PFMEA TRAINING

MARCH 2026

HYSTER-YALE
MATERIALS HANDLING

TYPES OF FMEA

DFMEA (Design Failure Mode and Effects Analysis)

- DFMEA is used during product design to identify and mitigate potential design-related failures before the product is released to production.

PFMEA (Process Failure Mode and Effects Analysis)

- PFMEA is used in the manufacturing/assembly process to analyze and prevent process-related failures that could affect product quality.

FMEA-MSR (Failure Mode and Effects Analysis – Monitoring and System Response)

- FMEA-MSR is used during customer operation/in-service use to evaluate how well the system can monitor failures and respond safely through diagnostics and system reactions.

TIMELINE OF FMEA REVISIONS (1993–2019)

Year	Edition	Key Changes
1993	AIAG 1st Edition	Introduced the first standardized PFMEA format with S/O/D ratings and RPN for risk evaluation.
1995	2nd Edition	Refined definitions and improved consistency in describing failure modes, effects, causes, and controls
2001	3rd Edition	Added major technical clarifications and upgraded guidance for DFMEA & PFMEA.
2008	4th Edition	Expanded S/O/D tables, clarified PFMEA fields, and strengthened links to Control Plan and APQP while still using RPN
2019	AIAG–VDA Harmonized Edition	Introduced 7-step method & RPN is replaced by Action Priority (AP). FMEA MSR is introduced as new supplemental FMEA type.

WHAT IS PFMEA & WHY IT IS IMPORTANT?

PFMEA is a structured, proactive risk-analysis method used to identify how a manufacturing or assembly process can fail, why it fails, and what impact those failures may have. Its purpose is to predict and prevent process failures before they occur, rather than reacting after defects appear.

IMPORTANCE OF PFMEA:

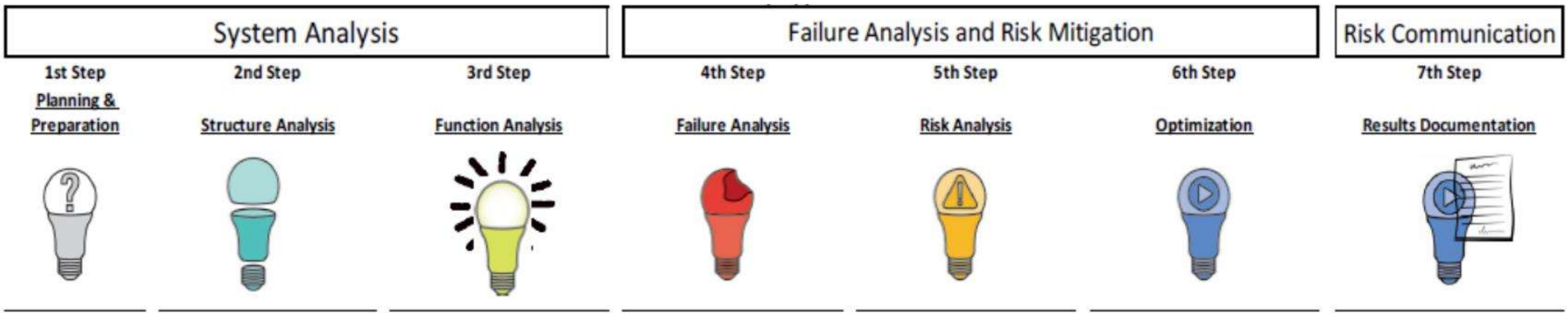
- Prevents defects before they reach customers.
- Improves process reliability & capability.
- Reduces downtime and waste.
- Supports compliance with standards like IATF 16949.
- Builds a culture of proactive quality.

7-STEP VDA PFMEA APPROACH

System Analysis
1. Planning & Preparation
2. Structure Analysis
3. Function Analysis

Failure analysis & Risk Mitigation
4. Failure Analysis
5. Risk Analysis
6. Optimization

Risk Communication
7. Documentation & Communication



7-STEP VDA PFMEA APPROACH

Stepwise detailed format of VDA PFMEA with each sub sections

Planning & Preparation(Step 1)

Structure Analysis (Step 2)			Functional Analysis (Step 3)			Failure Analysis (Step 4)			
Process Item, System, Subsystem, Part Element or Name of Process	Process Step, Station No., and Name of focus Element	Process Work Element 4M Type	Function of the Process Item, Function of System, Subsystem, Part Element	Function of the Process Step & Product Characteristics (Quantitive Value is optional)	Function of the Process Work Element and Process Characteristics	Failure Effects (FE) to the next Higher Level Element &/or End User	S E V	Failure Mode (FM)	Failure Cause (FC) of the Next lower Element or Chracteristics

Risk Analysis (Step 5)							Optimisation (Step 6)											
Current Prevention Control (PC)	O C C of FC	Current Detection Controls (DC) of FC or FM	Detection (D) of FC or FM	PFMEA AP	Special Characteristics	Filler Code (Optional)	Prevention Action	Detection Action	Responsible Person's Name	Target Competion Date	Status	Action Taken with Pointer to Evidence	Completion Date	S E V	O C C	D E T	Special Characteristics	PFMEA AP

STEP 1: PLANNING & PREPARATION

Purpose: Establish a solid foundation before PFMEA analysis begins.

A) Define PFMEA Boundaries

1. Clarify what process steps are included and what is excluded.
2. Identify the start and end points of the process under review.
3. Ensure all team members have a common understanding of the scope.

B) Identify Team & Roles

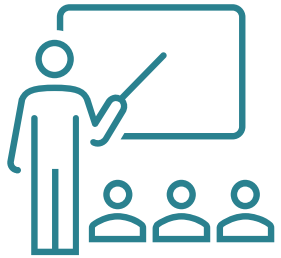
1. Form a cross-functional team (Manufacturing, SQE, DQ, Engineering, ME, Quality, Supplier, Operator etc).
2. Assign clear roles:
   - Moderator – Facilitates PFMEA discussion
   - Process Owner – Provides process knowledge
   - Recorder – Documents PFMEA content
   - Experts – Contribute technical insights
3. Confirm team availability throughout PFMEA sessions.

STEP 1: PLANNING & PREPARATION

C) Collect Requirements & Reflection-Lessons Learned

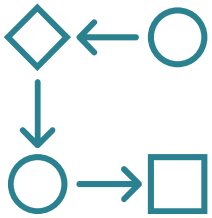
Gather customer requirements, regulatory requirements, and internal standards.

1. Review previous PFMEA, field issues, internal defects, and audit findings.
2. Bring in best practices and continuous improvement learnings.



D) Understand Process Flow

1. Study the process flow diagram (PFD).
2. Verify each step is correctly sequenced and reflects actual shop-floor conditions.
3. Confirm interfaces with upstream and downstream operations.
4. Ensure the PFD serves as the basis for PFMEA structure analysis.



STEP 1: PLANNING & PREPARATION EXAMPLE (LASER NUMBERING)

1. PFMEA BOUNDARIES

- Component enters at laser station.
- Ends after marking verification.
- Includes- Loading, Marking, Program selection, Inspection.
- Excludes - Machining and Packing.

2. TEAM & ROLE

- Manufacturing Engineer leads PFMEA.
- Operator provides process inputs.
- Quality Engineer reviews ratings.
- Maintenance supports laser capability.

3. REQUIREMENTS & LESSONS LEARNED

- Correct part number as per drawing.
- Marking must be permanent and legible.
- Traceability required.
- Past issues: wrong program, poor readability.

4. PROCESS FLOW UNDERSTANDING

- Load part.
- Select program.
- Perform laser marking.
- Verify marking.
- Release to next process.

STEP 2: STRUCTURE ANALYSIS

Purpose: Break the process into structured, logical elements to understand the relationships between Process → Process Steps → Work Elements.

A) Define the Overall Process Structure

1. Identify the main manufacturing/assembly process under analysis
2. Confirm alignment with the Process Flow Diagram (PFD)
3. Ensure the structure accurately reflects the real shop-floor sequence

B) Break Down the Process into Process Steps

1. List each individual step involved in transforming input to output.
2. Validate steps with the process owner and operators
3. Confirm that all value-added and non-value-added steps are included.
4. Include interfaces with adjacent processes (incoming, outgoing)

Structure Analysis (Step 2)		
Process Item, System, Subsystem, Part Element or Name of Process	**Process Step, Station No., and Name of focus Element**	**Process Work Element 4M Type**
2	**3**	**4**
Laser Numbering Process	Part Loading	**M1- Man** Skilled Manpower Level-III **M4-Method** OMS

STEP 2: STRUCTURE ANALYSIS

C. Identify Work Elements for Each Step

1. Work elements describe how the task is performed, divided into:
   - Man – Operator actions, skill level, ergonomics
   - Machine – Equipment, tooling, automation, fixtures
   - Material – Part condition, variation, supply quality
   - Method – SOPs, torque specs, parameters, instructions
2. These elements help identify where potential failures may occur.

D. Confirm Logical Linkage: Process → Step → Work Element

1. Verify that every work element links to the correct process step.
2. Ensure a clear traceability chain for later PFMEA steps (function, failure mode, cause).
3. Validate with cross-functional team to avoid missing elements.

STEP 3: FUNCTION ANALYSIS

Purpose: Define what each process step and work element must do to meet requirements and ensure defect-free output. Link function(Step 3)to structure (Step 2)

A) Identify Functions of the Overall Process

1. Define the intended purpose of the complete process.
2. Clarify how the process contributes to product quality and customer requirements.(In plant, At Customer & at End user)
3. Establish high-level performance expectations (e.g., correct assembly, safe operation, compliance).

B) Define Functions for Each Process Step

1. For every step in the process structure (from Step 2):
   - Describe what the step must achieve (not how).
   - Ensure functions are measurable, clear, and aligned with the PFD.

STEP 3: FUNCTION ANALYSIS

C) Identify Functions of Work Elements (Man, Machine, Material, Method)

1. Each work element contributes specific functional requirements:
   - Man: Correct action, sequence, handling, skill application.
   - Machine: Provide required force, speed, accuracy, safety.
   - Material: Must meet specifications, free from defects.
   - Method: SOP clarity, parameter control, correct instructions.
2. These functions help determine where failures might occur later.

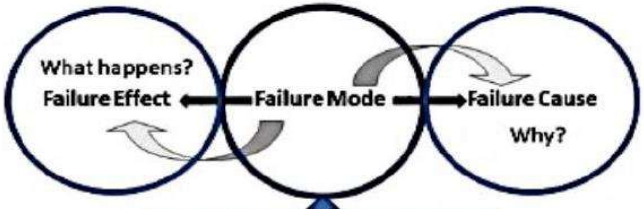
D) Validate Completeness with the Team

1. Review all defined functions with the cross-functional PFMEA team..
2. Ensure no process step or work element lacks a defined function.
3. Confirm that team members have a shared understanding before moving to Failure Analysis (Step 4).

Functional Analysis (Step 3)		
Function of the Process Item, Function of System, Subsystem, Part Element	**Function of the Process Step & Product Characteristics (Quantitive Value is optional)**	**Function of the Process Work Element and Process Characteristics**
5	**6**	**7**
A)Expected Function at our plant - 1.Make correct laser mark **B)Expected Function at Ship to Plant -** 1.Avoid mix-ups during assembly **C)Expected Function at End user -** 1.Support warranty tracking	1. Load Correct part & orientation.	Ensure correct part code and orientation based on fixture keys

STEP 4: FAILURE ANALYSIS

Purpose: Identify how the process can fail, what the consequences are, and why failures occur—forming the core of PFMEA risk evaluation.



A) Identify Failure Modes for Each Function

1. For every function of process step defined in Step 3 ask: "How can this function fail?"
2. Capture all practical and realistic ways the process step or work element may not meet its intended function.
3. Include failures related to:
   - Incorrect assembly
   - Variation in parameters
   - Missing/incorrect parts
   - Human errors or machine limitations

Failure Effects (FE) to the next Higher Level Element &/or End User	S E V	Failure Mode (FM)	Failure Cause (FC) of the Next lower Element or Chracteristics
8	9	10	11
A)Failure Effects On our Plant - 1.Wrong marking applied 2.Rework / scrap **B)Failure Effects On Ship to Plant -** 1.Customer line disruption **C)Failure Effects On End user-** 1.Wrong component in product causes functional issue	**8**	Wrong part loaded	1. Part mix-up in trolley; 2. Identical geometry parts; 3.label missing on bin

STEP 4: FAILURE ANALYSIS

B) Determine the Effects of Each Failure Mode

1. Define what happens if the failure mode occurs.
2. Effects may be at:
   - Customer level – Performance issues, safety risks, complaints
   - Next process – Rework, scrap, misalignment, productivity loss
   - End User – Regulatory or legal violations.
3. Effects drive the Severity (S) rating later in Step 5.

C) Identify Potential Causes of Each Failure Mode

1. For each failure mode, ask “Why could this failure happen?”
2. Causes may come from the 5 work elements:
   - Man – lack of training, fatigue, incorrect action
   - Machine – wear, instability, calibration drift
   - Material – variation, contamination, incorrect part
   - Method – unclear instructions, wrong

STEP 4: FAILURE ANALYSIS

D) Link Failures to Specific Work Elements

1. Ensure each failure mode and cause is tied to a specific step and work element from Step 2.
2. This clarifies responsibility and makes optimization (Step 6) more effective

E) Validate Completeness with Cross-Functional Team

1. Review all failure modes, effects, and causes with: CFT
2. Confirm nothing is missed (especially past lessons learned).
3. Ensure agreement before moving on to Risk Analysis (Step 5).

STEP 5: RISK ANALYSIS

Purpose: Evaluate the risk level of each failure using Severity, Occurrence, and Detection to determine Action Priority (AP) as required by VDA.

A) Evaluate Severity (S)

1. Assess the seriousness of the effect of each failure mode.
2. Severity reflects impact on the customer, safety, compliance, or next process..
3. High severity indicates critical risks requiring immediate attention.
4. Severity does not change unless the effect itself changes.

B) Evaluate Occurrence (O)

1. Estimate the likelihood that the cause will occur.
2. Consider real data:- Past defect history, Process capability, Field issues, Supplier performance.
3. Higher occurrence indicates weak process controls.

STEP 5: RISK ANALYSIS

C) Evaluate Detection (D)

1. Assess the ability of current controls to detect failures before shipment or before they affect downstream process.
2. Consider detection strength of:
   - Poka-yoke devices.
   - In-process checks
   - Automated inspection
3. Higher D = lower chance of detection.

D) Determine Action Priority (AP)

1. Use the VDA-mandated AP Table to categorize risk:-
   - AP High (H) – Immediate action required
   - AP Medium (M) – Action recommended
   - AP Low (L) – Action optional / Monitor.
2. AP replaces RPN and ensures focus on severity-driven risks, especially those related to safety or regulatory impact

Risk Analysis (Step 5)						
Current Prevention Control (PC)	O C C of FC	Current Detection Controls (DC) of FC or FM	Detection (D) of FC or FM	PFMEA AP	Special Characteristics	Filler Code (Optional)
12	13	14	15	16	17	18
1.Dedicated bins for each part	5	Operator visual check	8	**H**	Yes	--

DETERMINE ACTION PRIORITY

Severity		Occurrence 1	2-3	4-5	6-7	8-10	Detection
	1	L	L	L	L	L	1
		L	L	L	L	L	2-4
		L	L	L	L	L	5-6
		L	L	L	L	L	7-10
	2-3	L	L	L	L	L	1
		L	L	L	L	L	2-4
		L	L	L	L	M	5-6
		L	L	L	L	M	7-10
	4-6	L	L	L	L	M	1
		L	L	L	M	M	2-4
		L	L	L	M	H	5-6
		L	L	M	M	H	7-10
	7-8	L	L	M	M	H	1
		L	L	M	H	H	2-4
		L	M	M	H	H	5-6
		L	M	H	H	H	7-10
	9-10	L	L	M	H	H	1
		L	L	H	H	H	2-4
		L	M	H	H	H	5-6
		L	H	H	H	H	7-10

Action Priority Table

How to Identify Action Priority

Step 1 — Identify the Severity (S) Rating.
These groups define the left side of the AP table.

Step 2 — Identify the Occurrence (O) Rating.
These groups define the top row of the AP table.

Step 3 — Identify the Detection (D) Rating.
These groups are on the right side of the AP table.

Step 4 — Locate the Intersection in the Grid.
Now find the cell where:

- ✅ Severity group row
- ✅ Occurrence group column
- ✅ Detection group row (on the right)overlap in the AP matrix.

You will see one of the colors:
Green → L (Low Priority)
Yellow → M (Medium Priority)
Red → H (High Priority)

DETERMINE ACTION PRIORITY - EXAMPLE

Suppose as per your PFMEA below is your criteria to identify AP:
Severity -8 . Occurrence- 5, Detection-8.

Step 1- Identify severity column for – 8

Severity	7-8	L	L	M	M	H
		L	L	M	H	H
		L	M	M	H	H
		L	M	H	H	H

Step 2- Identify Occurrence column for 5

Bold marked grids are common for the S & O now.

				Occurrence		
				4-5		
Severity	7-8	L	L	**M**	M	H
		L	L	**M**	H	H
		L	M	**M**	H	H
		L	M	**H**	H	H

Step 3 - Identify Detection column for – 8

				Occurrence				
				4-5				
Severity	7-8	L	L	M	M	H		Detection
		L	L	M	H	H		
		L	M	M	H	H		
		L	M	**H**	H	H	7-10	

Now the common intersection Grid for S,O,D is highlighted in bold red letter. Which is our Action Priority for above criteria.

STEP 5: RISK ANALYSIS

E) Prioritize Failure Modes for Improvement

1. Highlight high-risk items that require corrective or preventive actions.
2. Prioritize based on:
   - High S alone (e.g., safety-critical functions)
   - High AP combinations
   - Repeated causes or chronic issues
3. Prepare action plans as input for Step 6: Optimization

STEP 5: RISK ANALYSIS

Action Priority is a decision mandate — not a numeric result.

KEY PFMEA PRINCIPLE	WHY THIS STRENGTHENS AUDIT	SO, WHAT DOES AP 'H' REALLY MEAN?	WHY AP 'H' IS IMPORTANT-
• Severity is fixed because the effect on the customer does not change in PFMEA.	• Prevents number manipulation • Forces action-based risk reduction • Ensures high-severity risks receive appropriate attention	• AP 'H' highlights high customer impact that must not be accepted without action. • It is not a score to optimize, but a decision trigger for mandatory action.	• Identifying AP 'H' is an opportunity to address high-impact risks that can otherwise be: a) Overlooked b) Incorrectly accepted c) Diluted through reassessment instead of action

Severity stays constant — AP 'H' forces action to reduce risk, not numbers.

STEP 6: OPTIMIZATION

Purpose: Implement and verify improvement actions that reduce risk by addressing high-priority failure modes identified in Step 5.

A) Define Preventive & Corrective Actions

1. Develop actions that eliminate causes, reduce occurrence, or improve detection.
2. Prioritize actions for failure modes with:
   - AP High (H)
   - High Severity (S) even if occurrence is low
   - Repeated or systemic issues
3. Ensure actions target root causes, not symptoms.

B) Assign Ownership & Target Dates

1. Assign each action to a responsible owner
2. Establish clear due dates, required resources, and deliverables.
3. Ensure accountability through cross-functional alignment.

Optimisation (Step 6)											
Prevention Action	Detection Action	Responsible Person's Name	Target Competion Date	Status	Action Taken with Pointer to Evidence	Completion Date	SEV	OCC	DET	Special Characte	PFMEA AP
19	20	21	22	23	24	25	26	27	28	29	30
Part wise color coding to the dedicated bins with serial number tracing.	1.Scanning of color bins done by automated machine. 2.If color mismatch with standard, buzzer will be in place	XYZ	3/21/2026	Completed	CP No-16 updated with Rev no 03 Dated-03/22/2026	3/22/2026	8	3	3	Yes	L

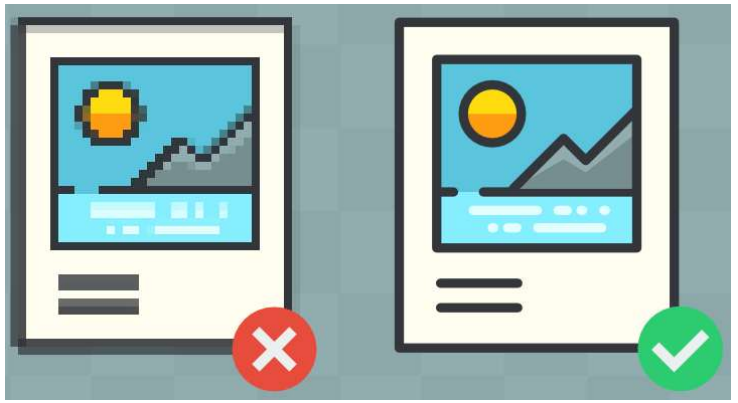
STEP 6: OPTIMIZATION

C) Implement Actions & Track Progress

1. Execute actions according to the defined schedule.
2. Track progress via:- Daily management boards, Quality meetings, Project reviews.
3. Address barriers early to avoid delays.

D) Re-Evaluate S, O, D After Actions

1. Once corrective actions are completed, reassess:
   - Occurrence (O) – Should decrease if root cause is eliminated
   - Detection (D) – Should improve if controls were strengthened
   - Severity (S) – Only changes if the effect is eliminated (rare)
2. Recalculate Action Priority (AP).



E) Verify Effectiveness of Actions

1. Confirm improvement through:- Pilot run data, Process capability studies, Field performance, Audit results.
2. Ensure the risk reduction is sustainable long-term.

STEP 7: DOCUMENTATION & COMMUNICATION

Purpose: Ensure all PFMEA outcomes are clearly documented, communicated, and integrated into the organization's quality system for ongoing control and future learning.

A) Document Final PFMEA Results

1. Record updated Severity, Occurrence, Detection, and AP values.
2. Ensure all actions from Step 6 are marked as:- Completed, Verified, Effective.
3. Maintain consistency with VDA/AIAG aligned PFMEA format.
4. Ensure the PFMEA reflects the current, actual process, not a theoretical one.

B) Update Control Plan

1. Align the Control Plan with PFMEA outcomes:
   - Updated process controls.
   - Revised inspection methods
   - New poka-yoke or error-proofing
   - Revised reaction plans
2. Control Plan must mirror PFMEA logic:
   - Cause → Prevention Control
   - Failure Mode → Detection Control

STEP 7: DOCUMENTATION & COMMUNICATION

C) Communicate Results to Stakeholders

1. Share updated PFMEA with:
   - Manufacturing, Quality, SQE, ME, Launch Team, Suppliers
2. Communicate critical risks, updated controls, and required changes in:
   - SOPs
   - Work instructions
   - Training modules
3. Ensure all functions understand their responsibilities.

D) Archive Documentation for Traceability

1. Store controlled PFMEA and supporting documents (Control Plan, Lessons Learned, Action Logs) in the official system.
2. Make documents accessible for:- Audits, Program reviews, Future product/process development.

STEP 7: DOCUMENTATION & COMMUNICATION

E) Capture Lessons Learned

1. Record successes, issues, and systemic learnings.
2. Feed lessons learned into:- Future PFMEAs, Product/Process Standards, Engineering guidelines
3. Helps avoid repeated failures across programs and platforms.

F) Confirm PFMEA is a Living Document

1. Ensure PFMEA is continuously updated when:-
   - New failures appear
   - Process changes occur
   - Supplier changes happen
   - New customer issues arise
2. Reinforce PFMEA as a dynamic risk management tool, not a one-time activity.

SEVERITY, OCCURRENCE, DETECTION & AP - TABLE

Severity "S"

Process General Evaluation Criteria Severity (S) Potential Failure Effects rated according to the criteria below.				
S	**Effect**	**Impact to Your Plant**	**Impact to Ship-to Plant (when known)**	**Impact to End User (when known)**
10	**High**	Failure may result in an acute health and/or safety risk for the manufacturing or assembly worker	Failure may result in an acute health and/or safety risk for the manufacturing or assembly worker	Affects safe operation of the vehicle and/or other vehicles, the health of driver or passenger(s) or road users or pedestrians.
9		Failure may result in in-plant regulatory noncompliance	Failure may reult in in-plant regulatory noncompliance	Noncompliance with regulations.
8	**Moderately high**	100% of production run affected may have to be scrapped. Failure may result in in-plant regulatory noncompliance or may have a chronic health and/or safety risk for the manufacturing or assembly worker	Line shutdown greater than full production shift; stop shipment possible; field repair or replacement required (Assembly to End User) other than for regulatory noncompliance. Failure may result in in-plant regulatory noncompliance or may have a chroni health and/or safety risk for the manufacturing or assembly worker.	**Loss** of primary vehicle function necessary for normal driving during expected service life.
7		Product may have to be sorted and a portion (less than 100%) scrapped; deviation from primary process; decreased line speed or added manpower	Line shutdown from 1 hour up to full production shift; stop shipment possible; field repair or replacement required (Assembly to End User) other than for regulatory noncompliance	**Degradation** of primary vehicle function necessary for normal driving during expected service life.
6	**Moderately low**	100% of production run may have to be reworked off line and accepted	Line shutdown up to one hour	**Loss** of secondary vehicle function.
5		A portion of the production run may have to be reworked off line and accepted	Less than 100% of product affected; strong possibility for additional defective product; sort required; no line shutdown	**Degradation** of secondary vehicle function.
4		100% of production run may have to be reworked in station before it is processed	Defective product triggers significant reaction plan; additional defective products not likely; sort not required	Very objectionable appearance, sound, vibration, harshness, or haptics.
3	**Low**	A portion of the production run may have to be reworked in-station before it is processed	Defective product triggers minor reaction plan; additional defective products not likely; sort not required	Moderately objectionable appearance, sound, vibration, harshness, or haptics.
2		Slight inconvenience to process, operation, or operator	Defective product triggers no reaction plan; additional defective products not likely; requires feedback to supplier	Slightly objectionable appearance, sound, vibration, harshness, or haptics.
1	**Very low**	No discernible effect	No discernible effect or no effect	No discernible effect.

AIAG&VDA 2019 standard

SEVERITY, OCCURRENCE, DETECTION & AP - TABLE

Occurrence "O"					
Occurrence Potential (O) for the Process					
Potential Failure Causes rated according to the criteria below. Consider Prevention Controls when determining the best Occurrence estimate. Occurrence is a predictive qualitative rating made at the time of evaluation and may not reflect the actual occurrence. The occurrence rating number is a relative rating within the scope of the FMEA (process being evaluated). For Prevention Controls with mutiple Occurrence Ratings, use the rating that best reflects the robustness of the control.					
O	**Prediction of Failure Cause Occurring**	**Incidents per 1000 items/vehicles**	**Time Based Failure Cause Prediction**	**Type of Control**	**Prevention Controls**
10	**Extremely high**	**≥ 100 per thousand, ≥ 1 in 10**	**Every time**	**None**	No prevention controls.
9	**Very high**	**50 per thousand, 1 in 20**	**Almost every time**	**Behavioral**	Prevention controls will have little effect in preventing failure cause.
8		**20 per thousand, 1 in 50**	**More than once per shift**		
7	**High**	**10 per thousand, 1 in 100**	**More than once per day**	**Behavioral or Technical**	Prevention controls somewhat effective in preventing failure cause.
6		**2 per thousand, 1 in 500**	**More than once per week**		
5	**Moderate**	**0.5 per thousand, 1 in 2 000**	**More than once per month**		Prevention controls are effective in preventing failure cause.
4		**0.1 per thousand, 1 in 10 000**	**More than once per year**		
3	**Low**	**0.01 per thousand, 1 in 100 000**	**Once per year**	**Best Practices: Behavioral or Technical**	Prevention controls are highly effective in preventing failure cause.
2	**Very low**	**≤ 0.001 per thousand, 1 in 1 000 000**	**Less than once per year**		
1	**Extremely low**	**Failure is eliminated through prevention control**	**Never**	**Technical**	Prevention controls are extremely effective in preventing failure cause from occurring due to design (e.g. part geometry) or process (e.g. fixture or tooling desing).

AIAG&VDA 2019 standard

SEVERITY, OCCURRENCE, DETECTION & AP - TABLE

Detection "D"			
Detection Potential (D) for the Validation of the Process Design			
Detection Controls rated according to Detection Method Maturity and Opportunity for Detection.			
D	**Ability to detect**	**Detection Method Maturity**	**Opportunity for Detection**
10	**Very low**	No testing or inspection method has been established or is known	The failure mode will not or cannot be detected
9		It is unlikely that the testing or inspection method will detect the failure mode	The failure mode is not easily detected through random or sporadic audits.
8	**Low**	Test or inspection method **has not been** proven to be effective and reliable (e.g. plant has little or no experience with method, gauge R&R results marginal on comparable process or this application, etc.)	Human inspection (visual, tactile, audible), or use of manual gauging (attribute or variable) that should detect the failure mode or failure cause
7			Machine-based detection (automated or semi-automated with notification by light, buzzer, etc.), or use of inspection equipment such as coordinate measuring machine that should detect failure mode or failure cause
6	**Moderate**	Test or inspection method has been proven to be effective and reliable (e.g. plant has experience with method, gauge R&R results are acceptable on comparable process or this application, etc.)	Human inspection (visual, tactile, audible), or use of manual gauging (attribute or variable) that will detect the failure mode or failure cause (including product sample checks)
5			Machine-based detection (semi-automated with notification by light, buzzer, etc.), or use of inspection equipment such as coordinate measuring machine that will detect failure mode or failure cause (including product sample checks)
4	**High**	System has been proven to be effective and reliable (e.g. plant has experience with method on identical process or this application), gauge R&R results are acceptable, etc.	Machine-based detection method that will detect failure mode **downstream**, prevent further processing or system will identify the product as discrepant and allow it to automatically move forward in the process until the designated reject unload area. Discrepant product will be controlled by a robust system that will prevent outflow of the product from the facility
3			Machine-based detection method that will detect failure mode **in-station**, prevent further processing or system will identify the product as discrepant and allow it to automatically move forward in the process until the designated reject unload area. Discrepant product will be controlled by a robust system that will prevent outflow of the product from the facility
2			Machine-based detection method that will detect the cause and prevent the failure mode (discrepant part) from being produced
1	**Very high**	Failure mode cannot be physically produced as-designed or processed, or detection methods proven to **always** detect the failure mode or failure cause	

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PFMEA EXAMPLE FOR LASER NUMBERING OPERATION: STEP 2, 3 & 4

Structure Analysis (Step 2)			Functional Analysis (Step 3)			Failure Analysis (Step 4)			
Process Item, System, Subsystem, Part Element or Name of Process	**Process Step, Station No., and Name of focus Element**	**Process Work Element 4M Type**	**Function of the Process Item, Function of System, Subsystem, Part Element**	**Function of the Process Step & Product Characteristics (Quantitive Value is optional)**	**Function of the Process Work Element and Process Characteristics**	**Failure Effects (FE) to the next Higher Level Element &/or End User**	**S E V**	**Failure Mode (FM)**	**Failure Cause (FC) of the Next lower Element or Chracteristics**
2	3	4	5	6	7	8	9	10	11
Laser Numbering Process	Part Loading	**M1- Man** Skilled Manpower Level-III **M4-Method** OMS	**A)Expected Function at our plant -** 1.Make correct laser mark **B)Expected Function at Ship to Plant -** 1.Avoid mix-ups during assembly **C)Expected Function at End user -** 1.Support warranty tracking	1. Load Correct part & orientation.	Ensure correct part code and orientation based on fixture keys	**A)Failure Effects On our Plant -** 1.Wrong marking applied 2.Rework / scrap **B)Failure Effects On Ship to Plant -** 1.Customer line disruption **C)Failure Effects On End user-** 1.Wrong component in product causes functional issue	**8**	Wrong part loaded	1. Part mix-up in trolley; 2. Identical geometry parts; 3.label missing on bin

Step 5 & 6 on next slide

PFMEA EXAMPLE FOR LASER NUMBERING OPERATION: STEP 5 & 6

Risk Analysis (Step 5)							Optimisation (Step 6)											
Current Prevention Control (PC)	O C C of FC	Current Detection Controls (DC) of FC or FM	Detection (D) of FC or FM	PFMEA AP	Special Characteristics	Filler Code (Optional)	Prevention Action	Detection Action	Responsible Person's Name	Target Competion Date	Status	Action Taken with Pointer to Evidence	Completion Date	S E V	O C C	D E T	Special Characteristics	PFMEA AP
12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1.Dedicated bins for each part	5	Operator visual check	8	**H**	Yes	--	Part wise color coding to the dedicated bins with serial number tracing.	1.Scanning of color bins done by automated machine. 2.If color mismatch with standard, buzzer will be in place	XYZ	3/21/2026	Completed	CP No-16 updated with Rev no 03 Dated-03/22/2026	3/22/2026	8	3	3	Yes	**L**

Before optimization actions the AP is High(H), but after new Preventive/Detection action occurrence & detection number changes. So, the AP changes from **H** ⇨ **L**.

THANK YOU

HYSTER-YALE
MATERIALS HANDLING