CATEGORIZING FAILURE

Figure 1. An FMEA process should use 10-point scales to rank the severity, occurrence and detection of each failure mode.

Severity ranking criteria

Description of failure effect	Effect	Ranking
No reason to expect failure to have any effect on safety, health, environment or mission.	None	1
Minor disruption of production. Repair of failure can be accomplished during trouble call.	Very low	2
Minor disruption of production. Repair of failure may be longer than trouble call but does not delay mission.	Low	3
Moderate disruption of production. Some portion of the production process may be delayed.	Low to moderate	4
Moderate disruption of production. The production process will be delayed.	Moderate	5
Moderate disruption of production. Some portion of production function is lost. Moderate delay in restoring high function.	Moderate to high	6
High disruption of production. Some portion of production function is lost. Significant delay in restoring function.	High	7
High disruption of production. All of production function is lost. Significant delay in restoring high function.	Very high	8
Potential safety, health or environmental issue. Failure will occur with warning.	Hazard	9
Potential safety, health or environmental issue. Failure will occur without warning.	Hazard	10

Occurrence ranking criteria

Ranking	Frequency of occurrence/ operating hours	Description
1	1/10,000	Remote probability of occurrence; unreasonable to expect failure to occur
2	1/5,000	Low failure rate
3	1/2,000	Low failure rate
4	1/1000	Occasional failure rate
5	1/500	Moderate failure rate
6	1/200	Moderate failure rate
7	1/100	High failure rate
8	1/50	High failure rate
9	1/20	Very high failure rate
10	1/10	Very high failure rate

Detection ranking criteria

Ranking	Description
1-2	Very high probability of detection
3-4	High probability of detection
5-7	Moderate probability of detection
8-9	Low probability of detection
10	Very low probability of detection

used to prevent the probability of failure for each component or subcomponent.

4. Brainstorm potential failure modes. Once everyone in the team has a deep understanding about how the process or product works, the team can start thinking about things that could happen to affect the process. After a brainstorming session, organize the ideas by grouping them into categories. Categorizing failure modes can be done using many different ways, including failure type (i.e., electrical, mechanical or user-created).

A failure mode is an event that causes a functional failure, any of the myriad ways in which a product or process can fail. Examples of failure modes abound. Low discharge pressure could be a compressor failure mode. Knocking could be an engine failure mode. Seized bearings are a bearing failure mode. Burnout is a motor failure mode. A dead battery is a car battery failure mode.

Note that failures are not limited to problems with the product, and failures could be tied to user mistakes. Those types of failures should be included in the FMEA. Anything that can be done to ensure the product works correctly, regardless of how the user operates it, will move the product closer to 100 percent total customer satisfaction. The use of mistake-proofing techniques, also known by its Japanese term poka-yoke, can be a good tool for preventing failures related to user mistakes.

For example, an FMEA involving a coffee maker could try to engineer out the user mistake of putting too much or too little ground coffee in the filter. This will ensure that the machine is making the right coffee with the same quality of taste for all users.

5. Assign an effect for each failure mode. Each failure mode should have an effect that determines the severity of the failure. It is also known as the consequence of failure.

The effect of a failure mode on the system is influenced by the availability of standby or redundancy in the system. For example, a transformer that supplies electricity is critical, but the existence of a standby generator will reduce the criticality of the system. However, this performance must be considered and compared. If the transformer failed, would the generator be able to supply the electricity needed with the same efficiency? What is the time interval between when the transformer fails and when the generator starts to work? Will any failures have a severe effect on the product, the process or the whole system that will cost a lot of money to repair?

One failure mode could have several effects. For example, an electrical cutoff in the home could stop the refrigerator and damage food or prevent you from doing work on the computer.

Several failure modes could have one effect. A dead car battery or tire failure has the same effect on your vehicle – it will be difficult to make it to work on time with such a failure early in the morning.

The team must determine the end-effect each failure mode has on the system or the process. This means examining how each failure affects the entire system, the facility or the other connected processes.

One failure mode could have several effects.

6. Assign severity rankings. Severity, occurrence and detection are each ranked on a 10-point scale, ranging from one as the lowest ranking to 10 as the highest. Figure 1 shows a standard example of rankings for all three. In the severity category, potential safety, health and environmental failure modes generally indicate high risk, with rankings of nine and 10. Production losses and costs rank from a low of two to a high of eight, depending upon the length of potential delays and the severity of their effects on the entire system.