PART C

R&M RELATED TECHNIQUES

The activities above are achieved by applying R&M techniques. There are many techniques that have been developed over the years. This section aims to present a fairly comprehensive set of techniques but can not guarantee to cover all techniques.

Chapter 1 Operational Needs Analysis

In terms of R&M, Operational Needs Analysis addresses the effect of various levels of R&M on the delivery of functionality. The levels of R&M considered will be influenced by the practicality and cost of their achievement. It therefore contributes to the determination the appropriate R&M requirements to be specified.

Chapter 2 Environmental Conditions Analysis

The environmental conditions are not really within the remit of the R&M function. However they do affect the R&M performance and this aspect is usefully included in this manual.

Chapter 3 Modification Impact Analysis

Any modification carried out on a system will impact upon other system performance parameters in addition to those that are key to the purpose of the modification. The R&M performance is very likely to be altered by every modification. Impact analysis aims to determine the extent of this alteration at a stage when this can be considered in the decision on proceeding with the modification. (This chapter is presently being developed)

Chapter 4 Trade-Off Studies

During the specification and design stages, a number of solutions are likely to be under consideration. A number of factors should be considered in deciding between solutions. One of these is R&M. This chapter concentrates on the R&M aspects of trade-off studies.

Chapter 5 R&M Allocation and Apportionment

Once R&M requirements have been set against high level functions or equipment assemblies it is necessary, as part of the design process, to identify the allowable contributions from the lower level items of equipment. This is particularly so when these items are being produced under separate or sub-contracts.

Chapter 6 High Integrity Specification (of all types of system and equipment)

The design of equipment (particularly software) with a reliability requirement beyond that which is practically testable during the pre-delivery and early service stages of a systems life has been addressed in recent years. Although the solutions currently available can not be seen as perfect, best practice should be followed. This applies to both the specification area, where appropriate wording is required, and the design, where appropriate techniques must be used in order to make the necessary claims in the acceptance phase. (This chapter is presently being developed)

Chapter 7 Derating

Part derating is a long established reliability technique although perhaps now with different justification to that applied in the past. Recent research has shown that the relation of reliability and temperature is not as defined by the Arrhenius equation. However derating is still valuable in ensuring that elements of the system are operated within their specification even when subjected to external events beyond the limits defined in the specification.

Chapter 8 Lifed Item

The designation of certain items as 'lifed' remains a valuable tool in controlling mechanisms of failure. Its use is not popular from a logistical viewpoint, particularly when built in test can detect failure of the lifed item. This section explains their operation and discusses their use.

Chapter 9 Critical Item

Critical items are another valuable tool that are often misused. This section explains their operation and discusses their use.

Chapter 10 High Integrity Design

The best point to introduce high reliability is in the specification and design phases (a right first time approach). This is particularly so in the software area where Def-Stan 00-55 requires specific activities to be performed during design. This chapter addresses the usage of detailed techniques and references appropriate literature. (This chapter is presently being developed)

Chapter 11 Redundancy Optimisation

The use of redundancy needs to be well thought out. This chapter addresses the need, benefits and pitfalls. (This chapter is presently being developed)

Chapter 12 R&M Design Criteria

On a large project it is useful to define criteria for the design process to follow. This chapter addresses the setting, monitoring and dealing with deviations from such criteria.

Chapter 13 Test, Analyse and Fix

Test, analyse and fix is a practical approach to identifying and resolving the weak areas of a design. This chapter discusses the application of the technique.

Chapter 14 Step Stress Testing

This chapter discusses the application of the step stress technique and comments on its advantages, applicability to situations and the constraints.

Chapter 15 Reliability Growth Testing

This chapter addresses the technique of reliability growth testing, its application, its advantages and problems that may be encounted.

Chapter 16 Highly Accelerated Stress Testing

The benefits and short comings of highly accelerated stress testing, together with the process are addressed in this chapter.

Chapter 17 Ease of Maintenance Assessment

Ease of Maintenance Assessment (EMA) is the means whereby the Project Team confirms whether equipment can be maintained in-service and meets the maintainability and ease of maintenance criteria within the maintenance strategy. This chapter provide guidance for the production and publication of EMA Reports.

Chapter 18 Data Reporting, Analysis and Corrective Action System

This chapter addresses the DRACAS process, the collection flow and storage of relevant data, its analysis and closing the loop to achieve improvements.

Chapter 19 Sneak Circuit Analysis

Sneak circuits are circuits (normally electronic although the principle applies to electrical, pneumatic and hydraulic) outside the main functional path that might affect the function. An example includes the passage of a signal through monitor connections, power supply lines and the capacitative coupling of an amplifier's input and output causing oscillation. This chapter discusses the aims, application and benefits of such analysis.

Chapter 20 Tolerance Analysis

Any design is implemented using components with actual values slightly different from the ideal. Statistical consideration of the effect of these inaccuracies on the accuracy of the output is of benefit to the design review process and can lead to changes that reduce production cost and increase reliability. The chapter addresses the process, aims and benefits. (This chapter is presently being developed)

Chapter 21 Built-In-Test Effectiveness Analysis

The effectiveness of built in test is important to availability in that the built in test initiates corrective maintenance. This chapter addresses the appropriate examination of the system and the application and extension of the FMECA technique to elicit the relevant results. (This chapter is presently being developed)

Chapter 22 Testability Analysis

Poor testability increases the probability of equipment going into service with latent faults. This can reduce the exhibited reliability from that exhibited during design testing. This chapter discusses the ways of performing such analysis and the benefits thereof. (This chapter is presently being developed)

Chapter 23 R&M Checklists

R&M checklists provide a rapid check of important aspects of a design. This chapter addresses their content, tailoring them to a particular review and the benefits obtainable.

Chapter 24 Physics of Failure

The physics of failure technique aims at identifying the optimum location in a design to apply resource in order to improve reliability. This chapter discusses the process, the benefits and the use of the results. (This chapter is presently being developed)

Chapter 25 Worst Case Stress Analysis

All prediction work becomes invalid if any part of the system (however small and seemingly insignificant) is used outside its operating envelope. Worst Case Stress Analysis looks for such ‘weak links’ in the system. The chapter addresses the application and benefits of the technique. (This chapter is presently being developed)

Chapter 26 Goal Structuring Notation

Goal Structuring Notation (GSN) is a graphical notation for presenting the structure of engineering arguments. The approach may be used to present any situation where one wishes to make a claim and where the support for that claim will be based upon evidence and argument. This would include situations such as R&M, safety, support or legal based cases.

Chapter 27 Fault Tolerance Analysis

This chapter discusses the application, benefits and use of the results of Fault Tolerance Analysis. (This chapter is presently being developed)

Chapter 28 Dependent Failure Analysis

This chapter discusses the application, benefits and use of the results of Dependent Failure Analysis.

Chapter 29 Fault / Success Tree Analysis

This chapter discusses the application of Fault Tree Analysis and the modifications to perform Success Tree Analysis.

Chapter 30 Reliability Block Diagrams

This chapter discusses the application of the RBD technique.

Chapter 31 Human Impact on R&M

Human impact on R&M is a separate technique to Human Reliability Assessment but a major support to it. The chapter addresses the application and use of the technique.

Chapter 32 Human Reliability Assessment

Human reliability is an area of growing concern. The chapter looks at the technique for assessing human reliability and using the results to achieve positive improvement. (This chapter is presently being developed)

Chapter 33 Failure Mode, Effects (and Criticality) Analysis (FMEA/FMECA)

FMECA is a well known technique but needs explaining with emphasis on the purpose, tailoring of worksheets and use of the results.

Chapter 34 Event Tree Analysis

ETA is a well established technique. The chapter explains its use and how to link it to FTA for an overall cause-consequence view. (This chapter is presently being developed)

Chapter 35 Availability Prediction

Availability is predicted by combining reliability and maintainability. This chapter concentrates on ensuring that all the correct elements are combined and the methods of combination. (This chapter is presently being developed)

Chapter 36 Reliability Prediction

Reliability Prediction has been the subject of much discussion in recent years. This chapter presents a balanced view of the arguments such that the reader can decide on the applicability for a given application. The chapter also emphasizes appropriate use of the results and address the misunderstandings held by many engineers and engineering managers.

Chapter 37 Maintainability Prediction

Maintainability Prediction has not been discussed as vociferously as Reliability Prediction mainly due to its lower prominence. However a similar approach is appropriate with an emphasis on the understanding of the meaning and usefulness of the results. (This chapter is presently being developed)

Chapter 38 Markov Modelling

Markov Modelling is a useful technique for the analysis of more difficult situations and the determination of generic results (such as those in Part D Chapter 6). This chapter presents the method.

Chapter 39 Availability Demonstration

Demonstration, here, is the practical determination of the truth of a hypothesis. In this case that the availability is greater than a certain value with a given level of confidence. This chapter addresses the way of designing and carrying out such a demonstration

Chapter 40 Reliability Demonstration

As for availability but substituting reliability.

Chapter 41 Maintainability Demonstration

As for availability but substituting maintainability.

Chapter 42 Testability Demonstration

As for availability but substituting testability. (This chapter is presently being developed)

Chapter 43 Assurance Through the R&M Case

This chapter presents an overview of the R&M Case with reference to the Def-Stan and ways of satisfying the requirements.

Chapter 44 Production Reliability Acceptance Testing

This chapter discusses the techniques applicable to testing the reliability through the production run.

Chapter 45 Environmental Stress Screening

This chapter addresses the benefits of ESS and the ways of generating and carrying out an effective programme.

Chapter 46 Data Classification

This chapter provides background and discussion on the implementation of the Defence Standard.

Chapter 47 In-Service Data Collection

The uses and benefits of collection are stressed in this chapter while addressing the available methods. CuSum is one technique addressed under this chapter.

Chapter 48 Monitor/Control of Subcontractors/Suppliers

In most systems the prime contractor contracts out much of the work to sub-contractors. The extent to which the main contract requirements for R&M should be passed through and the extent to which an allocation process should be carried out is addressed for different situations in this chapter.

Chapter 49 R&M Plans & Programmes

R&M Plans & Programmes are an important element of managing for the achievement of R&M. This chapter looks at the similarities and differences of R&M Plans to other project plans and explores why separate plans are often required. The provision of R&M procedures within an organization is also discussed.

Chapter 50 R&M Data Storage

Data storage is central to the long term improvement of R&M for specific systems and systems in general. This chapter looks at the types of data to be stored, the degree of detail required and the period of time for which data remains valid. (This chapter is presently being developed)

Chapter 51 Software Reliability Techniques

This chapter contains guidance on the two complementary approaches to the achievement of software reliability at the design and implementation phase; Fault Avoidance and Fault Tolerance. Fault avoidance requires taking steps to avoid faults during software development, and to detect and correct those faults that do occur. Fault tolerance requires designing software to correct or tolerate errors in service.

Chapter 52 Software Reliability Evaluation

This chapter describes the methods that can be adopted to evaluate the software reliability that has actually been achieved, including evidence from testing, field data, fault data and analytical arguments.

Chapter 53 Fishbone Analysis

Fishbone analysis is a form of cause and effect analysis and is used to explore the causes of a singe effect. The fishbone diagram enables the relationships and hierarchy of events to be arranged and depicted in a logical order proving a means for their relative importance to be conveniently compared. (This chapter is presently being developed)

Chapter 54 BIT Effectiveness Analysis

BIT effectiveness analysis is a form of testability analysis that embraces the relative virtue and outcomes (effects) of two or more courses of action. Bit effectiveness analysis is commonly used in the fields of electronic and system engineering where it may be inappropriate or impractical to practically determine the effectiveness of BIT under all system conditions particularly when that system is a subset of a much larger host system or whose interfaces and/or functionality may change subject to application. (This chapter is presently being developed)