Utilizing the MADe Modeling Tool

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Research Goals

Reliability Analyses (FMEA, FMECA, Reliability Predictions, FTA, CIL)

- Efficiently re-usable.
  - Library of common Spacecraft subsystems and components
- Develop standardized formats
- Relate to systems engineering models.
- Verify consistency.

Why use MADe?

- What is it?
  - A modeling tool that allows users to generate a variety of analyses across different engineering domains.
  - Currently has 3 modules (SRA, RAM, PHM).
- What can it do?
  - Design & Safety: FMEA, FMECA, FTA
  - Reliability & Availability Engineering: RBD Analysis
- Why is it useful to us?
  - Pre-formatted reports
  - One file vs Multiple files
  - Vast and available resources (palette, library)
  - Versatile.

Real Life Applications in Aerospace

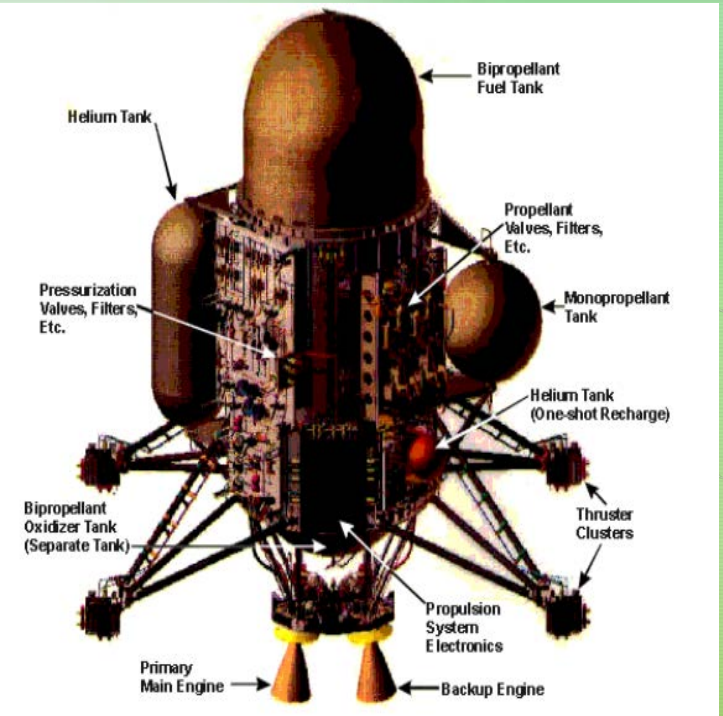


Figure 1: Propulsion System

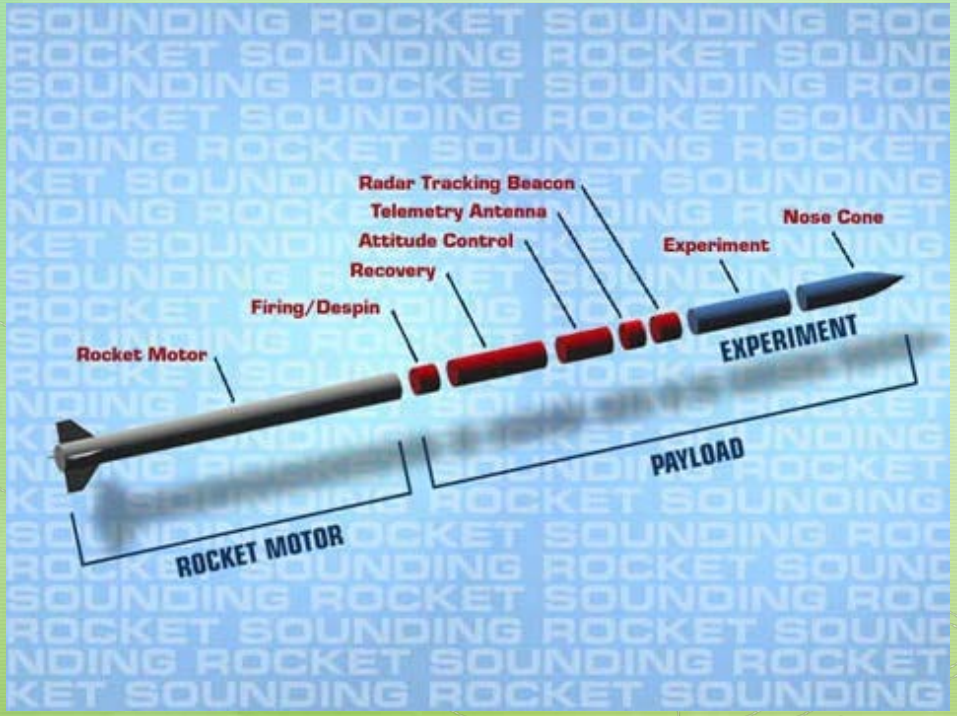


Figure 2: Sounding Rocket System

Schematic Diagram

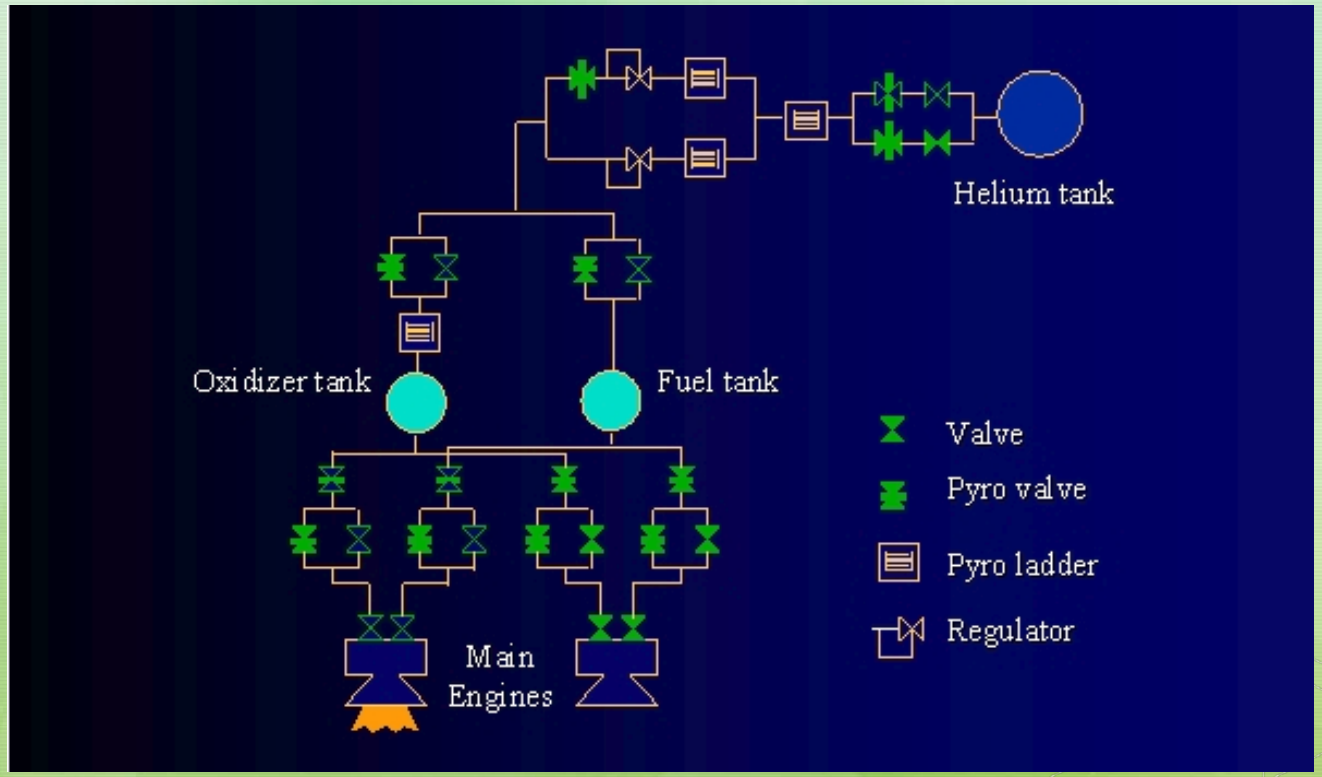


Figure 3: Propulsion System

Models in MADe

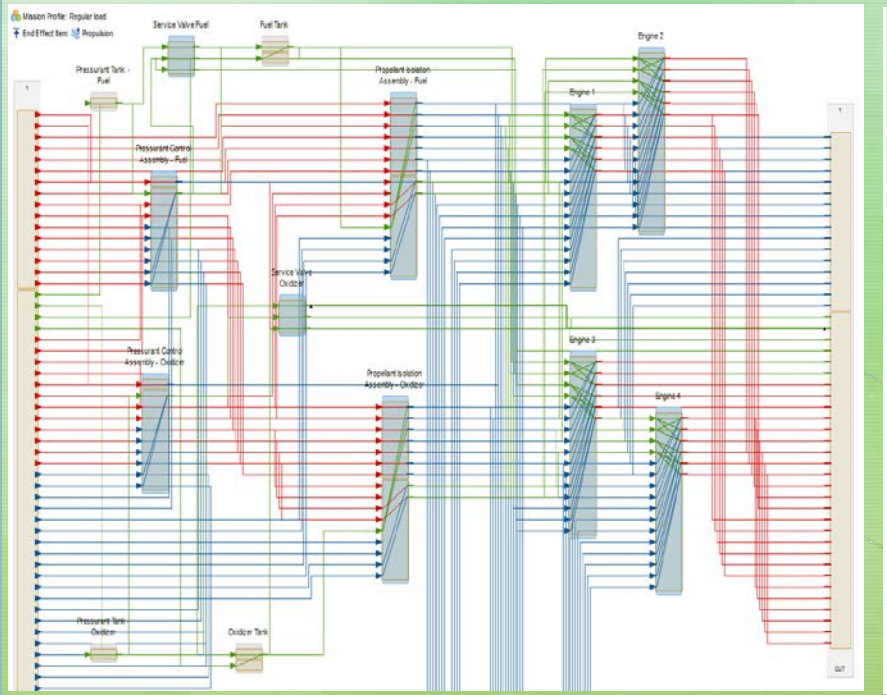


Figure 4: Propulsion System

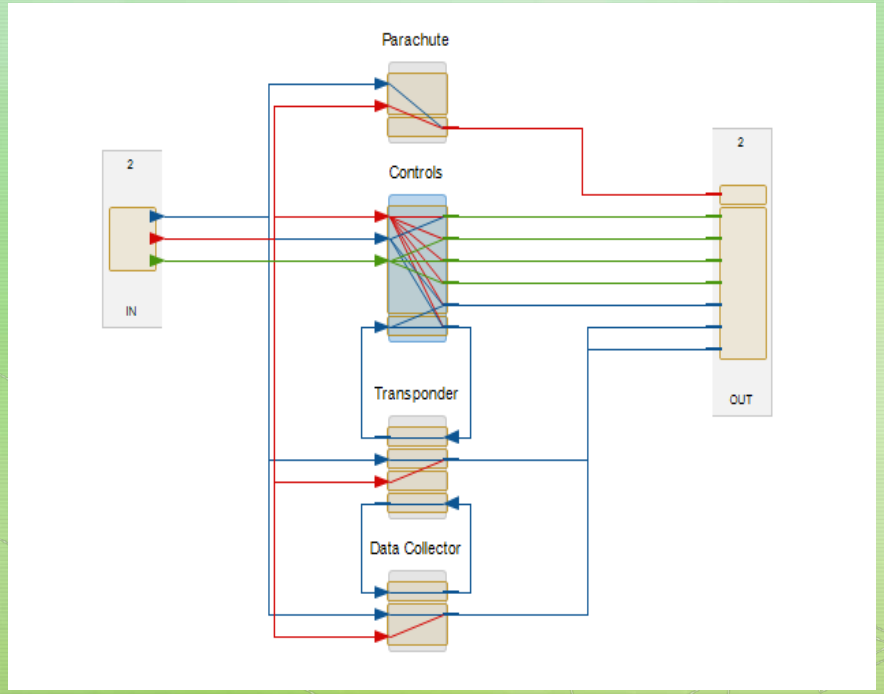


Figure 5: Payload Subsystem of Sounding Rocket System

Features of MADe

Figure 6: Functional Modeling for Transponder Component

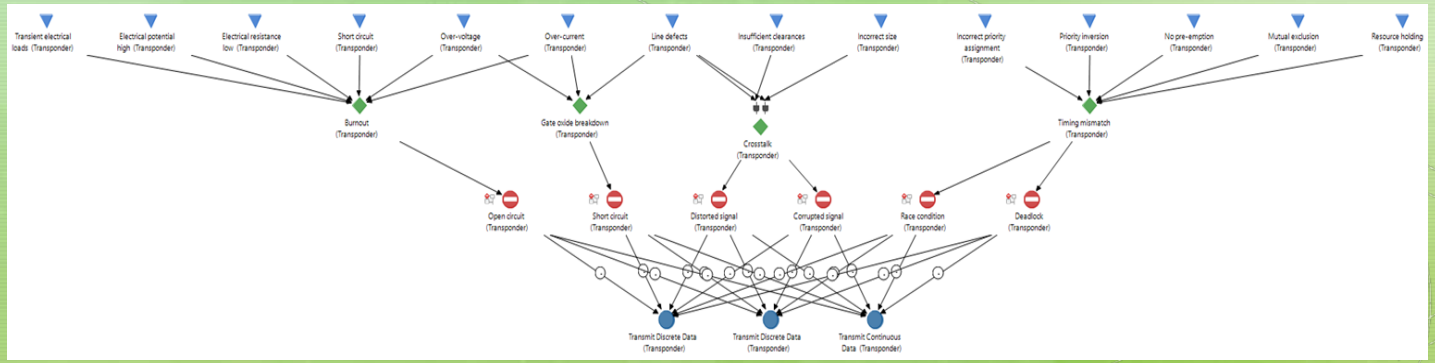


Figure 7: Failure Diagram for Transponder Component

Features of MADe cont'd

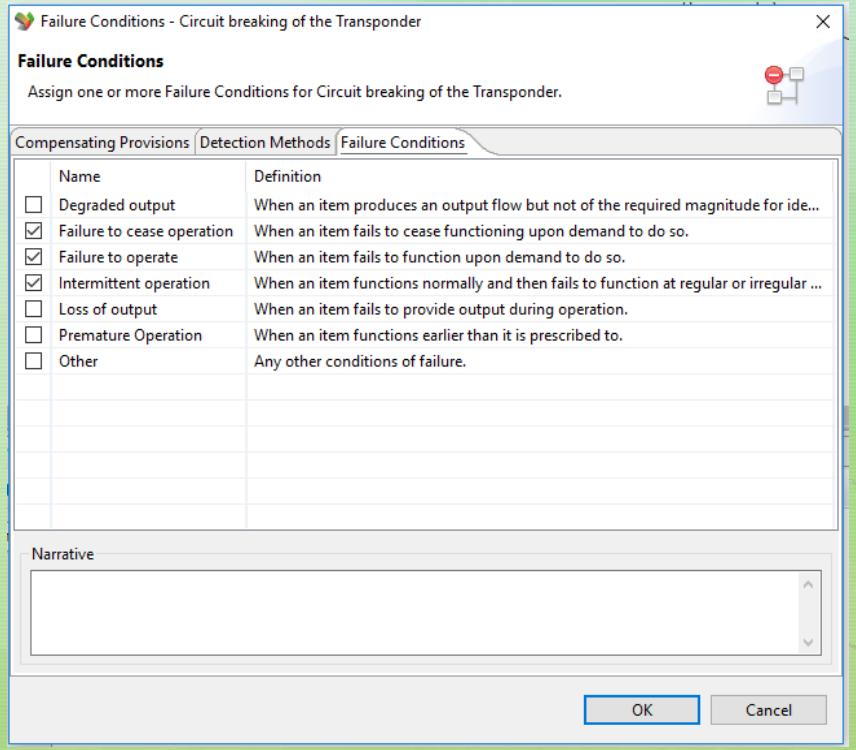


Figure 8: Additional Information on Failure Diagram

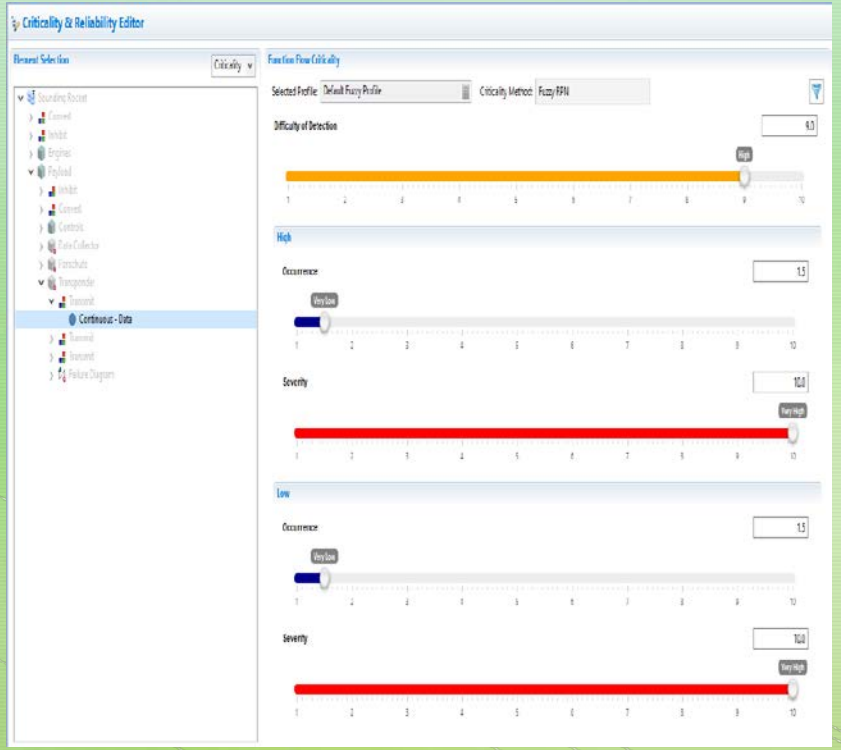
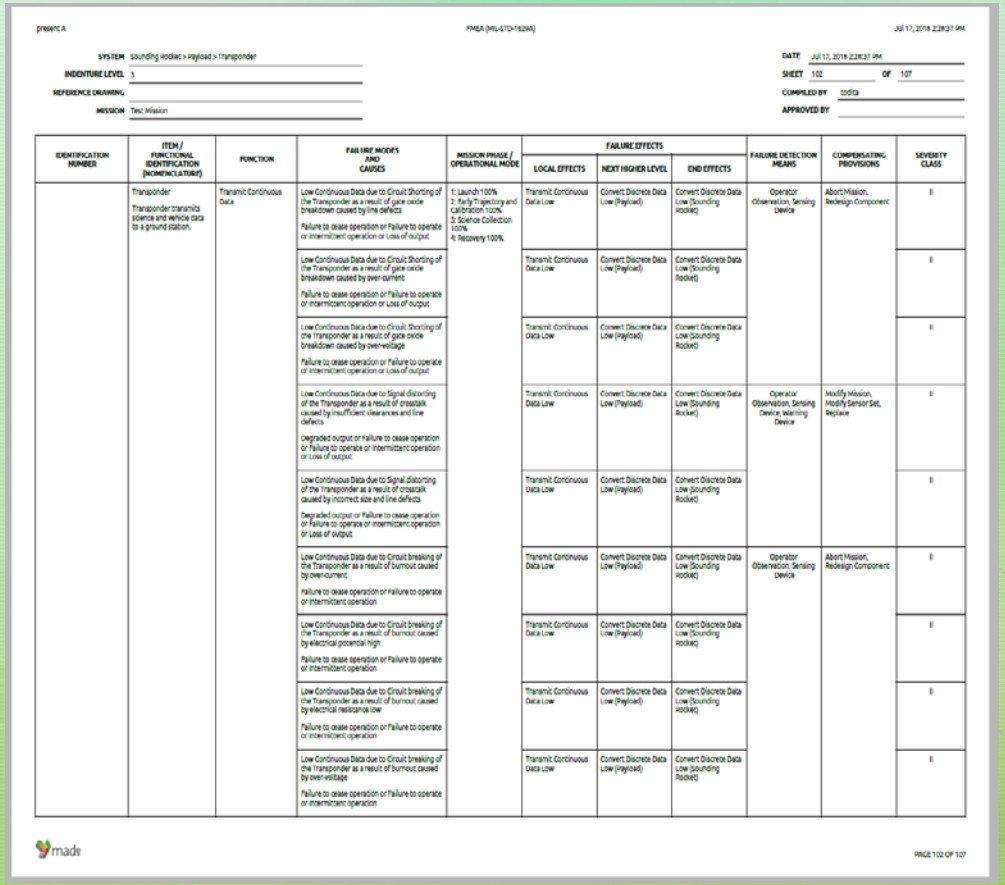


Figure 9: Criticality & Reliability Editor

Generated Reports



presrc A — FMEA (MIL-STD-1629A) — Jul 17, 2018 2:28:37 PM

SYSTEM: Sounding Rocket > Payload > Transponder
INDENTURE LEVEL: 3
REFERENCE DRAWING:
MISSION: Test Mission
DATE: Jul 17, 2018 2:28:37 PM
SHEET: 102 OF 107
COMPILED BY: rzdita
APPROVED BY:

IDENTIFICATION NUMBER	ITEM / FUNCTIONAL IDENTIFICATION (NOMENCLATURE)	FUNCTION	FAILURE MODES AND CAUSES	MISSION PHASE / OPERATIONAL MODE	FAILURE EFFECTS			FAILURE DETECTION MEANS	COMPENSATING PROVISIONS	SEVERITY CLASS
					LOCAL EFFECTS	NEXT HIGHER LEVEL	END EFFECTS			
	Transponder Transponder transmits science and vehicle data to a ground station.	Transmit Continuous Data	Low Continuous Data due to Circuit Shorting of the Transponder as a result of gate oxide breakdown caused by line defects Failure to cease operation or Failure to operate or intermittent operation or Loss of output	1: Launch 100% 2: Early Trajectory and Calibration 100% 3: Science Collection 100% 4: Recovery 100%	Transmit Continuous Data Low	Convert Discrete Data Low (Payload)	Convert Discrete Data Low (Sounding Rocket)	Operator Observation, Sensing Device	Abort Mission, Redesign Component	II
			Low Continuous Data due to Circuit Shorting of the Transponder as a result of gate oxide breakdown caused by over-current Failure to cease operation or Failure to operate or intermittent operation or Loss of output		Transmit Continuous Data Low	Convert Discrete Data Low (Payload)	Convert Discrete Data Low (Sounding Rocket)			II
			Low Continuous Data due to Circuit Shorting of the Transponder as a result of gate oxide breakdown caused by over-voltage Failure to cease operation or Failure to operate or intermittent operation or Loss of output		Transmit Continuous Data Low	Convert Discrete Data Low (Payload)	Convert Discrete Data Low (Sounding Rocket)			II
			Low Continuous Data due to Signal distorting of the Transponder as a result of crosstalk caused by insufficient clearances and line defects Degraded output or Failure to cease operation or Failure to operate or intermittent operation or Loss of output		Transmit Continuous Data Low	Convert Discrete Data Low (Payload)	Convert Discrete Data Low (Sounding Rocket)	Operator Observation, Sensing Device, Warning Device	Modify Mission, Modify Sensor Set, Replace	II
			Low Continuous Data due to Signal distorting of the Transponder as a result of crosstalk caused by incorrect size and line defects Degraded output or Failure to cease operation or Failure to operate or intermittent operation or Loss of output		Transmit Continuous Data Low	Convert Discrete Data Low (Payload)	Convert Discrete Data Low (Sounding Rocket)			II
			Low Continuous Data due to Circuit breaking of the Transponder as a result of burnout caused by over-current Failure to cease operation or Failure to operate or intermittent operation		Transmit Continuous Data Low	Convert Discrete Data Low (Payload)	Convert Discrete Data Low (Sounding Rocket)	Operator Observation, Sensing Device	Abort Mission, Redesign Component	II
			Low Continuous Data due to Circuit breaking of the Transponder as a result of burnout caused by electrical potencial high Failure to cease operation or Failure to operate or intermittent operation		Transmit Continuous Data Low	Convert Discrete Data Low (Payload)	Convert Discrete Data Low (Sounding Rocket)			II
			Low Continuous Data due to Circuit breaking of the Transponder as a result of burnout caused by electrical resistance low Failure to cease operation or Failure to operate or intermittent operation		Transmit Continuous Data Low	Convert Discrete Data Low (Payload)	Convert Discrete Data Low (Sounding Rocket)			II
			Low Continuous Data due to Circuit breaking of the Transponder as a result of burnout caused by over-voltage Failure to cease operation or Failure to operate or intermittent operation		Transmit Continuous Data Low	Convert Discrete Data Low (Payload)	Convert Discrete Data Low (Sounding Rocket)			II

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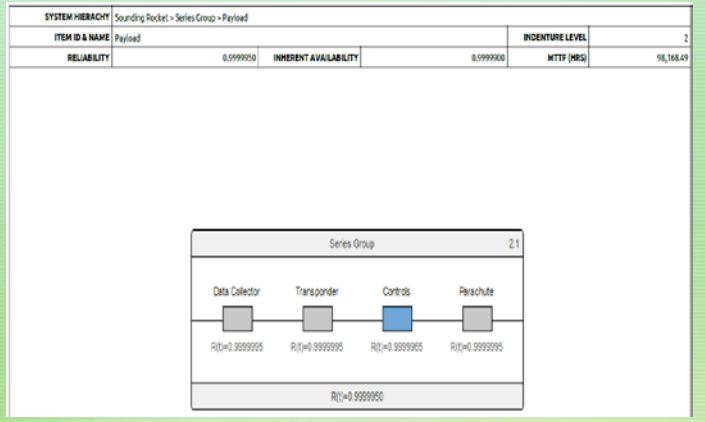
Figure 10: FMEA Report



SYSTEM HIERACHY	Sounding Rocket > Series Group > Payload				
ITEM ID & NAME	Payload			INDENTURE LEVEL	2
RELIABILITY	0.9999950	INHERENT AVAILABILITY	0.9999900	MTTF (HRS)	98,168.49

Figure 11: RBD Report

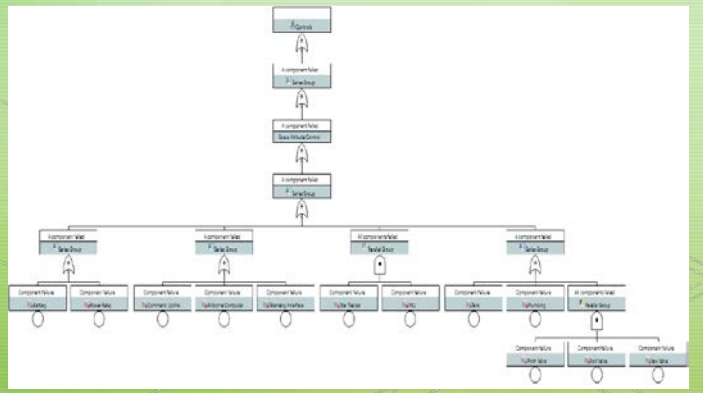


Figure 12: Fault Tree Analysis

Challenges/Lessons Learned

- Navigation/Complexity Issues
- Continued development of Reliability Analyses in Aerospace.

- High importance in meeting regulation standards.
- Broaden the scope of describing and understanding component failures and faults due the library of failure causes and mechanisms.
- Modeling tool’s vast potential.

References

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Acknowledgements

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