

CHAPTER 16

REPRESENTING THE INITIAL R&M CASE USING GOAL STRUCTURING NOTATION (GSN)

CONTENTS

	Page
1 Introduction	3
2 Purpose and Benefits	3
3 Representing the Initial R&M Case	4
4 Avoiding Over Complexity	6

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1. INTRODUCTION

1.1 This Chapter provides a discussion of how the Initial R&M Case may be represented using Goal Structuring Notation (GSN).

1.2 The Initial R&M Case[1][2] will typically consist of a set of supporting documentation that provides a structured argument, supported by a body of evidence that:

- a) Provides traceability between each R&M requirement and the source of that requirement.
- b) Demonstrates that the User Requirements will be satisfied given that System or service Requirements derived from them have been met.
- c) Includes the risk mitigation activities that are common to all potential solutions and may require specific and timely mitigation activities. These activities may form part of the contractual requirements or scope of supply.
- d) Provides assurance that the R&M requirements are robust, for example Specific, Measurable, Achievable, Realistic and Time bound (SMART).

1.3 Goal Structuring Notation (GSN) is a graphical notation for presenting the structure and justification of engineering arguments. It has in recent years been used within the risk-based Safety domain to depict Safety Case structure. 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. For a summary of the basic principles of GSN (see PtCCh26).

2. PURPOSE AND BENEFITS

2.1 The purpose of the Initial R&M Case is to support the R&M requirements raised by the Purchaser and to clarify the R&M needs of the User. In order for the R&M requirements to be fully bounded the Initial R&M Case should include context information including the anticipated system usage, its operating environment, failure definitions, etc.

2.2 The benefit of illustrating the initial R&M Case with GSN is that:

- a) The dependency of the R&M requirements upon other related project disciplines, and the outputs from these disciplines are clarified.
- b) It provides a clear summary to the supplier of how the R&M requirements have been developed.
- c) The outline structure of the Initial R&M Case can be determined in advance with details of the evidence being provided later.
- d) Progress towards the successful completion of the Initial R&M Case can be monitored by using coloured coding of the symbols for the supporting evidence and related goals.

3. REPRESENTING THE INITIAL R&M CASE USING GSN

3.1 This section provides an example of how GSN may be used to represent the key evidence and arguments that support the top level Goal of an example of an Initial R&M Case. The description is supported by the GSN example provided in Figures 1-7.

3.2 The GSN diagram representing the Initial R&M Case will consist of the typical GSN elements as shown below.

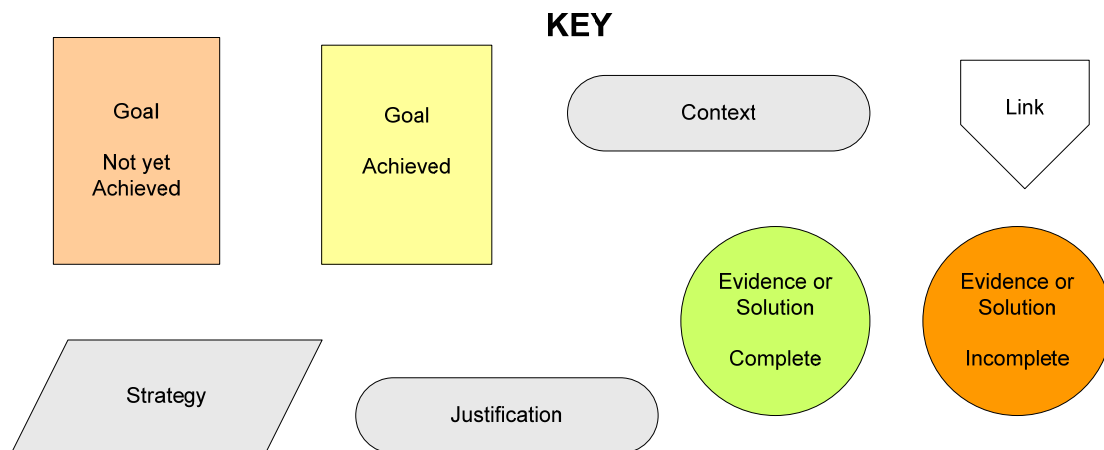


Figure 1 – Typical Goal Structuring Notation Elements

3.3 It will be seen that the Evidence and Sub-Goals elements have been colour coded to show the status of the element. This technique is typically used as an aid to management of the Initial R&M Case, highlighting areas that are complete and those that still require work. The particular notation adopted and supporting evidence available will depend on the specific project or programme.

3.4 A typical top level Goal for an Initial R&M Case might be for the R&M requirements for a system or service to satisfy the User Requirements. The Initial R&M Case structured argument is then built top down, decomposing the top level Goal into lower level, more detailed goals.

3.5 It will be seen in the Figure 1 that context has been considered necessary. Context is the basis on which the goal (or sub-goal) is claimed. So in order to argue that “R&M requirements for System x will satisfy User Requirements” it is necessary to define exactly what is meant by “User Requirements” and “System X”, e.g.

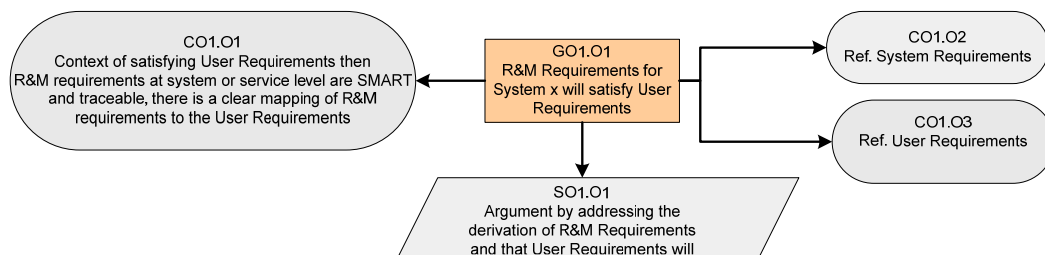


Figure 2 – Excerpt from Figure 4

3.6 The strategy employed to achieve the top level goal may typically address two key areas:

- a) Good practice is used in the derivation of R&M requirements, and
- b) The relationship between User Requirements and System Requirements is clear.

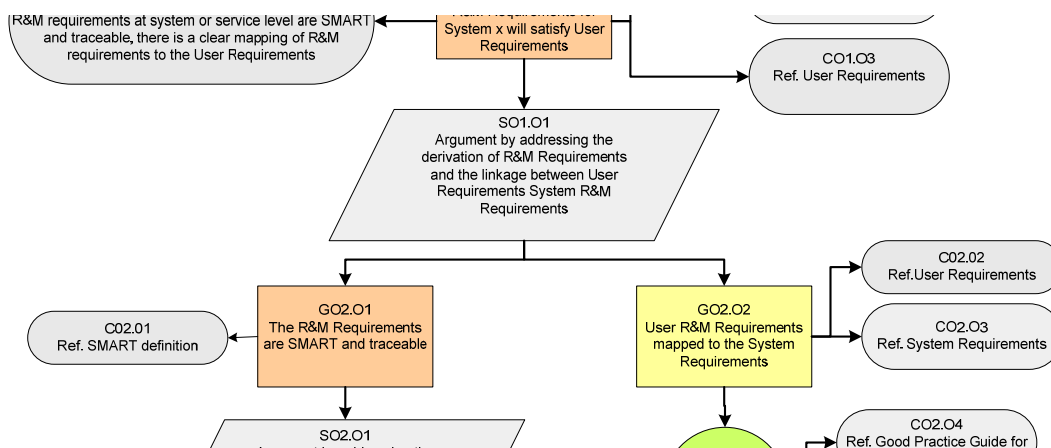


Figure 3 – Excerpt from Figure 4

3.7 It will be seen that these items become sub-goals which again require Context information to fully explain the strategy. In the example provided, the following are considered too lengthy to include in a clear summary diagram:

- a) The definitions of SMART.
- b) The User Requirements that are considered applicable to the R&M Programme.
- c) The R&M System Requirements that address the User Requirements.

3.8 The argument by addressing the elements of the R&M requirements that make them Specific, Measurable, Achievable, Realistic and Time bound (SMART) and traceable is expanded by considering what is needed to make the R&M requirements SMART and also how requirements traceability is achieved. As can be seen from Figure 1, this has been expanded into 7 sub goals.

3.9 It can be seen from Figures 1-7 that after expansion of the goals down to the fourth level (G04.xx), the goals no longer require further expansion, refinement or explanation. Rather the goals are supported directly by a Solution element which refers to a piece of evidence. In the example, this evidence will be seen to comprise analysis reports, the evidence framework, workshop reports, plans etc. Some are R&M generated items but much of the case is dependent upon the completion of other related activities such as; the Use Study, the Integrated Test, Evaluation and Acceptance Plan (ITEP), the Risk and Opportunities Management Plan (ROMP).

4. AVOIDING OVER COMPLEXITY

Diagrams can become unwieldy and in many instances the Initial R&M Case will be complex as it relies upon significant volume of supporting evidence, much of which exists at the project, rather than R&M level. In order to avoid over complexity, GSN diagrams should aim to present the outline of the Initial R&M Case only and accept that much of the rigour of the argument will have to be embedded in other documents, e.g. Integrated Test Evaluation and Acceptance Plan (ITEAP), failure definitions document, etc.

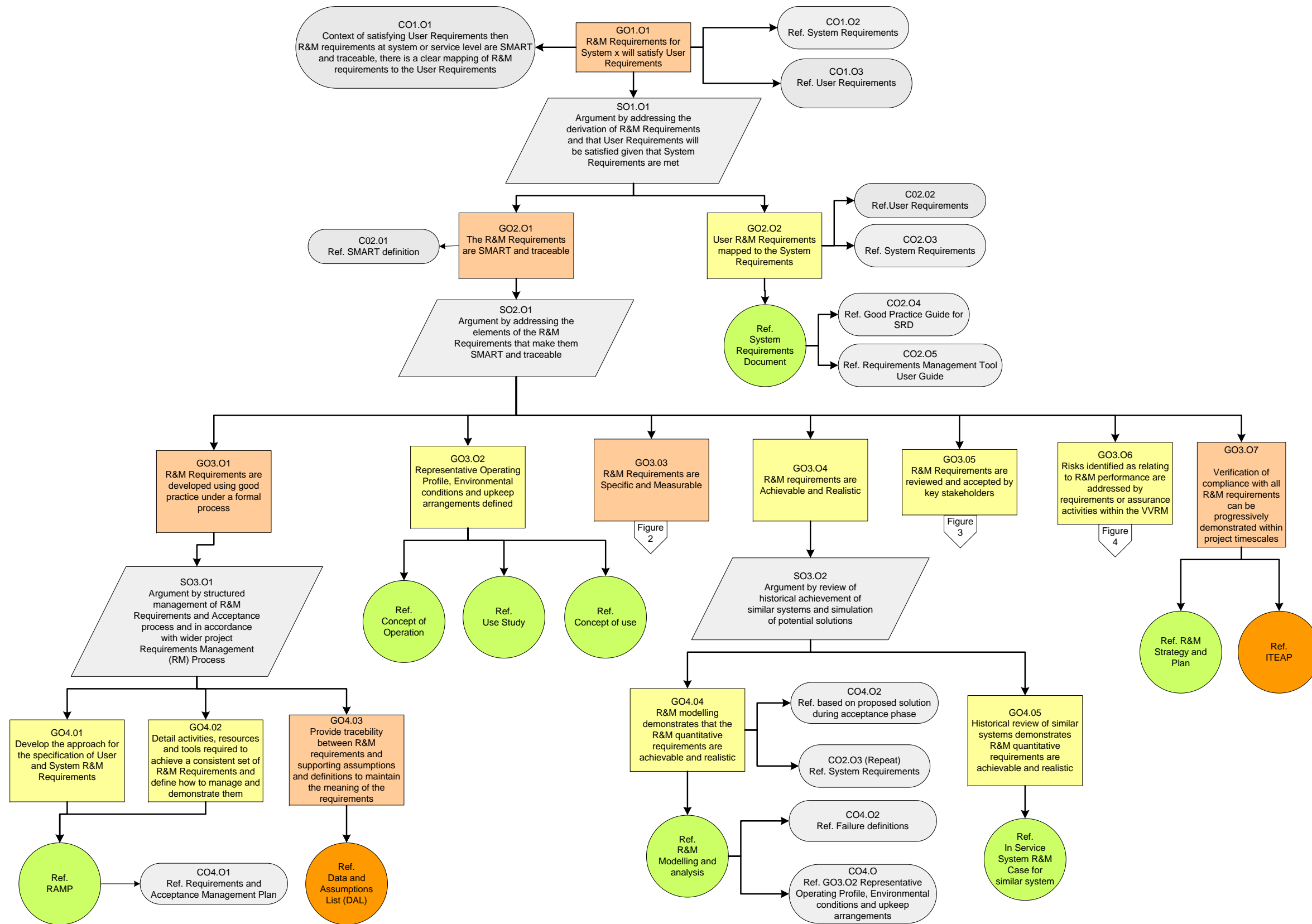


Figure 4 - Example of Initial R&M Case High Level Goal Expanded

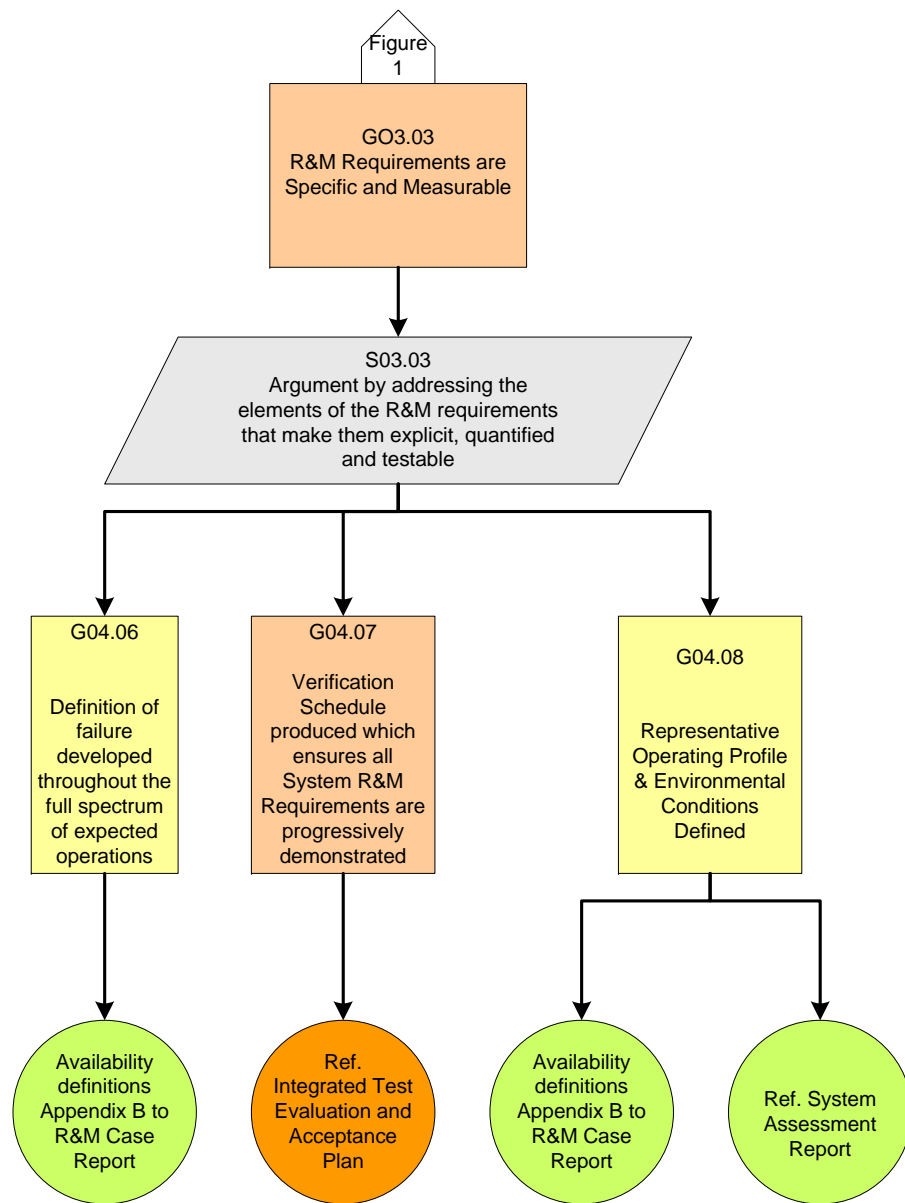


Figure 5 - Expansion of G03.03, Specific and Measurable Requirements

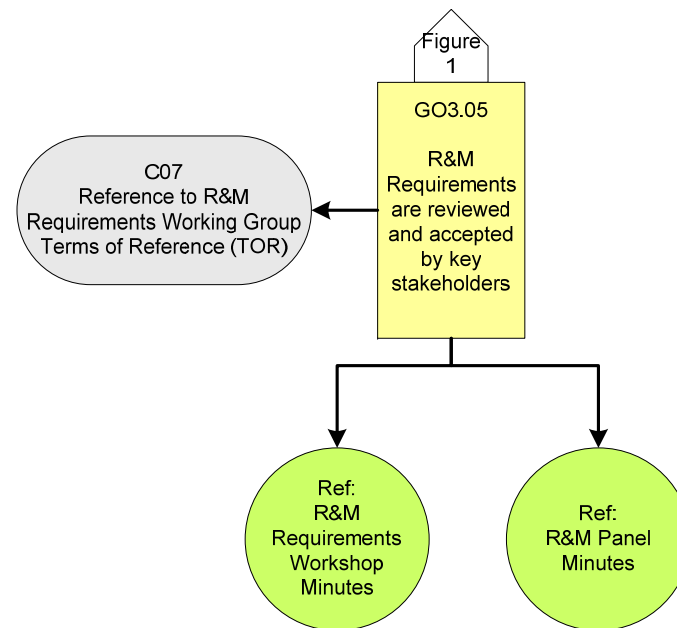


Figure 6 - Expansion of G03.06, Stakeholder Acceptance of R&M Requirements

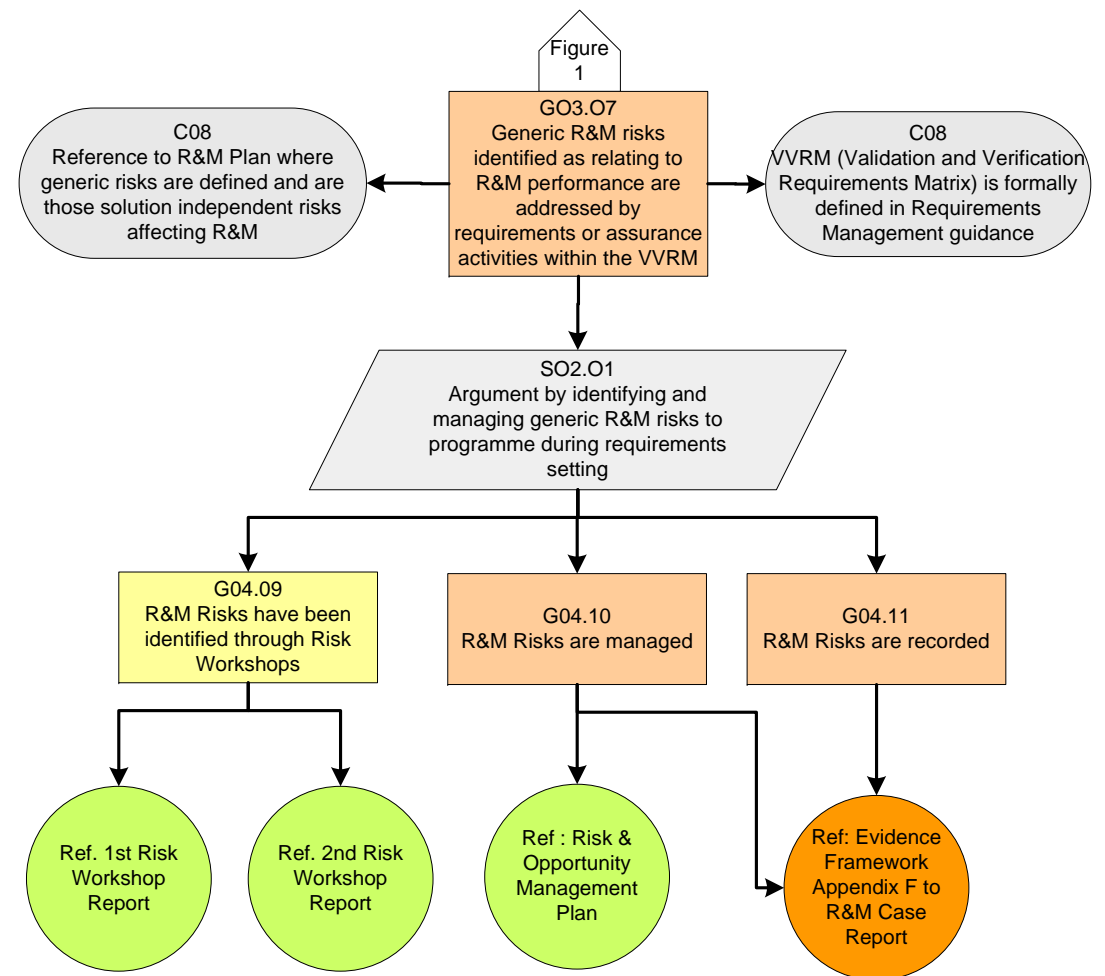


Figure 7 - Expansion of G03.06, R&M Risks Managed

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REFERENCES

- 1 Defence Standard 00-42 Part 3. Reliability and Maintainability (R&M) Assurance Guide R&M Case
- 2 BS 5760 18: 2010. Reliability of systems, equipment and components Part 18: Guide to the demonstration of dependability requirements – The dependability case. Dated May 2010, British Standards Institution.

