

An Improved Method for Forming UN R155 VTA Test Cases

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Abstract

In recent years, there have been frequent incidents of automotive cyber security, with WP.29 Passed the world's first mandatory regulation on automotive cyber security UN R155 This regulation requires that vehicle models must obtain vehicle type approval (VTA) for cyber security. The UN R155 regulation itself does not provide clear requirements, allowing technical service agencies to conduct regulatory compliance testing according to unified standards. The use cases for VTA certification testing can only be finally confirmed by the certification review agency during formal testing. For manufacturers, this uncertainty brings certain difficulties to vehicle model certification work. This article summarizes the development plan of certification test cases and further proposes improvement methods by researching the implementation rules of VTA issued by certification management agencies in various countries, which can help manufacturers cope in advance and successfully pass VTA certification.

Keywords

UN R155, VTA, test case.

1. Introduction

January 22, 2021, WP.29 has passed UN R155 Vehicle cyber security Regulations, which is the world's first mandatory regulation for automotive cyber security. The mandatory requirements for automotive cyber security under UN R155 regulations are divided into two parts: firstly, the cyber security management system requirements for automotive manufacturers; The second is the cyber security capability requirements for vehicle products. Corresponding to the cyber security management system certification (CSMS certification) and vehicle type approval (VTA) respectively.

The testing during the type approval stage is carried out by the certification or technical service agency and is a necessary part of the vehicle type approval process. In the requirements of Article 5.1.2 of UN R155 regulation, it is specified that vehicle type testing should be carried out to confirm that the OEM has implemented the cyber security measures stated in the document. Testing should be carried out by the certification agency or technical service agency or through sampling in cooperation with the OEM.

UN R155 clause 5.1.2 requires three levels of meaning:

- (1) The subject of testing implementation is the certification agency or technical service agency;
- (2) The object of the test implementation is at least one certified vehicle model;
- (3) The purpose of testing implementation is to verify whether the declared cyber security measures are effectively implemented.

Article 5.1.2 only states that testing should be conducted through sampling and provides the key points of sampling, but does not specify specific implementation details. Automobile manufacturers are very concerned about the uncertainty of testing during the type approval stage, such as how many test cases need to be implemented in total, and what scope and content

to use for case screening. This article aims to study the use case development plan for R155 formal approval testing.

2. Research on the Implementation Rules of R155 Vta

Certification management agencies are obliged to communicate with each other through the Type Approval Information Exchange Database (DETA) on their respective detailed methods for implementing the R155 regulation. Since the official release of the regulation, several seminars have been held on the implementation of the R155 regulation. This article conducts research and analysis on the VTA implementation details in France, the Netherlands, Japan, and Germany.

2.1. France

CNRV is the competent authority in France responsible for vehicle type approval within the scope of the 58 Agreement, and specific testing is usually carried out by technical institutions such as UTAC; In August 2021, CNRV released a manual introducing the implementation details of R155 regulation certification, which is divided into two stages: system certification and vehicle model testing.

Before the vehicle model test, an audit will be conducted in accordance with the terms of Annex 5, and scoring and evaluation will be conducted based on the audit results. The scoring results will not directly affect whether the test is passed, but will affect the number of test items; Projects that fail the test are allowed to undergo retesting after rectification by the enterprise, and additional testing items will be added during retesting, not just testing the last project that failed.

2.2. The Netherlands

The R155 certification in the Netherlands is managed by RDW, which divides the entire R155 certification into two stages: document review and implementation review:

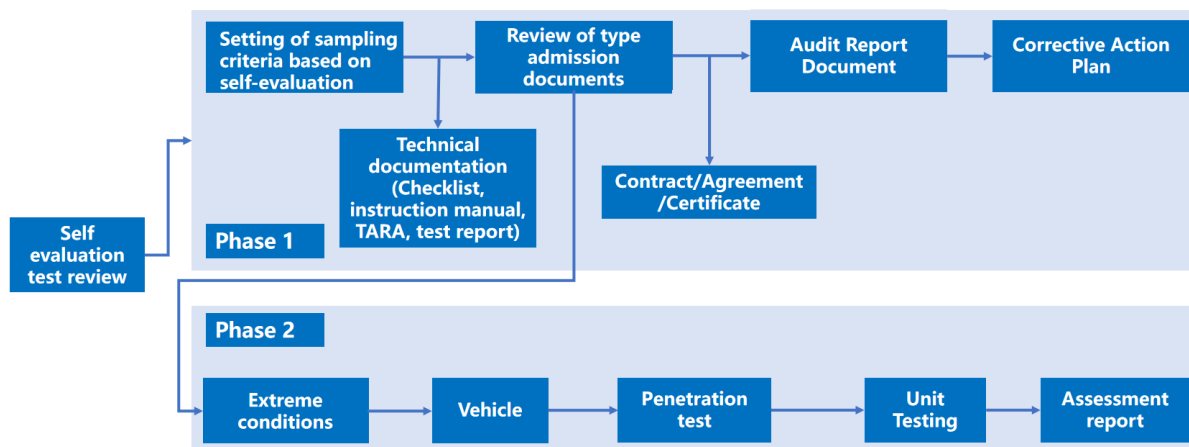


Fig. 1 R155 VTA process in the Netherlands

2.3. Japan

The R155 VTA testing in Japan was conducted by NTSEL under the guidance of the Ministry of Land and Transport (MLIT), and the entire R155 certification testing was divided into two parts: CSMS certification and product testing.

Testing is carried out according to the requirements of CSMS. Before conducting testing, appropriate testing items need to be determined based on the production process and risk assessment results. The purpose of testing is not to discover new vulnerabilities, but to verify whether the vehicle's measures meet the requirements of CSMS.

The delineation of the testing scope includes the following key points:

- The process management requirements belong to the system audit content, and the risk analysis related to vehicle models will be used as input documents for testing and testing;
- The requirements of the supply chain belong to the system requirements;
- The part of the backend that only interacts with vehicles is related to vehicle model testing, while the rest are system requirements;
- The interaction between the vehicle and the cloud, diagnosis, and the interior of the vehicle are the core parts of the experiment.

2.4. Germany

The type approval in Germany is the responsibility of KBA, which has recognized institutions such as Rheinland and South Germany and issued implementation rules in January 2021, including system certification and testing verification:

At least one actual test must be conducted in accordance with regulations. The scope and content of testing should be planned based on the following aspects:

- Risk analysis and the resulting high-risk items;
- The safety objectives declared by the OEM (if applicable, also in the later production stage);
- Minimum safety objectives and functional scope required by regulations (Appendix 5);
- Testing should focus on significant risks, and in the worst-case scenario, testing may need to be conducted on different vehicles.

In addition to actual testing of the product, testing also includes verifying the effectiveness of relevant documents (such as the completeness of risk analysis and the appropriateness of conclusions), including evaluating whether the measures declared by the OEM have achieved the minimum safety goals and the required functional scope;

When selecting testing and vehicles, platform side safety should be considered;

Significant statements made by OEMs, such as statements that high-risk items do not affect other components/systems of the vehicle, must be verified;

If the certification agency has the necessary testing equipment, the testing should be conducted in TS's own laboratory environment. If appropriate, the manufacturer should assist with testing (such as providing analytical tools).

3. Summary of Implementation Rules for R155 Vta

Referring to the practical experience of R155 VTA implementation in various countries, the key points for forming certification test cases can be summarized as follows:

The testing is based on risk analysis and manufacturer's testing documents, including functional testing and safety testing. The testing documents should include the testing plan, expected testing results, and actual testing results. The testing plan should include a description of the testing scenarios and tests conducted on each interface/component of the vehicle under consideration. TS will evaluate the completeness of the testing plan and the consistency between the actual results of the manufacturer's testing and the expected results.

Reusable vehicle manufacturers should design their own test cases when necessary, especially when there are significant gaps in the testing plan.

Testing should prioritize external interfaces as they pose higher risks. In some cases, such as if security is particularly dependent on internal components, random samples of internal components can also be tested.

Attack level for security testing: Generally speaking, the higher the risk of the component/interface being considered, the higher the assumed attack level chosen. Usually, white box or gray box testing should be conducted, and the manufacturer should provide relevant input and support. Specific test cases can be developed based on the following aspects:

- Only copy the safety tests that have been carried out by the manufacturer.
- Some predefined "standard tests" (brute force attacks, blurring, etc.) will be executed.
- Use publicly accessible information sources/databases to investigate vulnerabilities in the test object. If a vulnerability is found and does not exceed the set attack level, the relevant attack will be executed.
- Identify potentially vulnerable interfaces based on available design files and functional specifications. Then, experienced penetration testers will perform individually specified attack attempts on these interfaces (at a given attack level).

4. R155 Vta Test Case Development Plan

Based on the practical experience and key points of R155 VTA implementation in various countries, this article studies the development plan of R155 VTA test cases.

The flowchart is shown in the figure, and the specific process is as follows:

Step 1: Firstly, obtain the manufacturer's TARA report and testing documents. The testing documents include integration validation testing documents and confirmation testing documents. These input documents must first be reviewed by the certification agency to ensure the integrity of TARA and the appropriateness of conclusions. Therefore, the development of the testing plan can be trusted and based on the above documents.

Step 2: Analyze the TARA report, select all high-risk items, extremely high-risk items, and some medium risk items. On the one hand, match the test cases in the confirmation test document. If there are relevant cases, reuse them and add them to the security test case set. If there are no relevant cases, adapt the use cases from the security test attack library formed according to Appendix 5; On the other hand, confirm whether these high-risk and extremely high-risk items have been mitigated. If so, match the test cases in the integration validation testing document. If there are relevant cases, reuse and add them to the functional test case set. If there are no relevant cases, re involve the use cases.

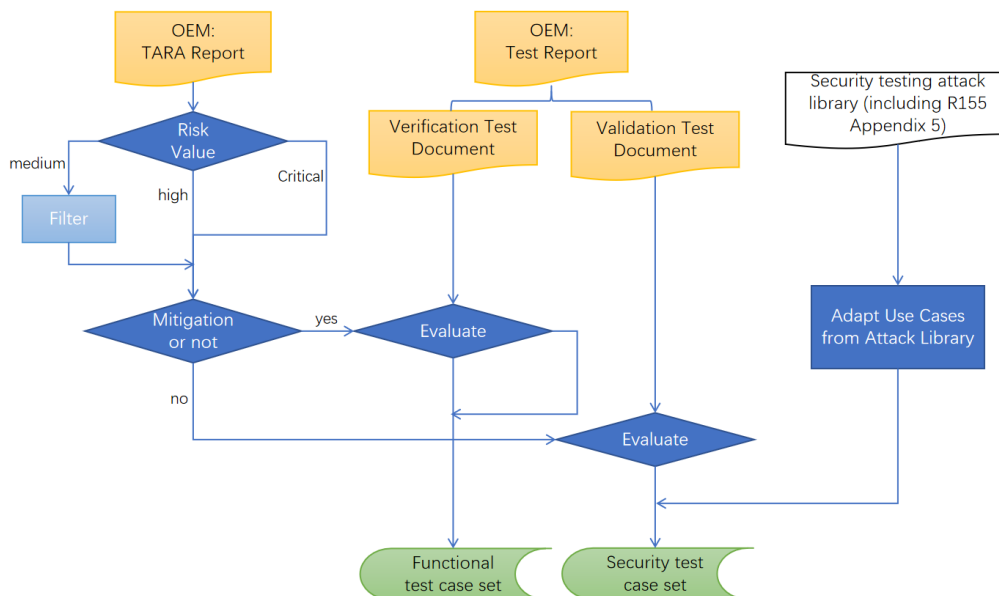


Fig. 2 R155 VTA Test Case Development Process

5. Existing Problems and Improvement Methods

The core of the above plan is to screen test cases based on risk values, but in practice, the number of medium risk items in TARA reports is usually very large, and the number of final use cases cannot be controlled solely through risk value screening. Therefore, this article further

proposes a method for determining use cases based on three factors: comprehensive risk value, attack feasibility, and attack vector:

Step 1: If the risk values of two risk items are consistent, further evaluate the feasibility of the risk item attack path; If the attack feasibility of two risk item attack paths is different, select the risk item with high attack feasibility for the next use case matching; If the same, proceed to step 2;

Step 2: If the attack feasibility of two risk term attack paths is the same, further analyze the attack vectors. The selection order of the attack vectors is: Network>Adjacent>Local>Physical.

6. Conclusion

The UN R155 regulation itself does not provide clear VTA certification testing requirements, allowing technical service agencies to conduct regulatory compliance testing according to unified standards. The use cases for VTA certification testing can only be finally confirmed by the certification review agency during formal testing. For manufacturers, this uncertainty brings certain difficulties to vehicle model certification work. This article summarizes the development plan of certification test cases and further proposes improvement methods by researching the implementation rules of VTA issued by certification management agencies in various countries, which can help manufacturers cope in advance and successfully pass VTA certification.

Acknowledgements

This paper was supported by the subject "National Key R&D Plan of the Ministry of Science and Technology (Project No: 2020YFB1600204)".

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