independent of the organization being assessed	Independent of the organization being assessed	Adequate separation of responsibility from personnel in other functions	Need NOT be independent of the organization being assessed
Assessors (other than competent asessor)		May be from the organization being assessed provided clear separation of the reponsibilities of the assessors from personnel in other functions		

A-INPUT

Onsite

Plan assessment → Brief team & organization → Perform interview → Consolidate evidence → Clarify gaps in open session

	Plan assessment	Brief team & organization	Perform interview	Consolidate evidence	Clarify gaps in open session
SP: Sponsor	S	S			
LA: Lead Assessor	R	R	R	R	R
CA: Co-Assessor	S	S	S	S	S
LC: Local Contact	S	S	S	S	S
IN: Interviewee	S	S	S		S

	Plan assessment	Brief team & organization	Perform interview	Consolidate evidence	Clarify gaps in open session
Description	The LA clarifies planning input & plans the assessment. All participants agree to the agenda. The assessors sign the NDA.	The LA briefs the CA & LC. The SP explains the assessment purpose. The LA briefs the organization.	The LA assign an interviewer to lead the interview. The IN answers. The assessors take notes. The LC collects evidences.	The assessors consolidate the information & identify gaps. The assessors draft a 1st rating	The assessors ask what is needed to close the information gaps. The IN answers. The assessors take notes. The LC collects evidence.
Output	Assessm. Scope Assessm. Plan Assessm. Agenda NDA	Kick-off presentation	Notes & evidence	Strengths, potentials & information gaps	Notes & evidence

KM Assessment Process 4.1 is compliant to the documented assessment process (p. 248) in the VDA Automotive Spice Guideline, Part 2.

Onsite

| Rate PAs & capability levels | Feedback to organization | Feedback to sponsor | Report assessment | Plan improvement |

	Rate PAs & capability levels	Feedback to organization	Feedback to sponsor	Report assessment	Plan improvement
SP: Sponsor		S	S	S	R
LA: Lead Assessor	R	R	R	R	S
CA: Co-Assessor	S	S		S	S
LC: Local Contact		S		S	S
IN: Interviewee		S		S	

	Rate PAs & capability levels	Feedback to organization	Feedback to sponsor	Report assessment	Plan improvement
Description	The assessors consolidate information. The assessors perform the ratings and calculate levels. The assessors prepare the feedback.	The LA presents the feedback.	(optional step) The LA explains the results and answers the questions from the SP	The LC provides the list of evidences. The assessors draft & review the report. The LA sends the report. The SP, LA & CA sign the log.	The SP sets priorities and initiates related improvement workshops.
Output	Process profiles	Feedback presentation	-	Assessment report Assessment log	Improvement plan

A-INPUT

Guideline For Interviewees

Prepare for the interview

Understanding
▪ Ensure correct understanding of the SPICE process, its purpose and practices
▪ Ensure correct understanding of our strategy, process description, and needed artifacts
▪ Reflect on the last "Process Audit" and weaknesses that were detected

Presentation
▪ Prepare introduction slides
▪ Choose at least 5 examples to show that all actions are performed throughout the whole process
▪ Exercise presentation several times

Artifacts
▪ Update, release and check-in artifacts as planned
▪ Be prepared to show coverage
▪ Ensure you are able to guide the assessor through each artifact

Convince in the interview

Strategy
▪ Report your responsibility – very compactly; use the role description or ONE introduction slide for your work
▪ Show the defined process as the basis for your explanation

Consistency
▪ Explain what you do using the defined process step by step. In parallel open the artifacts and show your work
▪ Use the prepared examples and show consistency

Completeness
▪ Report progress and status
▪ Show coverage
▪ Show trends and derived actions

Start of interview
- ▪ Be friendly. Reduce stress. Ensure, that the interviewee does not feel he is being grilled. Start with a very easy question.

How to raise questions
- ▪ Start with an 'open' question to get a lot of information. Use 'closed' questions to get precise or detailed answers.
- ▪ Be an active listener. Repeat what you have understood if you need additional confirmation.

Do not …
- ▪ Never assume any activities or work products
- ▪ Never phrase a question in a way that indicates a certain answer or expectation
- ▪ Never blame a person. Never provide feedback (i.e. rating or indicators for it) during interviews. Never be ironic.

Find the gaps
- ▪ Follow the feature / change request / bug report from the source to the realization, to the qualification and to closure
- ▪ Repeat at least 3 times. Check consistency and completeness. Do not get distracted by sidetracks of 'storytellers'

End of interview
- ▪ Be friendly. Reduce stress. Ensure, that the interviewee does not feel he is being grilled.
- ▪ Invite participants to the feedback presentation.

A-INPUT

N Not achieved 0% to 15%	There is little or no evidence of achievement of the defined attribute in the assessed process. **Outcome:** Outcome/achievement not existent, or content judged inacceptable.
P Partially achieved >15% to 50%	There is some evidence of an approach to, and some achievement of, the defined attribute in the assessed process. Some aspects of achievement of the attribute may be unpredictable. **Outcome:** Some outcomes/achievements implemented, but projects/OUs still incapable of reaching quality, time, or budget goals and targets
L Largely achieved > 50% to 85%	There is evidence of a systematic approach to, and significant achievement of, the defined attribute in the assessed process. Some weakness related to this attribute may exist in the assessed process. **Outcome:** Outcome/achievement implies a significant likelihood, however no certainty, of reaching quality, time, and budget goals and targets.
F Fully achieved > 85% to 100%	There is evidence of a complete and systematic approach to, and full achievement of, the defined attribute in the assessed process. No significant weaknesses related to this attribute exist in the assessed process. **Outcome:** No process risk with respect to quality, time, budget. Goals and targets identified, even in presence of imperfections.

Rating Guideline

1. **Interview** the team members who perform the process and gather evidences like affirmations and work products for each practice (of both Base Practices and Generic Practices) within the assessment scope.

2. **Clarify** how each practice is expected to be applied within the specific project, scope and schedule.

3. **Rate** the achievement of each practice based on the evidence of application using **NPLF**
   (**N**ot achieved / **P**artly achieved / **L**argely achieved / **F**ully achieved)

N	P (-)	P (+)	L (-)	L (+)	F
0% 15%	32,5%	50%	67,5%	85%	100%

4. **Rate** the degree to which the related Process Attributes (PAs) are achieved using NPLF.

5. If applicable, **aggregate** the PA ratings of several process instances (but never of different processes)
   a. Assign values for each NPLF rating: N → 0; P– → 1; P+ → 2; L– → 3; L+ → 4; F → 5
   b. Assign each value a pre-defined weighting, round the arithmetic mean and convert back

6. **Check** for rating consistency

7. **Calculate** the capability level of the related process: a 'F' rating of the PAs is expected – start with capability level 1 and climb up level by level. Only at the highest level is a PA rating of 'L' accepted.

Process xyz	PA1.1	PA2.1	PA2.2	PA3.1	PA3.2	PA4.1	PA4.2	PA5.1	PA5.2
Capability Level 1	L/F								
Capability Level 2	F	L/F	L/F						
Capability Level 3	F	F	F	L/F	L/F				

NPLF

Assessment Report

The lead assessor reports the assessment team result to the sponsor.

The report includes as a minimum:

- ▪ The assessment input including constraints, if any
- ▪ The strengths and potentials per process
- ▪ The resulting capability and process attribute profiles
- ▪ The practice ratings and objective evidences
- ▪ The reasons for rule deviations, if applicable
- ▪ Unique title, version number, change history, distribution list

The report should also include:

- ▪ A Management Summary
- ▪ Basic recommendation for next improvement steps

In addition the lead assessor asks the sponsor to sign the assessment log.

IT ISN'T ONLY AUTOMOTIVE SPICE WHICH WE SIMPLIFY

Acceptance of processes is the key

Accepted processes are lived and make it possible to learn from each other.

Accepted processes can fulfil norms – and provide benefit.

The focus lies on the most important process results.
The responsibility for content and release are clear.
Participants agree on the most direct path to the goal.

Accepted processes are based on simple rules.

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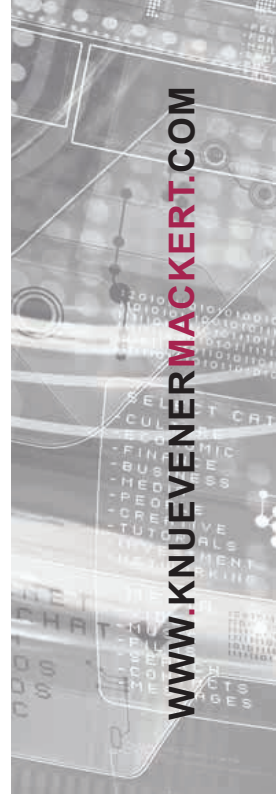
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