Application of

VDA „Field Failure Analysis"

in the Electronics Supply Chain

Training Support / Process Steps

Action Group „Field Failure Analysis – NTF"

- ZVEI Guideline

  Field Failure Analysis in the

  Electronics Supply Chain

    - *www.zvei.org/*Schadteilanalyse
    - Published in Feb. 2014
    - Free Download
    - Available in German and English

Action Group „Field Failure Analysis – NTF"

- VDA Recommendation 2009

  - Based on VDA 6.3
  - Additional **Audit Standard 2011**
  - Also used for contractual agreements

VDA Process „Schadteilanalyse Feld „ (Field Failure Analysis)":

- The Standard Tests should focus on known Failure Mechanisms (according to the test specification)

- Only for new Failure Mechanism the Root Cause Analysis Process (8D) is started

- Within the NTF Process the reason for the i.O.-Part is evaluated

- OK means i.O. (in Order)
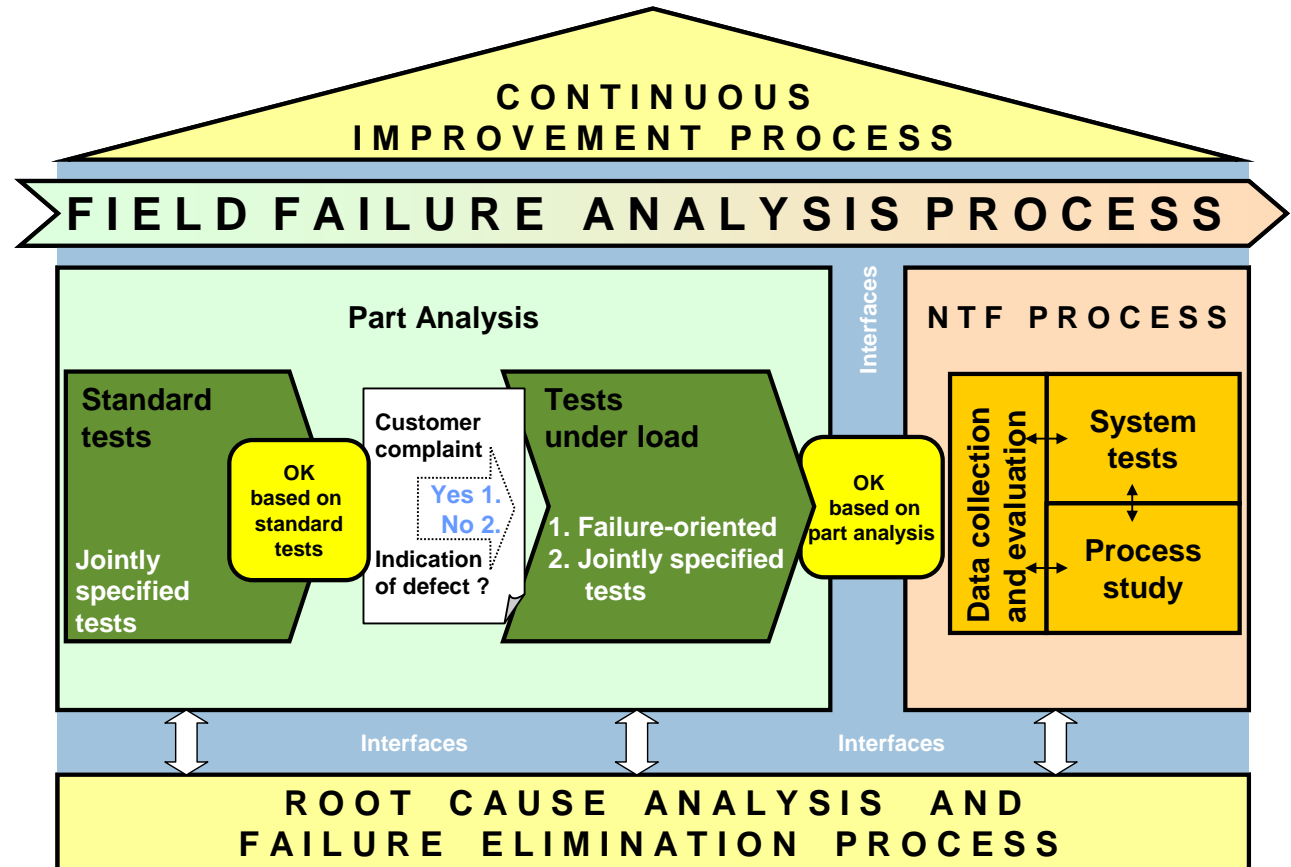
Source: VDA - QMC

Field Failure Analysis Process – NTF

ZVEI:
Die Elektroindustrie

AK)* NTF triggering criteria fulfilled?

Parts analysis

no

AK)*

yes

NTF - PROCESS

Warranty Parts

Standard tests

I.O. based on standard tests

Jointly specified tests

Customer complaint

Yes 1.
No 2.

Indication of defect ?

Tests under load

1. Failure -oriented
2. Jointly specified tests

I.O. based on Part Analysis

Data collection and evaluation

System tests

Process study

System, process I.O.?

yes

no

STOP

PART / SYSTEM / PROCESS ➔ N.I.O.

ZVEI:
Die Elektroindustrie

Process Step

Input

AK)* NTF triggering criteria fulfilled?

no   yes

Parts analysis

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I.O. based on standard tests

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2. Jointly specified tests

AK)*

I.O. based on Part Analysis

N T F - P R O C E S S

Data collection and evaluation

System tests

Process study

System, process I.O.?

yes

no

STOP

➢ **Output**

PART / SYSTEM / PROCESS ➜ N.I.O.

Available Tools, Resources, Basics, etc.

Standard Testing

VDA Inspection – Standard Testing
Agreed test plan

Process Step

Reception of field failure part

Warranty Parts

Parts

Standard tests

I.O. based on standard tests

Jointly specified tests
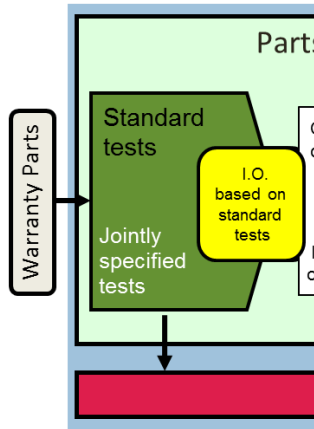
> **Identity check (part number etc.)**
> **Part is in good shape[1], can be tested**
> **Documentation is complete[1]**
> **Priority, e.g. rapid analysis for parts from vehicle breakdown**
> **Documentation of the test results**

Input

Output

Specific test plan for each part number, for example: short[2] function test
Agreed I.O./N.I.O. criteria
Comply with agreed lead time requirements

Basics

Standard Testing (Annotations)

- [1] Part and Documentation:

  - The part shall not be damaged during dealer repair, storage, packaging or transportation back to the manufacturer
  - Complete documentation, as agreed with the customer, e.g. list of all failure codes written in electronics control unit

- [2] Testing shall be economically reasonable, see VDA chapter 2.1

  - The field failure analysis process is an escalating test concept as shown in Fig. 1 which includes the **part analysis** (from the standard tests and tests under load) and the **NTF process** (NTF = no trouble found). The escalating test concept is intended to ensure that the requirements described in the following sections can be implemented with a degree of effort which can be justified in **economic terms**.

    The defects identified by this analysis concept are submitted to a systematic **root cause analysis and defect elimination** based on the problem-solving process[1].

Testing under Load – Failure-oriented

VDA Part Analysis – Testing under Load Failure-oriented

Process Step

Standard testing with result I.O.; plus useful failure indications

Parts analysis

Customer complaint

Yes 1.
No 2.

Indication of defect ?

Tests under load

1. Failure-oriented
2. Jointly specified tests

PART / SYSTEM / PR

Input
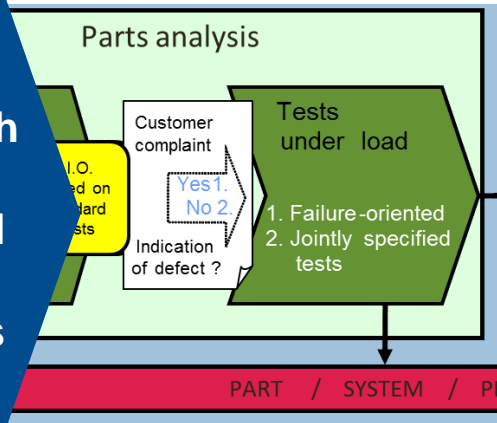
➢ **Evaluation of indications[3] and related failure modes in end-product**

➢ **Testing under load according to the indicated failure conditions[4]**

➢ **Documentation of test results**

➢ **Part analysis finished[6]**

Output

Specific inspection test plan with indication of failure conditions[5a] according to known failure modes
Customer documentation (dealer diagnostics, OEM/Tier1 pre-analysis) [5b]
Agreed I.O./N.I.O. conditions
Comply with agreed lead time requirements

Basics

- [3] See VDA chapter 10.1.1: <u>Data to be provided by customer</u>

- [4] The „jointly specified tests" will not be done

- [5a] See VDA chapter 2.3 B:

> The evaluation of the customer's complaint makes it possible to specify "failure-oriented" tests in the tests under load, if no defects were detected in the course of the standard tests. If the complaint by the customer and / or mechanic is not stated or no conclusions can be drawn from it, the "jointly specified" tests are carried out (see also Section 5.1.3: "Specifying and classifying the tests in standard tests and tests under load").

- [5b] Active request of further available documentation can be helpful

Testing under Load – jointly specified tests

VDA Part Analysis – Testing under Load
Jointly specified tests

Process Step

Standard testing with result I.O.; no useful failure indications

Parts analysis

I.O. ed on dard ests

Customer complaint

Yes 1.
No 2.

Indication of defect ?

Tests under load

1. Failure-oriented
2. Jointly specified tests

PART / SYSTEM / P

Input
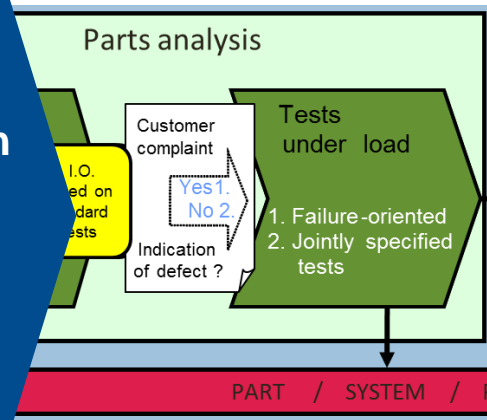
➤ **Jointly specified tests to be done as agreed in the test instruction** [6]

➤ **Documentation of test results**

➤ **Part analysis finished** [7]

➤ **Agree with customer about part return back to customer, archive or scrap**

Output

Specific inspection test plan with jointly specified tests
Agreed I.O./N.I.O. conditions
Comply with agreed lead time requirements

Basics

■ [6] The diagnosis of the field failure part is executed according to a test specification that has been agreed in advance (e.g. data sheet or control plan agreed at PPAP), describing a standard test with sub-sequent testing under load (agreed jointly or failure focused)

- The tested field failure part must not be damaged as long as it is considered "in order"

- Example: Flash memory component

  - PPAP test conditions for product validation: 100.000 cycles of read and write

  - Field failure diagnosis: demonstrate a 1-week use case, corresponding to 128 cycles of read and write, assuming 15 years of life time

Cycles / Time (vertical axis)

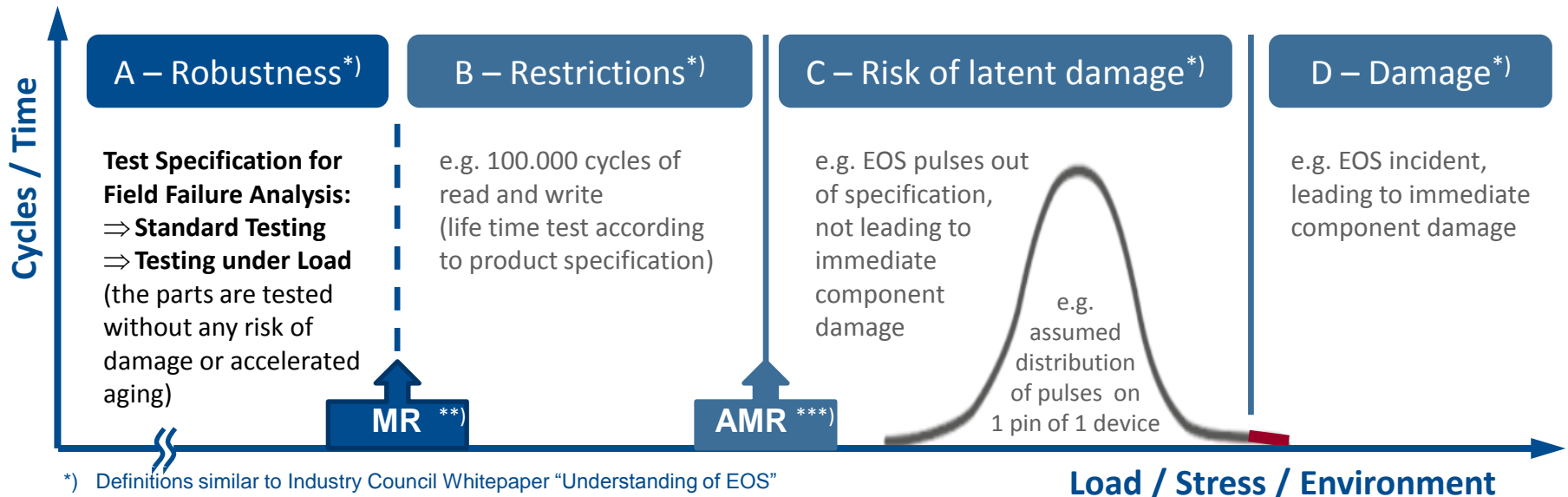| A – Robustness[*]	B – Restrictions[*]	C – Risk of latent damage[*]	D – Damage[*]
Test Specification for Field Failure Analysis: ⇒ **Standard Testing** ⇒ **Testing under Load** (the parts are tested without any risk of damage or accelerated aging)	e.g. 100.000 cycles of read and write (life time test according to product specification)	e.g. EOS pulses out of specification, not leading to immediate component damage	e.g. EOS incident, leading to immediate component damage

MR **)

AMR ***)

e.g. assumed distribution of pulses on 1 pin of 1 device

Load / Stress / Environment

*) Definitions similar to Industry Council Whitepaper "Understanding of EOS"
**) MR = Maximum Rating = Normal usage conditions in vehicle
***) AMR = Absolute Maximum Rating = Limit for component specification

Testing under Load (Annotations)

- 7) The lead time target for parts analysis is achieved after testing under load. The problem solving process (e.g. 8D method) can be executed outside of the lead time target.

NTF Triggering Criteria

**VDA Parts Analysis – NTF Process
NTF Triggering Criteria**

Process Step
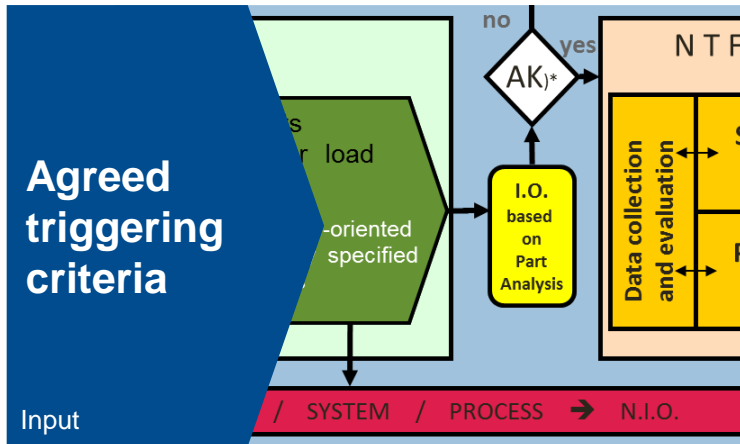
Agreed
triggering
criteria

➢ **Triggering criteria fulfilled:
Start the NTF Process as described in the
NTF guideline[8], with the available parts**

➢ **Triggering criteria not fulfilled:
Parts will be counted as I.O.-parts**

Input

Output

Examples of agreed NTF triggering criteria:

➢ **High quantity[9] of analyzed parts with result I.O. during a period of time**

➢ **Parts from vehicle breakdown or during monitoring period at SOP**

Basics

NTF Triggering Criteria (Annotations)

- 8) Content of the NTF Guideline: Build a project team (customer, Tier1, Tier-n), action plan, etc.

  - See VDA audit standard and manual chapter 3.7:

3. NTF-Process		
Minimum requirements / assessment-relevant:	Possible examples of requirements and verification depending on product risk	Notes (input-output) and references
3.1 Are triggering criteria and a guideline for an NTF-process available and are they used (input)?		
- defined triggering criteria - monitoring system - triggering of the NTF-process after exceedance - NTF-process-line of action	- agreement to triggering criteria - KPI OK according to parts analysis - executed NTF-processes (especially lessons learned) - project and test plan - NTF-guideline	Cap. 3.1 Cap.6.1.2 Cap. 10.3.4 Cap. 5.2.1
3.2 Is the NTF-process executed according to the guideline?		
- execution on own responsibility at first step - usage of adequate methods - data collection / data assessment - possible system check/ process study - documentation of the process steps	- project management methods - QM-methods - NTF-reports - action plans - statistical analysis - multiple layer diagram	Cap. 3 Cap. 10.3.4

- The number of failures
- The production and failure periods examined
- The triggering criteria
- The teams involved
- The checks and tests employed, including the associated parameters
- The processes examined
- A description of the main failures
- The analysis methodology
- Improvement actions in the part analysis processes, the component, system and / or process, with deadlines

- 9) In particular cases and for good reasons, also a single part can run through a NTF investigation

NTF – Data Collection and Evaluation

VDA Parts Analysis – NTF Process
Data Collection and Evaluation

Process step

Input

> **Part analysis result I.O.**
>
> **Data**

N T F - P R O C

Data collection and evaluation

System tests

Process study

Output
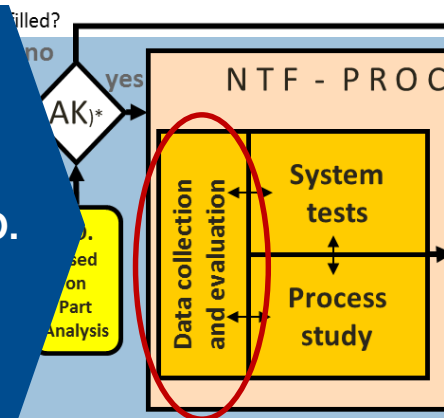
> Customer provides all agreed data[11] within agreed lead time[10]
> Supplier verifies all internal data[12] and customer data within agreed lead time
> Application and test evaluation at customer according to data verification results and within agreed lead time
> Planning and orientation of further activities according to team meetings (regions, vehicle models, etc.)

> Test bench description and test criteria at customer
> Revision level of test and application programs
> Technical product specification
> Field data analysis, worldwide dealer repairs

> Time in service, failure occurrence date, mileage, before/after vehicle assembly, before/after component assembly
> Vehicle environmental conditions, failure conditions, user application profile
> Change history
> Mission Profile over complete supply chain

Basics

NTF – Data Collection and Evaluation (Annotations)

- **10)** Due dates to be agreed within the NTF-Team (e.g. action plan)

- **11)** Typical customer data sources

  - Overview of parts analysis results
  - Change history on system level (interaction with other vehicle components)
  - Internal complaints, 0-km complaints, special parts
  - Field complaints data from worldwide dealer repairs
  - Diagnostics protocols for each dealer repair
  - Worldwide customer complaints and dealer analysis comments

  VDA Recommendation:
  - Complaints / rejects from the defined reference markets and other markets
  - Vehicle data (e.g., repair history, production data, engine and transmission variants, special equipment, mileage)
  - Damage classifications (e.g., damage key references)
  - Classification of customer complaints / rejects
  - Operating conditions (e.g., any specific conditions in the country in question, special vehicles, climatic conditions)
  - Diagnosis results (e.g., error codes, diagnostic report)
  - Analysis results from previous analyses
  - Service and repair instructions, diagnosis requirements
  - Comprehensive failure data-bases (e.g., development, internal production, 0 km failures, field failures)
  - Production process data
  - Knowledge gained from comparable products from other customers

- **12)** Typical supplier data sources

  - Overview of parts analysis results
  - Change history, relocations, supplier change, etc.
  - Internal complaints and supplier complaints

  VDA Recommendation:
  - Measured values and information from the part analysis
  - Damage classifications (e.g., damage key references)
  - Classification of customer complaints / rejects
  - Analysis results from previous analyses
  - Failure codes which have been read out
  - Operating conditions (e.g., any specific conditions in the country in question, special vehicles, climatic conditions)
  - Product life history (including software and hardware levels)
  - Comprehensive failure data-bases (e.g., development, internal production, 0 km failures, field failures)
  - Production process data
  - Knowledge gained from comparable products from other suppliers

NTF – System Tests

VDA Parts Analysis – NTF Process
System Tests

Process Step

Input

- ➢ **Part analysis result I.O.**

- ➢ **Vehicle System**
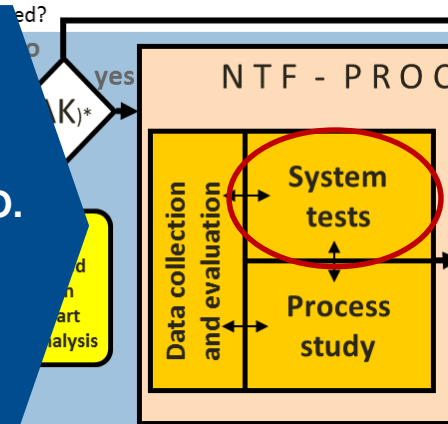
- ➢ **Focus on demounted vehicle components (e.g. reproduce the failure mode in vehicle system or on test bench)**

- ➢ **Measurement in system environment (if possible in vehicle)**

- ➢ **Coordination of tests and results on system level**

- ➢ **Contribution of vehicle components (HW/SW/…)**

Output

- ➢ **Agreed specification or agreed product use versus real use case in the field**

Basics

NTF – Process Study

VDA Parts Analysis – NTF Process
Process Study

Process Step

Input

- ➢ **Part analysis result I.O.**
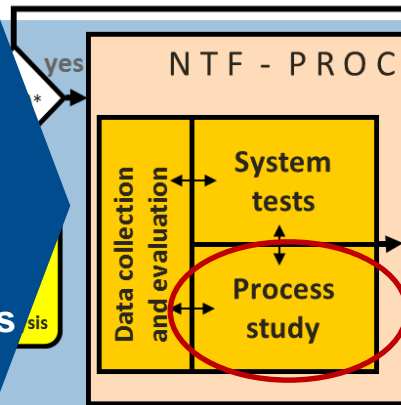
- ➢ **Analysis, Repairs, Diagnostics Process**

N T F - P R O C
Data collection and evaluation
System tests
Process study

- ➢ **Verify effectiveness of parts analysis process at OEM, Tier1 and Tier-n**
- ➢ **Review findings from APQP with relation to the described vehicle failure mode**
- ➢ **Feedback into Lessons-Learned (if applicable)**
- ➢ **Part Average Analysis[13] for critical process steps**
- ➢ **Statistical evaluation of process parameters**

Output

- ➢ **NTF guideline and action plan**
- ➢ **Parts analysis inspection plan**
- ➢ **APQP documentation, VDA 6.3 process audit findings**
- ➢ **Repair and diagnostics instructions, software failure codes**
- ➢ **Fault tree analysis (FTA), Red-X, Shainin®, etc.**

Basics
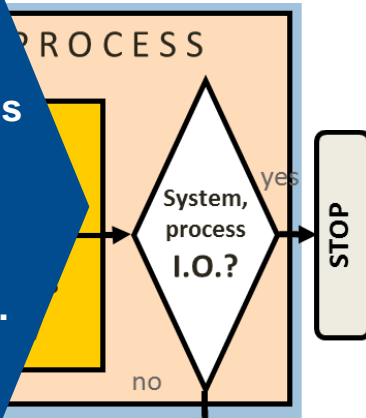
- [13] Part Average Analysis: Statistical evaluation of tolerance limit values that can lead to system failure in certain combinations.

End of NTF investigation

VDA Parts Analysis – NTF Process
End of investigation

Process Step

Input

- **Part analysis result I.O.**
- **System I.O.**
- **Process I.O.**

PROCESS

System, process I.O.?

yes

STOP

no

- **No failure found during part analysis and NTF investigation (system and process verification)**
  - **Analysis result: Returned Part is "I.O."**

- **Returned Part has shown a failure and the vehicle failure mode has been reproduced**
  - **Analysis result: Returned part is "N.I.O." [14]**
  - **Hand-over to problem solving process of the fault-causing party (8D)**

Output

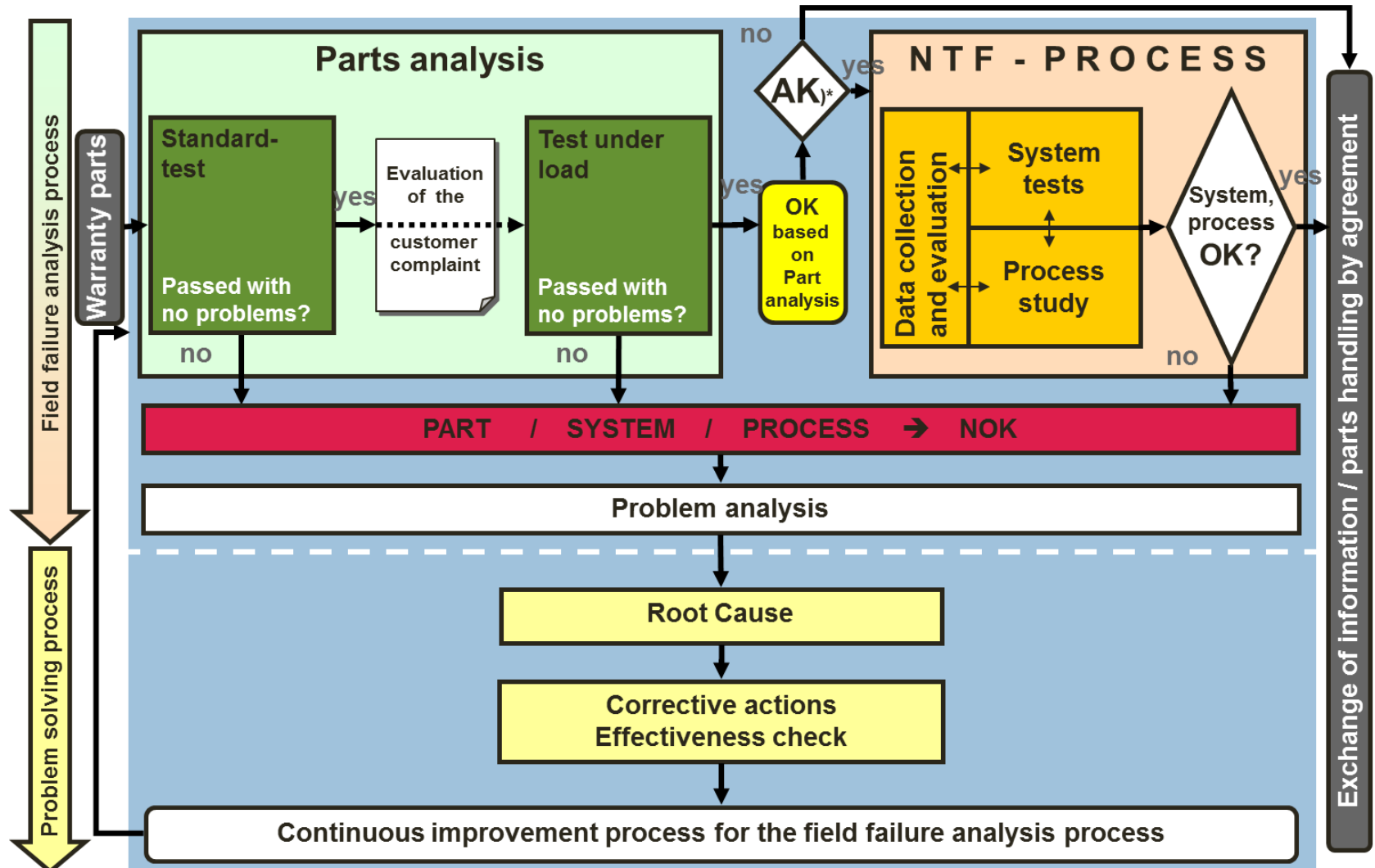**NTF guideline and report**

Basics

- [14] The n.i.O. test result confirms that the component does not or no more have the specified functionality in this particular application case. This result does not provide any root cause statement. The root cause shall be determined and eradicated in the subsequent problem analysis process (root cause analysis, corrective actions, verification of efficiency).

Continued problem solving process
according to QM-Handbook ISO/TS…

Field failure analysis process

Problem solving process

Warranty parts

Parts analysis

Standard-test

Passed with no problems?

Evaluation of the customer complaint

Test under load

Passed with no problems?

yes

no

OK based on Part analysis

AK)*

no

yes

yes

N T F - P R O C E S S

Data collection and evaluation

System tests

Process study

System, process OK?

yes

no

Exchange of information / parts handling by agreement

PART / SYSTEM / PROCESS ➔ NOK

Problem analysis

Root Cause

**Corrective actions
Effectiveness check**

Continuous improvement process for the field failure analysis process

Remark: OK means I.O. (in Order)

Source: VDA - QMC

Action Group „Field Failure Analysis – NTF"

*Free Download: www.zvei.org/*Schadteilanalyse

Thank you for the attention

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