How to Set Up a Reliability Program for Photovoltaic Modules

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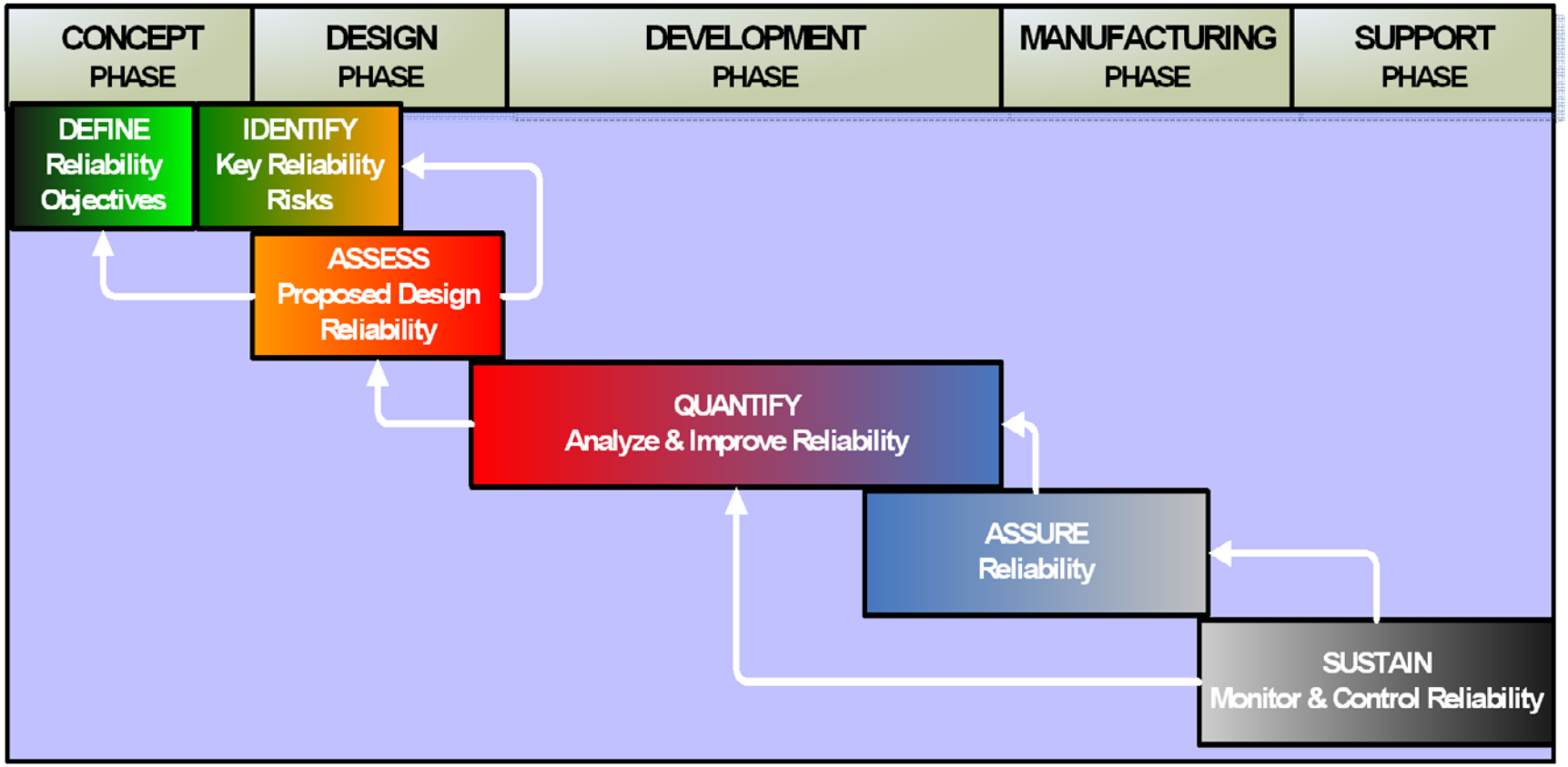
The Reliability Challenge

Most companies realize they have to balance three imperatives in order to develop highly reliable products and processes:

- Ensure that their products meet or exceed reliability requirements
- Meet project budget objectives
- Meet project timing objectives

Scope of a Reliability Program Plan

A Reliability Program Plan is a document that outlines the entire plan and set of action steps to achieve the reliability objectives for a project.



General Guidelines for Setting Up a Reliability Program

- **Set reliability objectives.**
- **Develop the specific action steps that will achieve the reliability objectives.**
- **Some resources for a reliability program:**
  - SAE JA1000/1: *Reliability Program Standard Implementation Guide*
  - ReliaSoft: *Blueprint for Implementing a Comprehensive Reliability Program*
  - Reliability Analysis Center: *Reliability Toolkit: Commercial Practices Edition*

Reliability Management Concepts and Tools

- **There are many standards on reliability management; for example, some of the military standards are:**
  - MIL-STD-2155 Failure Reporting, Analysis and Corrective Action System (FRACAS)
  - MlL-STD-785B Reliability Program for Systems and Equipment, Development and Production
  - MIL-HDBK-189 Reliability Growth Management

- **A FRACAS (failure reporting, analysis and corrective action system) is one of the most important management tools in a reliability program.**

Why FRACAS? Survey

- ***ReliaSoft* Survey shows FRACAS was ranked as the #3 important reliability task.**
- **In a survey published by the *IEEE Transactions on Reliability*, FRACAS was ranked #2 among reliability tasks with greatest effectiveness.**
- **In a similar survey published by the Reliability Analysis Center, FRACAS was ranked as the #1 important reliability task.**
- **To have a successful Reliability Program, you need to have an efficient FRACAS system!**
  - The characteristics of a closed-loop system provide the monitoring & control necessary to make FRACAS effective.
  - It causes the different groups/entities in the organization to effectively communicate and implement the corrective action and review its effectiveness.

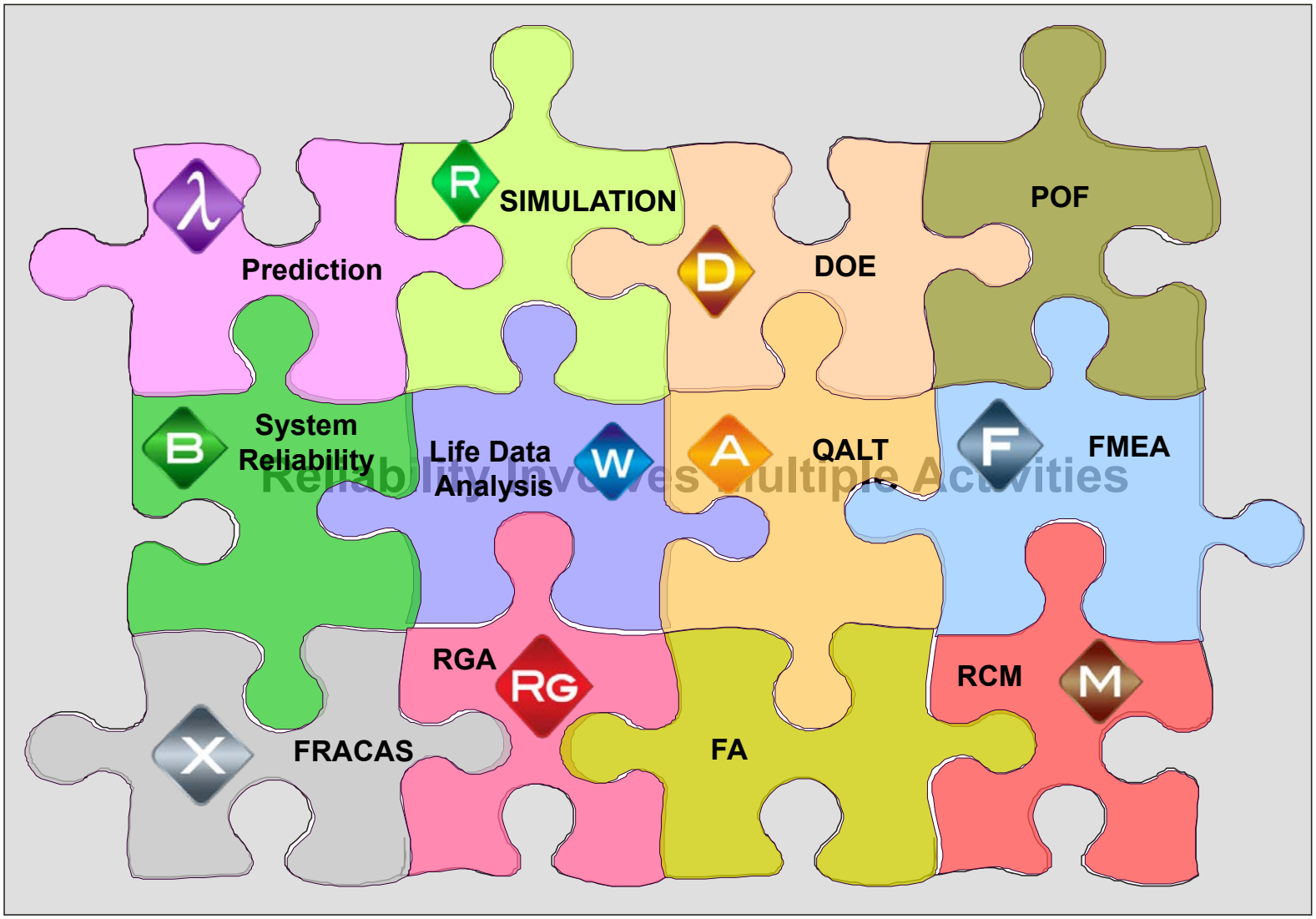
Why FRACAS? Benefits

- FRACAS promotes reliability improvement throughout the life cycle of a product. It can be used and applied during:
  - Initial product design/re-design to identify and eliminate known issues.
  - In-house development testing to improve the product, process or service.
  - Field testing.
  - Production and operations to increase efficiencies.
  - Capital equipment installation – reduce costs & time.
  - Supporting products in the field (end-user/customer).

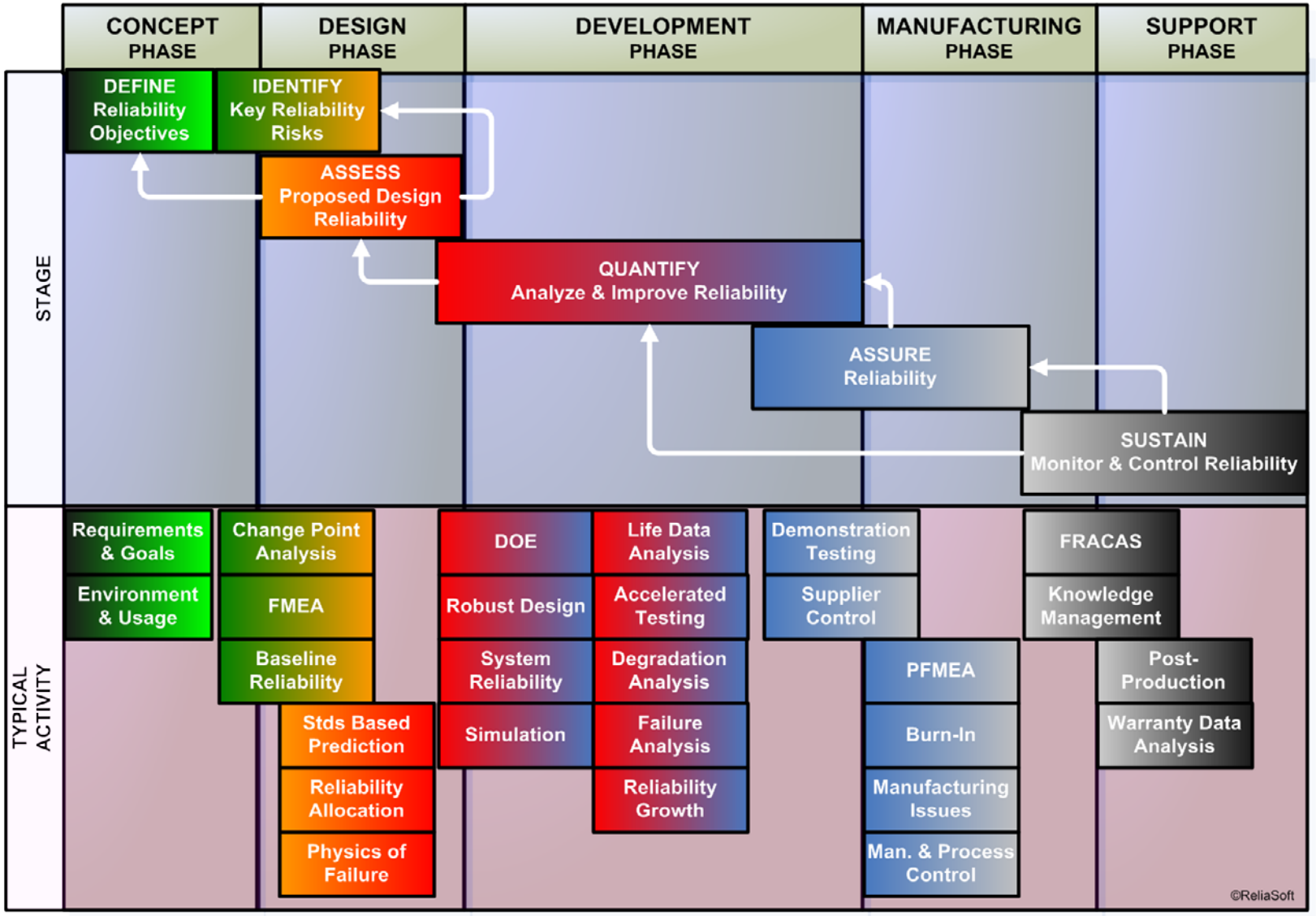
Why FRACAS? Benefits (*cont'd)*

- FRACAS promotes the reliability of a product or process by establishing a formal process followed by the entire organization:
  - Provides engineering data for corrective action and preventive action.
  - Identifies developing patterns of deficiencies.
  - Provides failure data for reliability analysis.
  - Helps avoid recurrence of failures in future designs.
  - Comprises a centralized lessons learned location that can help reduce time and effort for resolving both individual incidents as well as problems.
  - Essential for Quality/ISO certifications and audits.

Multiple Activities and Tools in Reliability Program



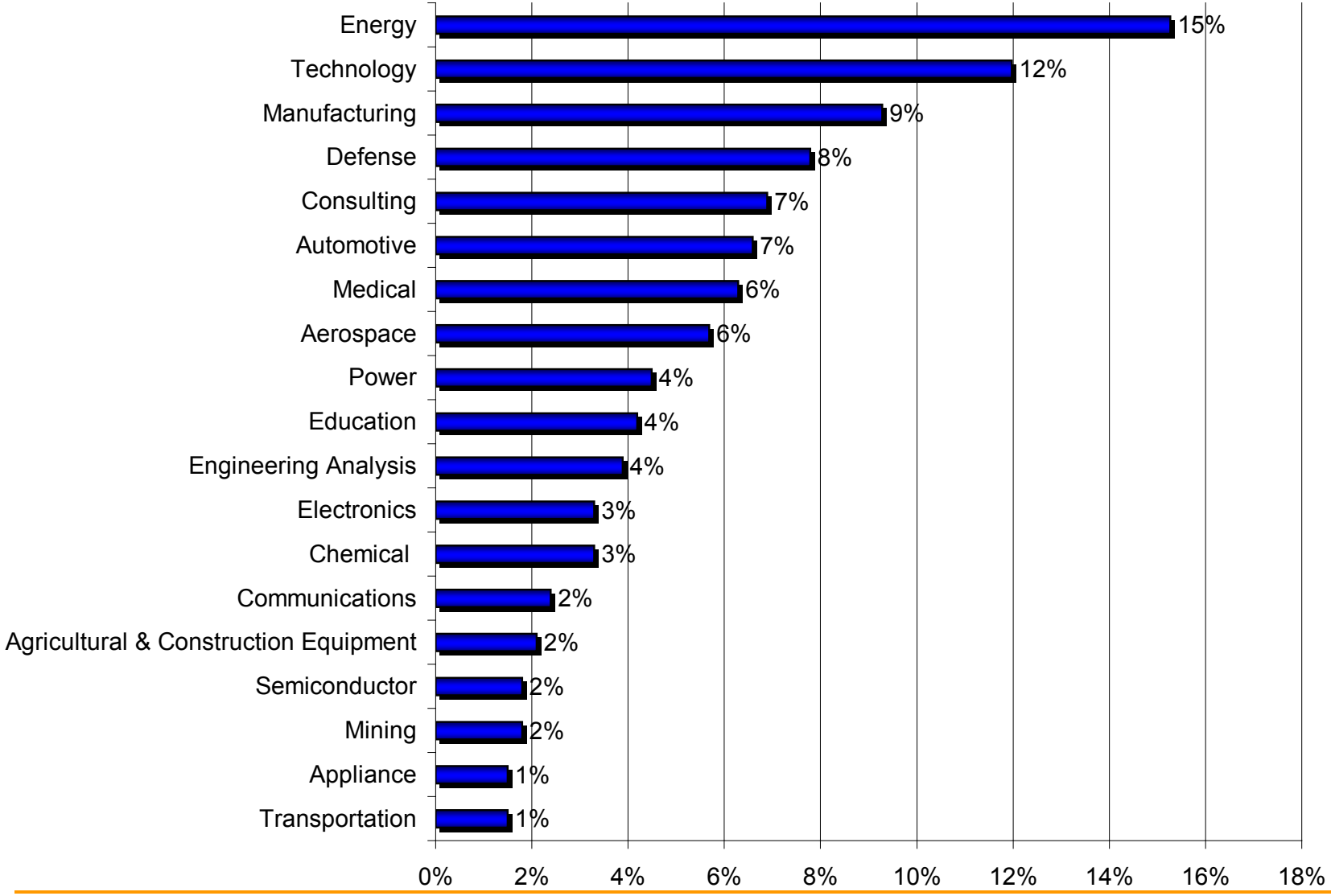
Micro Reliability: Statistic Tools Used in Reliability Program



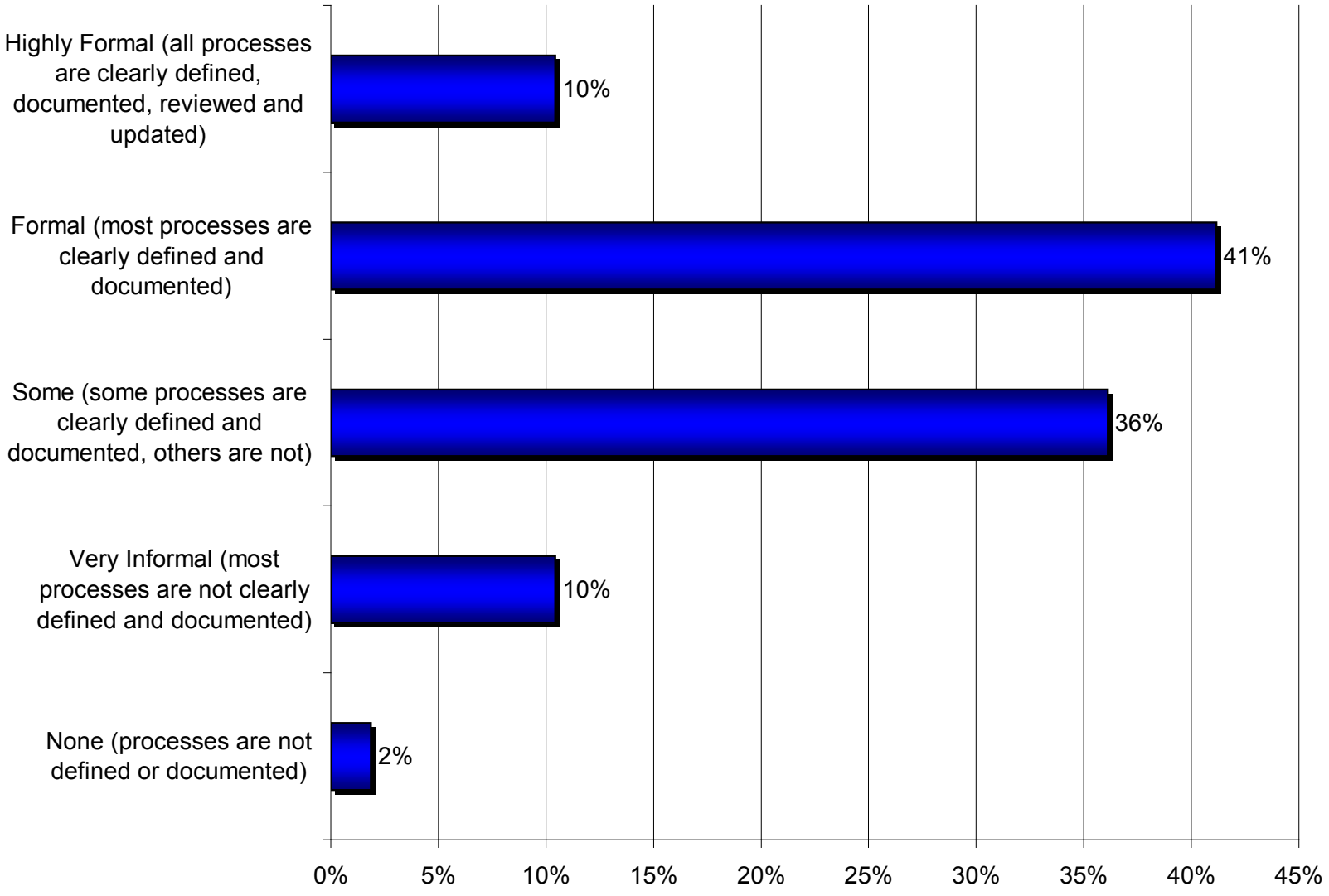
Reliability Program in Various Industries

- **In 2009, *ReliaSoft* conducted a survey on Reliability Programs from hundreds of companies.**
- **The survey tells us:**
  - How many of the companies have reliability programs and at what extent.
  - What are the commonly used tools in a reliability program.
  - And more….

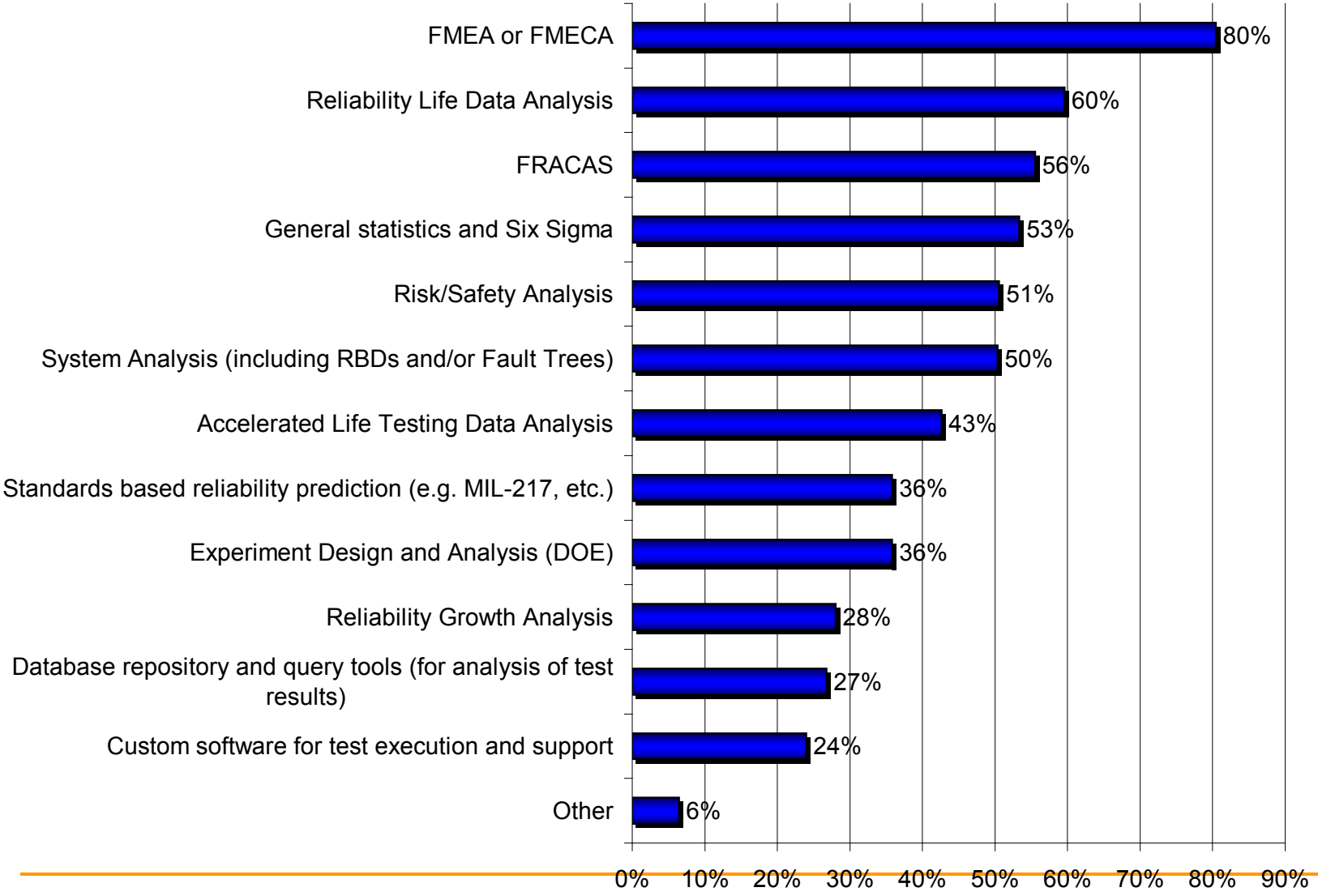
Industry Sectors Represents in the Survey



Status of Reliability Program at Various Companies



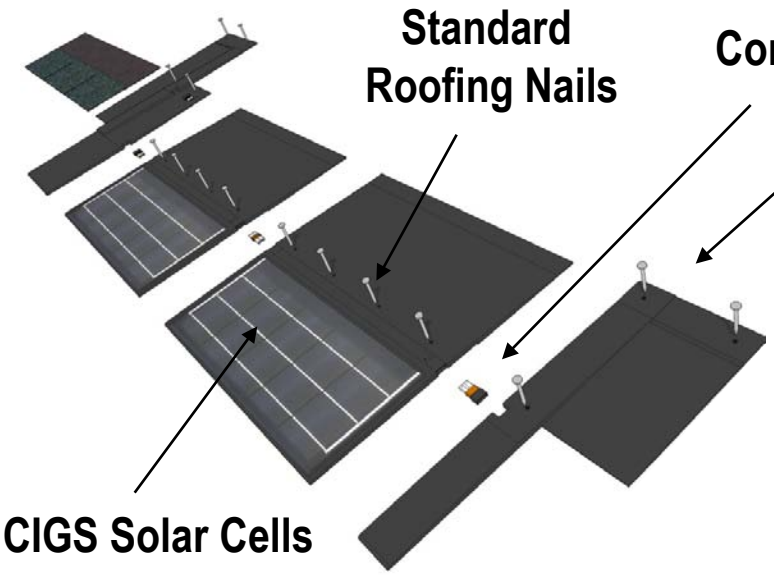
Management and Statistic Tools Used in a Reliability Program



Reliability Program for New PV Module Companies

- **How should a new PV module company set up a reliability program:**
  - Follow the reliability program guideline and tailor it for your company.
  - Use FRACAS to collect data and document all the mistakes and successes, and come up with acceptable plans for each reliability task.
  - Integrate reliability tasks with the concept, design, manufacturing and field use stages. Find out which reliability tasks can best benefit the company and start from them.
  - Start from small projects and show the benefit to managers. For example, use FMEA to identify failure modes and set up test plans; use HALT to identity the design flaws and thus improve the design.

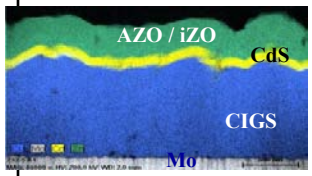
The Design… DOW™ POWERHOUSE™



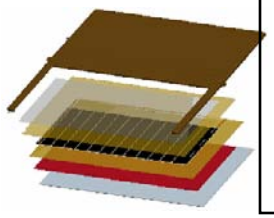
Designed With A Roofer In Mind

Need to overcome Design, Process, Installation Challenges to make a 20+ yr product

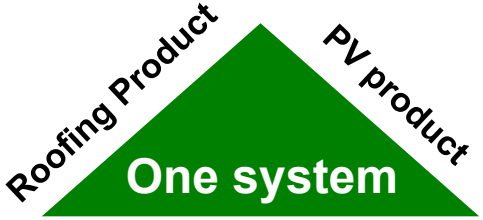
PV Knowledge
Thin Film Expertise
Process Knowledge
Efficiency Road Map



Reliability
20+yr Roofing product
20+yr PV product

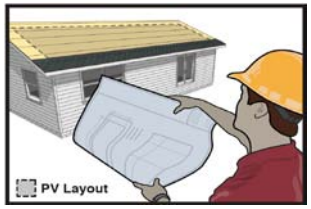


Product Design
10 materials
Organic /inorganic matl
10X CTE; 100X Modulus diff



Power Conversion
Shading mitigation
Every home is different
DC to AC conversion

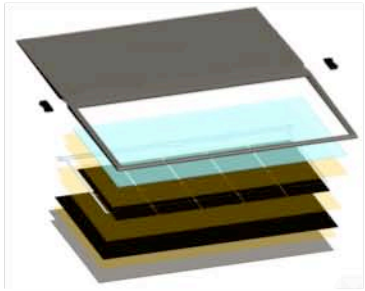
Process Steps
1000 x viscosity diff
Residual stresses



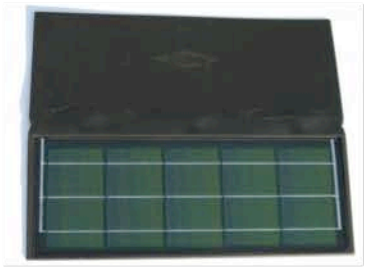
Channel
New Home/Reroofing
Design Capabilities

Reliability….

PV Cells



DOW™ POWERHOUSE™
Electrical Components & Materials



DOW™ POWERHOUSE™
Shingle

DOW™ POWERHOUSE™
Shingle Array

Test Protocols

- More than 10,000 parts tested/undergoing test
- Stress factors → temp, UV, hail, fire, rain, wind, ice, snow, humidity, electrical and force loads
- Reliability engineering tests "to failure" with focus on component, sub-system, and system level tests
- Application of modeling and physics of failure approach to derive transfer function between accelerated tests and life in field

Component

Sub-System

System

Lessons from Dow's Reliability Program

- It is never too early to start testing parts and prototypes – especially in regard to outdoor testing.
- Understand how qualification tests (IEC61646) and empirically derived standards based reliability approaches (ex. MIL-HDBK-217, Telcordia SR-332) apply.
- Virtual modeling and testing is critical.
  - Reduced costs and time for product development.
  - Link between accelerated testing and field life expectations.
- Multiple stress level testing is often required to derive appropriate acceleration factors.
- Both top down (system) and bottom up (component) approaches are useful.
- For a reliability program to be successful buy-in is necessary at all levels of the company and supply chain:
  - R&D, Manufacturing, Commercial, Supply Chain
  - Suppliers and Installers
  - Failure Reporting and Corrective Actions
- Suppliers may need assistance in understanding reliability requirements and setting up reliability programs.