INTRODUCTION TO RAMS ANALYSES FOR TELESCOPES AND ASTRONOMICAL INSTRUMENTS (IS-002)

Course Overview

This course intends to introduce the fundamentals of the RAMS (Reliability, Availability, Maintainability, Safety) analyses as part of the System Engineering activities within any project and, in particular, within the scientific projects linked to astronomical instrumentation and telescopes.

Summary of contents

Module 1: General Introduction to RAMS analyses: the five W´s

This module introduces the concept of Reliability, Availability, Maintainability and Safety in the framework of the System Engineering activities that take place during a project. The module is structured using the five W´s questions: What, Why, Who, Where and When, ending up with the "How" question, that introduces us to the type of analyses to be performed and how to produce them.

Module 2: RAMS theory: availability model

The aim of this module is to provide the definition of the parameters and the mathematical approach to be used in the RAMS calculations. We will start by introducing basic concepts such as the failure rate, the system availability, the MTBF or the MTTR and will continue by defining the different type of configurations in the reliability models and its formulae. The model shall end up with practical examples.

Module 3: Application to telescopes and astronomical instruments

This module provides the application of the ideas learnt in the previous modules to the astronomical instrumentation field. We will start with the typical assumptions that need to be considered before starting the breakdown of subsystems and components, study their configuration and apply the formulae to calculate the global system availability. Then, we will explore the close relationship between RAMS analyses and the Operation and Maintenance procedures, the typical subsystems to be analysed in an astronomical observatory and some special cases where the impact of RAMS analysis becomes particularly relevant. Finally, we will go through the RAMS analyses performed for a real telescope (TSPM) and an astronomical instrument (MEGARA).

Module 4: Reference RAMS standards

This module intends to provide a guideline of the reference standards and reliability prediction methods that can be of use in the preparation of the different RAMS analysis.

Appendix

The appendix includes additional useful templates as well as reference bibliography.

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Module 1: General Introduction to RAMS Analyses: the five W´s

Module 1.1. What are RAMS analyses?

Module 1.2. Why should they be performed?

Module 1.3. Who should perform them?

Module 1.4. Where are they included within a project?

Module 1.5. When should they be done?

Module 1.6. How can a RAMS analysis be performed?

- Safety analysis
- FMECA analysis
- FTA analysis
- Reliability analysis
- Transport analysis
- Maintenance analysis
- Spare analysis

Module 2: RAMS theory: availability model

Module 2.1. Definitions

- System Failure
- System availability and downtime
- Failure rate
- MTBF (Mean Time Between Failures)
- MTTR (Mean Time to Repair)

Module 2.2. Parameters and configurations

Module 2.3. Reliability Mathematical Models

- Basic equations
- System reliability models
    - Serial configuration
    - Parallel configuration
    - m out of n configuration
    - Stand-by redundancy

Module 2.4. Examples

Module 3: Application to telescopes and astronomical instruments

Module 3.1. General RAMS assumptions

Module 3.2. Relation to "Concept of Operations" and "Maintenance" documents

Module 3.3. Typical subsystems to analyze in an astronomical observatory

Module 3.4. Impact of RAMS analyses in special cases:

- Robotic telescopes
- Remote, isolated sites or with extreme conditions
- Giant telescopes. ELT case

Module 3.5. Examples:

- MEGARA instrument
- TSPM telescope

Module 4: Reference RAMS standards and related literature

- Organizations
- RAMS- related standards and literature
  - ESA Standards: ECSS
  - ISO Standards
  - IEC Standards
  - Literature: NASA Handbook for Systems Engineering
  - Reliability prediction: MIL-HDBK-217 and its progeny

Appendix: Templates and Bibliography

Templates

- FMECA template
- Reliability budget template

Bibliography consulted