

Formel Q

Capability Software



The „Formel Q Capability Software“ contains contractually agreed requirements of Volkswagen Group companies to ensure the quality of processes and thus of components in the procurement and supply chain.

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The German-language edition of the Formel Q Capability is binding. The companies affiliated with Volkswagen AG pursuant to §§ 15 ff. AktG can define a different language version as binding for their contracts with the respective suppliers.

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Foreword

Dear Sir or Madam,

The increasing digitalization of vehicle functions requires robust processes for the development of in-vehicle and vehicle-related software/systems. We have to face this task together in order to be successful with our products in the market.

With this document you receive the revised edition of the "**Formel Q Capability Software**" in your hands, which contains the basic quality requirements that we place on you as a supplying company.

Stable and mature development processes is the fundamental prerequisite for ensuring that every software-based component and therefore the entire vehicle meets the Volkswagen Group's quality requirements before the start of series production. Our suppliers and their supply chain are of crucial importance here and the special focus is on fulfilling customer satisfaction. In order to rule out start-up difficulties concerning new models, the degree of process maturity across the entire supply chain is in particular of high importance. The Formel Q Capability Software is binding for suppliers and their sub-suppliers for software-based vehicle components. It applies to all brands of the Volkswagen Group as well as the worldwide companies associated and is part of the acquisition and procurement procedure.

The supplier is obliged to comply with the applicable Volkswagen Group requirements and must also ensure implementation throughout its supply chain. This applies in particular to the quality requirements for the software.

You can access the currently valid Formel Q Capability Software and other multilingual information and Volkswagen Group documents on the Internet: ONE. Group Business Platform (ONE. KBP) under www.vwgroupsupply.com.

Wolfsburg, May 2022

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Content

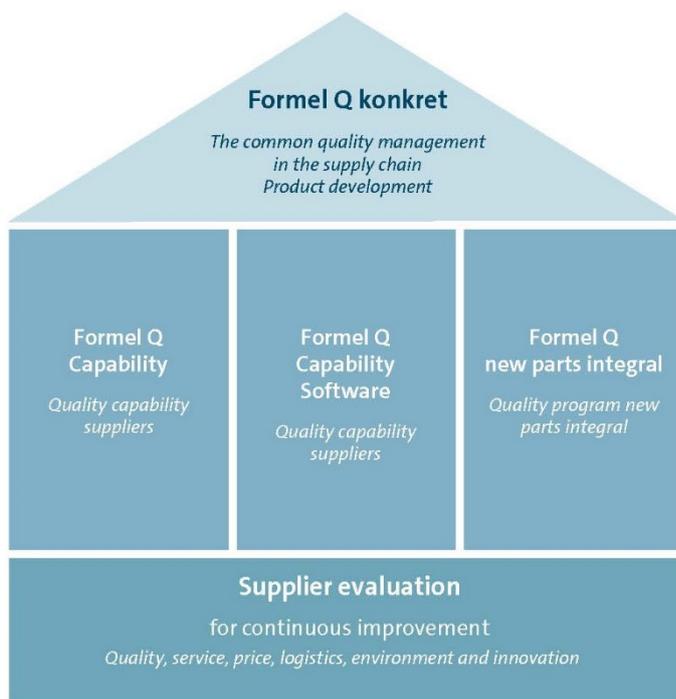
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0 General regulations

For simplicity, the responsible department (see Ch. 1.6) of the Volkswagen Group companies is referred to as “customer”.

The customer-specific quality requirements of the Volkswagen Group are specified in several Formel Q volumes. The following figure shows the structure of the quality assurance agreement for purchased parts (Formel Q) with its volumes:



The Formel Q series of publication is part of the contractual framework, which the suppliers conclude with the Volkswagen Group and its companies.

It consists of Formel Q Konkret as a cross-sectional agreement as well as the supplementary publications Formel Q Capability, Formel Q New Parts Integral and the current **Formel Q capability software**. The additional applicable documents serve to evaluate and support the suppliers in achieving and maintaining a high-quality and sustainable delivery capability.

The current version of the Formel Q capability software is based on the version of the quality management agreement between the companies of the Volkswagen Group and its suppliers "Formel Q konkret" that is valid at the time of the request. All of the following statements in this document elaborate on the relevant areas of this agreement.

These documents are stored on the ONE. KBP in the directory „Informationen\Geschäftsbereiche\Qualitätssicherung\Formel Q\Formel Q Fähigkeit“.

In addition, all documents and regulations specifically listed in Formel Q are part of the contract.

The applicable **Volkswagen Group quality documents** in the currently valid version:

- Group Basic Software Requirements (KGAS, LAH.893.909),
- Up-to-date information on the requirement for field damage parts for the Volkswagen Group.

Documents and forms in electronic form can be found in the ONE. KBP and refer to additional norms and standards.

Among others, the **VDA volumes and Automotive Standards (www.vda-gmc.de)** also apply:

- Automotive SPICE® Process Assessment Model,
- VDA Automotive SPICE® for Cybersecurity,
- VDA Automotive SPICE® Guidelines,
- VDA Automotive SPICE® Guidelines for Cybersecurity Process Assessment Model & Guidelines,
- VDA Band 2, Ensuring the Quality of Deliveries, Production Process and Product Release (PPF).

In addition, the technical delivery regulations and standards of the Volkswagen Group applicable to the respective product as well as applicable regulations, provisions, etc. also apply. In general, it is binding that development must always be state-of-the-art.

Information may be passed on to other Volkswagen Group companies that arise in the course of business relationships.

Confidential information may only be passed on to external third parties with the written consent of the customer. The external third parties are obliged to maintain secrecy.

1 Introduction

1.1 Purpose

The regulations of documents "Formel Q Konkret" and "Formel Q Capability" for supplier evaluation apply to development and series suppliers of in-vehicle and vehicle-related software / software-based systems.

The "Formel Q Capability Software" regulates the evaluation of the quality capability and quality performance of development and series suppliers.

1.2 Objectives

If a supplier is commissioned for development as part of a vehicle project, the commissioned supplier undertakes to carry out the software development process in accordance with the quality requirements of the "Group Basic Requirements Software" (KGAS) for the development project. The requirements of ISO 21434 also apply for suppliers of cybersecurity-relevant products,

In order to evaluate and ensure quality capability and performance, the customer carries out various QA activities for software developments. These are primarily based on the assessment model Automotive SPICE®, Automotive SPICE® for Cybersecurity and the VDA volume "Automotive Cybersecurity – Management System – Audit" or are related to these standards.

The activities are managed by specially trained employees of the customer (hereinafter referred to as "Assessors") in order to meet the requirements of ISO/IEC 33020. At least two assessors are always involved in the activities at the suppliers.

If necessary, measures for quality improvements are to be derived from the QA activities carried out with the fundamental aim of product and cost optimization through improved processes and quality.

Furthermore, the evaluation outcome from the aggregated QA activities performed has an impact on the procurement process. The result is part of the supplier rating (see Formel Q Konkret, Chapter 2).

1.3 Activities for the evaluation of the software quality capability

Activities are carried out that lead either directly or indirectly to a supplier rating.

The outcomes from the following activities lead to direct supplier rating:

1. The preparation of a supplier self-disclosure (LiSA) (see Ch. 2),
2. A potential analysis of the software development processes (PAS) (see Ch. 3) or
3. An assessment of the software development processes (SWA) (see Ch. 4).

The first is an activity that the supplier carries out or has it carried out by third parties. The other two activities are carried out by the Assessors.

The following activities lead indirectly through the escalation process (see Ch. 11) towards a supplier rating, if serious deficiencies are detected:

1. A Technical Revision Software (TRS) of the development processes (see Ch. 5) or
2. The outcome of a project-accompanying quality assurance (PQS) (see Ch. 10).

If unscheduled measures (see Ch. 12) have to be carried out, that are due to insufficient quality performance and/or ability of the supplier, the expenses can be reimbursed.

1.4 Significance and validity of the rating results

Before a contract is awarded to development and series suppliers of in-vehicle and vehicle-related software / software-based systems, a rating of the supplier's software quality capability must be available. According to the Formel Q Capability, there are the ratings "A", "B" or "C" assigned. This rating is valid for the entire Volkswagen Group.

A supplier with a "C" rating is not quality capable and therefore will not be considered in an upcoming award process.

Suppliers with a "B" rating will only be awarded contracts under conditions for improvement (see following chapters). The goal is to be qualified as an "A" rated supplier.

Suppliers with an "A" rating can be awarded contracts. An "A" rating is usually valid for four years, a "B" rating for two years. Thereafter, a new evaluation will be carried out by the customer at his discretion. For scopes with enhanced quality requirements (UEQA), an A-supplier status is mandatory before awarding. The classification of whether a UEQA exists is determined as part of the award process (UEQA can, for example, include emission-relevant scopes such as battery management, engine control unit or transmission control unit).

A rating pertains to software development for a product group at a development site. This product group is one of the following categories:

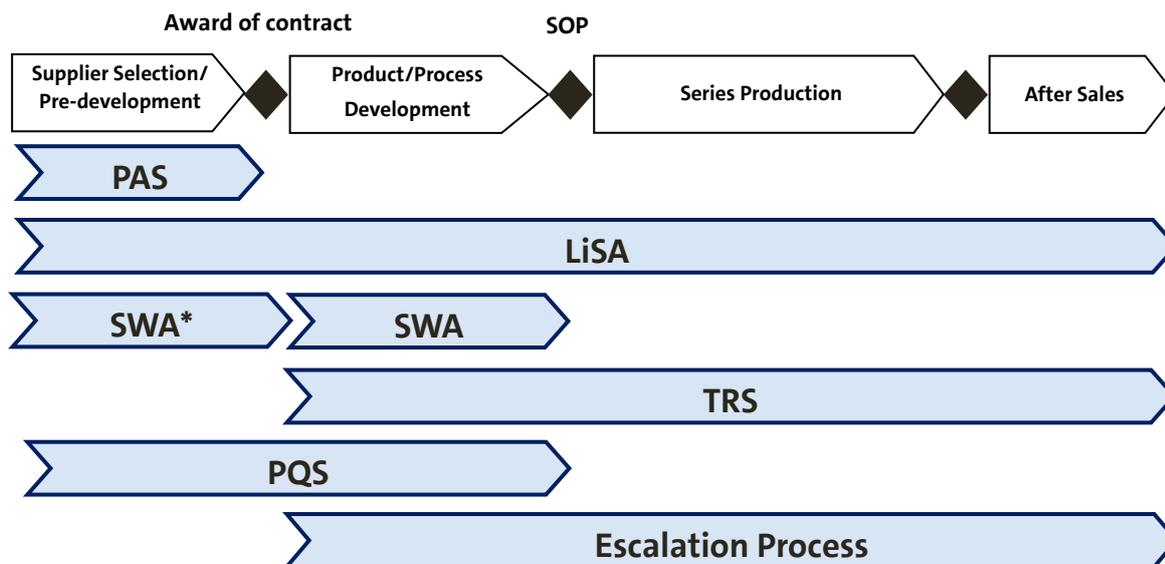
- Powertrain,
- Chassis,
- Restraint systems,
- instrument cluster,
- Body,
- infotainment,
- driver assistance systems,
- Software projects.

If the product group or development location changes, a new evaluation will be made. For new developments in the same product group at the same location, existing ratings can be adopted.

The current supplier classification is always used for an award assignment

1.5 Activities in the product life cycle

The activities for the evaluation of the software quality capability described in this document are mapped to the phases of the product life cycle as shown in the diagram below:



SWA*: see Ch. 4.6 and Ch. 4.7

Figure 1: Activities for evaluation of the Software Quality Capability

If a supplier has to be requalified due to insufficient quality, quality assurance or technical revisions are carried out during the course of the project to check the quality and continuous improvement.

QA activities can be carried out on-site or remotely throughout the entire product life cycle for supplier evaluation.

1.6 Contact

Whenever documents are to be sent to the customer's software quality assurance, the following central e-mail address or the brand address must be used (unless otherwise agreed):

Volkswagen Group Quality: software.qualitaet.vwag.r.wob@volkswagen.de

Audi Quality Assurance Vehicle Software: software-quality.gq@audi.de

Bentley Motors Software Quality: Software.quality@bentley.co.uk

CARIAD Supplier Quality: software-quality.gg@cariad.technology

MAN Truck & Bus SE Software Quality: softwarequality@man.eu

Dr. Ing. h.c. F. Porsche AG Quality Software: software.quality@porsche.de

Škoda Quality Assurance: software.qualitaet@skoda-auto.cz

2 Supplier Self-Disclosure

2.1 Introduction

The supplier self-disclosure (LiSA - Supplier self-estimation for software related systems) is a specified standard. The supplier must conduct an evaluation of its development processes according to the Automotive SPICE® Standard (VDA Scope) and Automotive SPICE® for Cybersecurity as well as VDA-Band Automotive Cybersecurity Management System Audit. Evaluations must be submitted for projects already in series production (development in past) and projects currently in development. In addition, the supplier makes a forecast of how he will develop in the future.

2.2 Procedure

There are generally at least two points in time in the product development process at which a LiSA must be provided for the customer. The first point in time is before the award as part of the inquiry process, the other after the award.

In addition, a LiSA can be requested by the customer at any time on a given occasion (e.g. critical project situation or completion of an improvement program).

The LiSA can be based on software assessments according to Automotive SPICE® and Automotive SPICE® for Cybersecurity as well as assessments according to the VDA volume Automotive Cybersecurity Management System Audit, which were carried out in the respective project. Alternatively, the project quality assurance can create an evaluation from the continuously performed process controls. If necessary, the supplier must make use of external support.

If the self-assessment corresponds to a "C" rating (see Ch. 4.4), the supplier can be rated as "C" directly before the award without any activity being carried out by the Assessors. In the case of self-disclosure after the award, the supplier must submit an improvement program and coordinate it with the Assessors.

3 Software Potential Analysis

3.1 Introduction

In preparation for the award of the contract to series and development suppliers for which the customer does not have a valid quality rating with regard to the software development processes, a Potential Analysis of the software development processes (PAS) must be carried out.

This potential analysis serves to evaluate the quality capability of the supplier in relation to the components, systems or software components requested for award. The experience of the supplier on comparable products or projects and the potential in the core processes of product and software development are evaluated.

These core processes are

- Project management
- Quality assurance
- Configuration management
- Software development (from system requirements management to coding) and
- Test (from unit to system test).

If the requested (software) component is cybersecurity-relevant, the following further procedures are relevant:

- Cybersecurity Risk Management,
- Cybersecurity Operations.

If the requested (software) component is safety-relevant in terms of functional safety, it is classified as an additional requirement and evaluated as such.

For UEQA, only a passed Automotive SPICE® Level 2 assessment serves as proof of an A rating and thus as a basis for the award (see Ch. 4), which means that the Software Potential Analysis is no longer necessary.

3.2 Implementation

The software potential analysis is carried out by Assessors at the supplier's development site. The duration of a potential analysis is one to three working days.

The supplier and the Assessors must coordinate a joint appointment for the potential analysis. In order not to delay the award process, this appointment must take place as soon as possible, however at the latest before the award decision is made.

The Potential Analysis follows a standard agenda that includes the following points:

- Introduction
- Analysis of the project management process,
- Analysis of the quality assurance process,
- Analysis of the configuration management process,
- Analysis of system and software development processes,
- Analysis of the test processes,
- Analysis of cybersecurity processes and their dependencies in the above processes,
- Preparation and presentation of the report by the Assessors and
- Acknowledge of the result (incl. rating).

Implementation evidence from development projects is used to evaluate the processes. If these (even as plans) are not yet available for the customer project, evidence from comparable projects can also be referenced.

In addition, valid process specifications from company-wide or comparable development projects (including but not limited to process descriptions, procedural instructions, plans, checklists, templates) of the supplier are evaluated.

As a result of a Potential Analysis of software development processes, the supplier is classified as the categories "B" or "C". A possible "A" rating can only be achieved through a Software Assessment later in the project.

The result of the Potential Analysis Software, with all issues found, is documented and announced immediately after the Potential Analysis. The report is signed by the Assessors and the responsible person of the supplier for information.

In addition to the rating, the final report also contains a list of the weaknesses found that are to be remedied by an improvement program in the event of an award.

3.3 Evaluation and supplier rating

Each of the analyzed processes is evaluated on its own.

As a result, there is a degree of fulfillment for each process, which is divided into 3 levels. The subdivision and meaning of the levels are shown in the following table.

Degree of fulfillment (per process)	Importance of the evaluation of a rating block
fulfilled	The process fulfills its objective. Both process specifications and application examples were evident.

Degree of fulfillment (per process)	Importance of the evaluation of a rating block
partially fulfilled	The objective of the process is only partly achieved . The weaknesses found pose a risk to achieving process and thus the product quality.
not fulfilled	The objective of the process is not fulfilled . Serious weaknesses in the process specifications or their execution were identified.
n/a	The process does not apply to the project.

Table 1: Rating of the evaluation blocks

The overall result is formed from the average of the degrees of fulfillment of the individual processes.

For the overall result, the mapping to the maturity levels "B", "C" or a "pending status" is carried out. The classification and the significance behind it are described in the following table:

Rating		Determination for award decisions
		Standard Scope
B	fulfilled	<u>The supplier can be used.</u> The rating in category "B" and a Milestone Plan is the grounds for the award of the contract.
~	partially fulfilled	<u>The supplier can be used conditionally.</u> Weaknesses in the supplier's development processes were identified. The weaknesses pose a risk to achieving product quality. In order to eliminate the risk, the supplier must accept an additional agreement as a contractual basis with a signature, in which quality objectives and consequences for non-achievement of the quality objectives are defined in consultation with the supplier. No rating will be made until the agreement has been made. The supplier is in pending status.
C	not fulfilled	<u>The supplier cannot be used.</u> The assessors' report shows that elementary development processes at the supplier are insufficient or unrecognizable.

Table 2: Criteria for ratings in the Potential Analysis Software

In addition to the possibility of averaging, a downgrading to "C" is also possible if at least one process has been classified as "not fulfilled". In this case, requirements for this process are not

met, which have a decisive influence on the product quality and lead to an unacceptable risk. The decisions are justified in the report of the Potential Analysis.

3.4 Pending status

As described, a supplier in pending status must sign an additional agreement in order to be taken into account for a contract award. In this regard, the supplier commits itself to create and implement a qualification program in order to remedy the found weaknesses. The qualification program must be agreed with the Assessors.

If the confirmation of the additional agreement and the agreement on the qualification program are not available by the time the contract award decision is made or four weeks after the announcement of the result at the latest, the supplier will be downgraded to "C". There is no award of contract.

If the signed additional agreement (see Ch. 9) has been submitted at the time of the award decision, the supplier is eligible for nomination for this award process.

The rating and evaluation by the Software Potential Analysis is not the same as the subsequent Software Assessment (see Ch. 4). The analysis of the Software Assessment based on Automotive SPICE® and Automotive SPICE® for Cybersecurity is much more detailed and based on evidence from the development project for the customer.

4 Software Assessment

4.1 Introduction

Based on the customer's requirements (see e.g. KGAS), an assessment of the software development processes (SWA) is carried out for software-based vehicle components and supplied software modules. This assessment serves to assess the supplier's software quality capability and performance in the implementation of the contractually defined product and process requirements.

The process assessment according to ISO/IEC 33020 with the Process Assessment Model (PAM) Automotive SPICE® and Automotive SPICE® for Cybersecurity is used for systematic and reproducible analysis.

As part of the assessment, the software development processes of the project are analyzed and verified using examples. If the verified samples show defects, this is considered as a lack of quality performance and in the case of systematic errors, considered as a lack of quality capability.

4.2 Scope of assessment

In the assessment, the following processes are considered according to VDA Scope:

- Project Management (MAN.3),
- Quality Assurance (SUP.1),
- Configuration Management (SUP.8),
- Problem Resolution Management (SUP.9),
- Change Request Management (SUP.10),
- System Requirements Analysis (SYS.2),
- System Architectural Design (SYS.3),
- Software Requirements Analysis (SWE.1),
- Software Architectural Design (SWE.2),
- Software Detailed Design and Unit Construction (SWE.3),
- Software Unit Verification (SWE.4)
- Software integration and Integration Test (SWE.5),
- Software Qualification Test (SWE.6),
- System Integration and Integration Test (SYS.4),
- System Qualification Test (SYS.5) and
- If applicable, Supplier Monitoring (ACQ.4).

If the supplier purchases development services (e.g. the development of software modules or the execution of test activities), the process Supplier Monitoring (ACQ.4) is also assessed.

If the requested (software) component is cybersecurity-relevant, the following additional procedures must be considered:

- Cybersecurity Risk Management (MAN.7),
- Cybersecurity Requirements Elicitation (SEC.1),
- Cybersecurity Implementation (SEC.2),
- Risk Treatment Verification (SEC.3),
- Risk Treatment Validation (SEC.4),
- If applicable, Supplier Request and Selection (ACQ.2).

Depending on the project, the scope can also vary, e.g. in the case of software-only projects, the system processes cannot be assessed.

If the (software) component under consideration is safety-relevant in terms of functional safety, it is classified as an additional requirement and evaluated as such. This means, for example, that the correct application of normatively required methods in software development and testing can be used as a criterion for quality capability and performance.

4.3 Quality capability

The processes mentioned in Chapter 4.2 are verified against the process attributes of Capability Level 1 and 2 by Automotive SPICE®. They are evaluated in the following four levels:

Process Attribute (PA)	Degree of fulfillment	Evaluation of the fulfilment of requirements
F	86% - 100%	Requirements fully achieved
L	51% - 85%	Requirements largely achieved
P	16% - 50%	Requirements partly achieved
N	0% - 15%	Requirements not achieved

Table 3: Rating of process attributes

The rating of the process attributes (PA) are used to calculate the process capability level of the assessed processes, as shown in the following table.

Process maturity	Process attributes	Assessment
Level 0	PA 1.1	N P Not (N) or partly achieved (P)

Level 1	PA 1.1	L F	Largely (L) or fully achieved (F)
Level 2	PA 1.1	F	Fully achieved (F)
	PA 2.1	L F	Largely (L) or fully achieved (F)
	PA 2.2	L F	Largely (L) or fully achieved (F)

Table 4: Process capability levels

4.4 Supplier rating

From the evaluation of the individual processes, a correlation to the supplier rating "A", "B" or "C" supplier that is relevant for the contract award is derived, as shown in the following table.

Rating	Requirements on process capability	Conclusion / Measures
A	All processes achieve Process Capability Level 2	<u>The supplier is quality-capable</u> The evaluation does not identify any serious weaknesses with regard to software development processes at the supplier.
B	All processes achieve at least Process Capability Level 1	<u>The supplier is conditionally quality-capable</u> The evaluation identifies weaknesses in product quality and/or process quality in one or more processes. The identified process weaknesses represent a possible risk to achieving product quality, which must be mitigated by additional measures. An improvement program must be implemented by the supplier in order to achieve the required process capability as soon as possible and to develop into an A-supplier.
C	At least one process has the Process Capability Level 0	<u>The supplier is not quality-capable</u> Both in product quality and process quality, major weaknesses have been identified in one or more processes An immediate improvement program must be started and implemented so that the weaknesses in subsequent deliveries are resolved.

Table 5: Project rating based on process capability levels

The rating takes effect at the moment the assessment result is announced. The rating is also relevant for further awards.

4.5 Implementation

For the Software Assessment, established software development processes are expected in the project in order to be able to evaluate the process capability and quality performance. There are three ways to rate a supplier:

- Supplier Self-Disclosure,
- A single Assessment or
- A distributed Assessment.

As a basis for carrying out a **single Assessment**, a completed development cycle with a released sample status is usually used as a general rule. A single assessment takes 4 - 10 working days, depending on complexity, language and country.

In the case of **time-related distributed Assessments**, it is assumed that there are causal and therefore temporal dependencies between the processes in a development process. For example, a software test can only be carried out when the software requirements have also been compiled.

In the case of distributed Assessments, several assessment appointments are agreed, at which a reduced selection of processes is assessed. One possibility is, for example, the division into three phases with the following process selection:

Planning phase: At the beginning of the B sample phase, processes such as project management, configuration management and quality assurance are assessed. These processes form the basis for successful project execution and must be established at the beginning of the project.

Specification phase: After completion of the specification phase, which is approximately in the middle of the B-sample development cycle depending on the project, the processes from system requirements analysis to software architectural design are assessed. This is the basis for the subsequent test phase.

Test phase: Before delivery of the B sample, the test processes from unit test to system test are assessed. At this time, the problem resolution management and change request management processes are also assessed, as experience has shown that there is sufficient evidence for process execution at the end of the test phase.

When assessing the specification and test phase, it is necessary that the supporting processes from the planning phase remain in focus and are continuously evaluated so that they can be finally evaluated in the last assessment phase. In addition, the processes that were evaluated with a capability level 0 in a previous part of assessments must be re-assessed. If no improvement can be observed in the re-assessed processes, the costs of the part of assessments will be reimbursed.

The detailed execution of a distributed Assessment or single Assessment is planned according to the project needs and usually announced at least four weeks in advance. The execution of Assessments must be taken into account by the supplier when planning the project.

The final result of the distributed Assessment, which is therefore relevant for further awards, will be announced after the last part Assessment.

If a supplier does not reach the agreed process capability level, a follow-up assessment will be carried out in the later course of the project in order to check and confirm the success of the improvement measures (see Ch. 7). The goal is to demonstrate the achievement of the process capability Level 2.

4.6 Assessment report and self-qualification of the supplier

The result of the software assessment with the rating and the significant deficits is documented and announced immediately after the assessment. At the end of the assessment, the report is duly signed by the Assessors and the responsible person on the supplier's side for information.

Within approximately the next four weeks, the Assessors will prepare a detailed assessment report that describes the deviations for each process in detail.

If deviations are shown in the report from the Assessors, the supplier must use them as a basis for the definition and implementation of improvement measures.

In addition, the supplier must conduct a comprehensive analysis of the deviations found in order to be able to identify systematic problems. Subsequently, the supplier shall define an improvement program (see Ch. 7), in which the implementation of the measures is planned with deadlines and responsibilities.

The improvement program shall be submitted to the responsible Assessors for review and to be agreed with them. For each improvement program, it can be stipulated that the supplier reports regularly on the progress of implementation. The form and frequency of the report are agreed with the responsible Assessors (see Ch. 10.3).

The supplier is responsible for the improvements in the project (process and product). If the necessary knowledge is not available in the company, the supplier must engage external assistance (e.g. consultants).

In the case of a "C" rating, a follow-up Assessment is needed in the current project. At least the processes assessed with Capability Level 0 are assessed again. In addition, the follow up assessment should also review all weaknesses identified including weaknesses not related to the downgrading. The goal is to demonstrate the achievement of the process Capability Level 2.

4.7 Adoption of assessment results

The decision to adopt an assessment result that was not prepared by the customer's assessors is made by the responsible Assessors on a case-by-case basis. An obligation for the customer to accept results from assessments or self-assessments does not derive from this. Before the assessment is carried out, the responsible Assessors check in each individual case whether a previous assessment is sufficient and applicable to the current project. In justified exceptional cases, it is possible to use an assessment or self-assessment result as a basis for evaluation, which was carried out without customer participation. At least the following criteria must be met:

- The sample under consideration refers to the entire product (Process context category = B, Entire Product / Delivery).
- The VDA Scope was considered.
- The evaluation was carried out using the VDA Automotive SPICE® Guidelines.
- It is a Class A or Class B assessment (requirement for the independence of assessors).
- The assessment result must not be older than 2 years.
- The assessment report including a list of the outcomes / evidences considered is available to the customer.

The customer is entitled, without giving reasons, to reject the assessment report and to carry out the assessment himself.

The customer reserves the right to check the assessment result using a Technical Revision Software (TRS) before determining the final supplier rating.

4.7.1 Review of platform or representative development scopes for award

The evidence of assessment does not necessarily have to be based on a customer project currently commissioned at the supplier. To assess the process capability, development scopes can be used that are either based on already developed basic functionalities of the product (platform scopes), or on functional scopes of other OEMs. The following requirements must be met

- The development scope of functions for the same product group was considered, which should be used for an award.
- The development scope of functions was developed at the location relevant to the award (same DUNS number).

The time and scope of the review must be agreed with the customer. The supplier must ensure that sufficient development activities can be demonstrated at the time of the assessment.

5 Technical Revision Software

5.1 Introduction

The Technical Revision Software (TRS) is another quality assurance method within the framework of the Volkswagen Group quality strategy.

While a Potential Analysis and the Software Assessment usually take place at defined milestones in the development project, the TRS can be carried out at any time during the development and in the ongoing series by Assessors of the customer.

The Technical Revision Software usually has an acute reason. Triggers for a TRS are e.g.:

- The obligation to inform the customer when specification deviations are detected (e.g. runtime behavior, resource consumption, software errors, vulnerabilities in terms of cybersecurity, free and open source software) was not complied with.
- A relocation of development activities to other locations was not indicated.
- Product features were insufficiently considered in the system test.
- Poor quality performance due to uncertain internal/external processes.
- Uncertain processes in the subordinate product development processes.
- Specified requirements have demonstrably not been implemented.
- To monitor compliance with a milestone plan/additional agreement.
- A Car Security Incident / Case was caused by the affected product.
- Preventive measure without direct cause or reason.

During the TRS, it is specifically focused on why problems could occur, how the supplier analyzes the problems and what corrective actions the supplier has taken to solve the problem.

However, a TRS can also be carried out as a **preventive measure** without a direct cause or reason. One reason may be the confirmation of previous Assessment ratings without the need for a full Assessment.

5.2 Implementation

The Technical Revision Software of the development processes can be announced to the management, the quality management or the project management of the respective supplier at short notice on the day before the execution. The duration is usually one to two days. An agenda is sent by the Assessors with the registration for the execution.

The TRS deals with a specific problem. Supporting processes and development processes are also considered. In addition, targeted code analysis or code reviews can be carried out.

Following the TRS, a report on the results will be presented on site. If necessary, it contains the weaknesses found, an evaluation of the risk and further measures.

In order to remedy the defects, an improvement program is agreed with the management of the supplier. The supplier's management commits to the Assessors bindingly and in writing that implementation deadlines for the improvement measures will be met.

5.3 Evaluation

The result of the TRS is an evaluation of quality performance. Conclusions can also be drawn about the process capability and product quality available in the project.

The overall result is presented at the end of the Technical Revision Software of the development processes in the form of a traffic light color logic, as described in the following table:

Assessment	Importance / Measures
	No risks were identified – no further action is required.
	Risks were identified – series or development are not urgently affected, but the problems must be resolved for upcoming (software) deliveries. Actions to eliminate the process weaknesses and product defects must be defined in order to achieve the necessary software or product quality.
	Acute risks for the series or in the development phase were identified. An immediate improvement program based on the weaknesses found must be started. In addition, the program "Critical Project and Series Supplier" (see Ch. 11).

Table 6: Meaning of a traffic light color in a Technical Revision Software

The TRS activities of the customer's Assessors can be regressed (see Ch. 12) if it turns out that the supplier is responsible for the problem.

6 Sub-Supplier management

6.1 Introduction

The Sub-Supplier Management from the Customer serves to identify possible risks in the supply chain during the procurement process. In the product development phase and in series production, these supply chains must be controlled and assured.

The Sub-Supplier Management includes all parts of the supply and process chain and all planned and implemented development activities and services that can have an impact on the required product quality, such as:

- outsourced process steps, remote development sites, development partners, commissioned third parties at the development site,
- Testing service providers, calibration laboratories, test laboratories,
- other service providers who may have an influence on product quality or the development process,
- Cybersecurity management system including cybersecurity incident management and asset management throughout the supply chain.

6.2 Stipulations

Direct suppliers (1st tier) are 100% responsible for the entire project management and the deliveries of the sub-suppliers they commission. The supplier must ensure that all risks within their supply and process chain are identified, evaluated and resolved by appropriate measures as their own responsibility.

With regard to software developments, the supplier must ensure that the requirements contained in the KGAS documents and the Formel Q Capability Software are also implemented by the sub-supplier.

6.3 Procurement phase

The Sub-Supplier Management is integrated into the procurement process. When submitting an offer, direct suppliers are requested to disclose the (software) supply chain and process chain.

The direct supplier is also required to carry out the evaluations of its suppliers as its own responsibility before awarding the contract. Right from the start of development, the supplier has to ensure that the sub-suppliers have a quality capability in accordance with the Customer's specifications. Appropriate evidence, e.g. a supplier self-disclosure, can be requested by the customer.

6.4 Product development phase

The supplier must check and ensure the product and process quality of its sub-suppliers. This also applies to processes outsourced to subcontractors, such as a test process or source monitoring for cybersecurity operations.

The customer reserves the right to review the control documentation and to verify the supplier's ratings, e.g. by means of a joint on-site assessment with Tier 1 nominated supplier at the sub-suppliers.

This on-site assessment is carried out using the QA methods described in this document. An evaluation of the sub-supplier directly influences the rating of the direct supplier, as the latter is responsible for the entire project and thus for its sub-suppliers.

6.5 Changes in the supply chain

Changes in the supply chain or the outsourcing of processes must be notified to the Customer in advance in writing and may lead to a re-evaluation of the (sub-) supplier. The Customer reserves the right to verify the changed sub-supplier structure.

7 Improvement Program

The improvement program is a plan with measures to eliminate deviations.

On the basis of the results of Customer as well as its own evaluations, the supplier is required to analyze the causes of the deviations and to define appropriate improvement measures. For each of these deviations, a target date and a responsible person must be named by the supplier. It is expected that the supplier will immediately initiate the necessary measures, implement the improvement program in the short term and confirm the sustainability and effectiveness of the measures initiated.

After implementation of all improvement measures, the sustainable effectiveness must be demonstrated by internal assessment and other appropriate activities of the supplier. The qualified complete result must be sent to the customer.

8 Milestone Plan

As part of the supplier evaluation, the premises for the implementation of the development order at the supplier as well as the quality goals of software including due dates are defined in a milestone plan. These quality goals of software include, for example:

- Quality goals for development processes according to Automotive SPICE® and additionally cybersecurity-relevant scopes must be according to Automotive SPICE® for Cybersecurity,
- Quality goals for product, e.g. function implementation, test coverage, release,
- Quality goals for implementation of KGAS (LAH.893.909) requirements in accordance with project progress.

The milestone plan is part of the contract and must be signed by the supplier. In preparation for the milestone acceptance, the supplier must have the achievement of the corresponding quality targets evaluated by an Automotive SPICE® assessor and send the result to the Customer. The evaluation of milestone achievement is carried out by the Customer.

9 Additional agreement

The Additional Agreement is a milestone plan supplemented with contractual penalties. It is used for planned contracts to suppliers in which extensive deficiencies in quality capability or performance have been identified during the supplier evaluation.

The amount of the contractual penalty is determined individually for each project. The contractual penalty is payable if the supplier does not achieve the quality targets at the agreed milestones in the commissioned development project.

10 Project-accompanying Quality Assurance

10.1 Introduction

In the project, regardless of the quality status, regular monitoring of the quality performance of the supplier's development can be carried out by the customer's quality assurance.

The core idea of the Project-accompanying Quality Assurance (PQS) is the inclusion of the Customer's QA in the quality assurance activities of the supplier. This includes at least the regular provision of the project and QA status information to the Customer's QA, but can also include joint quality assurance activities such as reviews.

In order to better support the supplier, the Customer can designate specially trained external personnel in a transition phase to collect and report the project and QA status of the supplier. The supplier bears the costs incurred. This continues until the supplier has established its own qualified personnel.

10.2 Implementation and measures

In a joint kick-off meeting with the supplier, the general conditions for Project-accompanying Quality Assurance are defined by responsible departments of the Customer. In addition to the software QA of the Customer, the component managers of the Customer from the development, the quality assurance of the Customer and other representatives of the Customer can be involved in the kick-off meeting.

As part of this kick-off meeting, the joint quality assurance activities are defined depending on the strategic significance of the project. These include:

- Definition of quality objectives to be monitored, including goals for cybersecurity development,
- Software Assessments (SWA),
- Software Potential Analysis (PAS),
- Technical Revisions Software (TRS),
- Code Analysis,
- Reviews of work products in the development project,
- Review of the improvement program and its implementation,
- Reporting incl. metrics and
- Escalation paths.

The required activities are documented with deadlines and responsibilities in a quality management plan. Based on the commitments in the quality management plan, the supplier is obligated to establish a regular quality status report.

10.3 Quality status report

After the start of the Project-accompanying Quality Assurance, it is defined together with the supplier which key figures/Metrics are to be regularly communicated to the Customer to determine the project status. The reporting dates are agreed together with the supplier.

The supplier undertakes to send the agreed measurement data to the notified bodies of the Customer on the agreed due dates.

A plan (dates and target values) must be agreed with the Customer for each key figure/Metric. The latter reserves the right to review the key figures on site at the supplier.

If the reported key figures do not match the status checked on site or if status reports are not delivered, the supplier can be escalated into the “Critical Supplier program” (see Formel Q Konkret, Ch. 4.11).

11 Escalation

If necessary, measures and improvement programs required by the customer are not implemented sustainably and on time, or if errors reoccur, an escalation in accordance with the program "Critical Project and Series Suppliers" will be initiated by the customer (see Formel Q Konkret, Ch. 4.11).

The program "Critical Supplier program" is primarily started if deficient quality performance is identified in a TRS or Project-accompanying Quality Assurance. However, it can also be started if:

- a supplier has received an order with an additional agreement or milestone plan, but has not achieved the agreed quality objectives,
- if it has been recognized in a TRS that the supplier is responsible for problems in development and series production,
- deadlines confirmed by the supplier for carrying out quality assurance activities are not met, or
- quality objectives agreed in the context of Project-accompanying Quality Assurance are not achieved.

12 Reimbursement

12.1 Introduction

With Reimbursement, the incurred travel expenses and subsistence expenses for the Customer Assessors are charged to the supplier. The Reimbursement is performance-based, depending on needed effort (working days of the Assessors at the supplier), hotel and travel expenses as a lump sum for domestic and abroad.

A Reimbursement is raised whenever the supplier generates additional expense for the Customer in the form of Re-assessments, Technical Revisions or Project-accompanying Quality Assurance. Additional expenses in this regard are all activities that do not take place due to an initial inspection by the Customer.

A Reimbursement is raised when:

- a re-Assessment becomes necessary because weaknesses were identified in the first Assessment,
- existing development activities or those already awarded to a supplier are outsourced to development locations different from that named in the contract („Nomination Letter“) and thus a re-evaluation of the new development site is required,
- a new evaluation of the process capability is required because important processes are modified, the supply chains are changed or process steps are outsourced,
- a Technical Revision is conducted due to emerged problems at the suppliers, or
- an additional Project-accompanying Quality Assurance is necessary.

Preventive measures conducted by the Customer are not reimbursed. The same applies to any actions that might arise from the Customer's own interest to fulfil its obligations to ensure quality and were not induced by the supplier.

12.2 Technical Factor

The Technical Factor generally expresses the ratio, in which the supplier is responsible for defects in his serial parts.

$$TF = (\text{claims recognized by the supplier}) / (\text{claims examined})$$

Software quality defects are a possible source of error and can therefore be used to form the Technical Factor. If a "C" supplier does not consistently implement improvement measures and is still rated with "C" until the start of series production, the Technical Factor is set to "1" in case of a software-based error. This means that the supplier is 100% responsible for the subsequent claims. The supplier is free to prove that process defects have not led to the error.

13 Documentation of supplier visits

After completion of a Software Potential Analysis, a Software Assessment or a Technical Revision Software, a report including the rating is provided on site or after the activity in the case of remote activities. These ratings, with any weaknesses found and the immediate measures identified, shall be summarized in a two-page report.

This report is duly signed by the Assessors and the project managers at the supplier for information. One copy remains with the supplier, one with the Assessors.

In the case of a Software Assessment and, if necessary, also in the case of further measures, a detailed report or a detailed protocol will be compiled afterwards. These detailed reports, as well as the two-page reports already prepared during the visit, serve as a basis for the supplier to prepare the improvement program.

14 List of abbreviations

ACQ	Process group "Acquisition" according to Automotive SPICE®
ONE. KBP	ONE. Group Business Platform
KGAS	Group Basic Software Requirements, LAH.893.909
LAH	"Lastenheft", requirement specification
LiSA	Supplier self-estimation for software related systems
MAN	Process group "Management" according to Automotive SPICE®
PA	Process attribute according to Automotive SPICE®
PAS	Potential Analysis Software
PQS	Project-accompanying quality assurance
SUP	Process group "Supporting" according to Automotive SPICE®
QA	Quality assurance
SWA	Software Assessment
SWE	Process group "Software Engineering" according to Automotive SPICE®
SYS	Process group "System Engineering" according to Automotive SPICE®
TF	Technical factor
TRS	Technical Revision Software
UEQA	Scopes with enhanced quality requirements (e.g. emission-relevant scopes such as battery management, engine control unit or transmission control unit)
VDA	Association of the Automotive Industry e.V.

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