# Reliability Master Black Belt®

Training number: Reliability_A03

## Procedure of the education:

In this practical module, participants demonstrate their skills through project work from their own practical environment. In various workshops, the projects are supervised by a coach from the Reliability Engineering Academy. The projects are evaluated on the basis of a defined scorecard system, taking into account the technical depth of the projects. Additionally it is required that a final project report (confidentiality is assured) is written by the participant.

Three requirements must be fulfilled for certification:

1. Over-all evaluation of all projects to be considered ≥ 10 points
2. At least 3 issues out of the reliability engineering content have to be evaluated ≥ 2 points
3. Written final report (volume ≥ 20 pages)

If these three requirements are fulfilled the Reliability Master Black Belt® education is finished. This is certified by the University of Stuttgart and the Reliability Engineering Academy by means of the certification document.

This allows the participant to bear the title „Reliability Master Black Belt".

In the following the four steps of education project definition, project evaluation, coaching and final report are described.

## Project definition:

The possible projects are defined together with the coach. The table below shows an overview about the issues and gives some possible project contents according to each issue.

Upon discussion with the coach it is possible to consider issues/methods from additional fields of reliability engineering.

During the education several different projects can be worked on. It is not necessary to receive all points for certification out of one single project.

| No. | Issue | Possible project contents (examples) |
|-----|-------|--------------------------------------|
| 1.1 | Reliability planning | Reliability analysis of forerunners, customer requirements, reliability targets, specification book |
| 1.2 | System analysis | System definition and system borders, reliability architecture (Boole), FTA, FMEA, HAZOP, DRBFM |
| 1.3 | Stress analysis | Load collectives, sources of stress, customer collectives |
| 1.4 | Modelling of damage and age | S/N-curve, linear damage accumulation (Haibach, Miner) |
| 1.5 | Reliability and lifetime calculation | Data analysis, Weibull analysis, failure rate calculation, reliability of electronic systems, reliability key figures, failure rate catalogues (SN29500, NPRD) |
| 1.6 | Test planning | Reliability goals for the testing, test plan evaluation, DVP&R, supplier testing programs, a priori knowledge, HALT, ALT |
| 1.7 | Testing | Documentation of testing (Failures, run times, …) internal and external |
| 1.8 | Field analysis | Field data analysis, warranty data, correlation of test and field, warranty cost analysis, automatic data collection and evaluation systems |

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Page 1 of 3

| No. | Issue | Possible project contents (examples) |
|-----|-------|--------------------------------------|
| 2.1 | Reliability management | Reliability process, reliability evaluation, risk evaluation, evaluation and supervision of design measures, reliability reporting, management of maturity levels (reliability targets) |
| 2.2 | Repairable systems / RAM | Availability, Maintainability, LCC |
| 2.3 | Software quality and software reliability | Requirements, functional safety, software testing |
| 2.4 | Design of Experiments | Test plan design, testing manual, variance reduction, screening, response surface models |
| 2.5 | Physics of Failure | Coffin-Manson, Arrhenius, multi dimensional damage accumulation |
| 2.6 | Reliability Growth | Duane, Crow-AMSAA |
| 2.7 | Reliability monitoring | Monitoring of testing progress, reliability monitoring, Bq-life (system and components, supplier testing programs) |
| 2.8 | Root Cause Analysis | Component change, Multi-Vari, sources of variance, confirmation tests |

**Project evaluation:**

After the definition of the projects to be integrated in the Reliability Master Black Belt® education a first evaluation regarding the certification takes place.

The projects are evaluated depending on the professional depth they allow regarding the issues above. The evaluation is done by the University of Stuttgart and the Reliability Engineering Academy.

There are three evaluation degrees:

- Basic         →   1 point
- Advanced     →   2 points
- Expert        →   4 points

In the following two possible certification scorecards for two typical cases are given.

Quality Engineer

| No. | Issue | Project content | Evaluation |
|-----|-------|-----------------|------------|
| 1.1 | Reliability planning | Definition of component reliability targets basing on field data evaluation of forerunner products, consideration of an improvement factor for proven and well-known components, consideration of risks emanating from changes in the production process, Integration of the reliability targets in supplier specification books | 2 |
| 1.6 | Test planning | Evaluation of supplier test programs considering the required reliability target | 1 |
| 1.7 | Testing | Introduction of a data base for the documentation of the running test program (run times, reclamations/failures) | 2 |
| 2.6 | Reliability Growth | Examination of the applicability of reliability growth models onto testing data | 2 |
| 2.7 | Reliability monitoring | Implementation of a standard reporting regarding the evaluation of the current progress of testing (content: Forecast of the system failure rate basing on the current testing results, evaluation of the failures having occurred and also evaluation of planned design measures, Weibull analysis for component failures | 4 |
| | | **Sum of project evaluation points:** | **11** |

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Page **2** of **3**

| No. | Issue | Project content | Evaluation |
|-----|-------|-----------------|------------|
| 1.2 | System analysis | Identification of system failure modes basing on field experience, forerunners and delta analysis regarding the stress-strength interference. Evaluation of criticality and priorization of identified failure modes | 2 |
| 1.3 | Stress analysis | Definition of field load scenarios basing on field load collectives and measured loads from internal test runs, basing on that computation of stresses on component/failure mode level. Definition of reference loads for the design of components | 4 |
| 1.6 | Test planning | Test plan evaluation for the components/failure modes under consideration basing on the reference load and optimal adjustment/extension of the testing program | 2 |
| 2.5 | Physics of Failure | Application of physics of failure models and usage of material parameters to compute acceleration factors for the testing program | 2 |
| | | **Sum of project evaluation points:** | **10** |

Important: Certification requires the sum of all project points to be ≥ 10 points and at least 3 issues with ≥ 2 points each.

It might happen that an adjustment of evaluation takes place during the project work (e.g. due to organizational reasons at the participant's company).

**Coaching / Project supervision:**

During the project work the participant is coached by an experienced coach from the Reliability Engineering Academy. The coaching refers to the projects themselves and also to the final written report. The standard coaching budget for a Reliability Master Black Belt® education is 10 days. The coaching effort is individually defined together with the participant and can also be adjusted during the running program.

**Final written report:**

The final written report (≥ 20 pages) is checked and acknowledged by the University of Stuttgart and by the Reliability Engineering Academy.

**Precondition:**

Certified Reliability Black Belt®

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Page 3 of 3