### Design FMEA Linkage

#### Potential Failure Mode and Effects Analysis
(Design FMEA)

<table>
<thead>
<tr>
<th>Item</th>
<th>Function</th>
<th>Potential Failure Mode</th>
<th>Potential Effect(s) of Failure</th>
<th>Sev</th>
<th>Class</th>
<th>Potential Cause(s)/Mechanism(s) Failure</th>
<th>Occur</th>
<th>Current Process Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide adequate Time to ½ amplitude</td>
<td>Time to ½ amp inadequate</td>
<td>•Poor handling quality (7)</td>
<td>7 CC</td>
<td>Inadequate Stiffness of transmission cover assembly</td>
<td>3</td>
<td>•Performance Testing •FEA – Transmission cover stiffness</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Detect**: Planned tests
  - Transfer to or from DV Plan
  - evaluations
  - builds
  - bucks
- **Prevent**: Reduces Occurrence

- **Brainstorm causes**
  - man
  - material
  - method
  - machine
  - environment
- **Output to Characteristics Matrix**

- **Customer focus/experience**
  - end user
  - assembler
  - maker
  - regulatory body

- **Anti function** for functional approach
  - full
  - partial
  - intermittent
  - excess function

- **Inputs from Requirements & Specifications**
- **Inputs from QFD relationships**
## DFMEA Inputs – Warranty Data

### Table: Top Parts & Conditions

<table>
<thead>
<tr>
<th>Part #</th>
<th>Part Description</th>
<th>Total Incidents</th>
<th>Total Part Incid</th>
<th>Condition Incidents</th>
<th>Condition Cost</th>
<th>Condition Code</th>
<th>Condition Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>60539-94</td>
<td>GASKET, PRIMARY COVER</td>
<td>69</td>
<td>$3,513</td>
<td>59</td>
<td>$2,984</td>
<td>3207</td>
<td>NOT SEALING (NO APPARENT DAMAGE)</td>
</tr>
<tr>
<td>12052</td>
<td>OIL SEAL</td>
<td>62</td>
<td>$9,230</td>
<td>51</td>
<td>$7,739</td>
<td>3207</td>
<td>NOT SEALING (NO APPARENT DAMAGE)</td>
</tr>
<tr>
<td>12066</td>
<td>OIL SEAL</td>
<td>59</td>
<td>$8,193</td>
<td>45</td>
<td>$6,906</td>
<td>3207</td>
<td>NOT SEALING (NO APPARENT DAMAGE)</td>
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<tr>
<td>25416-99A</td>
<td>SEAL, QUAD</td>
<td>33</td>
<td>$28</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60567-90A</td>
<td>PRIMARY COVER GASKET</td>
<td>29</td>
<td>$33</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60543-99</td>
<td>CHROME PRIMARY COVER</td>
<td>53</td>
<td>$15,227</td>
<td>19</td>
<td>$5,580</td>
<td>1203</td>
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<td>60562-99</td>
<td>PRIMARY COVER, POLISHED</td>
<td>25</td>
<td>$6,289</td>
<td>9</td>
<td>$2,234</td>
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<td>25414-99</td>
<td>POLISHED DERBY COVER</td>
<td>12</td>
<td>$404</td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

### Graph: 2001 Warranty to Date

The graph illustrates the warranty incidents for different components over time. Each bar represents a specific component, with the length indicating the number of incidents. The graph shows a trend over the years, with a focus on the percentage of incidents for each category, as indicated by the % values on the graph.
DFMEA Linkage to PFMEA

Characteristics Matrix Development

• Potential Significant Characteristics Are Typically Transferred from the DFMEA

• Characteristics are compared with the process steps to Identify potential causes of failure.

  • Causes are transferred to the PFMEA
# Characteristics Matrix - Linkage from DFMEA to PFMEA

<table>
<thead>
<tr>
<th>Potential Significant and Critical Characteristics from DFMEA</th>
<th>Process Operation from Process Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.090 TO 1.110 ' FACE OF PRIMARY HOUSING</td>
<td></td>
</tr>
<tr>
<td>BUSHING TO FACE OF JACK SHAFT SEAL</td>
<td></td>
</tr>
<tr>
<td>DOWEL PINS 0.260 TO 0.270 ' TO FACE</td>
<td></td>
</tr>
<tr>
<td>AXIAL SHAFT SEAL MINIMUM SHOULDER</td>
<td></td>
</tr>
<tr>
<td>SNAP RING FACE</td>
<td></td>
</tr>
<tr>
<td>SEAL COMPRESSION HEIGHT</td>
<td></td>
</tr>
<tr>
<td>PRIMARY GASKET SEAL SURFACE FINISH</td>
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<td>SEPARATION DAMAGE</td>
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<table>
<thead>
<tr>
<th>Direction of Improvement</th>
<th>Severity</th>
<th>Material Handling</th>
<th>Component Failure</th>
<th>Component Malfunction</th>
<th>Process Failure</th>
<th>Process Steps</th>
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<td></td>
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<table>
<thead>
<tr>
<th>Special Characteristics Matrix</th>
<th>Weighted Importance</th>
<th>Relative Importance</th>
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<tbody>
<tr>
<td></td>
<td>0</td>
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**APQP Linkages**

**Potential Critical and Significant**

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**High/Medium Interactions are causes/failure modes in PFMEA**
Failure Mode Development

• Developed Through Brainstorming
  • PFMEA Team make-up is crucial for accurate Failure Mode Development

• Internal Failures

• External Failures
  • Warranty Data

• All Stakeholders Considered
  • Internal and External
## PFMEA Inputs – Warranty Data

### 2001 - All Models

#### Top Parts & Conditions

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### 2001 Warranty To Date

- **Incidents**
  - 0%
  - 10%
  - 20%
  - 30%
  - 40%
  - 50%
  - 60%
  - 70%
  - 80%
  - 90%
  - 100%

- **Incidences**
  - 0
  - 33.75
  - 67.5
  - 101.25
  - 135
  - 168.75
  - 202.5
  - 236.25
  - 270

- **Parts**
  - NOT SEALING - GASKET, COVER
  - NOT SEALING - OIL SEAL
  - NOT SEALING - OIL SEAL
  - NOT SEALING - SEAL, QUAD
  - NOT SEALING - COVER GASKET

### APQP Linkages
Potential Cause Development

• Developed Through Brainstorming

• Information gathered from surrogate problem resolution activities (Corrective Action Reports)

• Manufacturing operators provide the best input to Root Cause Analysis

• A tour of the manufacturing area may identify several possible causes of failure
# Process FMEA Linkage

**ITEM:** Primary Drive Housing Assembly  
**Model Year/Vehicle(s):**  
**Core Team:**

### Process Responsibility:

**Key Date:**

### Potential Failure Mode and Effects Analysis (Process FMEA)

<table>
<thead>
<tr>
<th>Process Function</th>
<th>Potential Failure Mode</th>
<th>Potential Effect(s) of Failure</th>
<th>Severity Class</th>
<th>Potential Cause(s)/Mechanism(s) of Failure</th>
<th>Occurrence</th>
<th>Current Process Controls</th>
</tr>
</thead>
</table>
| Op 120 Assemble Transmission Cover | Case not properly assembled  
- torque inadequate | •Poor handling quality (7)  
- T to ½ amp inadequate | 7 CC | Torque tool malfunction | 3 | •Weekly calibration  
•Daily quality audits |

- **Potential Cause(s)/Mechanism(s):**
  - Inputs from process flow
  - Anti function
  - Warranty Data
  - From Characteristics Matrix

- **Potential Effect(s) of Failure:**
  - Brainstorm causes
    - end user
    - assembler
    - maker
    - regulatory body

- **Severity Class:**
  - 7 CC
Recommended Actions

• Actions are mandatory for ALL failure modes resulting in a Severity of 9 or 10

• Actions recommended for any severity of 5 or higher with an occurrence of 4 or higher

• Actions recommended for any failure modes resulting in a high RPN regardless of Severity X Occurrence combination

• Actions center around reduction of occurrence
  • Improving detection is only used as a temporary measure
PFMEA Selection

CRITICAL CHARACTERISTICS
Safety/Regulatory

SIGNIFICANT CHARACTERISTICS
Customer Dissatisfaction

ALL OTHER CHARACTERISTICS
Appropriate actions / controls already in place

Severity

Ocurrence

APQP Linkages