Reliability Program Overview for Developers

Reliability Assurance Plan (RAP)

Amnon Ganot - November, 2010

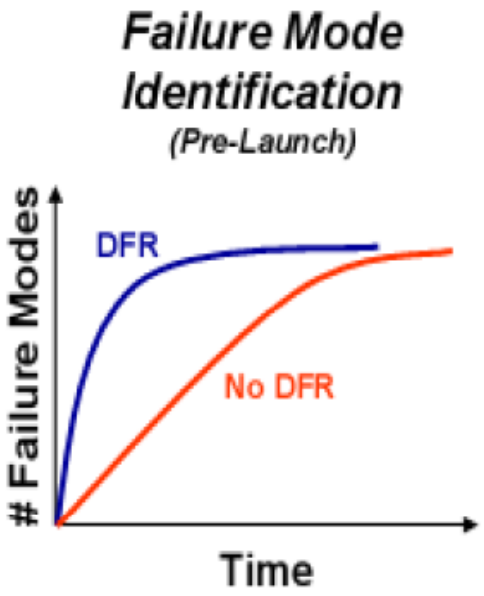
Agenda

- *Toolbox*
  - Design
  - Tests
  - Monitor
- *Reliability Assurance Plan (RAP)*
- *Design For Reliability (DFR)*
- *Summary*

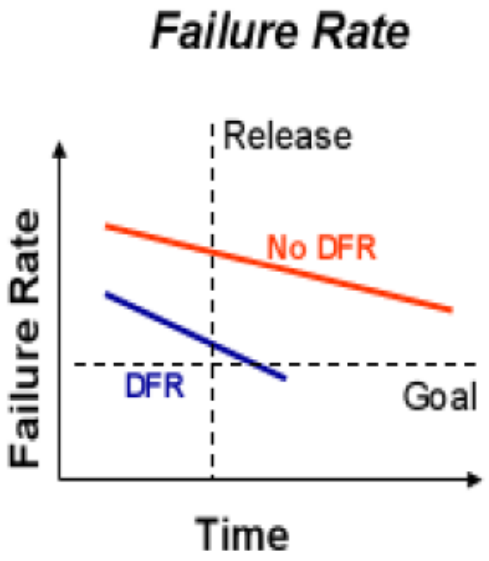
Reliability Assurance Plan

- *A good reliability program can drastically improve product performance and longevity as well as minimize total Life Cycle Cost, and can ultimately improve customer satisfaction.*

DFR Benefits



Identify & "eliminate" inherent failure modes before launch. (Minimize Excursions!)



Start with lower "running rate", then aggressively "grow" reliability. (Reduce Warranty Costs)

Reduce overall costs by employing DFR from the beginning.

Reliability Assurance Plan

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Reliability Assurance Plan

- Reliability Objectives
  - Objectives shall be quantitative, and the plan should include the activities which will help achieve them.
  - Examples of Objectives:
    - MTBF should be higher than 2000 [Hours]
    - MTTR should be less than 2 [Hours]
    - There should be no more than 2 PMs per year

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Reliability Assurance Plan

- System Failures
  - Clearly define what constitute a system failure for the system being tested.

Reliability Assurance Plan

- Ratio of fatalities to the number of passengers carried.
  - Air travel is 285 times safer.

- Ratio of fatal accidents to the number of cars/planes in service.
  - A car is 2 times safer.

- Fatalities per million miles traveled.
  - Air travel is 52 times safer.

- Fatalities per trip:
  - Air travel is 5 times safer.

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Reliability Assurance Plan

- Existing Reliability Data
  - Indicate existing sub-system that are intended to be used in the new project as well as their known reliability in the field

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Reliability Assurance Plan

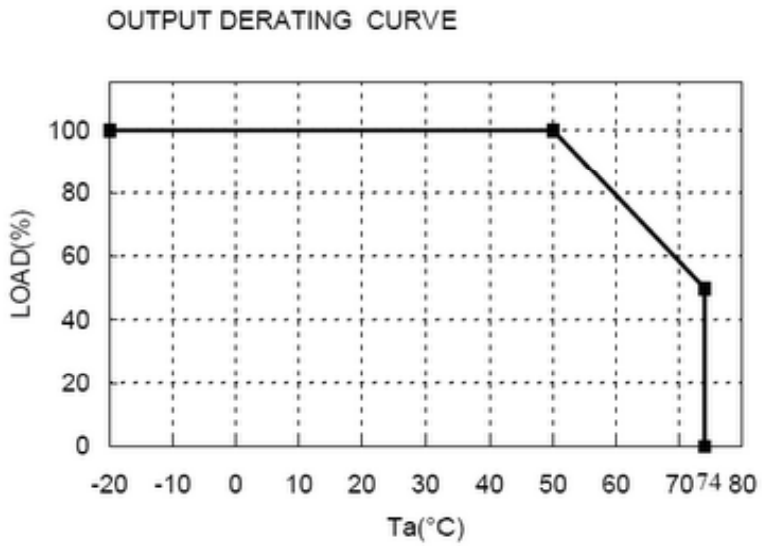
- Stress & Derating Strategy
  - Components and materials will be used at loads that are less than their limiting conditions
  - Design will minimize or balance stresses and thermal loads and/or reduce sensitivity to those stress or loads
  - Establish parts selection and component derating guidelines

Reliability Assurance Plan

- Stress & Derating Strategy (cont.)
  - Example:
    - 1.

Part Type	Derating Parameter	Derating Level I	II	III
Capacitors				
• Film, Mica, Glass	DC Voltage Temp from Max Limit	50% 10°C	60% 10°C	60% 10°C

    - 2.



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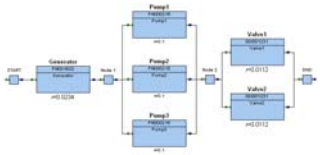
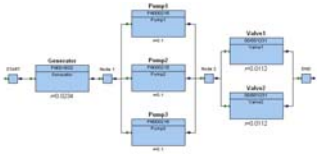
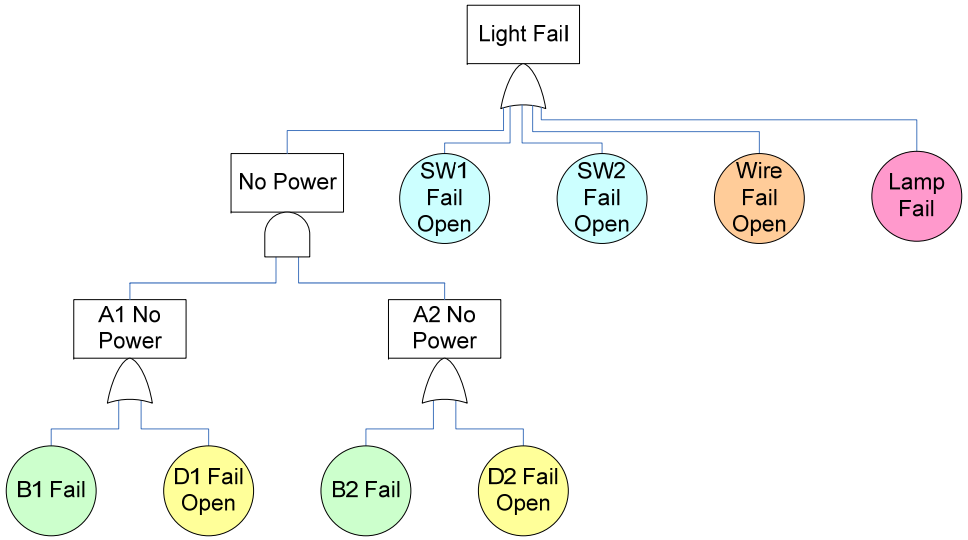
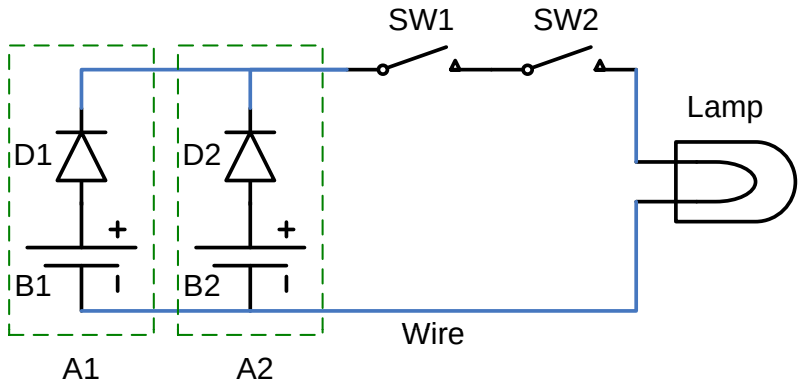


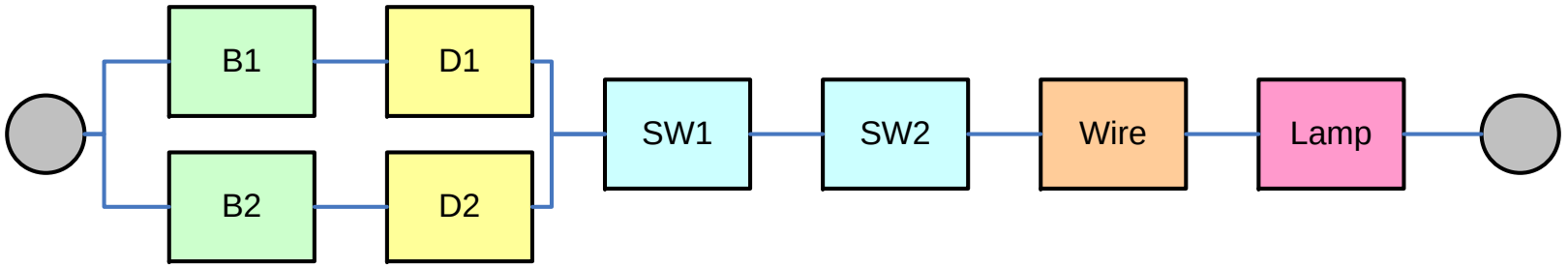
- Reliability Modeling
  - Prepare a Reliability Block Diagram that represent the logical structure of the system with regard to how the reliability of its components affects the system reliability
  - Elements which are not relevant for (or used in) the required function under consideration are removed

Reliability Assurance Plan









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Reliability Assurance Plan

- Reliability Allocation
  - With complex equipment and systems, it is important to allocate reliability goals at subsystem and assembly levels early in the design phase
  - Use the ARINC Technique to allocate reliability among the reliability building blocks of the system

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Reliability Assurance Plan

- Reliability Prediction
  - To determine the estimated life of a unit for comparison to expected or specified reliability
  - To identify the "weakest link" in a system for potential corrective actions
  - Comparison of competing designs
  - Judge Feasibility of design
  - Identify components with inadequate design margin
  - Provide field replacement requirements

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Reliability Assurance Plan

- Reliability Training
  - Establish the reliability training program for the project. Define the different training groups based and their reliability skill needs (management, system engineers, designers, integrators, service engineers, etc.). Define the course topics for each of the groups. Set time table for each course

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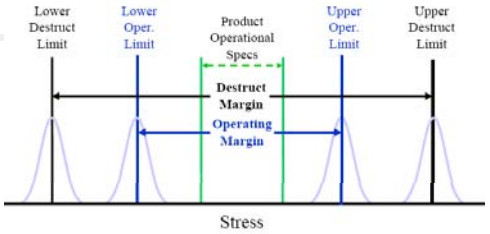
Reliability Assurance Plan

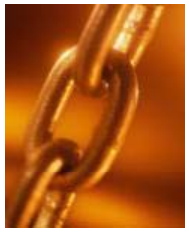
- FMEA strategy
  - FMEA - FMEA (Failure Mode and Effects Analysis) is a proactive tool, technique and quality method that enables the identification and prevention of process or product errors before they occur.
  - Conduct an FMEA for each subsystem that is either under high stress, or there is no past experience with, or its failure might causes a safety issue

Reliability Assurance Plan

- ALT strategy
  - ALT - Accelerated Life Test (ALT) is the process of determining the reliability of a product (usually performed on individual assemblies rather than full systems) in a short period of time by accelerating the use environment.
  - Conduct an ALT when there is a wear-out mechanism involved and/or to find dominant failure mechanisms

Reliability Assurance Plan





- HALT strategy
  - HALT – Highly Accelerated Life Test is performed during design to find the weak reliability links in the product. The applied stresses to the product are well beyond normal shipping, storage, and application conditions.

  - Conduct an HALT for each subsystem that is either under high stress, or there is no past experience with, or its failure might causes a safety issue

Reliability Assurance Plan

- HASS strategy
  - HASS (Highly Accelerated Stress Screen) - A production screen using the same accelerated techniques as HALT, but derated. Its purpose is to monitor the manufacturing process for deviations, by screening production units
  - Conduct an HASS for subsystems that are either under high stress, or there its failure might causes a safety or high loss issue

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Reliability Assurance Plan

- RDT Plan
  - Reliability Demonstration Tests are long duration physical stress tests which measure product reliability and accelerate failure mechanisms. Product performance is monitored and data is statistically analyzed to determine if it meets its goals. Accelerated environments (elevated stresses) and multiple samples are used to reduce test time.
  - Run RDT for each subsystem whose reliability goals where challenging or there is doubt whether it has achieved its reliability goals
  - Run RDT for the complete system to validate it's reliability level.

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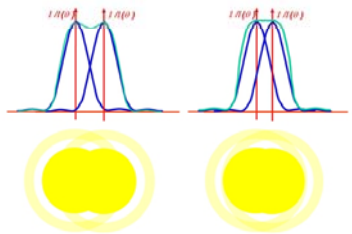
Reliability Assurance Plan

- FRACAS Strategy
  - Failure Reporting, Analysis & Corrective Action System
  - The primary purpose of the FRACAS is to establish and manage a closed-loop system adequate for use by the project in the processing and management of hardware and software anomaly reports
  - Define the resolution to be used when reporting failures



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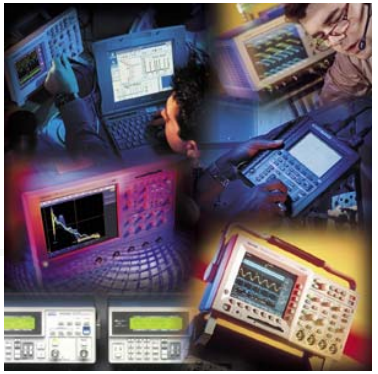

- Testability Strategy
  - Testability - A design characteristic that allows the status (operable, inoperable or degraded) of an item to be *determined*, and faults within the item to be *isolated* in a *timely efficient* manner
  - Fraction Faults Detected (FFD) - The quantity of *faults detected* by Build In Test (BIT) or External Test Equipment (ETE) divided by the quantity of faults detected by all fault detection means (including manual).
  - Fault Isolation Resolution (FIR) - The *probability* that any detected fault can be *isolated* by BIT or ETE to an ambiguity of size “x” or less.

Reliability Assurance Plan

•Testability Strategy (cont.)

- **Fraction Faults Detected (FFD)**

Safety	100%*
Critical	95%
Major	90%
Minor	85%

- **Fault Isolation Resolution (FIR)**

One FRU	85%
Two FRUs	10%
Three or more FRUs	5%

* Means that all safety faults will be detected!

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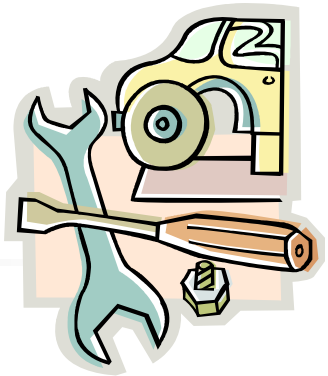

- Reliability Centered Maintenance (RCM)
  - Preventive Maintenance – actions performed periodically (or continuously) prior to a failure to achieve the desired level of safety and reliability for a system
  - Corrective Maintenance – repairs or other corrective action taken after a failure has occurred
  - RCM determines proper balance of planned and unplanned maintenance, to establish a "Failure Management Strategy"

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- Reliability Growth Plan
  - The Reliability Growth Test (RGT) is an "engineering task" designed to improve the design reliability
  - It recognizes that the drawing board design of a complex system cannot be perfect from a reliability point of view and allocates the necessary time to fine tune the design by finding problems and designing them out
  - Set a Reliability Growth Plan when there is a Challenge to state-of-the-art

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Questions?

Thanks for you attention