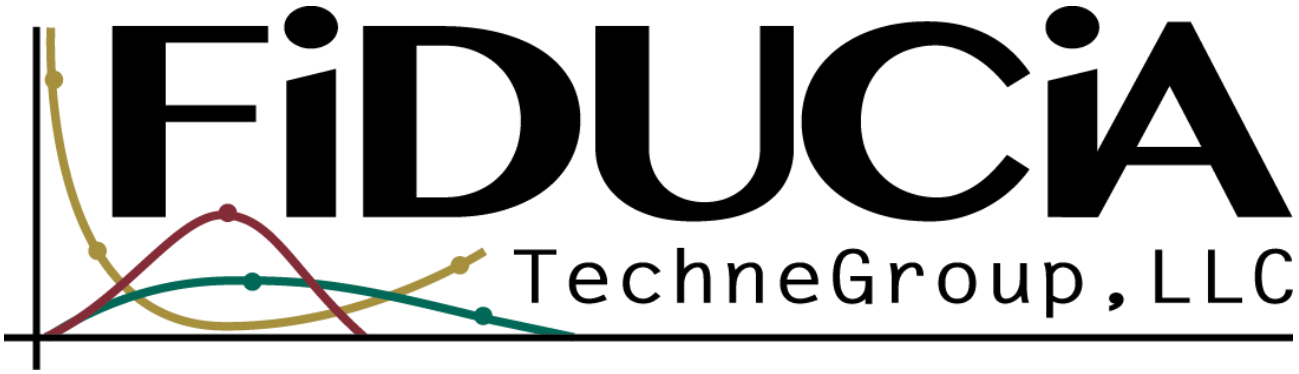

Reliability Life Cycle Management Case Study

Case Study:

RLCM

BEST TRUCKS *

The Challenge

- Our customer “Best Trucks” wanted to introduce a new engine to satisfy new European environmental regulations. Best Trucks wanted all the supporting elements surrounding the new engine (“Engine Installation System”) evaluated and redesigned.
- Since in the past Best Trucks had experienced a declined in reliability on similar projects, they wanted to maintain the current reliability level at start of production.
- Best Trucks also wanted to reduce development cost by reducing the complete vehicle prototype testing.

* Not real company name

Results:
The Reliability Targets were achieved and demonstrated before launch of new product. The customer began implementation of RLCM on all vehicle development programs.

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Case Study:

RLCM

BEST TRUCKS *

Recommendation

✓Implementation of Reliability Life Cycle Management

- ♦ Reliability Technical Risk Management
- ♦ Risk Mitigation and Proactive Activity Identification
- ♦ Reliability Planning and Tracking integrated in Product Development Process
- ♦ Comprehensive Proactive Reliability Activities
- ♦Reliability Growth Planning and Tracking

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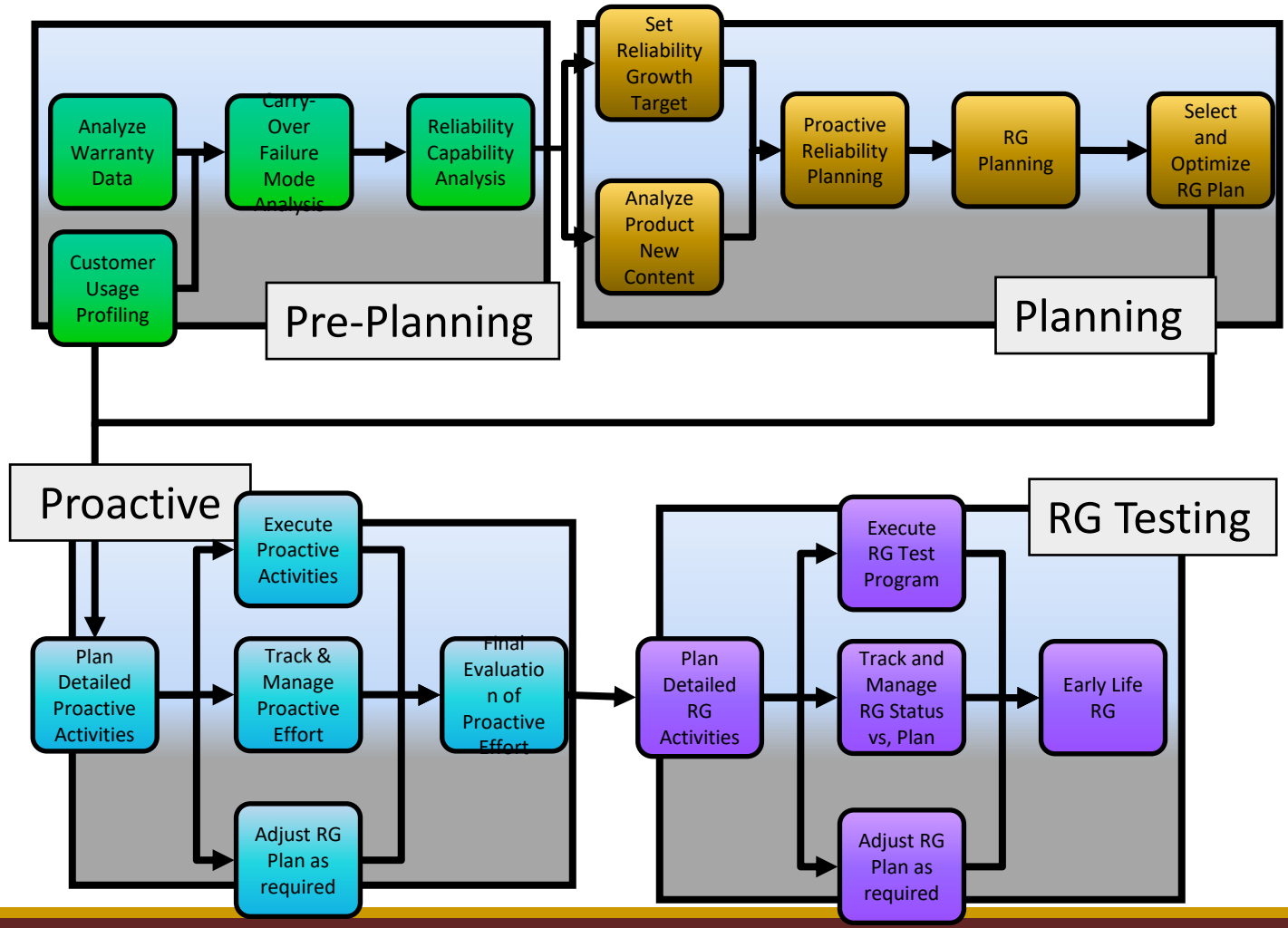
Case Study:

RLCM

BEST TRUCKS *

Reliability Life Cycle Management



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RLCM Road Map

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Case Study:

RLCM

BEST TRUCKS *

Pre-planning

- **Customer Usage Profiling** - Current customer applications and environments
  - duty cycle.
  - stress levels.
- **Carry-over Failure Mode Analysis**
  - Analysis of warranty data, testing, dealers, sales, manufacturing and marketing to determine current failure modes.
  - Eliminate current failure modes through design.
- **Reliability Capability Analysis**
  - Best value of the reliability measure product can attain. Considerations: Complexity and nature of the product, previous and new design concept, company's historic product reliability levels, and best-in-class and world class Reliability levels.
- **Warranty Data Analysis**
  - Analysis of the type of warranty data available for several years of mature build dates, at lest 3 years of data (Warranty Period) for selected model.
  - Warranty Data Analysis to Determine Failures per Unit, Annual Usage, FF for each functional group, FF trends and current R/100 for Useful Life and Early Life Periods.

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Objective:
Relevant data collection and calculations necessary for the planning phase.

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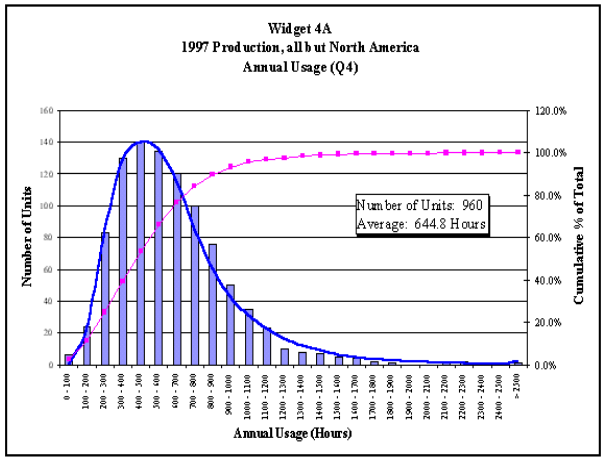
Case Study:

RLCM

Warranty Analysis



Reliability Capability

Group Description	Failure Frequency	L Load factor	P Product design factor	Pr Process factor	S Supplier factor	Se Servicablity Factor	Ot Other Factor(s)	CF	Trend Factor	Reliability Capability	FF Target	Relaibility Capability Notes
Driving unit	0,07	1,3	1,2	0,8	1	1	1	1,04	1	0,07	0,07	Thinner metal on the driving unit but stronger pushing force, thinner metal easier to manufacturer
Forming unit	0,00	1,2	1	1	1	1	1	1,2	1	0,00	0,00	Increase force due to new design
Electrical unit	0,28	1	0,75	1	1	1	1	0,875	1	0,25	0,22	New more accurate sensor and software changes due to accuracy of the sensor
Storing unit	0,05	1	1	1	1	1	1	1	1	0,05	0,05	
Button unit (C/O)	0,06	1	1	1	1	1	1	1	1	0,06	0,06	
Housing (C/O)	0,02	1	1	1	1	1	1	1	1	0,02	0,02	
	0,49									0,45	0,43	

BEST TRUCKS *

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Examples of analyses for Pre-Planning Phase

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Case Study:

RLCM

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Planning

- **New Content Analysis**
  - Quantitative reliability risk evaluation of new product design.
  - Prediction of the starting reliability (or unreliability) of the first prototypes using New Content results.
- **Target Setting**
  - Analysis of current product targets and feasibility within time and development constraints.
- **Proactive Reliability**
  - Initial planning of Proactive Reliability Activities (FMEA, FTA, DOE, ALT, HALT, etc.)
- **Reliability Growth (RG)**
  - Assessment of feasibility of RG Plan in terms of time, cost, and resources.
  - Calculation of the impact of enhanced proactive activities on test scenarios to optimize and minimize physical testing for useful life and early life.
  - Evaluation of risks associated with the RG Plan.
  - Determination of the number of test units according to the RG Plan.
  - Establishment of testing requirements.

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Objective:
To develop plans to reach the reliability goals established by the customer.

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Planning

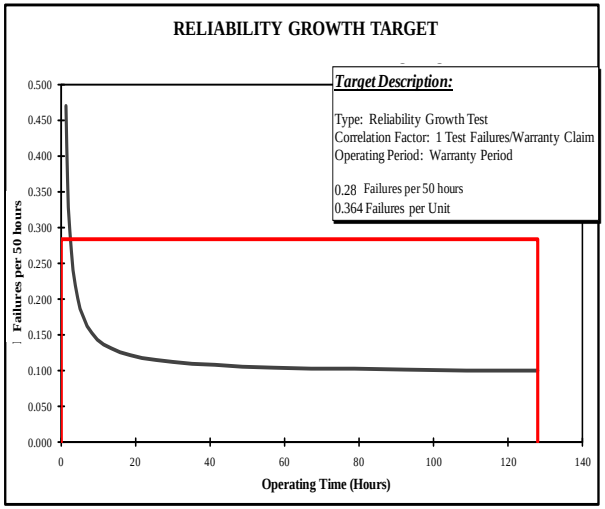
Case Study:

RLCM

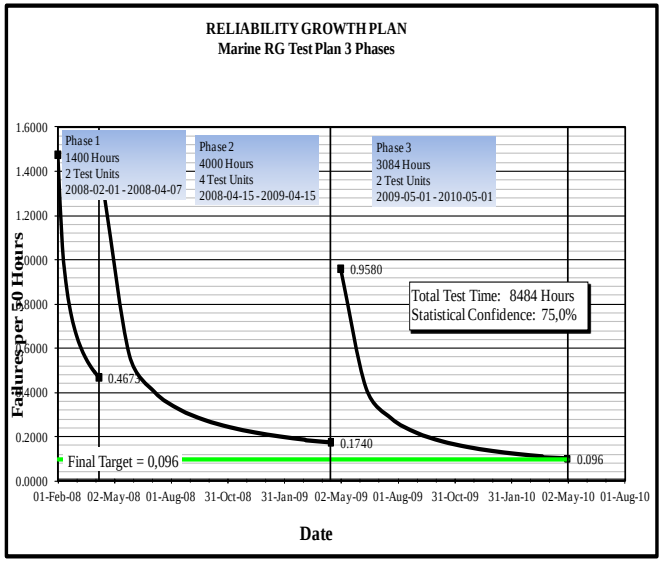
BEST TRUCKS *

New Content Analysis

Target Setting



RG Planning



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Examples of analyses for Planning Phase

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Case Study:

RLCM

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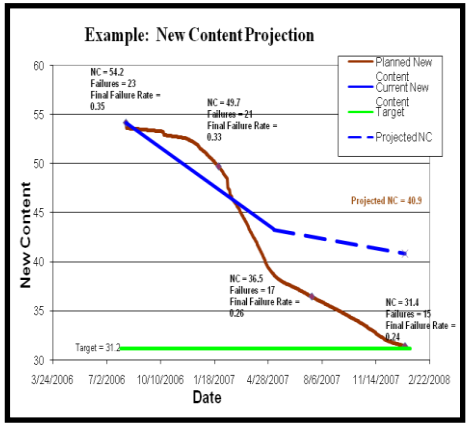
Proactive Planning

- **Detailed Planning of Proactive Activities**
  - Prioritize Proactive activities by their importance on New Content reduction.
  - Identify and schedule further risk reduction opportunities.
  - Make synergies with the existing Development Plans.
- **Execute Proactive Activities**
- **Track and Manage the Proactive Activity Results**
  - Quantify Progress of the Proactive Activity and the related credits.
  - Verify that the results of the Proactive Activities are Implemented in the following RG Phase or in the Production vehicles .
- **Adjust RG Plans as Required**



Proactive Reliaiblity Detailed Planning

Functional Group	Planned Proactive Activity	Proactive Activity Task	Begin Date	End Date	Percent Complete
Alternator	Design for Manufacturing / Design for Assembly	DFA	8-Oct-07	29-Oct-07	0,0%
Control System and Ignition system (old SIR classification)(EVC)	Design for Manufacturing / Design for Assembly	DFA on Control Unit	8-Oct-07	29-Oct-07	40,0%
Control System and Ignition system (old SIR classification)(EVC)	Reliability Analysis (FMEA, Fault Tree, Derating)	System FMEA on EVC	3-Dec-07	18-Jan-08	0,0%
Control System and Ignition system (old SIR classification)(EVC)	Subsystem Reliability Testing (RG, HALT, etc.)	Early rig tests	8-Jan-08	31-Jan-08	0,0%
Control System and Ignition system (old SIR classification)(EVC)	Subsystem Reliability Testing (RG, HALT, etc.)	EMC test	14-Jan-08	25-Jan-08	0,0%
Control System and Ignition system (old SIR classification)(EVC)	Subsystem Reliability Testing (RG, HALT, etc.)	vibration test	5-Nov-07	27-Jun-08	0,0%
Cooling System	Design for Manufacturing / Design for Assembly	DFA	7-Jun-07	21-Dec-07	50,0%
Cooling System	Reliability Analysis (FMEA, Fault Tree, Derating)	SFMEA	25-May-07	25-Jan-08	60,0%
Cooling System	Reliability Analysis (FMEA, Fault Tree, Derating)	Servieability Analysis	13-Aug-07	24-Mar-08	50,0%

Proactive Reliability Tracking

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Objective:
To increase the reliability of the design before prototypes are built.

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Case Study:

RLCM

BEST TRUCKS *

Reliability Growth Tracking

- **Plan Detailed RG Activities**
  - Definition of the logistic and operation details of the RG Test.
- **Execute Reliability Growth Testing**
  - Physical testing of units on the field.
- **Track and Manage RG Status vs Plan**
  - Continuous monitoring of RG charts to compare actual progress vs. plan.
  - Immediate identification of significant deviation.
  - Proactive corrective actions to ensure reliability targets are achieved on time.
- **Adjust RG Plan as required**
  - Update RG plans based on result of testing and problem solving activities.
  - Phase Review at the end of each RG Phase to properly verify RG Plan parameters consistency and applicability.
- **Early Life RG**
  - Conduct Early Life Reliability Growth for issues in manufacturing and assembly.

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Objective:

To demonstrate Reliability Targets through prototype testing.

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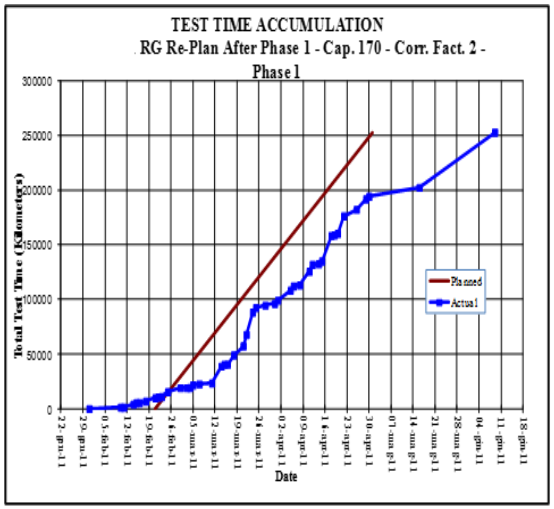
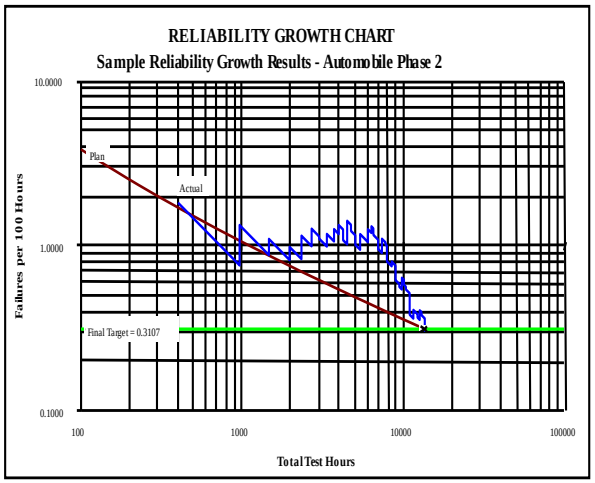
Case Study:

BEST TRUCKS *

Test Time Tracking

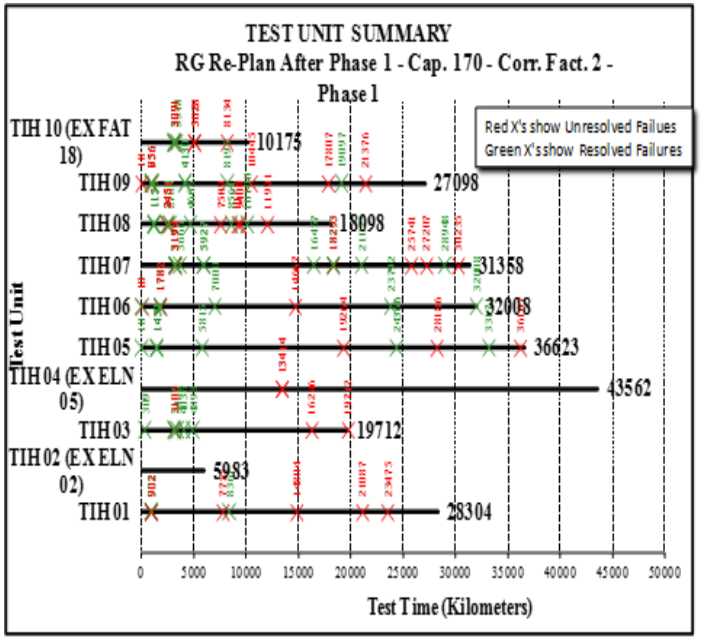


Reliability Growth Tracking



Reliability Growth Tracking

Test Unit Summary



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Examples of analyses for RG Tracking

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Case Study:

RLCM

BEST TRUCKS *

RLCM Results:

- Over 15% reduction in field testing time by increasing the upfront proactive reliability activities.
- Over $1 Million Dollar reduction in costs associated with prototype testing.
- Reaffirmation of a “data driven decision-making” culture for the company.
- Quantitative demonstration of Reliability before the launch of the new product.
- Best Trucks began the implementation of RLCM on all vehicle development programs worldwide.
- The RLCM process supported the company’s goal of moving from a TAAF (Test Analyze And Fix) Product Development Process to a Failure Prevention Process, and from Vehicle Testing for Growth to Vehicle Testing for Verification.

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Summary of RLCM Implementation

FiDUCiA TechneGroup, LLC