

# Severity, Occurrence, and Detection Criteria for Design FMEA

## SEVERITY EVALUATION CRITERIA

### CRITERIA: Severity of Effect on Product (Customer Effect)

| Effect   | Rank  | Rank |
|--|---|------|
| <b>Failure to meet safety and/or Regulatory Requirements</b> | Potential failure mode affects safe vehicle operation and/or involves noncompliance with government regulation without warning. | 10   |
|  | Potential failure mode affects safe vehicle operation and/or involves noncompliance with government regulation with warning.    | 9    |
| <b>Loss or Degradation of Primary Function</b>               | Loss of primary function (vehicle inoperable, does not affect safe vehicle operation).  | 8    |
|  | Degradation of primary function (vehicle operable, but at a reduced level of performance).                                      | 7    |
| <b>Loss or Degradation of Secondary Function</b>             | Loss of secondary function (vehicle operable, but comfort / convenience functions inoperable).                                  | 6    |
|  | Degradation of secondary function (vehicle operable, but comfort/ convenience functions at reduced level of performance).       | 5    |
| <b>Annoyance</b>   | Appearance or Audible noise, vehicle operable, item does not conform and noticed by most customers (>75%).                      | 4    |
|  | Appearance or Audible noise, vehicle operable, item does not conform and noticed by many customers (50%).                       | 3    |
|  | Appearance or Audible noise, vehicle operable, item does not conform and noticed by discriminating customers (< 25%).           | 2    |
| <b>No effect</b>   | No discernible effect.  | 1    |

| Likelihood of Failure | Criteria: Occurrence of Cause – DFMEA<br>(Design life/reliability of item/vehicle)                     | Criteria: Occurrence of Cause – DFMEA<br>(Incidents per items/vehicles) | Ppk   | Rank |
|-----------------------|--|---|-------|------|
|                       |  |   |       |      |
| <b>Very High</b>      | New technology/new design with no history.   | ≥100 per thousand<br>≥1 in 10   | <0.55 | 10   |
| <b>High</b>           | Failure is inevitable with new design, new application, or change in duty cycle/ operating conditions. | 50 per thousand<br>1 in 20  | ≥0.55 | 9    |
|                       | Failure is likely with new design, new application, or change in duty cycle/ operating conditions.     | 20 per thousand<br>1 in 50  | ≥0.78 | 8    |
|                       | Failure is uncertain with new design, new application, or change in duty cycle/ operating conditions.  | 10 per thousand<br>1 in 100   | ≥0.86 | 7    |
| <b>Moderate</b>       | Frequent failures associated with similar designs or in design simulation and testing.                 | 2 per thousand<br>1 in 500  | ≥0.94 | 6    |
|                       | Occasional failures associated with similar designs or in design simulation and testing.               | .5 per thousand<br>1 in 2,000   | ≥1.00 | 5    |
|                       | Isolated failures associated with similar designs or in design simulation and testing.                 | .1 per thousand<br>1 in 10,000  | ≥1.10 | 4    |
| <b>Low</b>            | Only isolated failures associated with almost identical design or in design simulation and testing.    | .01 per thousand<br>1 in 100,000  | ≥1.20 | 3    |
|                       | No observed failures associated with almost identical design or in design simulation and testing.      | ≤.001 per thousand<br>1 in 1,000,000                                    | ≥1.30 | 2    |
| <b>Very Low</b>       | Failure is eliminated through preventative control.  | Failure is eliminated through preventative control                      | ≥1.67 | 1    |

| Opportunity for Detection                           | Criteria:<br>Likelihood of Detection by Design Control  | Rank | Likelihood of Detection  |
|---|---|------|--------------------------|
| <b>No detection opportunity</b>                     | No current design control; Cannot detect or is not analyzed.  | 10   | <b>Almost Impossible</b> |
| <b>Not Likely to detect at any stage</b>            | Design analysis/detection controls have a weak detection capability; Virtual Analysis (e.g., CAE, FEA, etc) is <b>not correlated</b> to expected actual operating conditions  | 9    | <b>Very Remote</b>       |
| <b>Post Design Freeze and prior to launch</b>       | Product verification/validation after design freeze and prior to launch with <b>pass/fail</b> testing (Subsystem or system testing with acceptance criteria such as ride and handling, shipping, evaluation, etc.). | 8    | <b>Remote</b>            |
|   | Product verification/validation after design freeze and prior to launch with <b>test to failure</b> testing (Subsystem or system testing until failure occurs, testing of system interactions, etc.).               | 7    | <b>Very Low</b>          |
|   | Product verification/validation after design freeze and prior to launch with <b>degradation</b> testing (Subsystem or system testing after durability test, e.g., function check).                                  | 6    | <b>Low</b>               |
| <b>Prior to Design Freeze</b>                       | Product validation (reliability testing, development or validation tests) prior to design freeze using <b>pass/fail</b> testing (e.g., acceptance criteria for performance, function checks, etc.).                 | 5    | <b>Moderate</b>          |
|   | Product validation (reliability testing, development or validation tests) prior to design freeze using <b>test to failure</b> (e.g., until leaks, yields, cracks, etc.).  | 4    | <b>Moderately High</b>   |
|   | Product validation (reliability testing, development or validation tests) prior to design freeze using <b>degradation</b> testing (e.g., data trends, before/after values, etc.).                                   | 3    | <b>High</b>              |
| <b>Virtual Analysis - Correlated</b>                | Design and analysis/detection controls have a strong detection capability. Virtual analysis (e.g., CAE, FEA, etc.) is <b>highly correlated</b> with actual or extended operating conditions prior to design freeze. | 2    | <b>Very High</b>         |
| <b>Detection not applicable; Failure Prevention</b> | Failure cause or failure mode can not occur because it is fully prevented through design solutions (e.g., proven design standard, best practice or common material, etc.).  | 1    | <b>Almost Certain</b>    |

### RPN THRESHOLD

There is no threshold value for RPNs. In other words, there is no value above which it is mandatory to take a Recommended Action or below which the team is automatically excused from an action.

\*Note: Zero (0) rankings for Severity, Occurrence or Detection are not allowed



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# FMEA - Quick Reference Guide

| Item<br>Function   | Potential Failure Mode                           | Potential Effect(s) of Failure  | S<br>e<br>v | C<br>l<br>a<br>s<br>s | Potential Cause(s)/ Mechanism(s) Failure   | Current Design Controls Prevention | O<br>c<br>c<br>u<br>r | Current Design Controls Detection   | D<br>e<br>t<br>e<br>c | R.<br>P.<br>N. | Recommended Action(s)  | Responsibility & Target Completion Date     | Actions Taken   | Action Results |             |             |                |
|--|--|---|-------------|-----------------------|--|------------------------------------|-----------------------|---|-----------------------|----------------|--|---|---|----------------|-------------|-------------|----------------|
|  |  |   |             |                       |  |                                    |                       |   |                       |                |  |   |   | S<br>e<br>v    | O<br>c<br>c | D<br>e<br>t | R.<br>P.<br>N. |
| Must provide an FMEA which determines design risk and addresses potential significant and critical characteristic selection:<br>Measurable:<br>• Reduced RPN<br>• Number of significant and critical characteristics.<br>• Number of design actions. | FMEA not adequately performed; high risk remains | <ul style="list-style-type: none"> <li>Product liability</li> <li>Customer dissatisfaction</li> <li>Reduced performance of system or component</li> <li>Potential risk of injury</li> </ul> | 10          | YC                    | <ul style="list-style-type: none"> <li>Inadequate FMEA development</li> <li>Cross functional team not assembled</li> <li>Facilitation not used</li> <li>FMEA expertise is limited</li> </ul> | •Mistake Proofing                  | 5                     | <ul style="list-style-type: none"> <li>Design verification, planning and testing</li> <li>Training</li> </ul> | 2                     | 100            | Call an FMEA facilitator to reduce time required and improve quality of the FMEA process | Design team leader or project manager; ASAP | FMEA performed under the supervision and leadership of an expert/certified FMEA facilitator | 10             | 2           | 2           | 40             |

• Verb-noun measurable is desirable

• objective

• subjective

Anti function for functional approach

- full
- partial
- intermittent
- excess function

Customer focus/experience

- end user
- assembler
- maker
- regulatory body

Brainstorm causes

- man
- material
- method
- machine
- environment

Determine Root cause if YC

**Detect**

Planned tests

- Transfer to or from DV Plan
- evaluations
- builds
- bucks

Note: Must have written instructions.

**Prevent**

- Reduces Occurrence

Actions should:

- eliminate failure mode SEV=9/10
- eliminate causes on YS
- reduce occurrence
- improve tests "detection reduction last option"

- Name of team member to carry issue.
- Name of champion
- Date action desired completion

Brief action result description

Date action taken

Recalculate RPN, after action has been taken

- occurrence
- detection

**Note:** severity will likely stay the same unless failure mode is eliminated

See Severity Chart on opposite side

See Occurrence Chart on opposite side

See Detection Chart on opposite side

- Actions are Required: (by Priority)**
- 1.) When this exists (initiate Process FMEA to verify)
  - 2.) When this exists (initiate Process FMEA to verify)
  - 3.) For the top 20% Failure Modes / Causes (Pareto by RPN)

