AUTOMOTIVE SPICE® v3.1

POCKET GUIDE

EXTENDED VDA SCOPE

ASPICE v3.1

KUGLER MAAG CIE
besser mit uns

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In this pocket guide the processes of the so-called **extended VDA scope** (previously known as HIS scope) and the Process capability levels 1-3 are shown in detail.

For easy orientation, the following colors are used:

- **System Engineering Process Group**
- **Software Engineering Process Group**
- **Other process groups**
- **Process capability level**

107 **Evaluation, verification criteria and compliance in Automotive SPICE®**

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The purpose of this pocket guide is to provide you with a selection of widely used processes and most important model components of Automotive SPICE® v3.1 in a format as small as possible. We hope that it will be great convenience during your daily work or when performing assessments!

Kugler Maag Cie provides Automotive SPICE® training courses certified according to the International Assessor Certification Scheme (intacs™).

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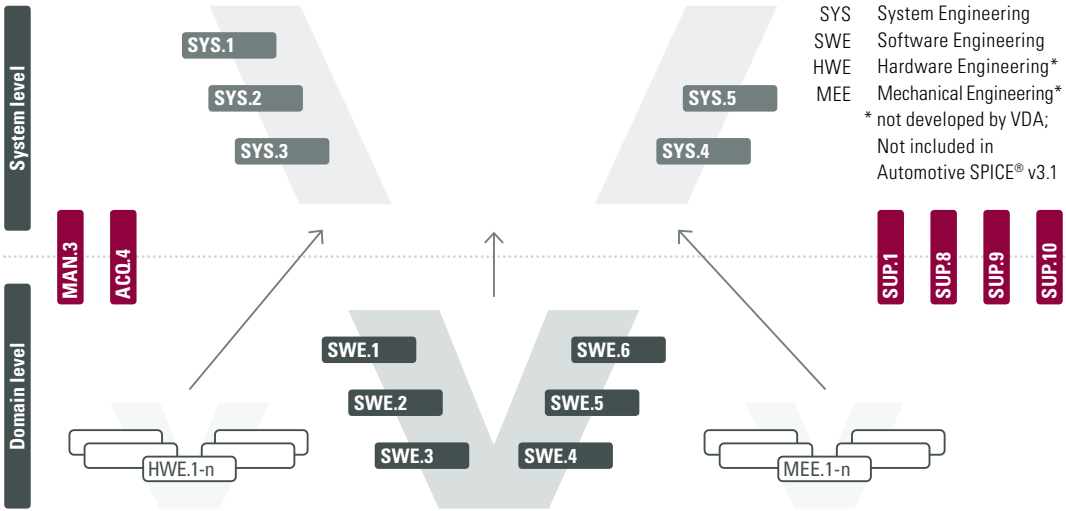
Automotive SPICE® at a glance

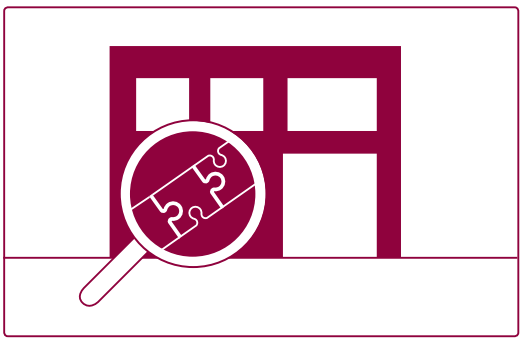
Automotive SPICE® is a standard used as a framework for improving and evaluating processes. It applies to the development of mechatronic systems focusing on the software and system parts of the product. However, as of version 3.1 of the standard it is possible to add further engineering disciplines (e.g. hardware engineering, mechanical engineering etc.) and the corresponding domain-specific processes to the scope of Automotive SPICE®, depending on the product to be developed.



Automotive SPICE® application

Companies within the automotive industry use Automotive SPICE® either …

… as a status determination for internal process improvement or …



… in order to determine the process quality of a supplier (capability determination) and thereby as a risk assessment tool during the supplier selection.

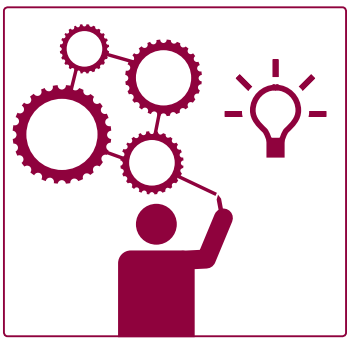
The application of Automotive SPICE® is a prerequisite for becoming and remaining a supplier of the most European car manufacturers. Because of the continuously evolving international interweaving of the supplier relations, the application of the standard has been expanded to Asia and the USA.

Automotive SPICE® and the organization

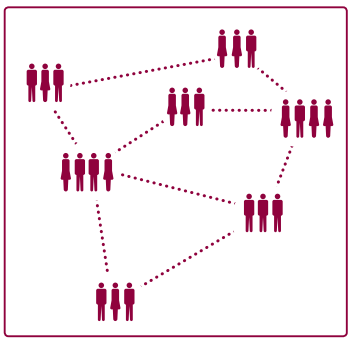
Besides being a status determination and risk assessment tool, Automotive SPICE® can also play an important role in supporting an organization achieve its goals, by helping it deal with three critical questions:

What needs to be done to achieve the set goals without falling into the common every day process pitfalls?

How can the cascading and implementation of every top-level goal down to the bits and bytes be ensured?



Can an organization-wide process landscape be established in which the coordination of cross-unit activities is a prerequisite?

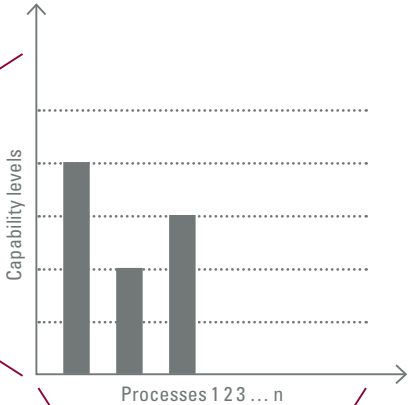


It goes without saying that in this context Automotive SPICE® can only be part of an integrated solution including appropriate development methods and an organizational culture that encourages initiatives, communication and decision decentralization.

Automotive SPICE® key concept

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



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

Process dimension process overview

Primary Life Cycle Processes (LCP)

Acquisition Process Group

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.1	Supplier Tendering
SPL.2	Product Release

Systems Engineering Process Group

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

Software Engineering Process Group

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

Supporting LCP

Supporting Process Group

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

Organizational LCP

Management Process Group

MAN.3	Project Management
MAN.5	Risk Management
MAN.6	Measurement

Process Improvement Process Group

PIM.3	Process Improvement

Reuse Process Group

REU.2	Reuse Program Management

LCP = Life Cycle Processes

Process dimension process elements

For what is the process needed?

Which work products could potentially be delivered to prove that the process purpose has been achieved?

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			

Base practices 1-5

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.*

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

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

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

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

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

Which results should be achieved by the process?

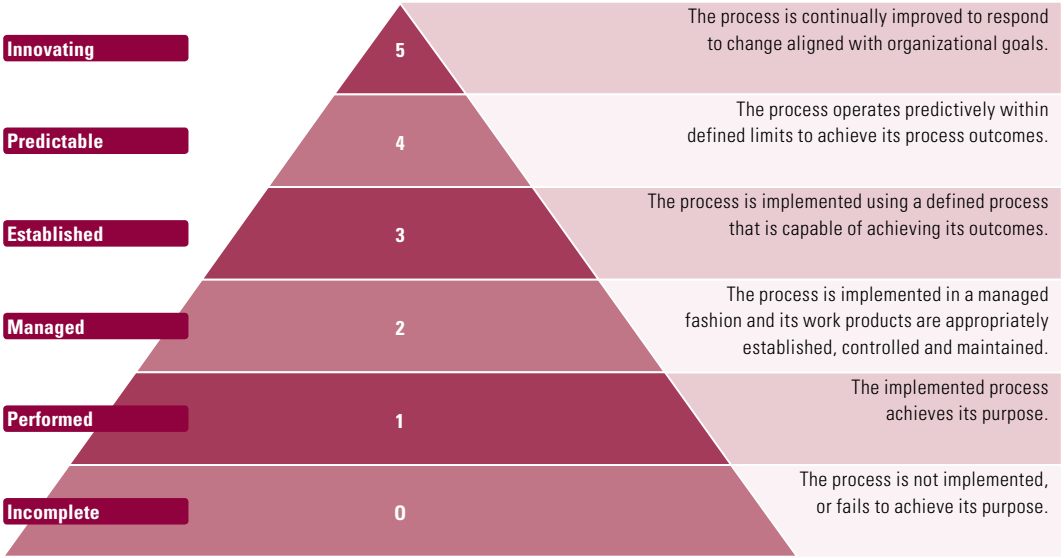
Based on experience, what could be done for generating the process outcomes and fulfilling the process purpose?

In Automotive SPICE® process results take the key position!

Know-how, experience and imagination are prerequisites for the process designers to define the best and most suitable way for their process to achieve the required results!

Capability dimension overview

The capability dimension consists of capability levels (CL) which are further subdivided into process attributes (PA).
The process attributes provide the measurable characteristics to determine the process capability.



Process capability determination key information

What is examined?	Typically a project, regarding a freely selectable process scope out of Automotive SPICE®. **For capability level 3** the assessors additionally evaluate organizational standard processes and interview experts regarding these topics.
What happens in the assessment?	A team of assessors interviews persons that use the processes in the assessed project and examines documents, tools and databases.
What is the result?	Capability profile (achieved levels), management summary, per process statements about strengths, weaknesses, risks, and screened evidences.

Process capability determination

The capability levels are determined by rating the process attribute for each capability level.
The rating is made using the NPLF rating scale. A capability level is achieved when its process attributes are rated with an L or F and all process attributes of lower capability levels are rated with an F.

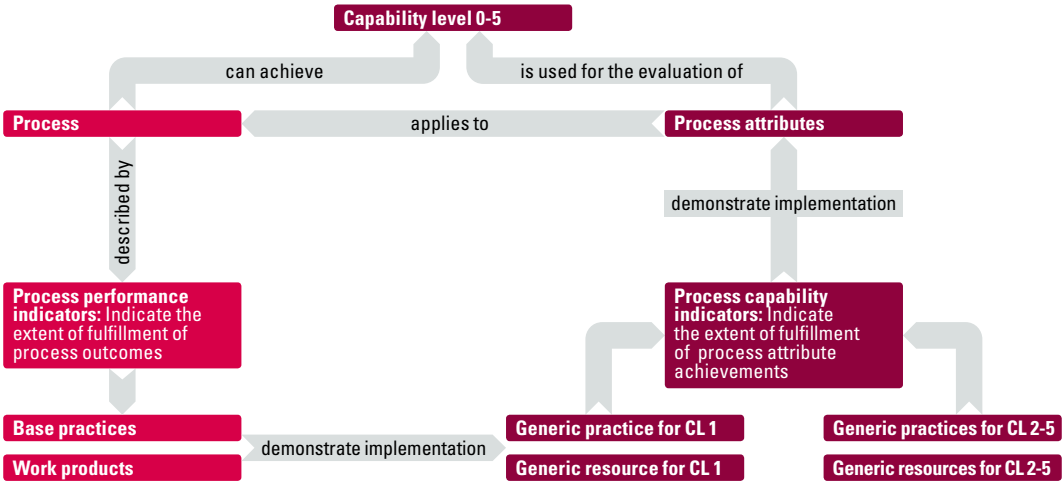
	PA1.1	PA2.1	PA2.2	PA3.1	PA3.2
Capability level 3	F	F	F	L or F	L or F
Capability level 2	F	L or F	L or F		
Capability level 1	L or F				

The NPLF rating scale

N	Process attribute *not* achieved	0 to ≤ 15% achievement
P	Process attribute *partially* achieved	> 15% to ≤ 50% achievement
L	Process attribute *largely* achieved	> 50% to ≤ 85% achievement
F	Process attribute *fully* achieved	> 85% to ≤ 100% achievement

Process capability determination indicators

Automotive SPICE® offers indicators that are used by the assessors to determine whether a certain capability level is achieved. The indicators should not be considered as a mandatory set of checklists to be followed.



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			

Base practices 1-5

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.*

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.*

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

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

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

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

Base practices 1-5

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.*

Base practices 6-11

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

Base practices 12-13

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.*

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			

Base practices 1-2

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.*

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.*

Base practices 3-6

BP 3 **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.*

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

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

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

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

Base practices 1-5

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 dependent 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 1, 2, 3, 4, 5	15-16	Improvement opportunity	Outcome 3, 4

Base practices 1-6

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

3 *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

Base practices 7-8

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			

Base practice 1

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.*

Base practices 2-8

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 plan	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			

Base practices 1-3

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.*

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.*

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

Base practices 4-8

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

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

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.*

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.*

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.*

Base practices 9

BP 9 **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.*

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			

Base practices 1-5

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.*

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.*

BP 3 **Record the status of problems.** A status according to the status model is assigned to each problem to facilitate tracking. Outcome 6

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.*

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

Base practices 6-9

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

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).*

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

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.*

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. bi-directional 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

Base practices 1-4

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.*

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

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

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

Base practices 5-8

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.*

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

BP 7 **Track change requests to closure.** Change requests are tracked until closure. Feedback to the initiator is provided. Outcome 7, 8

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.*

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			

Base practices 1-4

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

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.*

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

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.*

Base practices 5-8

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.*

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.*

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.*

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.*

Base practices 9-10

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

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.*

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 1, 2, 3, 4, 5, 6	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			

Base practice 1

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.*

Base practices 2-7

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 of 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.*

BP 7 **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.*

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			

Base practices 1-8

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.*

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			

Base practices 1-4

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

Base practices 5-6

BP 5 **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.*

BP 6 **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

Base practices 1-4

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.*

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.*

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.*

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

Base practices 5-8

BP 5 **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.*

BP 6 **Establish bidirectional traceability.** Establish bidirectional traceability between stakeholder requirements and system requirements. Outcome 6

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

BP 7 **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.*

BP 8 **Communicate agreed system requirements.** Communicate the agreed system requirements and updates to system requirements to all relevant parties. Outcome 8

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			

Base practices 1-5

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.*

BP 2 **Allocate system requirements.** Allocate the system requirements to the elements of the system architectural design. Outcome 2

BP 3 **Define interfaces of system elements.** Identify, develop and document the interfaces of each system element. Outcome 3

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.).*

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.*

Base practices 6-8

BP 6 **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.*

BP 7 **Ensure consistency.** Ensure consistency between system requirements and 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.*

BP 8 **Communicate agreed system architectural design.** Communicate the agreed system architectural design and updates to system architectural design to all relevant parties. Outcome 6

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 and test results is established; and
8. results of the system integration test are summarized and communicated to all affected parties.

Output work products

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			

Base practices 1-2

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

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

Base practices 3-4

BP 3 **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 timeliness 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).*

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.*

Base practices 5-9

BP 5 **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

BP 6 **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.*

BP 7 **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.*

BP 8 **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.*

BP 9 **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.*

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

Base practice 1

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

Base practices 2-7

BP 2 **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 test strategy. The test specification shall be suitable to provide evidence for compliance of the integrated system with the system qualification requirements. Outcome 2

BP 3 **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

BP 4 **Test integrated system.** Test the integrated system using the selected test cases. Record the system test results and logs. Outcome 4

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

BP 5 **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.*

BP 6 **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.*

BP 7 **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.*

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

Base practices 1-3

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 non-functional 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.*

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.*

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.*

Base practices 4-6

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.).*

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.*

BP 6 **Establish bidirectional traceability.** Establish bidirectional traceability between system requirements and software requirements. Establish bidirectional traceability between 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.*

Base practices 7-8

BP 7 **Ensure consistency.** Ensure consistency between system requirements and software requirements. Ensure consistency between 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 have76 to be ensured between stakeholder requirements and software requirements.*

BP 8 **Communicate agreed software requirements.** Communicate the agreed software requirements and updates to software requirements to all relevant parties. Outcome 8

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 requirement specification	Outcome 3
13-19	Review record	Outcome 5			

Base practices 1-5

BP 1 **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.*

BP 2 **Allocate software requirements.** Allocate the software requirements to the elements of the software architectural design. Outcome 2

BP 3 **Define interfaces of software elements.** Identify, develop and document the interfaces of each software element. Outcome 3

BP 4 **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.*

BP 5 **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.*

Base practices 6-9

BP 6 **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.*

BP 7 **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.*

BP 8 **Ensure consistency.** Ensure consistency between software requirements and software architectural design. Outcome 1, 2, 5, 6

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

BP 9 **Communicate agreed software architectural design.** Communicate the agreed software architectural design and updates to software architectural design to all relevant parties. Outcome 6

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			

Base practices 1-5

BP 1 **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

BP 2 **Define interfaces of software units.** Identify, specify and document the interfaces of each software unit. Outcome 2

BP 3 **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.*

BP 4 **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.*

BP 5 **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.*

Base practices 6-8

BP 6 **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.*

BP 7 **Communicate agreed software detailed design.** Communicate the agreed software detailed design and updates to the software detailed design to all relevant parties. Outcome 5

BP 8 **Develop software units.** Develop and document the executable representations of each software unit according to the software detailed design. Outcome 6

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	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

Base practices 1-4

BP 1 **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.*

BP 2 **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.*

BP 3 **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.*

BP 4 **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.*

Base practices 5-7

BP 5 **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 unit test specification and unit test results. Outcome 4

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

BP 6 **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.*

BP 7 **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.*

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 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.

Output work products

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			

Base practices 1-2

BP 1 **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

BP 2 **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

Base practices 3-5

BP 3 **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 timeliness 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.*

BP 4 **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

BP 5 **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

Base practices 6-9

BP 6 **Perform software integration test.** Perform the software integration test using the selected test cases. Record the integration test results and logs. Outcome 6

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

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

BP 7 **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

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

BP 8 **Ensure consistency.** Ensure consistency between elements of the software architectural design and test cases included in the software integration test specification. Outcome 7

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

BP 9 **Summarize and communicate results.** Summarize the software integration test results and communicate them to all affected parties. Outcome 8

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

** Comment: In correspondence to the original Automotive SPICE v3.1 standard note #3 is omitted intentionally in this process description.*

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	13-22	Traceability record	Outcome 5
08-52	Test plan	Outcome 1	13-50	Test result	Outcome 4, 6
13-04	Communication record	Outcome 6	19-00	Strategy	Outcome 1
13-19	Review record	Outcome 5			

Base practices 1-5

BP 1 **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

BP 2 **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

BP 3 **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

BP 4 **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.*

BP 5 **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.*

Base practices 6-7

BP 6 **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.*

BP 7 **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.*

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 practice 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.

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.

Generic practices 2.1.1-2.1.3

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*

a. timely production of artifacts meeting the defined quality criteria,

b. process cycle time or frequency

c. resource usage; and

d. boundaries of the process.

2 *At minimum, process performance objectives for resources, effort and schedule should be stated.*

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.

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.

Generic practices 2.1.4-2.1.7

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.

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.

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.

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.

PA 2.2 Work product management process attribute

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.

Generic practices 2.2.2-2.2.4

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

a. distribution,
b. identification of work products and their components
c. traceability.

Dependencies between work products are identified and understood.
Requirements for the approval of work products to be controlled are defined.

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.

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.

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.

Generic practice 3.1.1

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.

Generic practices 3.1.2-3.1.5

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.

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.

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.

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.

PA 3.2 Process deployment process attribute

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 analyzed as a basis for understanding the behavior 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 3.2.1-3.2.2

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.

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.

Generic practices 3.2.3-3.2.6

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.

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.

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.

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 behaviour, suitability and effectiveness of the defined process are identified.

Data are collected and analyzed to understand the behaviour, 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.*

Automotive SPICE® and ISO 26262

By implementing Automotive SPICE®, a large part of the ISO 26262 (Road vehicles – Functional safety) requirements can also be fulfilled. The table below displays the Automotive SPICE® support for an ISO 26262 implementation.

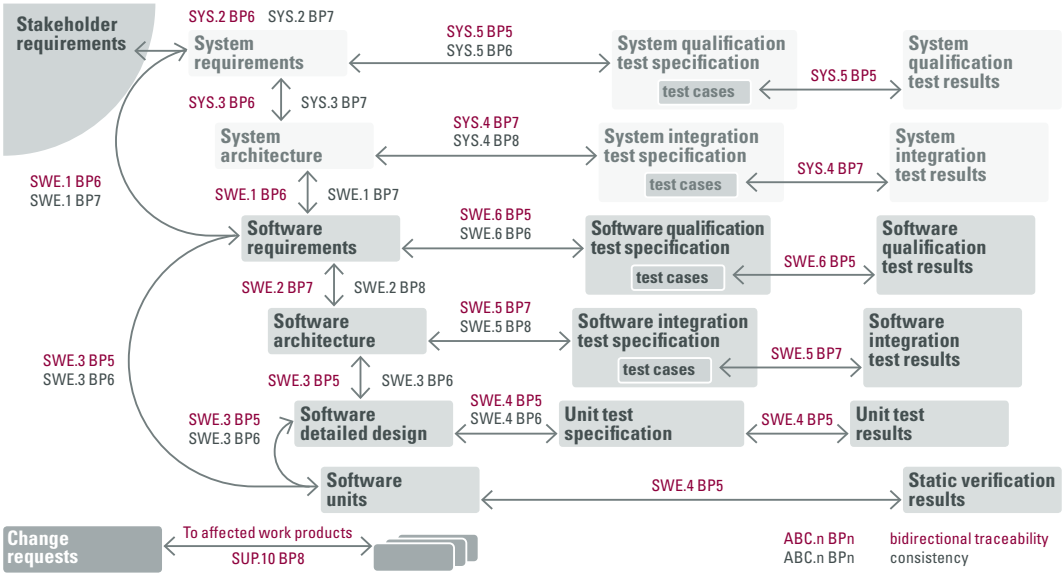
Automotive SPICE® extended VDA Scope		ISO 26262
SYS.1	Requirements Elicitation	Item definition (detailed level)
SYS.2	System Requirements Analysis	Functional safety concept
		Specification of the technical safety requirements
		Specification and management of safety requirements
SYS.3	System Architectural Design	System design
SWE.1	Software Requirements Analysis	Specification of software safety requirements
SWE.2	Software Architectural Design	Software architectural design
SWE.3	Software Detailed Design and Unit Construction	Software unit design & implementation
SWE.4	Software Unit Verification	Software unit testing
SWE.5	Software Integration and Integration Test	Software integration & testing
SWE.6	Software Qualification Test	Verification of software safety requirements
SYS.4	System Integration and Integration Test	Item integration and testing
SYS.5	System Qualification Testing	–
ACQ.4	Supplier Monitoring	Interfaces within distributed developments
SPL.2	Product Release	Release for production

Automotive SPICE® extended VDA Scope			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	
MAN.5 Risk Management		–	
SUP.1 Quality Assurance	●	Safety management during the concept phase and the product development	
	●	Functional safety assessment	
SUP.2 Verification	●	Verification	
SUP.4 Joint Review		–	
SUP.7 Documentation	●	Documentation	
SUP.8 Configuration Management	●	Configuration management	
SUP.9 Problem Resolution Management		–	
SUP.10 Change Management	●	Change management	
REU.2 Reuse Program Management		–	

● strong support ● medium support ● weak support

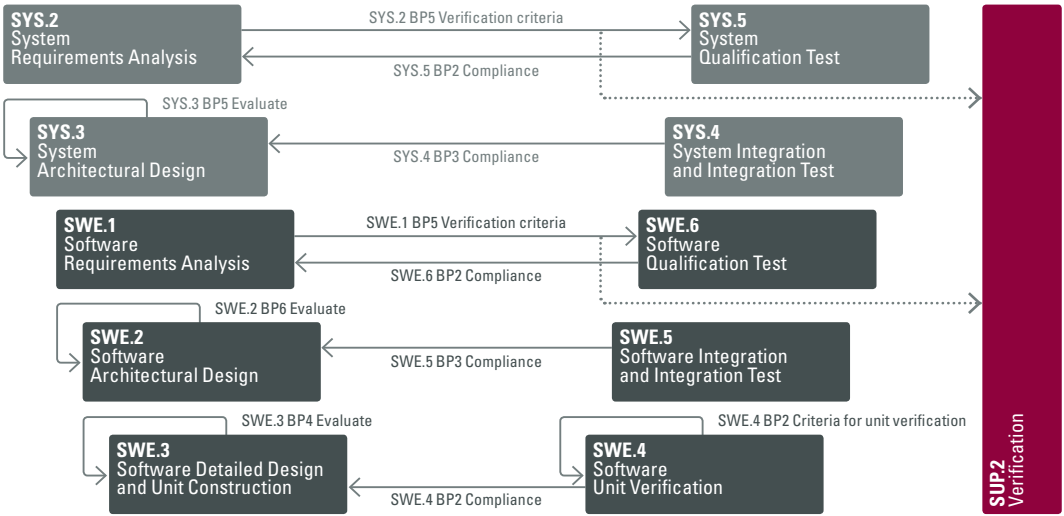
The Automotive SPICE® traceability and consistency concept

Traceability and consistency are both addressed in Automotive SPICE®. Traceability refers to the existence of meaningful references or links between work products. Consistency on the other hand addresses content and semantics.

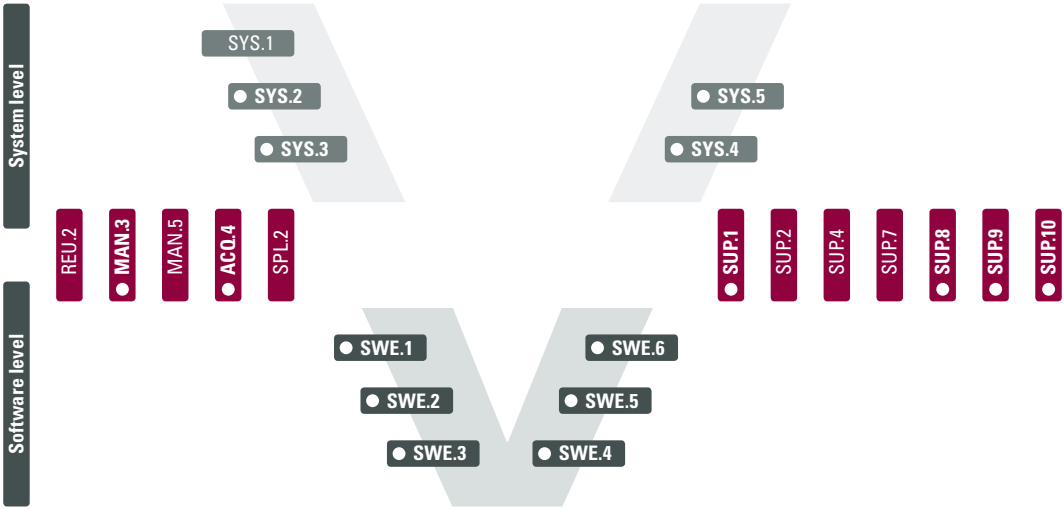


Evaluation, verification criteria and compliance in Automotive SPICE®

Verification criteria are used as input for the development of the test cases or other verification measures that ensure compliance with the requirements. **Evaluation of alternative (design) solutions** is required for system and software architectures. **Compliance with an architectural design** implies that the specified integration tests are capable of proving that interfaces and relevant interactions fulfill the architectural design.



The extended VDA Scope overview



REU Reuse Process Group
MAN Management Process Group
SPL Supply Process Group
ACQ Acquisition Process Group
SYS System Engineering Process Group
SWE Software Engineering Process Group
SUP Support Process Group

Automotive SPICE® v3.1 process overview

Acquisition Process Group

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.1	Supplier Tendering
SPL.2	Product Release

Systems Engineering Process Group

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

Software Engineering Process Group

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

Supporting Process Group

● **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.3**	**Project Management**
MAN.5	Risk Management
MAN.6	Measurement

Process Improvement Process Group

PIM.3	Process Improvement

Reuse Process Group

REU.2	Reuse Program Management

Explanation

● **XYZ.n** **VDA Scope**

XYZ.n extended VDA Scope

XYZ.n other process (not in this pocket guide)

Take your Ticket-to-Trade!

- Automotive SPICE®
- Functional Safety (ISO 26262)

We integrate these standards into an agile development process.

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