VDA QMC | Qualitäts Management Center im Verband der Automobilindustrie

FMEA Alignment VDA and AIAG

Status February 2018

Alignment of VDA and AIAG FMEA handbooks

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FMEA Alignment of VDA and AIAG

Currently suppliers providing products to both German and N.A. OEM's are required to assess their products' failure modes and effects differently, based on differences between the Severity, Occurrence, and Detection rating tables in the VDA and AIAG FMEA Manuals.

This causes confusion and adds complexity to the product development and product improvement activities of the suppliers.

A common set of FMEA requirements/expectations will enable suppliers to have a single FMEA business process and associated set of methods and tools to produce robust, accurate and complete FMEA's that would meet the needs and expectations of any of their customers.

Comparison of the FMEA Manual VDA and AIAG (Ford, GM, FCA)

Main focus of the project was the standardization of the criteria „severity“, „occurrence“ and „detection“ within the ranking tables.

During the discussion of the issues in the industry the team members of VDA and AIAG agrees that would be a good opportunity to harmonize and standardize other parts of the manual in addition.

Attendees

Audi AG
Continental Teves AG
Daimler AG
Daimler Truck North America*
FCA US LLC
Ford Motor Company
General Motors*
Honda of America Mfg., Inc.
Ing.-Büro Pfeufer (on b. of VDA-QMC)
Knorr-Bremse SfN GmbH
Nexteer Automotive*
ON Semiconductor
Opel Automobile GmbH
Robert Bosch GmbH
Schaeffler Technologies AG & Co KG
VOLKSWAGEN AG
ZF Friedrichshafen AG
ZF TRW

Embedding of the method in development process

- FMEA has to be worked out according the project plan and evaluated to the project mile stones according to the status of the analysis
- FMEA should be an integrated in design discussions and releases

APQP Phases	Plan and Define Program	Product Design and Development Verification	Process Design and Development Verification	Product and Production Validation	Feedback Assessment and Corrective Action

- The process responsibility of the management is stressed
- Priority of FMEA, availability of resources and input dimensions => In practice often the biggest challenge
- Result communication and inspection
- Reviews with the management

VDA Maturity Level	RG0	RG1	RG2	RG3	RG4	RG5	RG6	RG7
	Innovation Approval for serial Development	Requirement Management for Procurement Extensive	Definition of the Supply Chain and Placing of Extensive	Approval of Technical Specification	Production Planning Done	Serial tools, Spare Parts and Serial Machines Available	Product and Process Approval	Project End, Responsibility Transfer to Serial Production, Start, Requalifikation

Projects meeting and face to face meetings (1/5)

- **First contacts November 2014**
- **Since May 2015 regular conference calls (weekly / bi-weekly)**
- **Three face to face meeting took place**

1. **Design FMEA main results**

   Meeting in CW 07/2016 (AIAG)

   ✓ Review of VDA and AIAG approach
   ✓ Definition of 6 step approach
   ✓ Clarification of inputs and outputs of the 6 steps
   ✓ Review of Ranking Charts (S, O, and D)
   ✓ RPN is replaced by Action Priority (AP)
   ✓ DFMEA: Classification column special characteristics deleted

Projects meeting and face to face meetings (2/5)

- **Three face to face meeting took place - (duration 5 days)**

1. **Design FMEA main results**

- ✓ **Special Characteristics**
  SI 6 to IATF 16949/8.3.3.3 Special characteristics

  The organization shall use a multidisciplinary approach to establish, document, and implement its processes to identify special characteristics, including those determined by the customer and the risk analysis performed by the organization, and shall include the following:

  a) documentation of special characteristics in the product and/or manufacturing documents (as required), relevant risk analysis (such as Process FMEA), control plans, and standard work/operator instructions; special characteristics are identified with specific markings and are documented in the manufacturing documents which show the creation of, or the controls required, for these special characteristics;

  Rationale for change: *Clarifies the documentation of special characteristics in the product and/or manufacturing drawings.*

Projects meeting and face to face meetings (3/5)

- **Three face to face meeting took place - (duration 5 days)**

1. **DFMEA main results**

- ✓ **Special Characteristics**…
  Established Special Characteristics are marked with an abbreviation or symbol in documents such as Product drawings, Process FMEA (Special Characteristics column) and Control Plans.

  There is no column Special Characteristics in DFMEA.

  Evidence for the implementation of process controls for Special Characteristics should be monitored, archived and available.

Projects meeting and face to face meetings (4/5)

- **Three face to face meeting took place - (duration 5 days)**

  2. **Process FMEA main results**

     Meeting in CW 17/2016 (VDA)

     - ✓ Review of Process AIAG and VDA
     - ✓ Chapter Introduction
     - ✓ Disposition of PFMEA as 6 step approach
     - ✓ PFMEA: Classification column special characteristics remains
     - ✓ RPN is replaced by Action Priority (AP)

Projects meeting and face to face meetings (5/5)

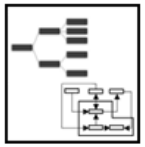
- **Three face to face meeting took place - (duration 5 days)**

  3. **FMEA-MSR (Monitoring and System Response) main results Meeting in CW 04/2017 (AIAG)**
     - ✓ Chapter “Supplemental FMEA for Monitoring and System Response (FMEA-MSR)” added
     - ✓ Included comments to the draft of the team members and their company colleagues
     - ✓ Detailing of the rank charts
     - ✓ Review of existing chapters and fine tuning of the wording

- **Next planned face to face meeting after yellow book phase**

  4. **Meeting in CW 12/2018 (VDA)**
     - ✓ Disposition of Feedback
     - ✓ Review of all chapters
     - ✓ Editorial and technical revision

Six steps of FMEA

System Analysis			Failure Analysis and Risk Mitigation		
1st Step Scope Definition	2nd Step Structure Analysis	3rd Step Function Analysis	4th Step Failure Analysis	5th Step Risk Analysis	6th Step Optimization
					
Project identification	System structure for a product or elements of a process	Overview of the functionality of the product or process	Establishment of the failure chain (potential Failure Effects, Failure Modes, Failure Causes) for each product or process function (step)	Assignment of Prevention Controls (existing and/or planned) to the Failure Causes and Failure Modes	Identification of the actions necessary to reduce risks
Project plan	Visualization of the analysis scope using a structure tree or equivalent: block diagram, boundary diagram, digital model, physical parts, or process flow diagram	Visualization of product or process functions using a function tree (function net), function matrix parameter diagram or process flow diagram	Visualization of product or process failure relationships (failure nets and/or the FMEA worksheet)	Assignment of detection controls (existing and/or planned) to the Failure Causes and Failure Modes	Assignment of responsibilities and deadlines for action implementation
Analysis boundaries: What is included and excluded from the analysis	Identification of design interfaces, interactions, close clearances, or process steps	Association of requirements or characteristics to functions and functions to system or process elements	Creation of failure structures by linking the failures in the failure chain	Rating of Severity, Occurrence and Detection for each failure chain	Implementation and documentation of actions taken
Identification of baseline FMEA with lessons learned		Cascade of customer (external and internal) functions with associated requirements	Identification of product noise factors or process sources of variation (4M) using a fishbone diagram, parameter diagram, or failure network Collaboration between customer and supplier (Failure Effects)	Collaboration between customer and supplier (Severity) Action Priority (AP)	Confirmation of the effectiveness of the implemented actions Assessment of risk after actions taken Continuous Improvement of the product and process
Basis for the Structure Analysis step	Basis for the Function Analysis step	Basis for the Failure Analysis step	Basis for the record of failures in the FMEA form and the Risk Analysis step	Basis for the product or process Optimization step	Basis for refinement of the product and/or process requirements and prevention / detection controls

D1: DFMEA Rank Chart Severity

Product General Evaluation Criteria Severity S		Corporate or Product Line Examples
SEV	Potential Failure Effects rated according to what the End User might experience	
10	Affects safe operation of the vehicle and/or other vehicles, the health of operator or passenger(s) or road users or pedestrians.	
9	Noncompliance with regulations.	
8	**Loss** of essential vehicle function necessary for normal driving during expected service life.	
7	**Degradation** of essential vehicle function necessary for normal driving during expected service life.	
6	**Loss** of convenience function.	
5	**Degradation** of convenience function.	
4	Perceived quality of appearance, sound or haptics unacceptable to most customers	
3	Perceived quality of appearance, sound or haptics unacceptable to many customers	
2	Perceived quality of appearance, sound or haptics unacceptable to some customers	
1	No discernible effect.	

D2: DFMEA Rank Chart Occurrence (Extract)

Occurrence Potential O for the Product Design			
	Occurrence criteria for potential Failure Causes resulting in the Failure Mode, considering Prevention Controls, rated for the intended service life of the item(Qualitative rating)	**History of product usage with-in the company (Novelty of design, application or use case)**	**Use of Best Practices for product design, Design Rules, Company Standards, Lessons Learned, Industry Standards, Material Specifications, Government Regulations and effectiveness of prevention oriented analytical tools including Computer Aided Engineering, Math Modeling, Simulation Studies, and Tolerance Stacks**
OCC	**Estimated Occurrence**	**Product Experience**	**Prevention Controls**
10	Occurrence during intended service life cannot be determined at this time, no preventive controls, or occurrence during intended service life of the item is extremely high.	First application of new technology anywhere without operating experience and / or under uncontrolled operating conditions. Use Case or operating conditions vary widely and cannot be reliably predicted.	Standards do not exist and best practices have not yet been determined. Analysis is not able to predict field performance.
1	Possibility of failure is virtually eliminated through preventative control and history of failure-free series production.	Identical mature design. Same application, duty cycle, and operating conditions. Testing or field experience under comparable operating conditions or mature design with long, failure-free series production experience under comparable operating conditions.	Design proven to conform to Standards and Best Practices, considering Lessons Learned, which effectively prevents the failure from occurring. Analysis is Capable of ensuring with high confidence that the failure cannot occur.

Note: A 10, 9, 8, 7 can drop based on process validation activities prior to start of series production.

D3: DFMEA Rank Chart Detection (Extract)

Detection Potential D for the Validation of the Product Design	
Detection Controls rated according to the best fit for each detection activity performed prior to delivery of the design for production	
DET	**Detection Capability**
10	**DETECTION CAPABILITY:** No test or test procedure not capable of detecting failure prior to delivery of design for production.
9	**DETECTION CAPABILITY:** General test procedure not designed to specifically detect the cause and/or failure mode.
8	**DETECTION CAPABILITY:** Procedure is uncertain and/or there is limited experience with the new procedure. **TIMING:** Post technical release and prior to production launch.
7	**DETECTION CAPABILITY:** Procedure is uncertain and/or there is limited experience with the modified procedure. **TIMING:** Post technical release and prior to production launch.
4	**DETECTION CAPABILITY:** Proven product design and development verification procedure with new usage profile. **TIMING:** Prior to technical release.
3	**DETECTION CAPABILITY:** Proven product design and development verification procedure with same usage profile as previous product. **TIMING:** Prior to technical release.
2	**DETECTION CAPABILITY:** Detection of Causes (including Noise Factors) with virtual analysis which are highly correlated to operating conditions and physical testing with high confidence. **TIMING:** Prior to technical release.
1	Detection of Causes (including Noise Factors) Previously validated.

Design FMEA Action Priority (AP) (Extract)

S	O	D	AP	Justification for Action Priority - DFMEA
9-10	6-10	1-10	H	High priority due to safety and/or regulatory effects that have a **high** or **very high** occurrence rating
9-10	4-5	7-10	H	High priority due to safety and/or regulatory effects that have a **moderate** occurrence rating and **high** detection rating
5-8	4-5	5-6	H	High priority due to the loss or degradation of an essential or convenience vehicle function that has a **moderate** occurrence rating and **moderate** detection rating
5-8	4-5	1-4	M	Medium priority due to the loss or degradation of an essential or convenience vehicle function that has a **moderate** occurrence and **low** detection rating
2-4	4-5	5-6	M	Medium priority due to perceived quality (appearance, sound, haptics) with a **moderate** occurrence and **moderate** detection rating
2-4	4-5	1-4	L	Low priority due to perceived quality (appearance, sound, haptics) with a **moderate** occurrence and **low** detection rating
1	1-10	1-10	L	Low priority due to no discernible effect

FMEA Action Priority (AP)

Action Priority (AP)	Action Expectation
High	The team must either identify an appropriate action to improve prevention and / or detection controls or justify and document why current controls are adequate.
Medium	The team should identify appropriate actions to improve prevention and / or detection controls, or, at the discretion of the company, justify and document why controls are adequate.
Low	The team could identify actions to improve prevention or detection controls.
It is recommended that potential Severity 9-10 failure effects with Action Priority High and Medium, at a minimum, be reviewed by management including any actions that were taken.	
This is not the prioritization of High, Medium, or Low risk. It is the prioritization of the need for actions to reduce risk.	

P1: PFMEA Rank Chart Severity (Extract)

Process General Evaluation Criteria Severity S			
	Failure Effects rated for Manufacturing, Assembly, and End User as shown in PFMEA		
SEV	**Your Process Ownership Your Plant**	**The Next Process Ownership(s) (when known) Ship to Plant**	**End User (when known) Customer**
10	Failure may endanger operator (machine or assembly), Possible long-term effects on health of production associates	Failure may endanger operator (machine or assembly), Possible long-term effects on health of production associates	Affects safe operation of the vehicle and/or other vehicles, the health of operator or passenger(s) or road users or pedestrians.
9	Failure may result in in-plant regulatory noncompliance	Failure may result in in-plant regulatory noncompliance	Noncompliance with regulations.
8	100% of product affected may have to be scrapped.	Line shutdown greater than full production shift. Stop shipment possible. Field repair or replacement required (Assembly to End User) other than for regulatory noncompliance.	**Loss** of essential vehicle function necessary for normal driving during expected service life.
...	...	...	...
1	No discernible effect	Defective product triggers no reaction plan. Additional defective products not likely. Sort not required. Feedback to supplier not required.	No discernible effect.

P2: PFMEA Rank Chart Occurrence (Extract)

Occurrence Potential O for the Process

Occurrence criteria for potential Failure Causes resulting in the Failure Mode within the manufacturing or assembly plant. Consider the criteria in the Process Experience column and Prevention Controls column, when determining the best Occurrence estimate. There is no need to evaluate and assign ratings to each of the individual factors.

	Occurrence rating considering process experience and prevention controls(Qualitative rating)	History of process usage within the company	Use of best practices for process design, fixture and tool design and/or effectiveness of set-up and calibration procedures, error-proofing verifications, preventive maintenance, work instructions, and statistical process control charting
OCC	**Estimated Occurrence**	**Process Experience**	**Prevention Controls**
10	Occurrence during manufacturing or assembly cannot be determined, no preventive controls, or occurrence during manufacturing or assembly is extremely high.	New process without experience. New product application.	Best practices and procedures do not exist.
1	Possibility of failure is eliminated through preventative control and history of failure-free series production. The failure cannot occur in series production.	Cause cannot occur because failure is eliminated through demonstrated preventative control.	Failure cannot occur in series production. Process proven to conform to procedures and Best Practices, considering Lessons Learned.

Note: A 10, 9, 8, 7 can drop based on process validation activities prior to start of series production.

P3: PFMEA Rank Chart Detection (Extract)

Detection Potential D for the Validation of the Process Design		
Detection Controls rated for each detection activity performed prior to shipment of the product. Detection Controls rated according to the best fit for each detection activity. Frequency shall be established in the FMEA or control plan. Company/business unit non-conforming material handling procedures apply.		
DET	**Ability to Detect**	**Detection criteria**
10	Absolute uncertainty	The failure will not or cannot be detected as no testing or inspection method has been established or is known.
9	Very remote	Failure is not easily detected. Random audits <100% of product. It is unlikely that the testing or inspection method will detect a possible malfunction or fault mechanism.
8	Remote	Defect (Failure Mode) detection downstream through visual, tactile or audible means. Ability of testing or inspection method is uncertain or the company/business unit has no experience with the defined testing or inspection method. The method relies on a human for verification and disposition.
2	Very high	Error (Failure Cause) detection in-station through use of controls that will detect error and prevent discrepant product from being produced. Proven testing or inspection method from identical processes under the same operating/boundary conditions (machines, material). Test/inspection/measuring equipment capability from identical processes confirmed through gauge repeatability and reproducibility evaluations. The required error proofing verification is performed.
1	Almost certain	Discrepant product cannot be physically produced due to design (part geometry) or process (fixture or tooling design). The effectiveness was demonstrated on this product.

Process FMEA Action Priority (AP) (Extract)

S	O	D	AP	Justification for Action Priority - PFMEA
9-10	6-10	2-10	H	High priority due to safety and/or regulatory effects that have a **high** or **very high** occurrence rating
9-10	4-5	7-10	H	High priority due to safety and/or regulatory effects that have a **moderate** occurrence rating and **high** detection rating
5-8	4-5	5-6	H	High priority due to the loss or degradation of a primary or secondary vehicle function or a manufacturing disruption that has a **moderate** occurrence rating and **moderate** detection rating
5-8	4-5	2-4	M	Medium priority due to the loss or degradation of a primary or secondary vehicle function or a manufacturing disruption that has a **moderate** occurrence and **low** detection rating
2-4	4-5	2-4	L	Low priority due to perceived quality (appearance, sound, haptics) or a manufacturing disruption with a **moderate** occurrence and **low** detection rating
2-10	1	1	L	Low priority due to the failure being virtually eliminated through prevention controls
1	1-10	1-10	L	Low priority due to no discernible effect
2-10	1	2-10	Error	O=1 implausible without D=1
2-10	2-10	1	Error	D=1 implausible without O=1

DFMEA Spreadsheet

Design Failure Mode and Effects Analysis (DESIGN FMEA)

SCOPE DEFINITION (STEP 1)

Company Name: Name of company responsible for DFMEA
Engineering Location: Geographical location
Customer Name: Name of customer(s) or [Product Family]
Model Year / Platform: Customer application or company model/style

Subject: Name of DFMEA project
DFMEA Start Date: Date DFMEA project started
DFMEA Revision Date: Latest revision date
Cross-Functional Team: Team Roster needed

DFMEA ID Number: Determined by the compa
Design Responsibility: Name of DFMEA owner
Confidentiality Level: Business Use, Confidenti

CONTINUAL IMPROVEMENT	STRUCTURE ANALYSIS (STEP 2)			FUNCTION ANALYSIS (STEP 3)			FAILURE ANALYSIS (STEP 4)			
History / Change Authorization (As Applicable)	1. Next Higher Level	2. Focus Element	3. Next Lower Level or Characteristic Type	1. Next Higher Level Function and Requirement	2. Focus Element Function and Requirement	3. Next Lower Level Function and Requirement or Characteristic	1. Failure Effects (FE) to the Next Higher Level Element and/or Vehicle End User	Severity (S) of FE	2. Failure Mode (FM) of the Focus Element	3. Failure Cause (FC) of the Next Lower Element or Characteristic
Handbook Example - this row can be hidden or deleted	Window Lifter Motor	Electrical Motor	Brush Card Base Body	Raise and lower window according to parameterization	Commutation system transports the electrical current between coil pairs of the electromagnetic converter	Brush card body transports forces between spring and motor body to hold the brush spring system in x, y, z position (support commutating	Torque and rotating velocity of the window lifter motor too low	6	Commutation system intermittently connects the wrong coils (L1, 3 and 2 instead of L1, 2 and 3), resulting in angle deviation	Brush card body bends in contact area of the carbon brush, due to too low stiffness in carbon brush contact area

RISK ANALYSIS (STEP 5)						OPTIMIZATION (STEP 6)									
Current Prevention Control (PC) of FC	Occurrence (O) of FC	Current Detection Controls (DC) of FC or FM	Detection (D) of FC/FM	DFMEA AP	Filter Code (Optional)	Prevention Action	Detection Action	Responsible Person's Name	Target Completion Date	Status	Action Taken with Pointer to Evidence	Completion Date	Severity (S)	Occurrence (O)	Detection (D)	DFMEA AP
Simulation of dynamic forces on	2	Sample test: measuring the elastics	2	L											

DFMEA Report

MSR columns - this columns can be hidden or deleted!

Design Failure Mode and Effects Analysis (DESIGN FMEA)

				SCOPE DEFINITION (STEP 1)	Company Name:			Subject:					Page	of			
					Name of company responsible for DFMEA			Name of DFMEA project									
CONTINUAL IMPROVEMENT	STRUCTURE ANALYSIS (STEP 2)				Engineering Location:			DFMEA Start Date:					DFMEA ID Number:				
History / Change Authorization (As Applicable)	1. Next Higher Level		2. Focus Element	3. Next Lower Level or Characteristic Type	Geographical location			Date DFMEA project started					Determined by the company				
Handbook Example - this	Window Lifter Motor		Electrical Motor	Brush Card Base Body													
	FUNCTION ANALYSIS (STEP 3)				Customer Name:			DFMEA Revision Date:					Design Responsibility:				
	1. Next Higher Level Function and Requirement		2. Focus Element Function and Requirement	3. Next Lower Level Function and Requirement or Characteristic	Name of customer(s) or [Product Family]			Latest revision date					Name of DFMEA owner				
Handbook Example - this row can be hidden or deleted	Raise and lower window according to parameterization		Commutation system transports the electrical current between coil pairs of the electromagnetic converter	Brush card body transports forces between spring and motor body to hold the brush spring system in x, y, z position (support commutating contact point)													
					Model Year / Platform:			Cross-Functional Team:					Confidentiality Level:				
					Customer application or company model/style			Team Roster needed					Business Use, Confidential, Proprietary, etc.				
	FAILURE ANALYSIS (STEP 4)				RISK ANALYSIS (STEP 5)												
	1. Failure Effects (FE) to the Next Higher Level Element and/or Vehicle End User	Severity (S) of FE	2. Failure Mode (FM) of the Focus Element	3. Failure Cause (FC) of the Next Lower Element or Characteristic	Prevention Control (PC) of FC	Occurrence (O) of FC	Detection Controls (DC) of FC or FM	Detection (D) of FC/FM	DFMEA AP	Filter Code (Optional)	Responsible Person's Name	Target Completion Date	Status	Action Taken with Pointer to Evidence	Completion Date		
					INITIAL STATE: Current Controls												
Handbook Example - this row can be hidden or deleted	Torque and rotating velocity of the window lifter motor too low	6	Commutation system intermittently connects the wrong coils (L1, 3 and 2 instead of L1, 2 and 3), resulting in angle deviation	Brush card body bends in contact area of the carbon brush, due to too low stiffness in carbon brush contact area	None	10	Sample test: measuring the elastics and plastic deformation effects of brush card body acc. test spec. MRJ82/60	2	H								
					OPTIMIZATION (STEP 6)												
					CHANGE STATE: Additional Actions												
					Simulation of dynamic forces on brush card body acc. FEM 6370	2	Sample test: measuring the elastics and plastic deformation effects of brush card body acc. test spec. MRJ82/60	2	L		Test engineer Mr. Max Mueller	mm/yyyy	Decision				

PFMEA Spreadsheet

Process Failure Mode and Effects Analysis (Process FMEA)

SCOPE DEFINITION (STEP 1)

Company Name: Name of company responsible for PFMEA
Plant Location: Geographical location
Customer Name: Name of customer(s) or [Process Family]
Model Year / Platform: Customer application or company model/style

Subject: Name of PFMEA project
PFMEA Start Date: Date PFMEA project started
PFMEA Revision Date: Date of most recent change
Cross-Functional Team: Team Roster needed

PFMEA ID Number: Determined by the compa
Process Responsibility: Name of PFMEA owner
Confidentiality Level: [Business Use, Confident

CONTINUOUS IMPROVEMENT	STRUCTURE ANALYSIS (STEP 2)			FUNCTION ANALYSIS (STEP 3)			FAILURE ANALYSIS (STEP 4)			
History / Change Authorization (As Applicable)	1. Process Item System, Subsystem, Part Element or Name of Process	2. Process Step Station No. and Name of Focus Element	3. Process Work Element [Man, Machine, Material (Indirect), Milieu (Environment), etc.]	1. Function of the Process Item [In-plant, Ship-to plant, Process Item, Vehicle End user, when known]	2. Function of the Process Step and Product Characteristic (Quantitative value is optional)	3. Function of the Process Work Element and Process Characteristic	1. Failure Effects (FE) [In-plant, Ship-to plant, Process Item, Vehicle End user, when known]	Severity (S) of FE	2. Failure Mode (FM) of the Process Step	3. Failure Cause (FC) of the Work Element
Handbook Example - this row can be hidden or deleted	Electrical Motor	[OP 30] Sintered bearing press-in process	Operator	Product: Convert electrical energy into mechanical energy (acc. control signal) In Plant: Assembly of components within cycle time,	Press in sintered bearing to achieve axial position in pole housing to max gap per print	Operator takes clean sintered bearing from chute and push it onto the press-in shaft until the upper stop	Product: Loss of mechanical energy because of too much friction between bearing and shaft, inner diameter of the bearing deformed because of too much	8	Axial position of sintered bearing is not reached, gap too small	Operator inserts a sintered bearing which was dropped to the ground floor before (contaminated with dirt)

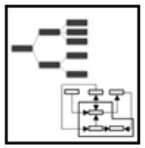
RISK ANALYSIS (STEP 5)							OPTIMIZATION (STEP 6)										
Current Prevention Control (PC) of FC	Occurrence (O) of FC	Current Detection Controls (DC) of FC or FM	Detection (D) of FC/FM	PFMEA AP	Sp Prod Char	Filter Code (Optional)	Prevention Action	Detection Action	Responsible Person's Name	Target Completion Date	Status	Action Taken with Pointer to Evidence	Completion Date	Severity (S)	Occurrence (O)	Detection (D)	PFMEA AP	Remarks
No prevention control	10	Lot Release Protocol Objective (Effectivity: 100%) Visual Gauge	2	L													

PFMEA Report

Process Failure Mode and Effects Analysis (Process FMEA)

				SCOPE DEFINITION (STEP 1)			Company Name:				Subject:				Page of						
							Name of company responsible for PFMEA				Name of PFMEA project										
CONTINUAL IMPROVEMENT	STRUCTURE ANALYSIS (STEP 2)						Engineering Location:				DFMEA Start Date:				PFMEA ID Number:						
History / Change Authorization (As Applicable)	1. Process Item System, Subsystem, Part Element or Name of Process		2. Process Step Station No. and Name of Focus Element		3. Process Work Element [Man, Machine, Material (Indirect), Milieu (Environment), etc.]		Geographical location				Date PFMEA project started				Determined by the company						
Handbook Example - this row can be hidden or deleted	Electrical Motor		[OP 30] Sintered bearing press-in process		Operator																
	FUNCTION ANALYSIS (STEP 3)						Customer Name:				DFMEA Revision Date:				Process Responsibility:						
	1. Function of the Process Item [In-plant, Ship-to plant, Process Item, Vehicle End user, when known]		2. Function of the Process Step and Product Characteristic (Quantitative value is optional)		3. Function of the Process Work Element and Process Characteristic		Name of customer(s) or [Product Family]				Latest revision date				Name of PFMEA owner						
Handbook Example - this row can be hidden or deleted	Product: Convert electrical energy into mechanical energy (acc. control signal) In Plant: Assembly of components within cycle time, without scrap or rework Ship to Plant: Assembly of motor to vehicle door without line stoppage, sort or		Press in sintered bearing to achieve axial position in pole housing to max gap per print		Operator takes clean sintered bearing from chute and push it onto the press-in shaft until the upper stop																
							Model Year / Platform:				Cross-Functional Team:				Confidentiality Level:						
							Customer application or company model/style				Team Roster needed				Business Use, Confidential, Proprietary, etc.						
	FAILURE ANALYSIS (STEP 4)						RISK ANALYSIS (STEP 5)														
	1. Failure Effects (FE) [In-plant, Ship-to plant, Process Item, Vehicle End user, when known]	Severity (S) of FE	2. Failure Mode (FM) of the Process Step		3. Failure Cause (FC) of the Work Element		Current Prevention Control (PC) of FC	Occurrence (O) of FC	Current Detection Controls (DC) of FC or FM		Detection (D) of FC/FM	PFMEA AP	Sp Prod Char	Filter Code (Optional)	Responsible Person's Name	Target Completion Date	Status	Action Taken with Pointer to Evidence	Completion Date	Remark	
							INITIAL STATE: Current Controls														
Handbook Example - this row can be hidden or deleted	Product: Loss of mechanical energy because of too much friction between bearing and shaft, inner diameter of the bearing deformed because of too much seating stress In Plant: None Ship to Plant: None End User: Window raises and lowers with difficulty	8	Axial position of sintered bearing is not reached, gap too small		Operator inserts a sintered bearing which was dropped to the ground floor before (contaminated with dirt)		No prevention control	10	Lot Release Protocol Objective (Effectivity: 100%) Visual Gauge inspection of axial gap of bearing to pole housing seat by Operator (Check the Checker: N/A); Detection indicator: OK/NOK (RED/GREEN area) and Operator		2	L								
							OPTIMIZATION (STEP 6)														
							CHANGE STATE: Additional Actions														

Six steps of FMEA-MSR

System Analysis			Failure Analysis and Risk Mitigation		
1st Step Scope Definition	2nd Step Structure Analysis	3rd Step Function Analysis	4th Step Failure Analysis	5th Step Risk Analysis	6th Step Optimization
					
Project identification	System structure for a product	Overview of the functionality of the product	Establishment of the failure chain (potential Failure Effects, Failure Modes, Failure Causes) for each product function (step)	Assignment of Monitoring Controls (existing and/or planned) to the Failure Causes and Failure Modes	Identification of the actions necessary to reduce risks
Project plan	Visualization of the analysis scope using a structure tree or equivalent: block diagram, boundary diagram, digital model, or physical parts	Visualization of product functions using a function tree (function net), function matrix, and/or parameter diagram(s)	Visualization of product failure relationships (failure nets and/or the FMEA worksheet)		Assignment of responsibilities and deadlines for action implementation
Analysis boundaries: What is included and excluded from the analysis	Identification of design interfaces, interactions, and close clearances	Association of requirements to functions and functions to system elements	Creation of failure structures by linking the failures in the failure chain	Rating of Severity, Frequency and Monitoring for each failure chain	Implementation and documentation of actions taken
Identification of baseline FMEA with lessons learned		Cascade of customer (external and internal) functions with associated requirements	Identification of product noise factors or using a fishbone diagram, parameter diagram(s), or failure network		Confirmation of the effectiveness of the implemented actions
			Collaboration between customer and supplier (Failure Effects)	Collaboration between customer and supplier (Severity) Action Priority (AP)	Assessment of risk after actions taken Continuous Improvement of the product
Basis for the Structure Analysis step	Basis for the Function Analysis step	Basis for the Failure Analysis step	Basis for the record of failures in the FMEA form and the Risk Analysis step	Basis for the product Optimization step	Basis for refinement of the product requirements and Monitoring Controls

MSR1: Rank Chart Occurrence (O) FMEA-MSR

FMEA Supplement of Monitoring and System Reaction (FMEA-MSR)	
SEV	Potential Failure Effects rated according to what the End User might experience
10	Affects safe operation of the vehicle and/or other vehicles, the health of operator or passenger(s) or road users or pedestrians.
9	Noncompliance with regulations.
8	**Loss** of essential vehicle function necessary for normal driving during expected service life.
7	**Degradation** of essential vehicle function necessary for normal driving during expected service life.
6	**Loss** of convenience function.
5	**Degradation** of convenience function.
4	Perceived quality of appearance, sound or haptics unacceptable to most customers
3	Perceived quality of appearance, sound or haptics unacceptable to many customers
2	Perceived quality of appearance, sound or haptics unacceptable to some customers
1	No discernible effect.

MSR2: Rank Chart Frequency (F) FMEA-MSR

Supplemental FMEA for Monitoring and System Response (FMEA-MSR)	
Frequency criteria (F) for the likelihood of occurrence of the cause in relevant operating situations during the design life of the vehicle	
FRQ	**Frequency criteria**
10	Frequency unknown or known to be unacceptably high during the design life of the vehicle
9	Failure cause is likely to occur during the design life of the vehicle
8	Failure cause may occur often in the field during the design life of the vehicle
7	Failure cause may occur frequently in the field during the design life of the vehicle
6	Failure cause may occur somewhat frequently in the field during the design life of the vehicle
5	Failure cause may occur occasionally in the field during the design life of the vehicle
4	Failure cause may occur rarely in the field during the design life of the vehicle
3	Failure cause is predicted to occur in isolated cases in the field during the design life of the vehicle
2	Failure cause is predicted to be significantly below the acceptance level but isolated cases cannot be excluded during the design life of the vehicle
1	Failure cause cannot occur or is predicted to be significantly below the acceptance level during the design life of the vehicle. Rationale is available.

MSR3: Rank Chart Monitoring (M) FMEA-MSR

Supplemental FMEA for Monitoring and System Response (FMEA-MSR)	
Monitoring Criteria (M) for Failure Causes, Failure Modes and Failure Effects by Monitoring during Customer Operation	
MON	**Monitoring criteria**
10	The fault/error/failure cannot be detected at all or not during the fault tolerant time interval. No monitoring / diagnosis of the function by the system.
9	The fault/error/failure can almost never be detected in relevant operating conditions. The response may not reliably occur during the fault tolerant time interval.
8	The fault/error/failure can be detected in very few relevant operating conditions. The response may not always occur during the fault tolerant time interval.
7	Low probability of detecting the fault/error/failure and/or responding during the fault tolerant time interval by the system or the driver.
6	The fault/error/failure will be detected by the system or the driver and respond in many operating conditions.
5	The fault/error/failure will be detected by the system or the driver and respond in very many operating conditions.
4	The fault/error/failure will be detected by the system or the driver and respond in most operating conditions.
3	The fault/error/failure will be automatically detected by the system and respond during the fault tolerant time interval with a high probability.
2	The fault/error/failure will always be detected automatically by the system and respond during the fault tolerant time interval in all relevant operating conditions.
1	The fault/error/failure will always be detected automatically by the system and respond during the fault tolerant time interval and in any operating condition.

FMEA-MSR Action Priority Logic (AP) (Extract)

S	F	M	AP	FMEA-MSR Action Priority Logic	Remarks
10	3-10	4-10	H	Safety requirements not fulfilled.	Poor monitoring leads to violation of safety requirements.
10	4-10	3	H	Safety and reliability requirements not fulfilled.	
10	5-10	1-2	H	Reliability requirements not fulfilled. Safety requirements fulfilled.	Good monitoring leads to warnings and unscheduled workshop visits. Reputation of product and company at risk.
9	2-10	3-10	H	Legal/Compliance requirements not fulfilled	Poor monitoring leads to violation of regulatory requirements.
9	4-10	1-2	H	Good monitoring degrades system performance to maintain compliance	Good monitoring leads to warnings and unscheduled workshop visits. Reputation of product and company at risk.
3 to 2	5-6	1-6	L	Nuisance warnings with moderate frequency	Poor perceived quality
3 to 2	2-4	1-10	L	Nuisance warnings with low frequency	Poor perceived quality
1	1-10	1-10	L	No discernible effect	

FMEA Action Priority (AP)

Action Priority (AP)	Action Expectation
High	The team must either identify an appropriate action to improve prevention and / or detection controls or justify and document why current controls are adequate.
Medium	The team should identify appropriate actions to improve prevention and / or detection controls, or, at the discretion of the company, justify and document why controls are adequate.
Low	The team could identify actions to improve prevention or detection controls.
It is recommended that potential Severity 9-10 failure effects with Action Priority High and Medium, at a minimum, be reviewed by management including any actions that were taken.	
This is not the prioritization of High, Medium, or Low risk. It is the prioritization of the need for actions to reduce risk.	

FMEA-MSR Spreadsheet and Report

FMEA-MSR MONITORING ANALYSIS (STEP 5)								FMEA-MSR OPTIMIZATION (STEP 6)												
Frequency (F) of FC	Rationale for Frequency (F)	Current Diagnostic Monitoring	Current System Response	Monitoring (M)	Severity (S)	MSR AP	Filter Code (Optional)	MSR Preventive Action	Diagnostic Monitoring Action	System Response	Responsible Person's Name	Target Completion Date	Status	Action Taken with Pointer to Evidence	Completion Date	Severity (S)	Frequency (F)	Monitoring (M)	MSR AP	Remarks

	FMEA-MSR RISK ANALYSIS (STEP 5)									
Preventive Action	Diagnostic Monitoring	System Response	Mitigated Severity (S) of FE	Frequency (F) of FC	Most Severe Failure Effect after System Response	Monitoring (M)	Rationale for Frequency (F)	MSR AP	Filter Code (Optional)	Remarks
INITIAL STATE:										

Handling of existing FMEA

- Existing FMEAs conducted with an earlier version of the FMEA hand-book may remain in their original form for subsequent revisions.
- Optionally, the team may decide to transfer the data to the latest form and update the FMEA in accordance with the latest FMEA procedure, in order to take advantage of improvements associated with the latest FMEA procedure.
- FMEA's that will be used as a starting point for new program applications should be converted to comply with the new format.
- However, if the team determines that the new program is considered a minor change to the existing product, they may decide to leave the FMEA in the existing format.
- New projects should follow this FMEA procedure if not otherwise defined unless company procedure defines a different approach.

Information flow from Design FMEA to Process FMEA

- Design FMEA contains information that is useful for Process FMEA
  - Failure Causes related to piece-to-piece
  - End User Failure Effects and Severity for the Failure Causes related to product characteristics
- Process FMEA contains information that needs alignment with the Design FMEA
  - Failure Effects and Severity for Failure Modes that are also shown in the Design FMEA
- **Not all Failures Causes in a Design FMEA are Failure Modes in a Process FMEA** .

Know-How Protection of the Design and Process FMEA

- The sharing of intellectual property between suppliers and customers is governed by legal agreements between suppliers and customers and is beyond the scope of this handbook.
- However, unless otherwise required by contractual agreement, for reasons of Intellectual Property (IP) protection the DFMEAs and PFMEAs prepared by suppliers for standard or "off the shelf" products should generally be considered proprietary information not given to the customers.
- But may be shown by special arrangement when requested.

Statement to the FMEA Presentation

The presentation is the current status of discussion of AIAG and VDA working group.
This presentation status is not fixed and nonbinding.

Release of Yellow Print was **15th November 2017** through AIAG QSC and VDA QMA following stakeholder review until **27th February 2018**.

Release of final version is scheduled **End of April 2018**

Publishing of the **Final Release** (Red Print) is planned **May 2018**

Trainings to the new manual of FMEA in 2018
will be provided after release of the final manual (Red Print)
by AIAG, VDA-QMC, and their licensees.

Status February 2018

Alignment of FMEA handbooks VDA and AIAG

Project Leader:

AIAG: Scott Gray
VDA: Jochen Pfeufer

Validation Testing

- **Participants**
  - Subdivision in design FMEA and process training FMEA
  - Maximum 2 participants per supplier
  - Maximum 12 participants per training
  - Different size of technology and qualification
  - Volunteers and recommendation of suppliers by Ford/GM/FCA/Daimler Truck and QMA of VDA
- **“Homework”**
  - The attendees develop a new FMEA in their organization
  - Timeframe from3 weeks to 30 days for finishing
  - The output will be evaluated by the team

Validation Testing

- **Training in N.A.**
  DFMEA 15th, 16th June 2017 PFMEA 24th, 25th July 2017
- **Training in Germany**
  DFMEA 29th, 30th June 2017 PFMEA 10th, 11th July 2017
- **Attendees**

  Accuride Corporation, Alpine Electronics GmbH, Axalta Coating Systems, Benteler Automobiltechnik GmbH, Delphi, Dr. Schneider Kunststoffwerke GmbH, EBK Krüger GmbH & Co. KG, F&P America Manufacturing, Faurecia Automotive, Gunite, Heinrich Huhn GmbH + Co. KG, IMS Gear, Iroquois Industries, Litens, Magna Getrag Magna International Inc., Mayco, International LLC, Paul Craemer, PWO Progress-Werk, WABCO Vehicle Control Systems, Wallstabe & Schneider GmbH & Co. KG

Validation Results

	DFMEA				PFMEA				D&PFMEA			
	VDA				VDA				VDA			
Question	1	2	3	4	1	2	3	4	1	2	3	4
Introduction	0	0	0	10	0	0	0	12	0	0	0	22
Basis of FMEA	0	0	0	10	0	0	0	12	0	0	0	22
External and Internal Req	0	0	0	10	0	0	2	10	0	0	2	20
FMEA Team for Design &	0	0	0	10	0	0	2	10	0	0	2	20
Demand for Action & Tim	0	0	0	10	0	0	3	9	0	0	3	19
Definition and Descriptio	0	0	0	10	0	0	1	11	0	0	1	21
1st Step: Scope Definition	0	0	2	8	0	0	2	10	0	0	4	18
2nd Step: Structure Analysis	0	0	2	8	0	0	1	11	0	0	3	19
3rd Step: Function Analysis	0	0	4	6	0	0	3	9	0	0	7	15
4th Step: Failure Analysis	0	0	0	10	0	0	0	12	0	0	0	22
5th Step: Risk Analysis	0	0	2	8	0	0	5	7	0	0	7	15
6th Step: Optimization	0	0	1	9	0	0	2	10	0	0	3	19
Annex	0	0	1	9	0	0	5	7	0	0	6	16
Rating Chart: Severity	0	0	1	9	0	0	2	10	0	0	3	19
Rating Chart: Occurrence	0	0	1	9	0	0	5	7	0	0	6	16
Rating Chart: Detection	0	0	0	10	0	1	3	7	0	1	3	17
FMEA Spreadsheet & Rep	0	0	1	9	0	0	3	8	0	0	4	17
Percentages	0%	0%	9%	**91%**	0%	0%	19%	**80%**	0%	0%	15%	**85%**

Question 1 I don't get it
Question 2 I understand partially, but would need some help in application
Question 3 I understand the major concepts, but have some questions on the details
Question 4 I get it, it is clear

Validation Results

	DFMEA				PFMEA				D&PFMEA			
	AIAG				AIAG				AIAG			
Question	1	2	3	4	1	2	3	4	1	2	3	4
Introduction	0	0	0	11	0	0	2	16	0	0	2	27
Basis of FMEA	0	0	0	11	0	0	1	17	0	0	1	28
External and Internal Req	0	1	2	7	0	0	3	15	0	1	5	22
FMEA Team for Design &	0	0	1	10	0	0	3	15	0	0	4	25
Demand for Action & Tim	0	0	2	10	0	0	2	15	0	0	4	25
Definition and Descriptio	0	0	3	8	0	0	3	15	0	0	6	23
1st Step: Scope Definition	0	0	4	7	0	0	5	13	0	0	9	20
2nd Step: Structure Analysis	0	3	6	2	0	1	7	10	0	4	13	12
3rd Step: Function Analysis	0	5	5	1	0	7	8	3	0	12	13	4
4th Step: Failure Analysis	0	2	8	1	0	1	6	10	0	3	14	11
5th Step: Risk Analysis	0	1	5	4	0	1	3	13	0	2	8	17
6th Step: Optimization	0	1	5	4	0	1	1	15	0	2	6	19
Annex	0	0	1	3	1	1	2	11	1	1	3	14
Rating Chart: Severity	0	1	3	6	0	0	7	10	0	1	10	16
Rating Chart: Occurrence	0	1	3	6	0	0	8	9	0	1	11	15
Rating Chart: Detection	0	1	3	6	0	0	4	13	0	1	7	19
FMEA Spreadsheet & Rep	0	2	3	1	0	1	4	9	0	3	7	10
Percentages	0%	11%	32%	**58%**	0%	4%	24%	**72%**	0%	7%	27%	**66%**

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Validation Results

	D&PFMEA VDA				D&PFMEA AIAG				D&PFMEA Overall			
Question	1	2	3	4	1	2	3	4	1	2	3	4
Introduction	0	0	0	22	0	0	2	27	0	0	2	49
Basis of FMEA	0	0	0	22	0	0	1	28	0	0	1	50
External and Internal Req	0	0	2	20	0	1	5	22	0	1	7	42
FMEA Team for Design &	0	0	2	20	0	0	4	25	0	0	6	45
Demand for Action & Tim	0	0	3	19	0	0	4	25	0	0	7	44
Definition and Descriptio	0	0	1	21	0	0	6	23	0	0	7	44
1st Step: Scope Definition	0	0	4	18	0	0	9	20	0	0	13	38
2nd Step: Structure Analysis	0	0	3	19	0	4	13	12	0	4	16	31
3rd Step: Function Analysis	0	0	7	15	0	12	13	4	0	12	20	19
4th Step: Failure Analysis	0	0	0	22	0	3	14	11	0	3	14	33
5th Step: Risk Analysis	0	0	7	15	0	2	8	17	0	2	15	32
6th Step: Optimization	0	0	3	19	0	2	6	19	0	2	9	38
Annex	0	0	6	16	1	1	3	14	1	1	9	30
Rating Chart: Severity	0	0	3	19	0	1	10	16	0	1	13	35
Rating Chart: Occurrence	0	0	6	16	0	1	11	15	0	1	17	31
Rating Chart: Detection	0	1	3	17	0	1	7	19	0	2	10	36
FMEA Spreadsheet & Rep	0	0	4	17	0	3	7	10	0	3	11	27
Percentages	0%	0%	15%	**85%**	0%	7%	27%	**66%**	0%	4%	21%	**75%**

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