VII. RELIABILITY TESTING

LET DEEDS MATCH WORDS

PLAUTUS

Reliability Testing

Reliability testing is reviewed in the following topic areas:

- **Reliability test planning**
- **Development testing**
- **Product testing**

Reliability Testing Introduction

Reliability testing is an activity carried out by both the supplier and customer. The main reasons for reliability testing are:

- **To induce and detect failure modes**
- **To implement corrective action**
- **To determine if systems meet requirements**
- **To compare estimated to actual failure rates**
- **To monitor reliability growth over time**
- **To determine the safety margin in a design**
- **To estimate MTBF or MTTF values**
- **To identify weaknesses in the design or parts**

An ideal test program will produce the discovery of every failure mode.

Reliability Test Planning

Reliability test planning is reviewed in the following topic areas:

- **Reliability test strategies**
- **Test environment**

Reliability Test Strategies

The project manager must consider the following factors in the test plan design:

- **How critical is the product?**
- **Are safety and reliability a concern?**
- **What level of reliability does the customer need?**
- **How mature is the design?**
- **Are new technologies or processes involved?**
- **How complex is the product?**
- **What environmental extremes are involved?**
- **What is the budget for testing?**
- **Are the facilities able to perform test conditions?**
- **How many items are available for testing?**
- **What is the existing design reliability?**

Planning should start early in the design process. A typical sample size would be 5 to 20 depending upon cost, complexity, and total number of items to be produced.

Reliability Test Strategies (Continued)

In planning the testing program, the project manager will have additional information such as:

- **Customer requirements**
- **Drawings, specifications**
- **Test plans, procedures**
- **Tests and inspections**
- **Cost analysis**
- **Tolerance studies**
- **Spare parts lists**
- **Critical parts lists**
- **Field service test plans**
- **Test facilities**
- **Capability lists**
- **Plant layout**

Reliability Test Strategies (Continued)

An example reliability test schedule is shown below:

	Month						
Item	0	1	2	3	4	5	6
Develop test plan	x						
Hazard analysis		x					
Reliability test procedures				x			
Design test equipment			x				
Build test equipment			x				
Equipment test procedures				x			
Prototype tests				x			
Revised tests					x		
Final test						x	
Test report							x

Types of Reliability Testing

- Demonstration Tests
- Qualification Testing
- Acceptance Testing
- Performance Testing
- Failure Free Testing
- Screening
- Development Tests
- Setting of Tolerances

Types of Testing (Continued)

Attributes

The selection of attributes to be tested is determined through a combination of:

- **A need to demonstrate function ability**
- **A need to demonstrate reliability**
- **Meeting costs for testing**
- **Meeting time factor for testing**
- **Availability of test equipment**
- **Availability of personnel**
- **Meeting customer requirements**
- **A need for interchangeability**
- **A need to optimize process and quality control**
- **A need to attain the required reliability**
- **Balancing costs of replacement and testing**

Classification of Characteristics

Functional attributes can be classified into categories. Military standard DOD-STD-2101, *Classification of Characteristics*, uses: critical, major, or minor classifications based on coordination, life, interchangeability, function, and safety. The classifications are:

Critical: **A defective item will have an adverse effect on safety**

Major: **There will be a significant degradation in performance**

Minor: **All other effects**

Sampling Versus 100% Testing

Production assessment testing is performed on samples drawn from production, while production acceptance testing is 100% testing on all production. Sampling may be based on:

- **The tolerance of risk**
- **The uniformity of the process**
- **The potential liability of a failure**
- **The ability to produce needed test items**
- **The cost of test items and the test itself**

Test Procedures

Test procedures are required for the proper execution of the test plan. There are 3 areas that the procedures must address:

1. **Calibration**

   - **Calibration of individual instruments**
   - **Calibration of testing or environmental equipment**
   - **Calibration of standards**

2. **Proofing the test equipment**

3. **The test procedure: A description of the tools, parts, hook ups, data, and materials required.**

Test to Failure

The easiest test plan to conceive and understand is the "test to failure" or complete testing approach. In this kind of test the selected number of units are placed on test and run until all have failed. Then the mean time to failure (MTTF) is calculated.

$$\text{MTTF} = \frac{\sum(t_1, t_2, \ldots, t_N)}{N}$$

The main disadvantage to this testing is the length of time the test will take. If the unit has a very large mean time to failure, the test can stretch far beyond reasonable limits.

Degradation Testing

Degradation testing is the use of enhanced stress to shorten the required test time. This is fairly easily and reliability done for electronic components (Arrhenius model) where elevated temperatures are used. Other elevated stress tests for electronic components frequently involve vibration (shake) testing.

Sometimes the reliability engineer will test mechanically at levels above the expected service and specification conditions to identify the weakest components in an assembly.

Truncation Tests

Truncated reliability tests are the most common type of planned test. Tests may be truncated in time or number of failures.

Truncated testing may be conducted with replacement or non-replacement of the failed units.

VII. RELIABILITY TESTING QUESTIONS

7.3. Salt cabinet tests, where coated materials are subjected to salt spray, is an example of:

a. Degradation testing
b. Truncation testing
c. Time to failure testing
d. Enhanced testing

7.4. The seeding of errors into a program and counting the number of seeded versus identified defects allows a test engineer to estimate the number of:

a. Defects in the program
b. Remaining defects
c. Errors left in the program
d. Seeded and unseeded errors

7.9. The Arrhenius model is a model used to convert the reliability results of high temperature testing to equivalent normal condition life. This model is used for:

a. Coated high temperature materials
b. Electronic components
c. Oxidation properties of galvanized steel
d. Long term rotating mechanical components

Answers 7.3. a, 7.4. a, 7.9. b