Experience with the implementation of ASPICE 3.1 and the VDA Automotive SPICE Guidelines in Assessments – Using Advanced Tools

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Abstract. When applying the Automotive SPICE 3.1 assessment model the VDA Automotive SPICE Guidelines need to be considered. This has an impact on the assessment planning, the interpretation of base practices and generic practices and the assessment reporting. The VDA Automotive SPICE Guidelines (blue-gold book [2]) contain rules and recommendations to interpret ASPICE 3.1 and also consider dependencies in the ratings. Assessors are now confronted with hundreds of additional rules and recommendations. The paper outlines from first experiences about how to handle this additional effort.

Keywords: Automotive SPICE 3.1, VDA, Automotive SPICE Guidelines

1 Introduction

1.1 Need for a strategy to handle the many hundred rules and recommendations

Automotive SPICE 3.1 [1],[2],[7],[12],[13],[14],[19],[24],[25],[30],[50] assessments, as usual, require interviews, evidence collection, rating of practices, rating of process attributes and the presentation of capability level and process attribute profiles.

However, when performing the interviews, the newly available VDA Automotive SPICE Guidelines (blue-gold book [2]) provide a lot of additional checklists, rules and recommendations to consider when rating a specific base or generic practice.

Rules. "One of a set of explicit or understood regulations or principles governing conduct or procedure within a particular area of activity" [Oxford dictionaries]

Meaning based on the VDA guideline:

A rule **shall be followed** for the rating in an assessment.

It might be necessary to not follow a rule to provide an objective and adequate rating.

In case of an infringement of a rule for the rating, **a justification shall be documented** to the assessment sponsor.

Recommendations. “A suggestion or proposal as to the best course of action, especially one put forward by an authoritative body” [Oxford dictionaries]

Meaning based on the VDA guideline:

A recommendation **should be followed** for the rating in an assessment.
It might be reasonable for an assessor to decide to NOT follow a recommendation.
In case of not following a recommendation, no documentation of this is needed.

Example to demonstrate the impact of rules, recommendations, and dependencies:

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.

SYS.5.BP1: 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.

For the BP1 of SYS.5 the blue gold book describes a checklist:

A test strategy shall comprise the following aspects:

a) A definition of the test scope
b) A definition of how specific requirements regarding testing (e.g. test-specific stakeholder requirements, ISO 26262) are covered.
c) A definition of the methods for test case and test data development (e.g. development of positive / negative tests, test of static and dynamic behavior, equivalence partitioning).
d) A definition of the criteria to select test cases including
    - the coverage of new or changed requirements
    - the coverage of changes in the architecture or interface specifications
    - the coverage of change requests
    - the coverage of item changes
    - the consideration of dependencies, based on the analysis of changes (e.g. causal chain analysis) and
    - the selection of appropriate test cases for regression testing including a set of test cases selected as a basis set to be executed.
e) A definition of the test environment regarding each test method
f) The assignment of test methods to project phases (e.g. stress test, smoke test and fault injection test).

g) A definition of the test coverage in relation to the project plan and release plan.
h) A definition of entry and exit criteria for the test
i) A documentation of sufficient test coverage of each test level, if the test levels (e.g. software qualification test, software integration test and unit test) are combined
j) An approach for the handling of failed tests

Based on the checklist the blue gold book describes a set of rules and recommendations, related to the SYS.5.BP1. The acronym RL stands for rule, and the acronym RC stands for recommendation.

[SYS.5.**RL**.1] If the test strategy does not cover all aspects above, **the indicator BP1 must not be rated F**.
[SYS.5.**RL**.2] If the test strategy does not cover aspect b), c) or d), **the indicator BP1 must not be rated higher than P**.

[SYS.5.**RC**.2] If project plan or release plan are not adequate, this should not be used to downrate the indicator BP1.

For instance, if the product is safety critical and the test plan does not cover safety related test methods (point b.) in the checklist above, the SYS.5.BP1 cannot be rated higher than P(artially).

Rules and recommendations can relate to more than one practice and one practice can relate to more rules/recommendations.
Using the blue gold book in parallel to an assessment is very time consuming, therefore an integration of the ASPICE 3.1 model and the additional rules and recommendations into one integrated assessment tool is required.

1.2 Need for a strategy to analyse the consistency

In addition to providing rules and recommendations per base practice the blue gold book [2] also describes consistency rules so that related ratings of practices are not contradicting and provide a consistent information in the assessment.

Example to demonstrate the impact of rules, recommendations, and dependencies continued:

SYS.5 System Qualification Test

For the system qualification test process, the ratings of base practices are related to each other and the blue gold book [2] provides for each process and each process attribute a constancy graph.

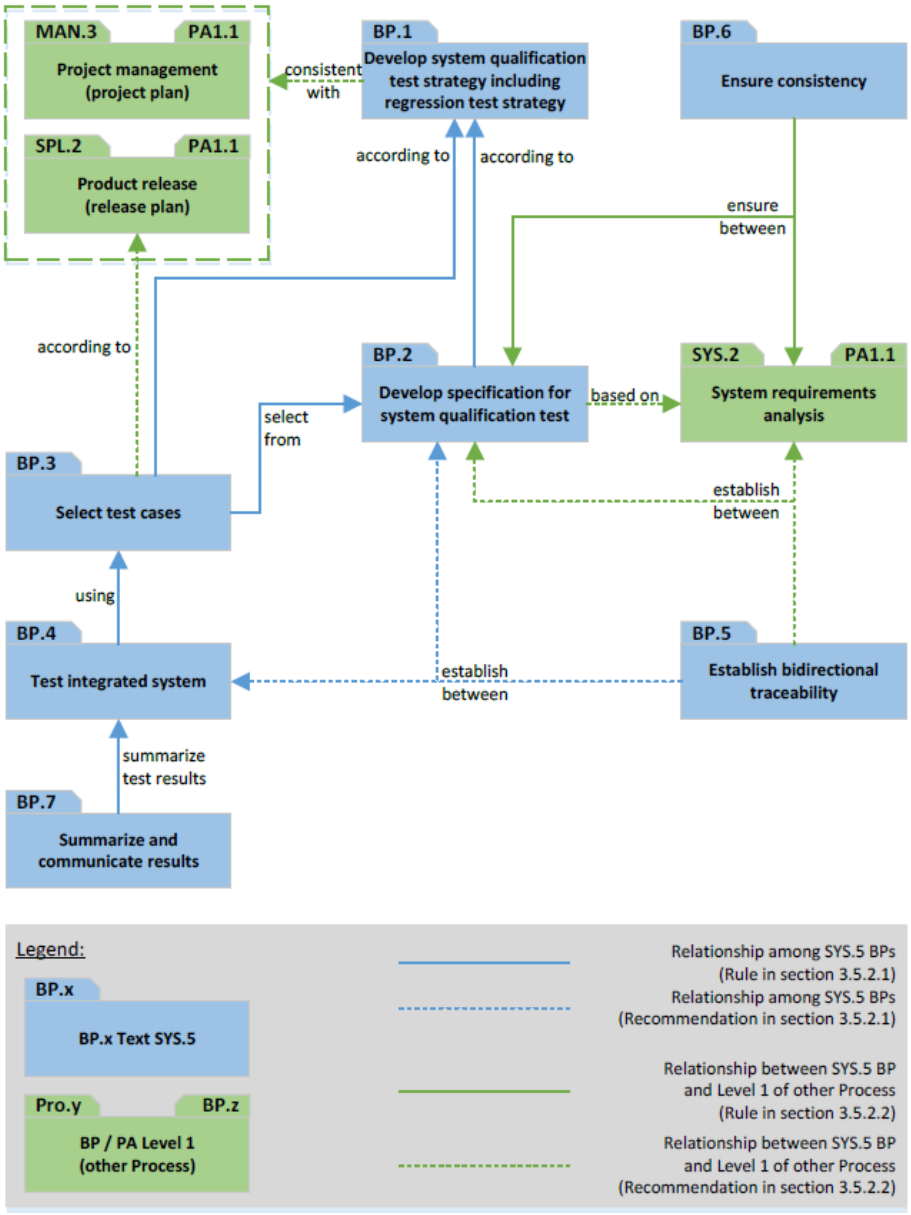

Figure 1: Consistency Graph for SYS.5 System Qualification Test

How to read the graph?

A blue arrow means a depends on rule relationship inside the same process. E.g. BP.2 shall not be rated higher than BP.1 (see Fig. 1).

A blue dotted arrow means a depends on recommendations relationship inside the same process. E.g. BP.5 should not be rated higher than BP.2 (see Fig. 1).

A green arrow means a depends on rule relationship to another process. E.g. BP.6 of SYS.5 System Qualification Test shall not be rated higher than SYS.2 System Requirements Analysis (see Fig. 1).

A green dotted arrow means a depends on recommendation relationship to another process. E.g. BP.2 of SYS.5 System Qualification Test should not be rated higher than SYS.2 System Requirements Analysis (see Fig. 1).

And the blue gold book is listing the following consistency rules. The acronym RL stands for rule, and the acronym RC stands for recommendation. Compare with Fig. 1 above.

[SYS.5.**RL**.8] If the strategy-related activities are not performed according to the defined strategy (BP1), the indicators BP2 and BP3, respectively, shall be downrated.

[SYS.5.**RL**.9] If the indicator for developing the test strategy (BP1) is downrated due to missing or inadequate definitions of methods for test case and test data development, the indicator BP2 shall be downrated.

[SYS.5.**RL**.10] If the indicator for developing the test specification (BP2) is downrated, the indicator BP3 must not be rated higher.

[SYS.5.**RL**.11] If the indicator for developing the test strategy (BP1) is downrated due to a missing or inadequate definition of the test case selection criteria, the indicator BP3 shall be downrated.

[SYS.5.**RL**.12] If the indicator for selecting test cases (BP3) is rated P or N, the indicator BP4 shall be downrated.

[SYS.5.**RC**.2] If project plan or release plan are not adequate, this should not be used to downrate the indicator BP1.

[SYS.5.**RC**.3] If the PA 1.1 for SYS.2 is downrated, this should be in line with the rating of the indicator BP2.

[SYS.5.**RC**.4] If only the release plan is not adequate, but the test cases are selected according to the strategy, this should not be used to downrate the indicator BP3.

[SYS.5.**RC**.5] If PA 1.1 for SYS.2 is downrated, this should be in line with the rating of the indicator BP5.

The use of the blue gold book in parallel to an assessment is very time consuming, therefore an integration of the ASPICE 3.1 model and the additional rules and recommendations into one integrated assessment tool is required.

1.3 Need to consider an integration of more norms in general

A vehicle is understood by a set of vehicle functions [11],[16],[17],[18],[23] and each function is assigned to a set of modules (components) in the car with a real time communication between the components by a bus. Therefore e.g. Volkswagen defined vehicle functions (FUN principle for function based vehicle development) and each supplier maps their own subfunctions/features, and system requirements to these vehicle functions [11], [23].

For Volkswagen projects additional KGAS criteria are required [11], [23] which further extend the set of questions applied by the ASPICE 3.1 model and the blue gold book.

Also functional safety (compare with point b.) in the example used in section 1.1 of the paper) requirements coverage needs to be considered in assessments, and the traceability also of safety and security requirements is checked [3],[4], [8],[9],[12],[13],[14],[15],[17],[19],[20],[21],[22].

In this case an assessor then needs to check different views. E.g. all norms are asking for functional designs, effect chains and dynamic views. In ISO 26262 it is called signal flow, in Automotive SPICE [7], [8],[9] this is called dynamic view, and in cybersecurity norms [10],[16], [27],[28],[47] this is also called a data and signal flow.

This means that in future assessment systems must be capable of displaying different views during the interviews and the reports [5].

In this paper we mainly deal with the ASPICE 3.1 model and the blue gold book [2] extension.

2 Integrated Assessment Systems

The previously described situation requires an integrated assessment approach, where assessors can see the ASPICE 3.1 model and the VDA Automotive SPICE Guidelines in one integrated view.

2.1 Integration of Rules and Recommendations as Views

For each process attribute the additional rules and recommendations can be displayed. This allows the assessor to still rate practice by practice, as before, and to see the additional rules and recommendations with each practice.

Keep in mind that one and the same rule or recommendation applies for 1:n practices so that a relationship model in the background is required.

To demonstrate this, screen shots are used by one of the first assessment systems supporting the VDA Automotive SPICE Guidelines (Capability Adviser System).

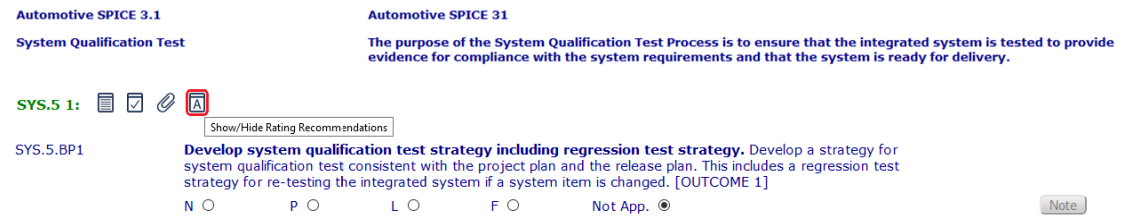

Figure 2: Options to Display Rules and Recommendations

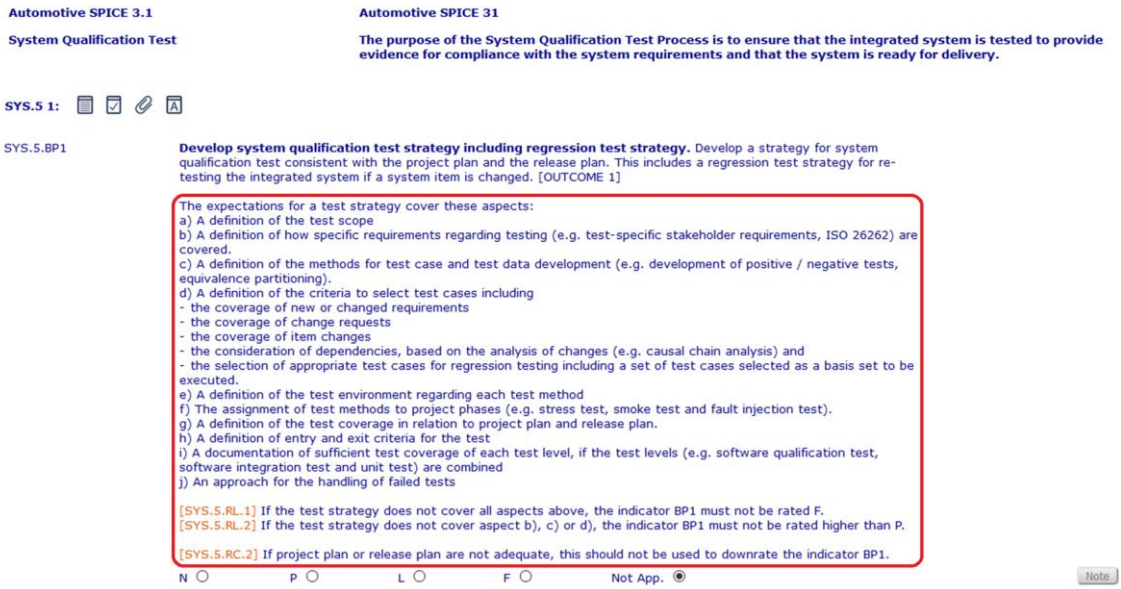

Figure 3: Checklists, Rules Recommendations are Displayed

When rules and recommendations are displayed as above and assessors are prepared the assessment time frame is still based on the number of practices checked by the ASPICE 3.1 model, so that with this working approach the additional time needed for an assessment according to the VDA guidelines is reduced

However, this requires such an optimised assessment system integration and a good preparation at the same time.

2.2 Integration of Consistency Views

The consistency views are more difficult and usually cannot be displayed with a simple (Excel based) assessment tool. This requires e.g. a relational database with relationship clauses where all n:m relationships are considered, the ratings are compared, and inconsistencies are listed.

If you rate a practice, this has impact on practices in the same process as well as to practices in related processes. In case of violation of rules the assessor must include an explanation for each violation in the assessment report.

How to keep an overview of all consistency rule restrictions when rules span across the whole assessment model? One potential answer is to put all constancy rules into a relational database and display a list of violations in the assessment system.

To demonstrate this, screen shots are used by one of the first assessment systems supporting the VDA Automotive SPICE Guidelines (Capability Adviser System).

Figures 4 and 5 show an example violation and how it is displayed in a relational database system for an assessor.

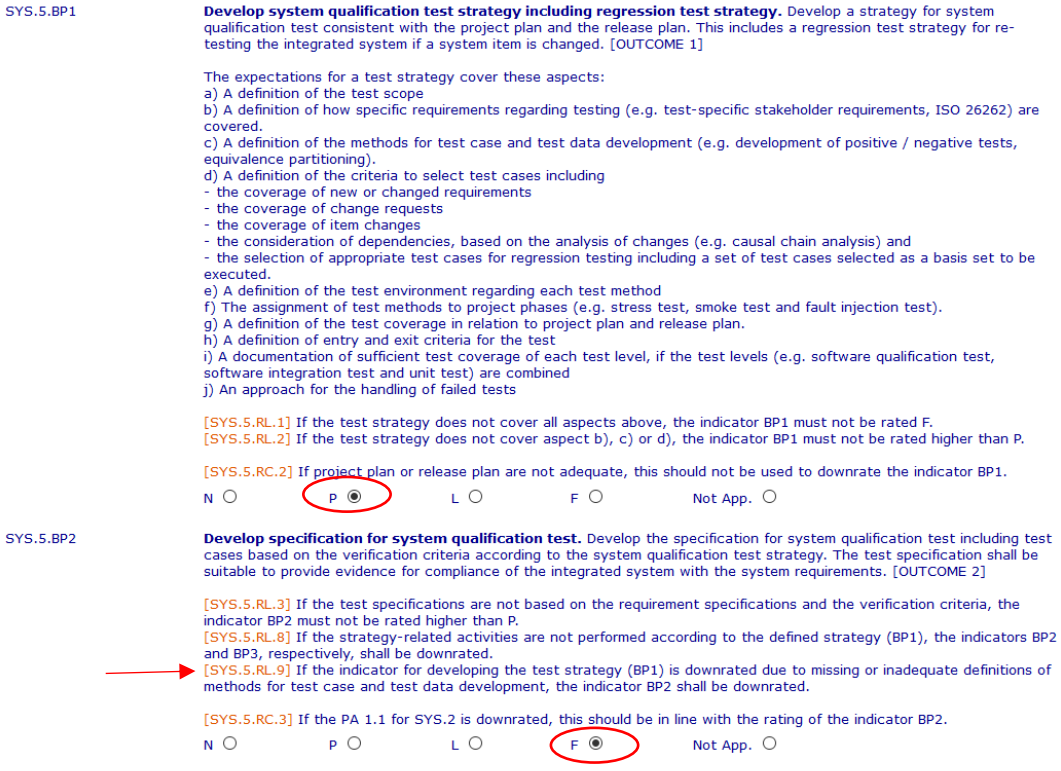

Figure 4: Rule Violation in Rating

Hide Rules | Hide Recommendations

Rated Rating	Rating	Related Rating	Rating	Rating Consistency:
SYS.5.BP3	L	SYS.5.BP1	P	[SYS.5.RL.11] If the indicator for developing the test strategy (BP1) is downrated due to a missing or inadequate definition of the test case selection criteria, the indicator BP3 shall be downrated.
SYS.5.BP2	F	SYS.5.BP1	P	[SYS.5.RL.9] If the indicator for developing the test strategy (BP1) is downrated due to missing or inadequate definitions of methods for test case and test data development, the indicator BP2 shall be downrated.

Figure 5: Rule Violations Reported from Relational Database

When writing assessment reports the assessor team can stick with the violation and write an appendix which lists all inconsistencies and explains the reason.

Another more likely option is that the assessor team discusses the deviations in the consolidation sessions and agrees a rating with no violation of rules.

2.3 Integration of Consolidation Sessions

Imagine that you lead a team of assessors (usually two to three assessors) and all assessors deal with the increased complexity of integrating ASPICE 3.1, rules, and recommendations. How would you then manage a consolidation of ratings?

To manage this more complex situation a more modern consolidation approach is required. A team assessment allows through the use of a multi-user database system that each assessor can have her/his own ratings, see all ratings of all assessors, see all comments of all assessors, and jointly they see all rules and recommendations.

To demonstrate this, screen shots are used by one of the first assessment systems supporting the VDA Automotive SPICE Guidelines (Capability Adviser System).

Figures 6 shows an example team view and how it is displayed in a relational database system for an assessor team (for ach on his computer connected to a server).

See Figure 6.

With such a team view the consolidation will need similar effort like in previous assessments (before the VDA Automotive SPICE Guidelines), otherwise the consolidation time will be more than double the effort.

SYS.5.BP1
Develop system qualification test strategy including regression test strategy.

Assessor 1	P	System test plan - SR03_MasterTestPLan_XCar_B05: Separates between system and system integration test. The filters (how to filter integration and system test), and also the document model (link model, documents, links) defined). b.) TSC as an input is considered, also the safety related test methods. However, the project is ASIL C and the test method selection was for ASIL B. c.) positive functional test and negative test (fault injection) is there. Not equivalence. Due to equivalence class missing downrating to P. System test plan - SR03_MasterTestPLan_XCar_B05:
Assessor 2	L	System and system integration test is defined. Filter done by integration tests against interface requirements, while system test is against functional requirements. Also ASIL is set, so that safety related tests can be filtered and reported. b.) TSC and ASIL requirements and safety test methods considered. c.) positive functional test and negative test (fault injection) is there. No equivalence class test is defined. d.) Select test cases is not clear, regression test is defined.
Assessor 3	P	…..

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]

The expectations for a test strategy cover these aspects:
a) A definition of the test scope
b) A definition of how specific requirements regarding testing (e.g. test-specific stakeholder requirements, ISO 26262) are covered.
c) A definition of the methods for test case and test data development (e.g. development of positive / negative tests, equivalence partitioning).
d) A definition of the criteria to select test cases including
- the coverage of new or changed requirements
- the coverage of change requests
- the coverage of item changes
- the consideration of dependencies, based on the analysis of changes (e.g. causal chain analysis) and
- the selection of appropriate test cases for regression testing including a set of test cases selected as a basis set to be executed.
e) A definition of the test environment regarding each test method
f) The assignment of test methods to project phases (e.g. stress test, smoke test and fault injection test).
g) A definition of the test coverage in relation to project plan and release plan.
h) A definition of entry and exit criteria for the test
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[SYS.5.RL.1] If the test strategy does not cover all aspects above, the indicator BP1 must not be rated F.
[SYS.5.RL.2] If the test strategy does not cover aspect b), c) or d), the indicator BP1 must not be rated higher than P.

[SYS.5.RC.2] If project plan or release plan are not adequate, this should not be used to downrate the indicator BP1

Figure 6: Team-view of ratings, comments, and rules

2.4 Easy to Use Assessment System

The more complex the content becomes, the easier to use the assessment system must become. With few views and clicks (and easy to understand menus) an assessment team must be able to operate, select right views and guide through actions of the assessment.

To demonstrate this, screen shots are used by one of the first assessment systems supporting the VDA Automotive SPICE Guidelines (Capability Adviser System).

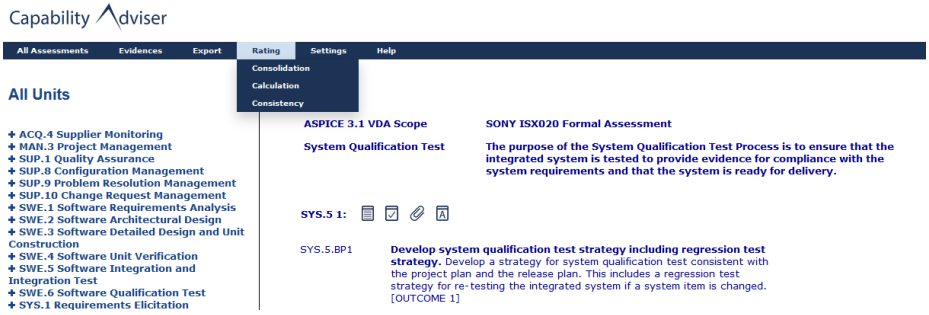

Figure 7: Views offered in Team Assessments for ASPICE3.1 and VDA Automotive SPICE Guidelines

Rating Consolidation View. The team sees all comments and ratings of all assessment team members and can consolidate the overall rating of a process attribute. This empowers the team work of an assessor team.

Rating Consistency View. The system considers all rating dependencies in the VDA Automotive SPICE Guidelines and displays all deviations.

The icon  opens a view with all related **rating rules and recommendations**.

This is only a subset of available views.

3 Conclusions

Without an optimisation of the assessment environment and tool support an assessment using the VDA Automotive SPICE Guidelines [2] will take significantly more days than before.

In ASPICE 3.1 without VDA Automotive SPICE Guidelines an assessment covering the VDA scope took approx.. 5 days on site.

Using ASPICE 3.1 and targeting level 3 the new assessment process foresees a one-day PA3.1 Process Definition interview with process owners beforehand, and then the project assessment.

When using the optimised approach (additional views and no additional rating effort; automatic display of rating inconsistencies; team supported view to reach a consolidated rating; easy to use switching between views) as outlined in this paper the onsite interviews of the project still stick with 5 days onsite as before.

So far we have performed already several ASPICE 3.1 assessments using the VDA Automotive SPICE guidelines in Germany, Japan, Austria and USA and the above assumptions rely on these first experiences.

In the next years more such assessment methods (cybersecurity, safety, etc.) will get integrated in an integrated assessment team approach],[12],[13],[14],[15],[17],[19],[20],[50].

4 Relationship with the SPI Manifesto

A platform were such new cross-cutting approaches can be discussed is EuroAsiaSPI². Its mission is to develop an experience and knowledge exchange platform for Europe where Software Process Improvement (SPI) practices can be discussed and exchanged and knowledge can be gathered and shared [31],[32], [33],[44]. The connected SPI manifesto defines the required values and principles for a most efficient SPI work. One main goal is to support changes by innovation and include all affected stakeholders.

The principle "**Create a learning organisation**" means that best practices and knowledge need to be shared. The assessment systems ins an organisation can become connected with different standards, learning options and access to best practices [50].

A further principle "**Support the organisation's vision and business objectives**" is proposed and should empower teas of assessors and improvement caches by team views and team based assessment and improvement systems [6],[50].

Another important platform for such new cross-cutting approaches is the European DRIVES project. DRIVES is a BLUEPRINT [34], [46],[48],[49] project for the automotive industry and creates a strategy that support the development of new business visions for 2030. It will also emphasise the combined use of different norms.

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