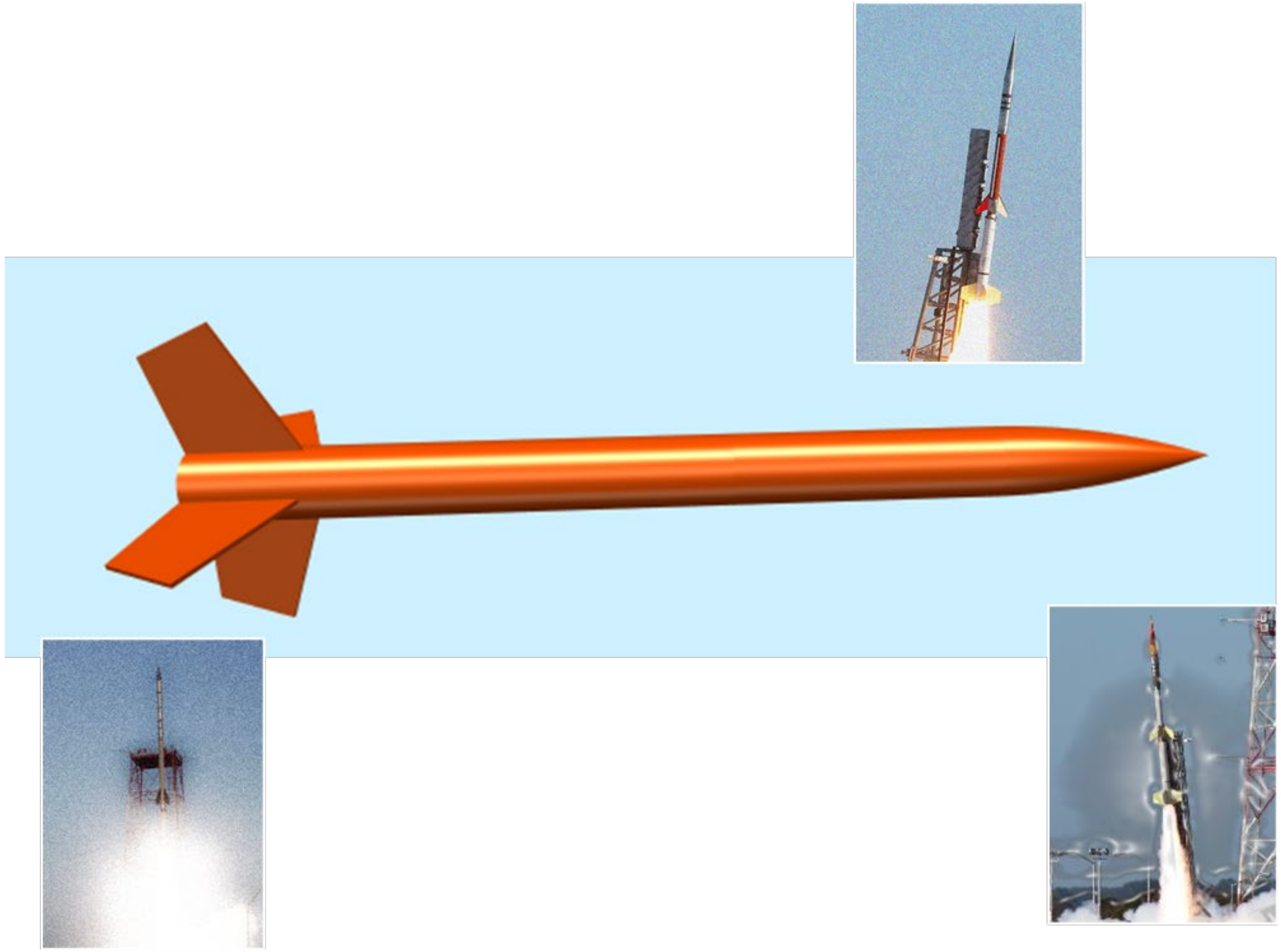
Sounding Rocket Critical Design Review

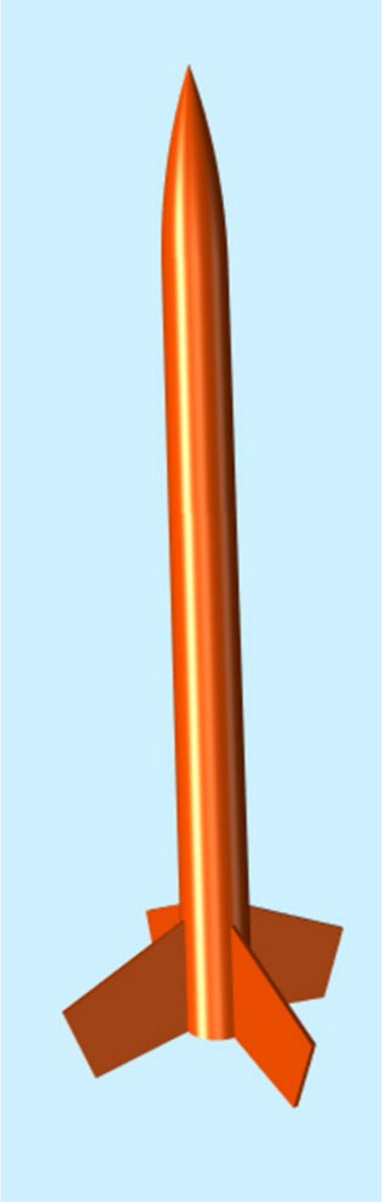
Cindy Judd - Ben Faltinowski - Austin Galley

SYSE 5450 - 05/02/2022



Agenda

- Team Introduction
- Project Overview
- Schedule
- CONOPS
- Requirements
- MBSE
- Critical Design of Sounding Rocket
- Risk
- Conclusion and Questions



Sounding Rocket Project Team

- Ben Faltinowski

  Model-Based Systems Engineer and Physical Designer
- Cindy Judd
  - Systems Engineering and Mission Planning
- Austin Galley

  Requirements Engineer and Risk Analysis/Mitigation

Sounding Rocket Project Overview

Ben

Project Overview

- The primary focus of the Sounding Rocket Project is to launch a provided payload to a pre-determined altitude, collect video and telemetry with the ability to land back and retrieve the data for post-flight feedback to the users
- Customer for the Sounding Rocket is Kino Junior High School of Mesa, AZ.
- Sounding Rocket Project provides a System with the following benefits:
  - Permit flight-borne science experiments to be launched
  - A fraction of the cost of well-known Sounding Rocket providers
  - Flight and mission capabilities as close to well-known Sounding Rocket providers as possible
  - FAA regulation compliance
  - Flexibility to test advanced space technologies (either now or later) by building in design features that allow for modular updates

Project Schedule

Cindy

Project Plan

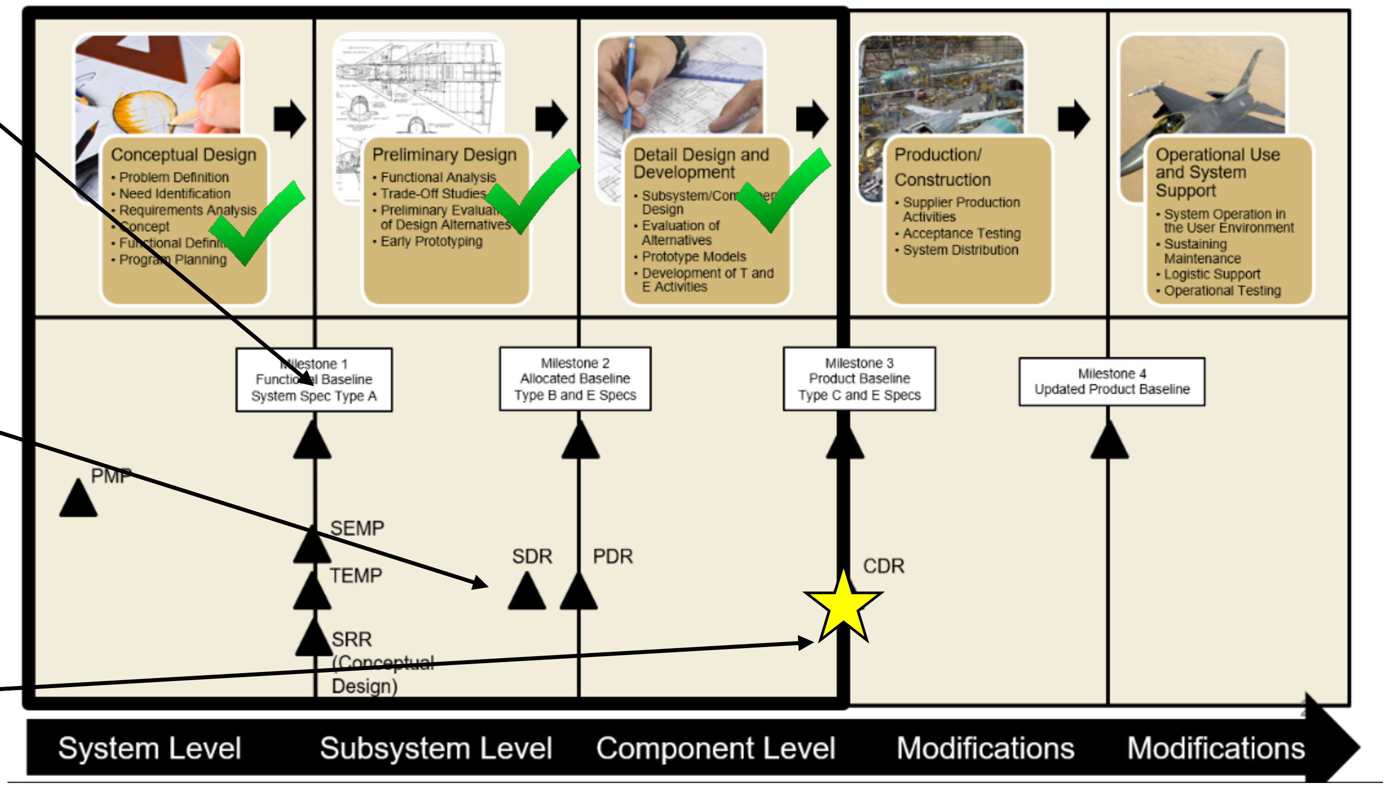
Conceptual Design
Concept of Operations
System Architecture Development
Requirements Development

Preliminary Design
System Architecture Development
- *MBSE*

Technical Performance Measures
Risk Identification and Mitigation
System Specification Documents

Detailed Design and Development
Modeling and Simulation
Prototype Models

System Life-Cycle Model



Project Schedule Overview

Project Plan/ Schedule Submittal
- Sep 2021

Subsystem Breakout
- Nov 2021

TPM Analysis
- Nov 2021

CONOPS Submittal
- Dec 2021

System Specification with Review
- Dec 2021

Preliminary Design Review
- Feb 2022

Critical Design Review
- May 2022

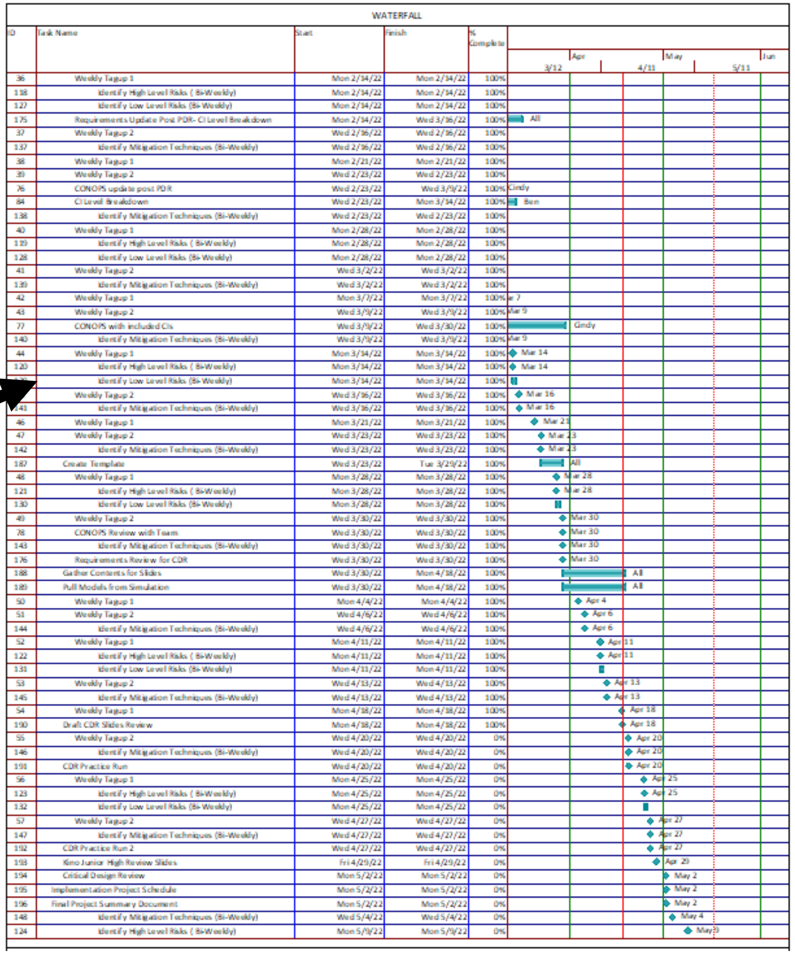
Implementation Project Schedule
- May 2022

Final Project Summary Document
- May 2022

Living document that captures critical activities, progress, performance, risk mitigation, business rhythms etc.

Schedule

- **Where we were (84%)**
  - Weekly Meetings
  - Weekly Risk Assessments
  - Completed PDR Package
  - Document Updates
- **Where we are at (99%)**
  - CIs developed and Selected
  - Requirements developed



Identify Mitigation Techniques (Bi-Weekly)	Wed 4/13/22	Wed 4/13/22	100%
Weekly Tagup 1	Mon 4/18/22	Mon 4/18/22	100%
Draft CDR Slides Review	Mon 4/18/22	Mon 4/18/22	100%
Weekly Tagup 2	Wed 4/20/22	Wed 4/20/22	0%
Identify Mitigation Techniques (Bi-Weekly)	Wed 4/20/22	Wed 4/20/22	0%
CDR Practice Run	Wed 4/20/22	Wed 4/20/22	0%
Weekly Tagup 1	Mon 4/25/22	Mon 4/25/22	0%
Identify High Level Risks (Bi-Weekly)	Mon 4/25/22	Mon 4/25/22	0%
Identify Low Level Risks (Bi-Weekly)	Mon 4/25/22	Mon 4/25/22	0%
Weekly Tagup 2	Wed 4/27/22	Wed 4/27/22	0%
Identify Mitigation Techniques (Bi-Weekly)	Wed 4/27/22	Wed 4/27/22	0%
CDR Practice Run 2	Wed 4/27/22	Wed 4/27/22	0%
Kino Junior High Review Slides	Fri 4/29/22	Fri 4/29/22	0%
Critical Design Review	Mon 5/2/22	Mon 5/2/22	0%
Implementation Project Schedule	Mon 5/2/22	Mon 5/2/22	0%
Final Project Summary Document	Mon 5/2/22	Mon 5/2/22	0%
Identify Mitigation Techniques (Bi-Weekly)	Wed 5/4/22	Wed 5/4/22	0%
Identify High Level Risks (Bi-Weekly)	Mon 5/9/22	Mon 5/9/22	0%

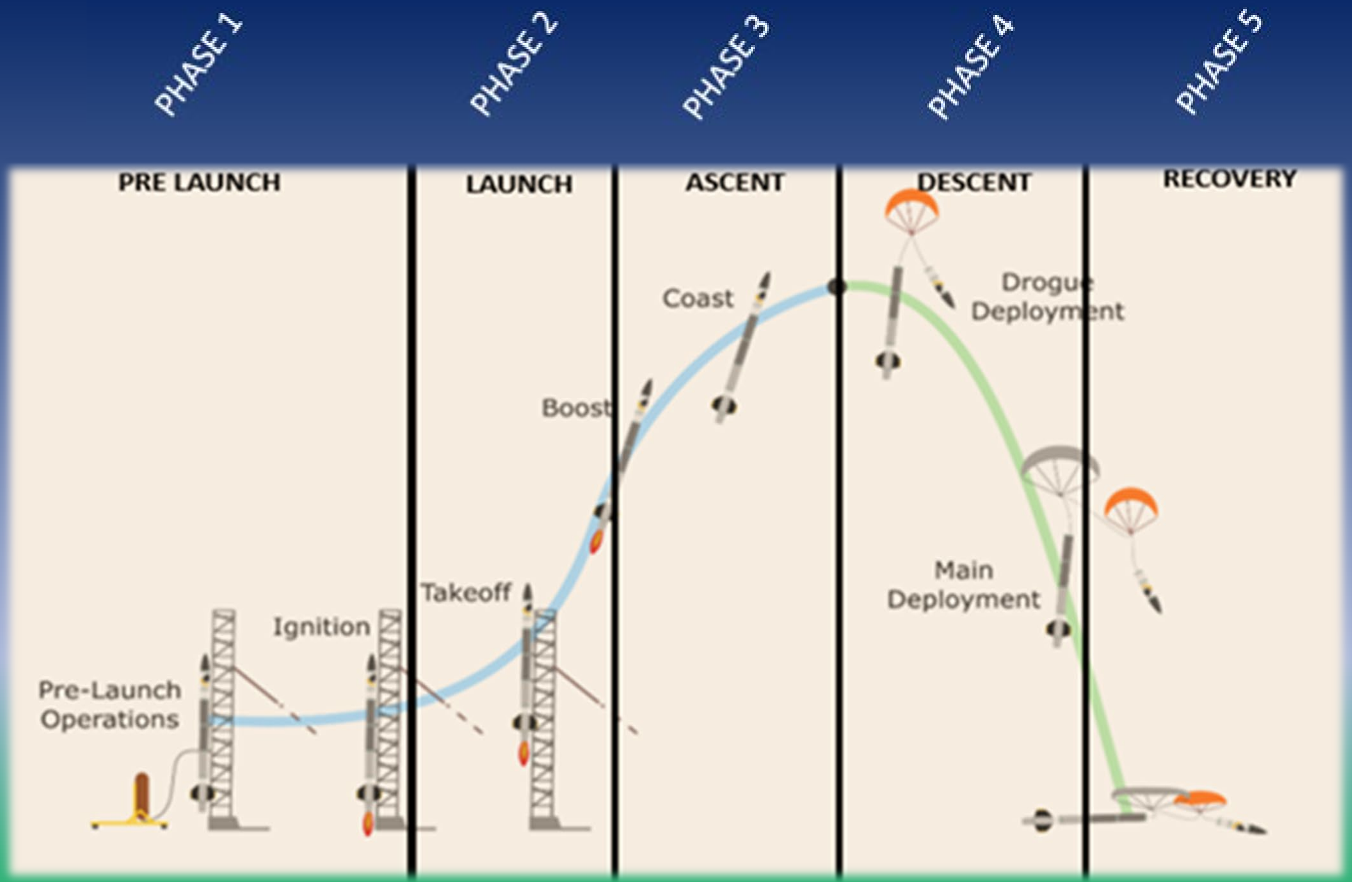
Concept of Operations CONOPS

Cindy

CONOPS

- The design and construction of the rocket vehicle, its motors, and launch operations shall be governed by standard NFPA 1127 and Tripoli Safety Code.
- The operating clearances for flying the rocket must comply with standards NFPA 1122, NFPA 1127, and Federal Aviation Administration Regulation on Aeronautics and Space Title 14, Chapter 1, Subchapter F, Part 101.

CONOPS


PHASE 1
PHASE 2
PHASE 3
PHASE 4
PHASE 5
PRE LAUNCH
LAUNCH
ASCENT
DESCENT
RECOVERY
Coast
Boost
Takeoff
Ignition
Pre-Launch Operations
Drogue Deployment
Main Deployment

Pre-Launch Phase

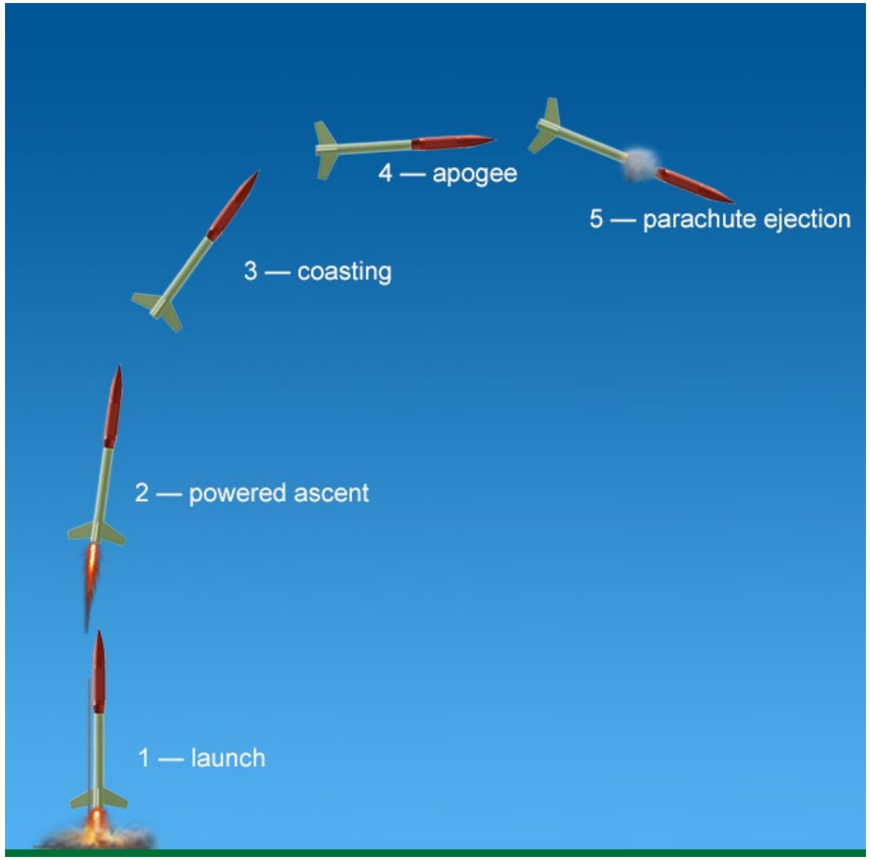
- T-2 Hours
  - Avionics, parachute deployment module and Go Pro turned on
  - Tower raised to vertical
  - Igniter Insertion, launcher cable connection and verification
  - Launch lug, couplers verified operational
  - Launch controller powered on an in configuration.
  - Avionics initialized (GPS, altimeter, accelerometer)
  - Comm checks on ground station
- T-2 Minutes
  - Arming
  - Feedback verification
  - Safety removed
  - Recovery system verified via buzzer feedback

Launch

- T-10 seconds
  - Countdown begins
- T-0 seconds
  - Rocket Igniter start command.
  - Launch
- T +3 Seconds
  - Telemetry verification from Eggtimer GPS using software on ground
  - Burnout initiated
  - Altitude and Speed verification

Ascent/Descent

- T+13-30 Seconds
  - Apogee reached (verified by recovery altimeters)
  - Descent Begins
  - First deployment charge activated
  - Parachute ejection



Recovery

- T+36 Seconds
  - Main chute deployment
- T+180 Seconds
  - Landing
  - GPS location verification
  - Items will be retrieved
  - Avionics and camera power down
  - Pack up initiated

CONOPS- FUNCTIONAL CAPABILITIES MATRIX AND SYSTEM STATES

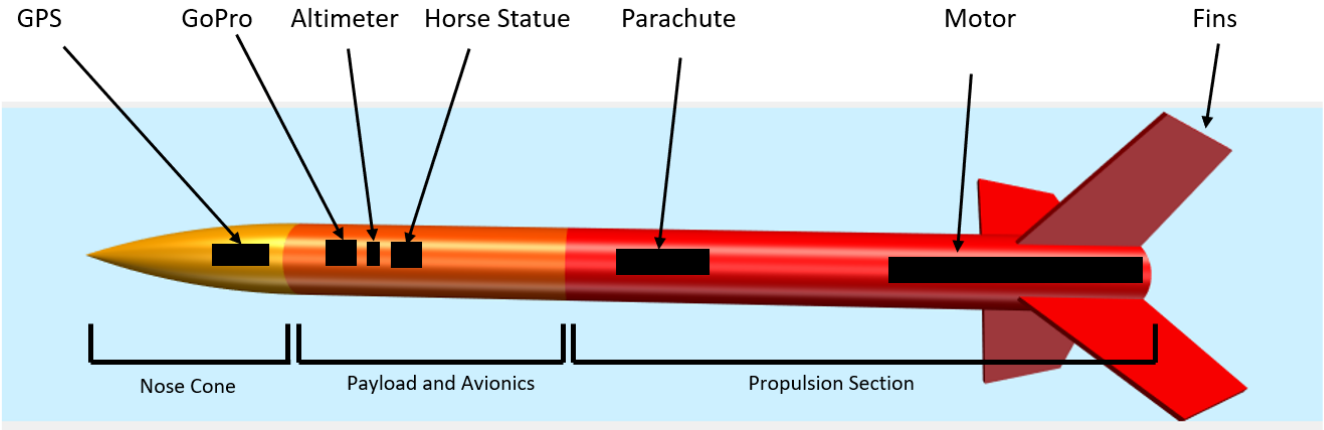
	t - 2 hours	T - 5 min	T - 4 min	T - 2 min	T - 0.4 sec	T - 0 sec	T + 3 sec	T + 10 sec	T + 13 sec	T + 16 sec	T + 36 sec	T + 120 sec	T + 180 sec	T + 5 min	T + 30 min	T + 60 min
General	Assembly	**Launch Pad Setup**	**Procedures Check**	**Arming**	**Firing**	**Takeoff**	**Motor burnout**	**Altitude control**	**Apogee**	**Separation**	**Primary Recovery**	**Secondary Recovery**	**Ground Arrival**	**Ground arrival Payload**	**Recovery**	**Disassembly**
Passing Criteria	Complete "Assembly Procedure"	Rocket on pad with right launch angle	Complete "Rocket Preparation"	Complete "Arming Checklist"	Motor ignites	Rocket leaves rail	Motor has finished burning	Rocket velocity reaches 0	Rocket starts descent	Nose cone and payload pilot chute ejected	Payload and reefed main deploy	Main unreefed	Rocket lies stable on the ground	Rocket lies stable on the ground	All rocket and payload parts are recovered	All rocket and payload parts are stored for shipping
Avionics	Join connectors between systems, insert into rocket	-	System check	Arming rocket, data acquisition and downlink starting	-	Detect launch, start altitude measurements	Altitude prediction calculations	-	Wake up recovery systems	Give ejection signal	-	Give unreefing signal	-	Turning off systems (except trackers)	Data saving and system packing	-
Propulsion	Motor assembling, insertion into rocket	Igniter Insertion	Check igniter conductivity	-	Firing	-	Stop burning	-	-	-	-	-	-	-	-	System cleaning and packing
Structure	Securing of each subsystem, rocket closing	Launch lugs slide nominally, structure is stable	Check coupler tightness	-	-	-	-	-	-	-	-	-	-	-	-	Packing parts
Recovery	Parachute folding, insertion in the rocket	-	-	Check buzzer feedback for nominal recovery system arming	-	-	-	-	-	-	Deploy recovery system	Cut reefing line	-	-	-	Cleaning and packing
Payload	Assembling, insertion in the rocket, payload set in standby	-	System check	-	-	Payload wakes up	-	-	-	Deploy payload pilot parachute	Deploy payload	-	-	-	Turn systems off	Datasaving, system packing
Ground Station	Set up ground station	-	System check	Initialize downlink, data acquisition and GPS start	-	Display event: takeoff	-	-	Display event: apogee	Display event: separation	Display event: Payload ejection and riefing	Display event: Recovery	Display event: rocket landing	Display event: payload landing	Data saving and system packing	Packing

Requirements

Austin

Functional Allocation

- Functional analysis of the sounding rocket consisted of comparing multiple well established sounding rocket projects that have been conducted and analyzing their different capabilities
- Functional Areas of the Sounding Rocket
  - Structure
  - Payload
  - Avionics
  - Propulsion
  - Recovery System
  - Ground Station
- Each of the functional subsystems are required for the operation of the Class I Sounding Rocket



Requirement Allocation

Requirements are broken down into functional allocation categories aligning with the different subsystems of the rocket

Requirements Hierarchy:

- System Requirements
- Functional Requirements
- Performance Requirements
- Configuration Item (CI) Requirements

Requirement Development and Derivation

- Established sounding rocket projects
- Trade Studies
- Rocksim – CI Allocation
- CI Requirements - COTS Products Analysis

Requirements Process

- Further Refined Functional and Performance Requirements post PDR
- Focus on Developing CI Requirements
  - Developed CI Requirements Using Sounding Rocket Block Definition Diagram and COTS Product's Specifications
- Generated Tolerances and Identified Parent Requirements for Tracing
- System Specification and Requirements Matrix Contains all Functional, Performance, and CI Requirements
- Propulsion Requirements Matrix Example:

Req ID	Description	Type	Tolerance	Parent Req
PR-0001	The rocket propulsion system when ignited shall provide thrust.	Functional	0	
PR-0002	The rocket shall have a departure velocity minimum of 480 mph to ensure the LV will follow a predictable flight path.	Performance	+/- 10	GR-0003
PR-0003	The rocket shall be able to sustain a minimum acceleration of 20 g over 14 seconds of time during ascent.	Performance	min	GR-0003
PR-0008	The rocket propulsion system shall use a nontoxic propellant type.	Functional	0	
PR-0009	The rocket propulsion system shall be a Commercial off the Shelf Motors (COTS) that has been certified by both the Tripoli and NAR associations.	Functional	0	
PRCI-1001	The rocket motor mass shall be no more that 570 g.	CI	+/- 10	ST-0003
PRCI-1002	The rocket motor length shall be no more than 455 mm.	CI	+/- 5	ST-0005

System Specification

- Scope of Requirements
- System Definitions
  - Functional Analysis
  - System Characteristics
    - CI Specification
    - Performance Characteristics
    - Physical Characteristics
  - Usability
- Requirements
  - Functional, Performance, and CI Requirement Allocation
- Technical Performance Measures
  - Launch Vehicle Characteristics
  - Camera

Sounding Rocket MBSE Model

Ben

What is MBSE?

- **MBSE = Model-Based Systems Engineering**: A method of compiling the design where the requirements and CONOPS methods are depicted in graphical form.
- A way of graphically linking and tracing the system's use cases and design blocks back to requirements in graphical form.
- Purpose of MBSE for Sounding Rocket: To design the system, including call attention to elements of the rocket system design that require further requirement and CONOPS definition.

MBSE Model Tools

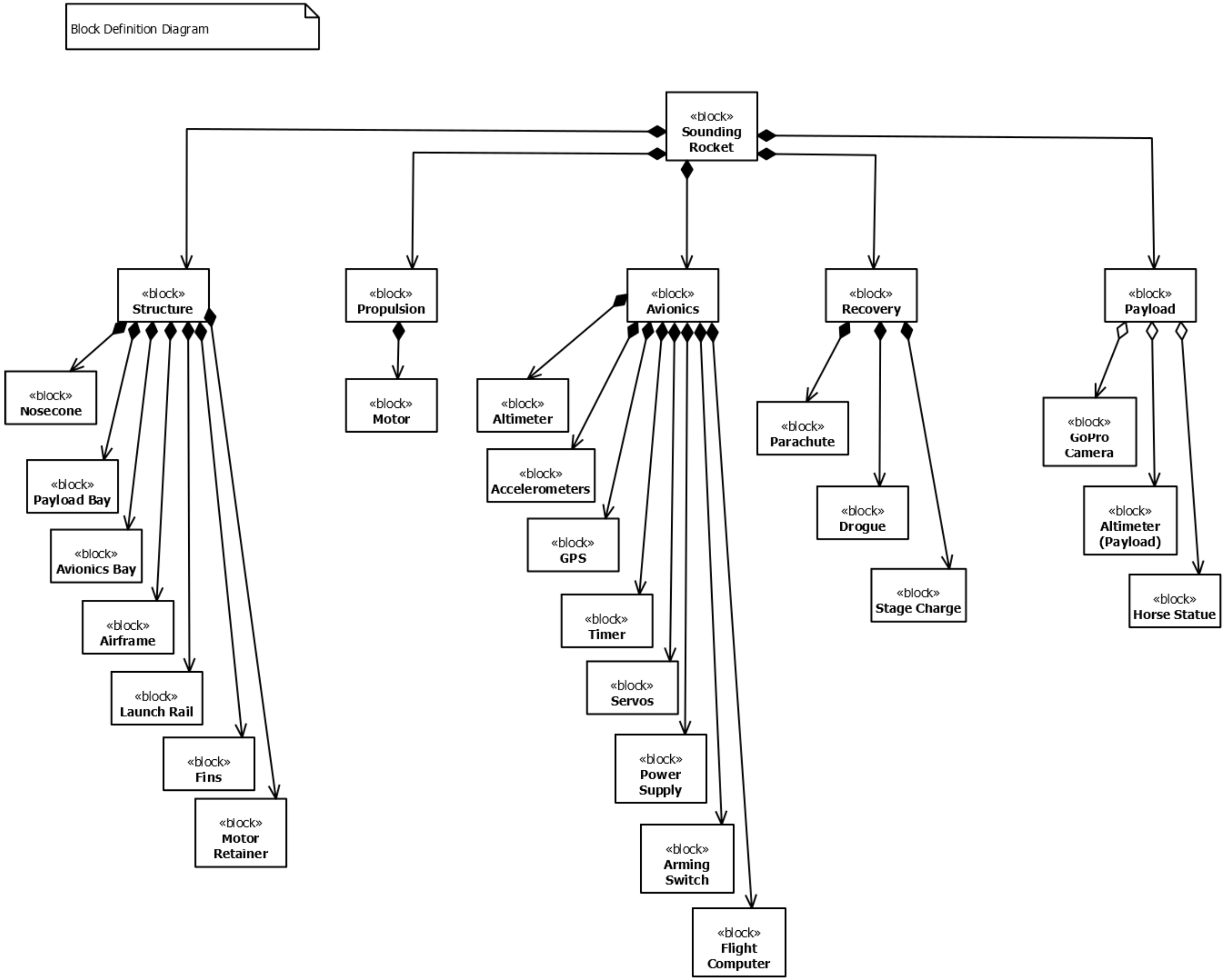
- **Software**: The software package used to generate the Sounding Rocket's MBSE Models is freeware called Gaphor.
- Gaphor works on all major platforms: Windows, Macos and Linux.
- Gaphor is written in Python and is 100% Open Source, available under a friendly Apache 2 license.
- Gaphor implements the UML, SysML, and RAAML OMG standards.

MBSE Model Block Definition Diagram

Ben

Primary Components of Functional System

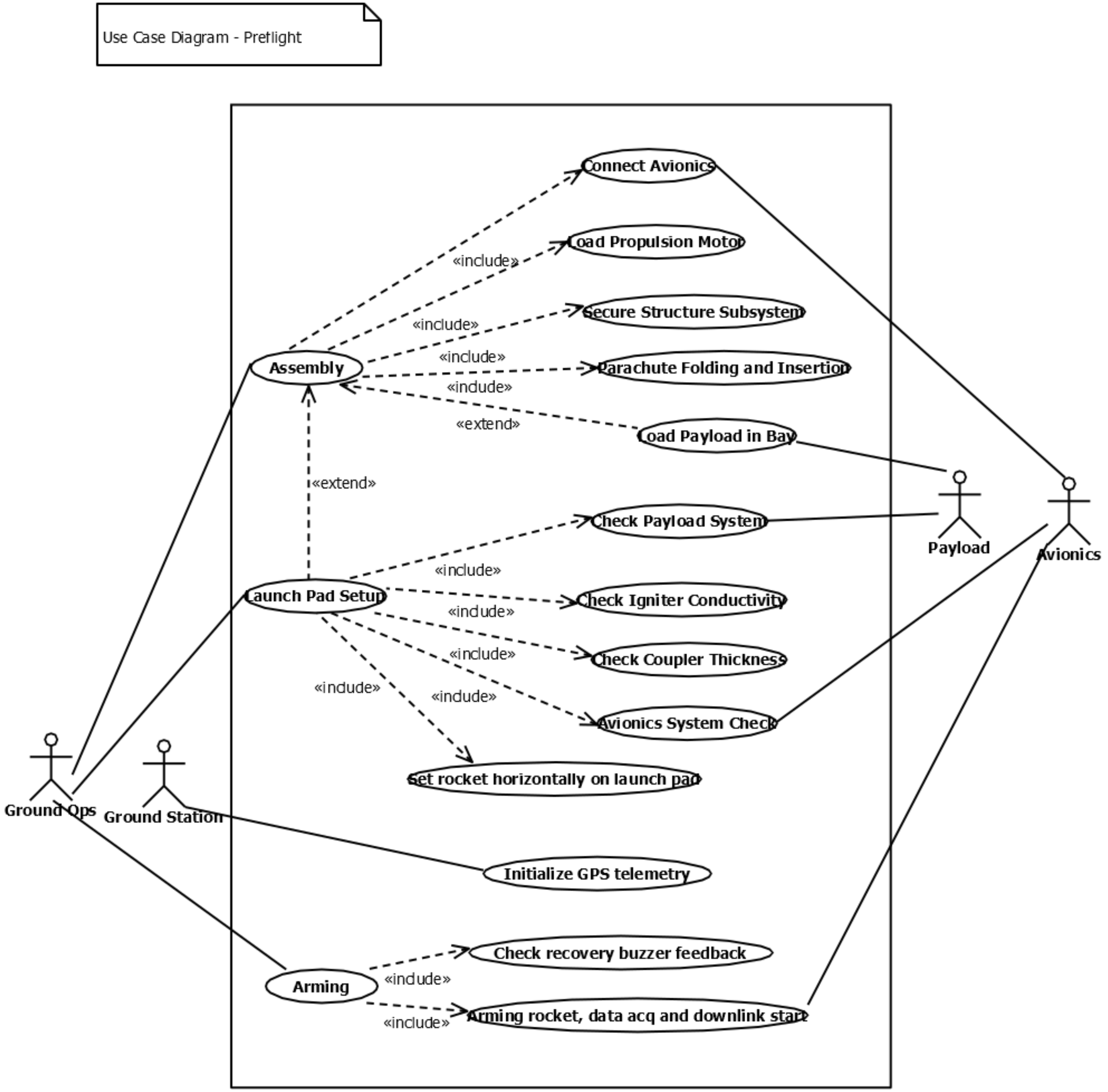
- This chart shows the Functional System MBSE Block Definition Diagram.
- This is a breakdown of the Sounding Rocket's subsystems and Configuration Items in MBSE format.



MBSE Use Case Diagrams

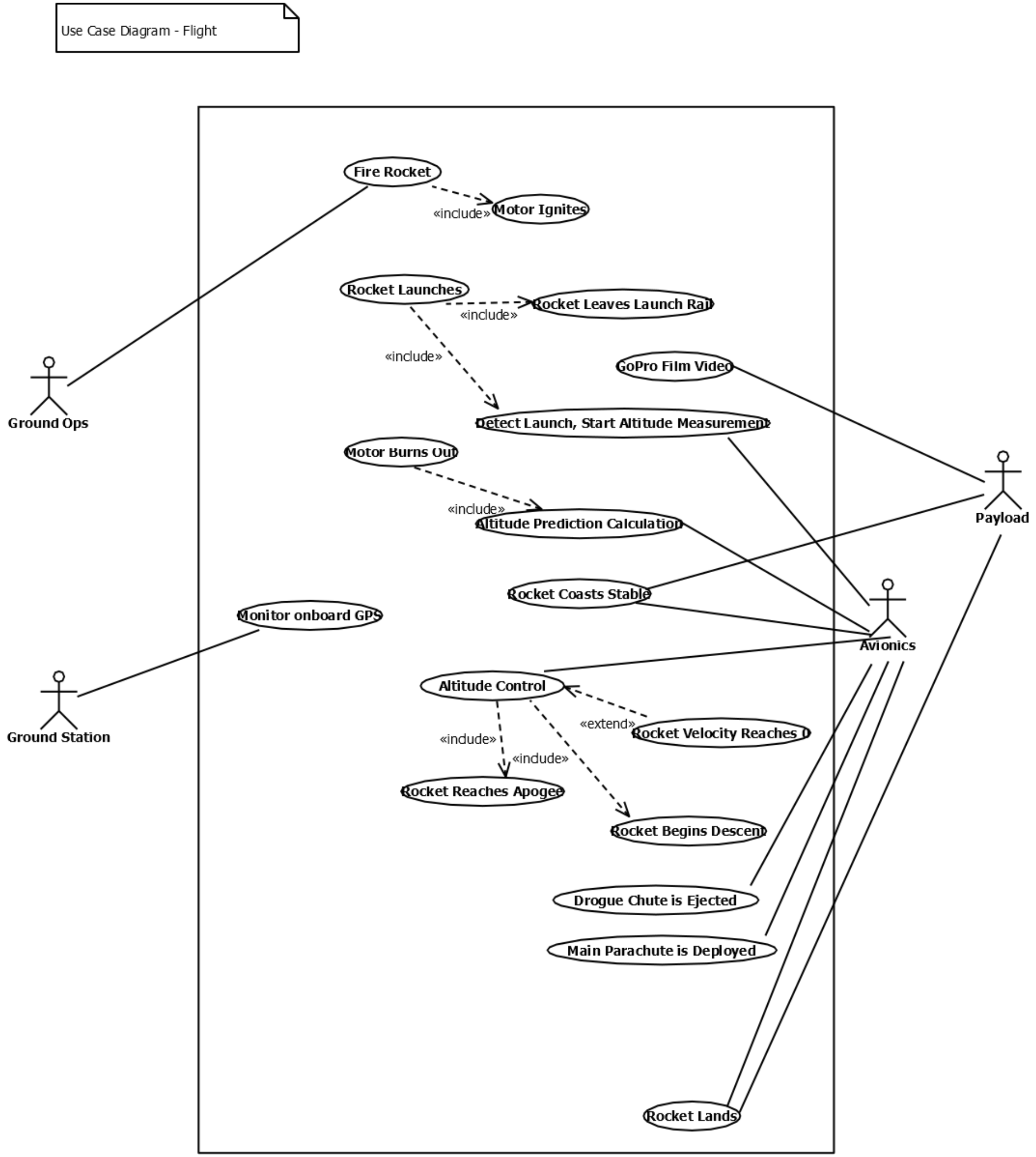
Use Case Diagram (Pre-Flight)

- This chart shows the MBSE Use Case Diagram for Preflight done with Gaphor.
- The model had various use cases applied for the sake of tracing back to individual requirements in an MBSE requirements diagram.



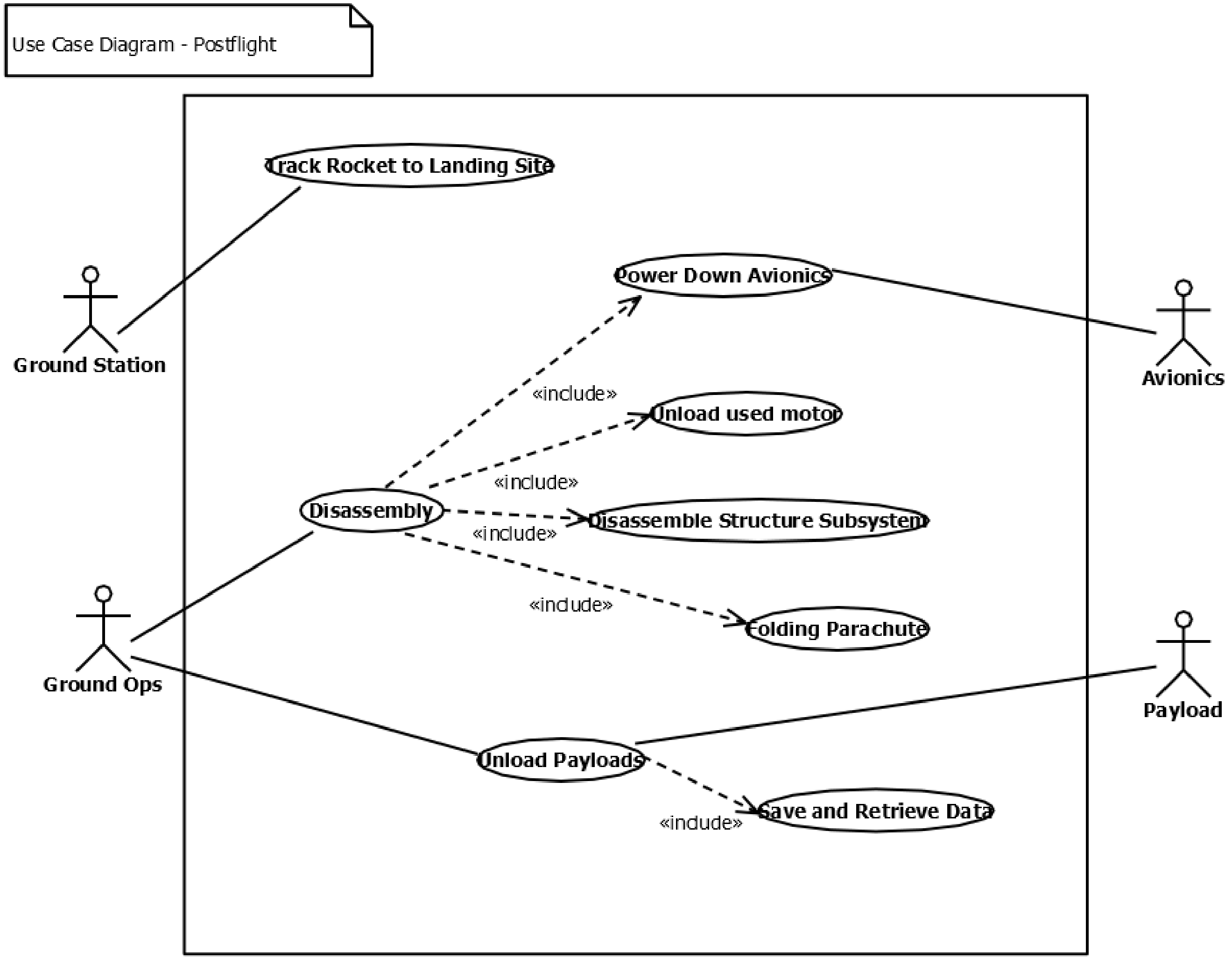
Use Case Diagram (Flight)

- This chart shows the MBSE Use Case Diagram for Flight done with Gaphor.
- The model had various use cases applied for the sake of tracing back to individual requirements in an MBSE requirements diagram.



Use Case Diagram (Post-Flight)

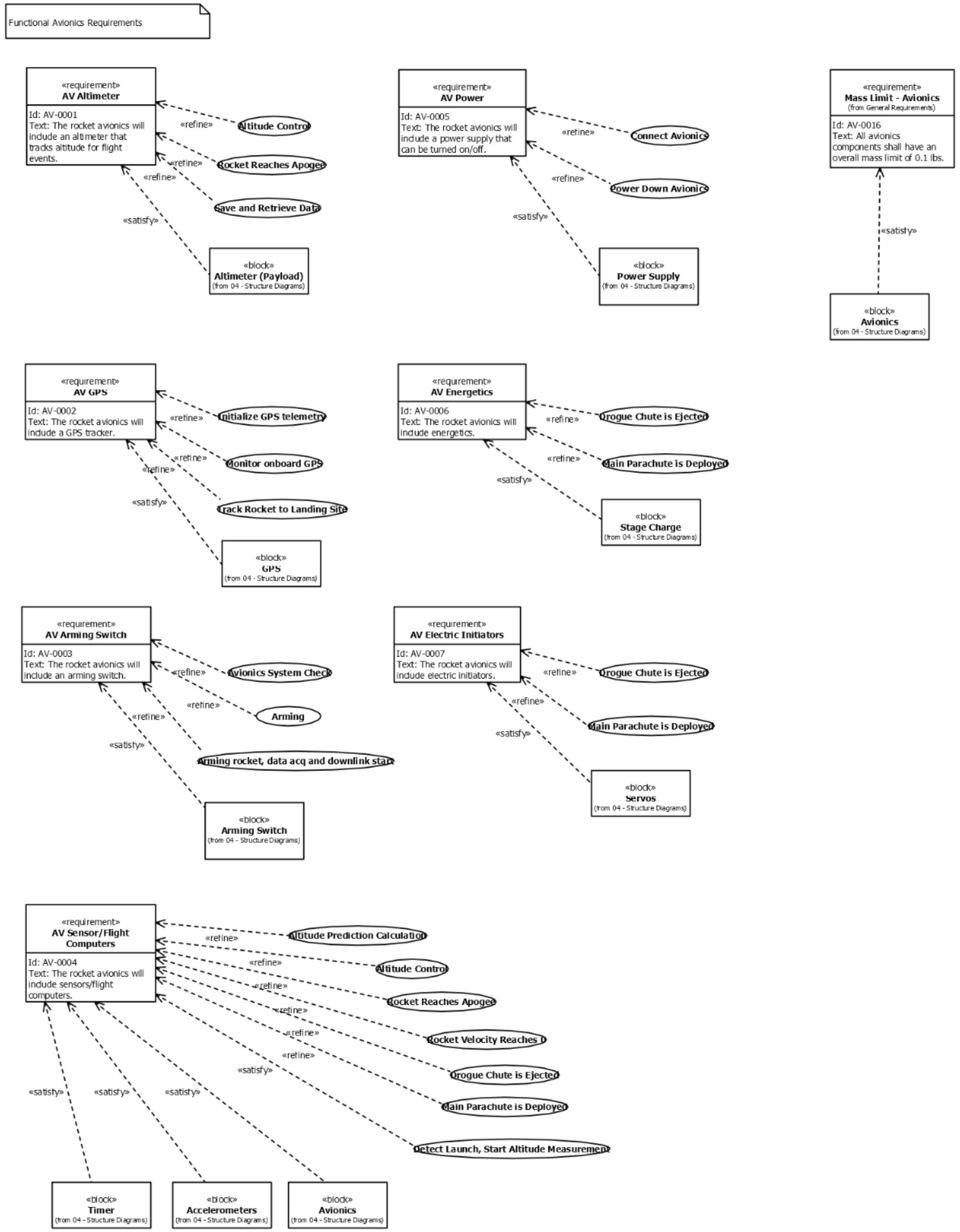
- This chart shows the MBSE Use Case Diagram for Post-Flight done with Gaphor.
- The model had various use cases applied for the sake of tracing back to individual requirements in an MBSE requirements diagram.



MBSE Requirements Diagrams

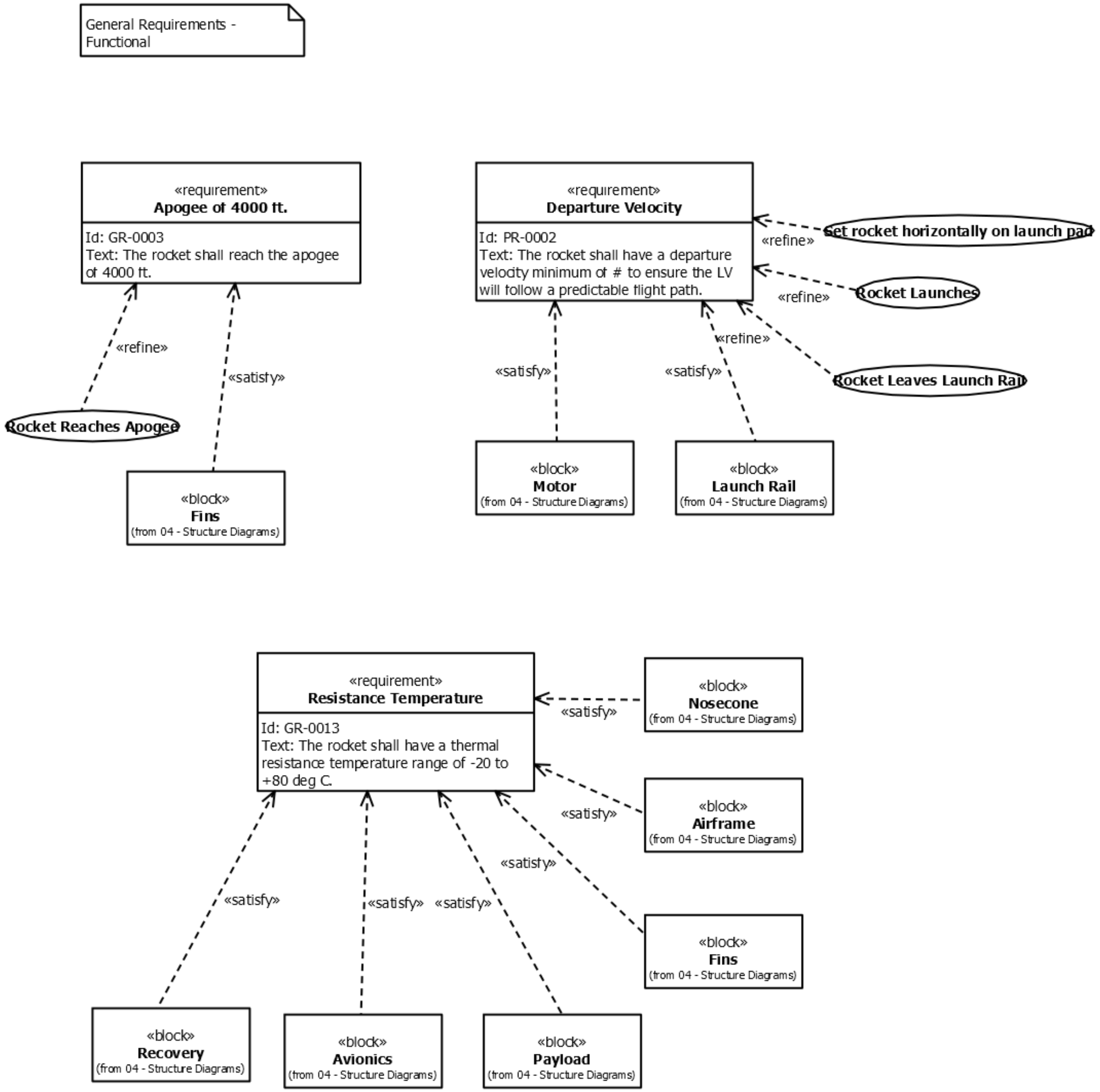
MBSE Requirements Diagram (Functional Avionics)

- This chart shows the Functional Avionics Requirements Diagrams for the Rocket (which include requirements and tracing to both Requirements and Use Case entries).
- In Gaphor, the Block Definition Diagram blocks and the Use Cases can be linked from their diagrams into the Requirements diagram and the associations between them and the requirements can be linked.



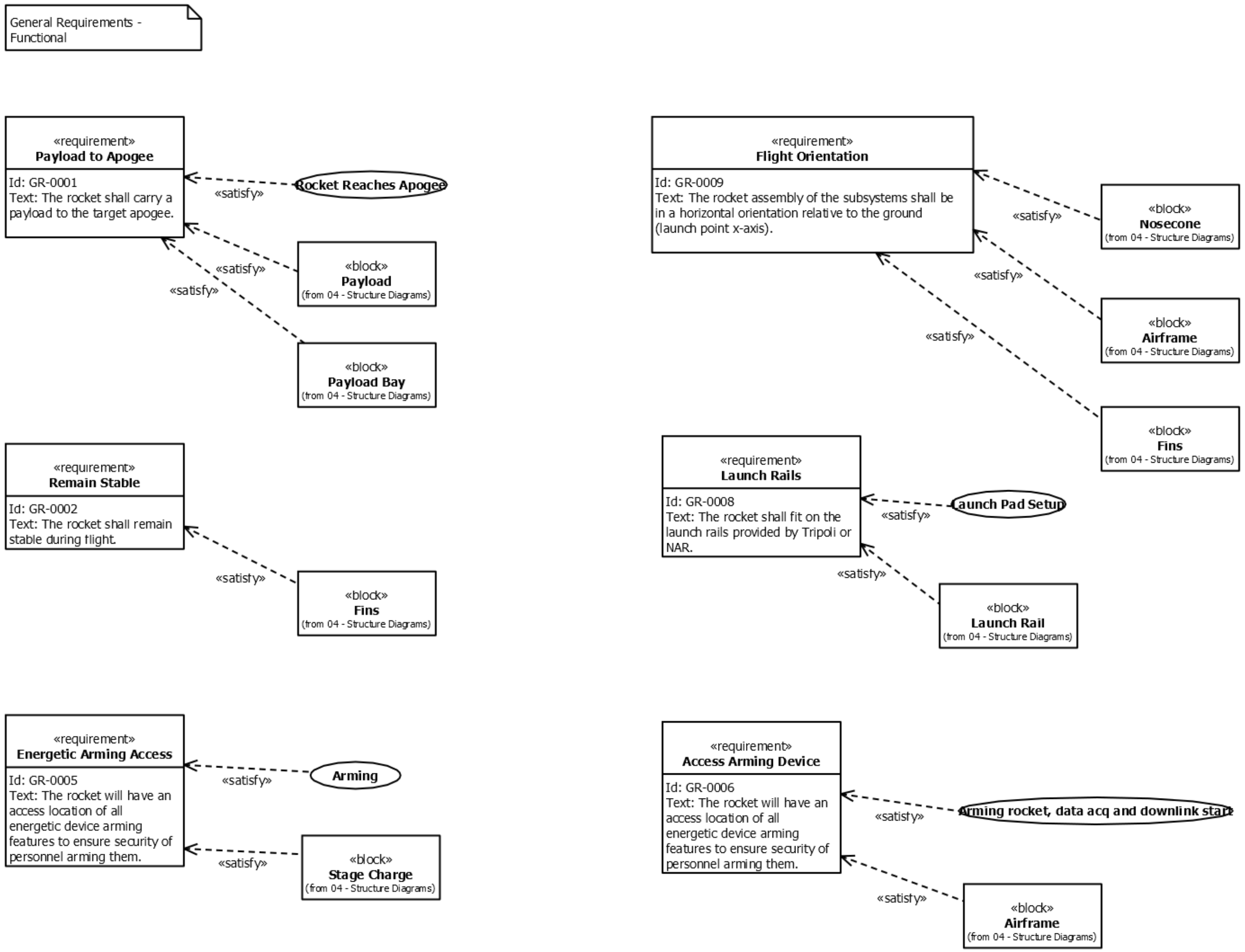
MBSE Requirements Diagram (General - Performance)

- This chart shows the General Requirements Diagrams for the Rocket (which include requirements and tracing to both Requirements and Use Case entries).



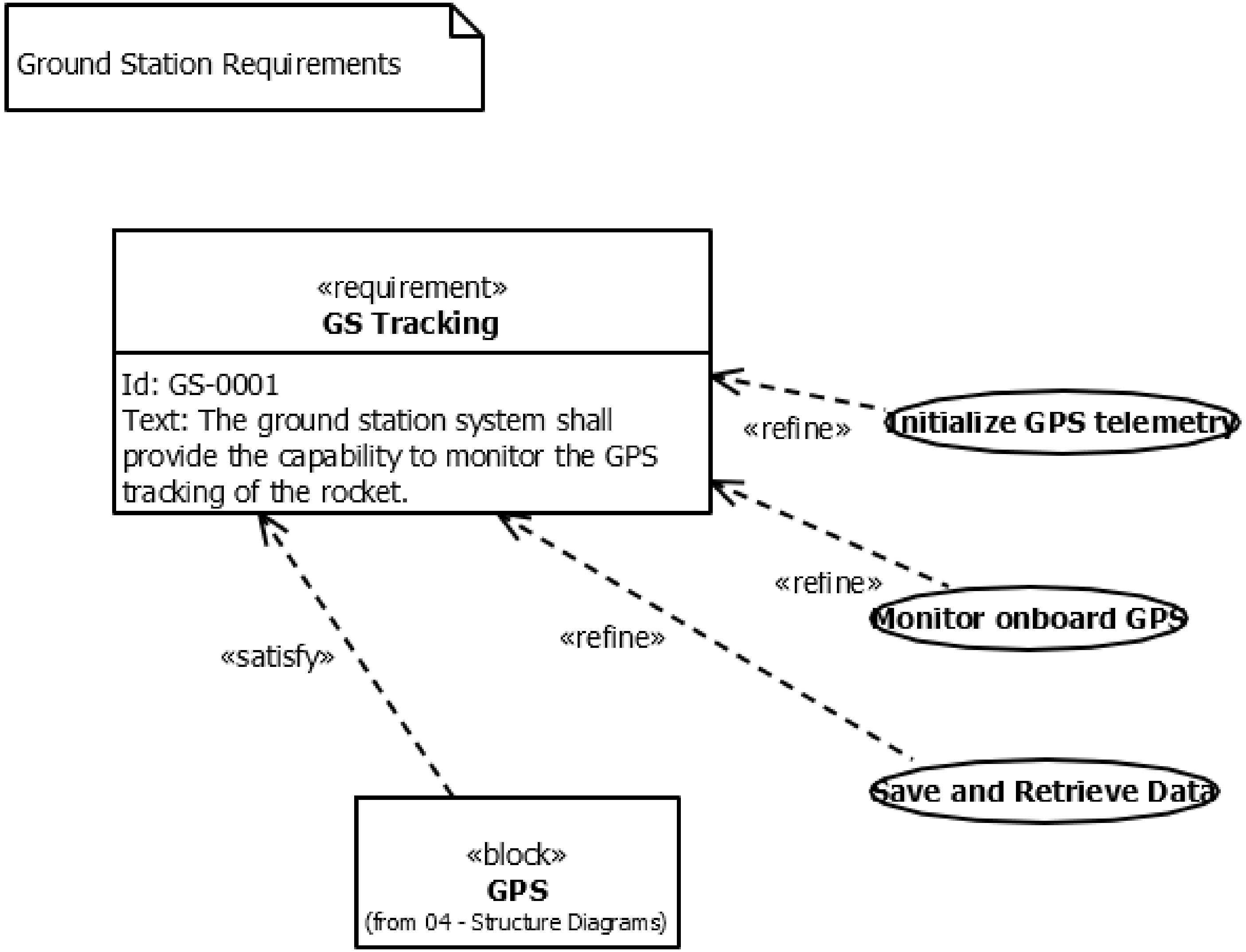
MBSE Requirements Diagram (General - Functional)

- This chart shows the General Requirements Diagrams for the Rocket (which include requirements and tracing to both Requirements and Use Case entries).



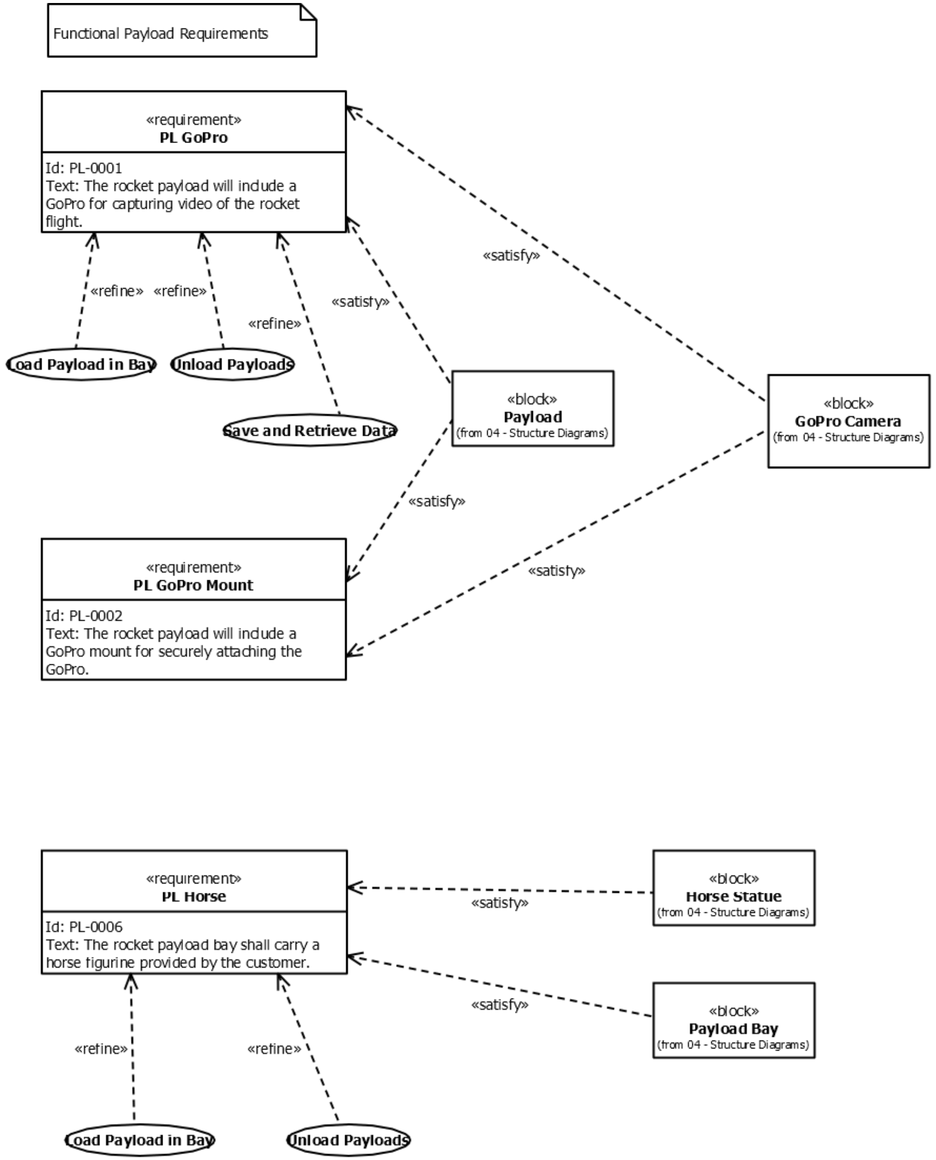
MBSE Requirements Diagram (Ground Station Functional)

- This chart shows the General Requirements Diagrams for the Rocket (which include requirements and tracing to both Requirements and Use Case entries).



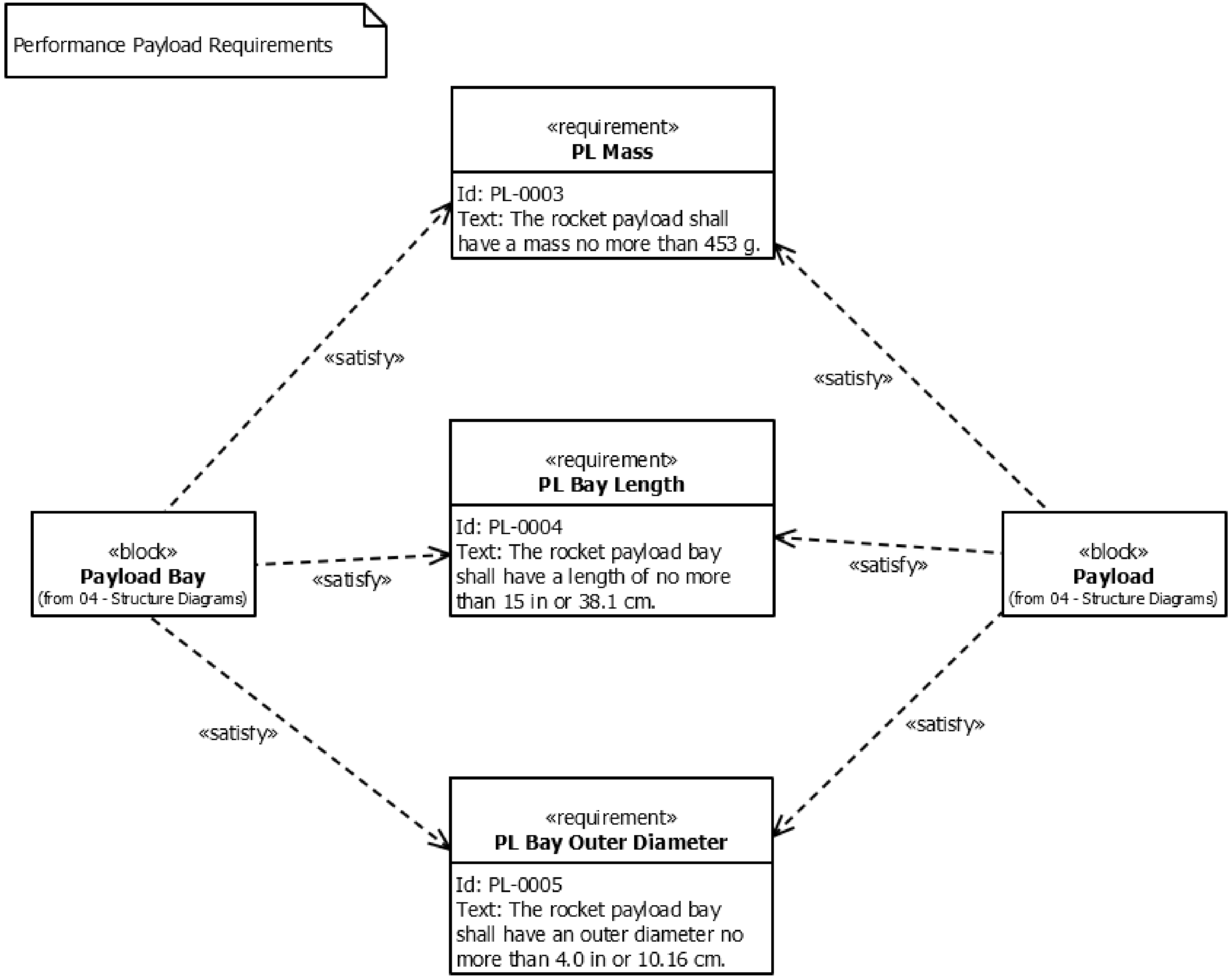
MBSE Requirements Diagram (Payload Functional)

- This chart shows the Payload Functional Requirements Diagrams for the Rocket (which include requirements and tracing to both Requirements and Use Case entries).



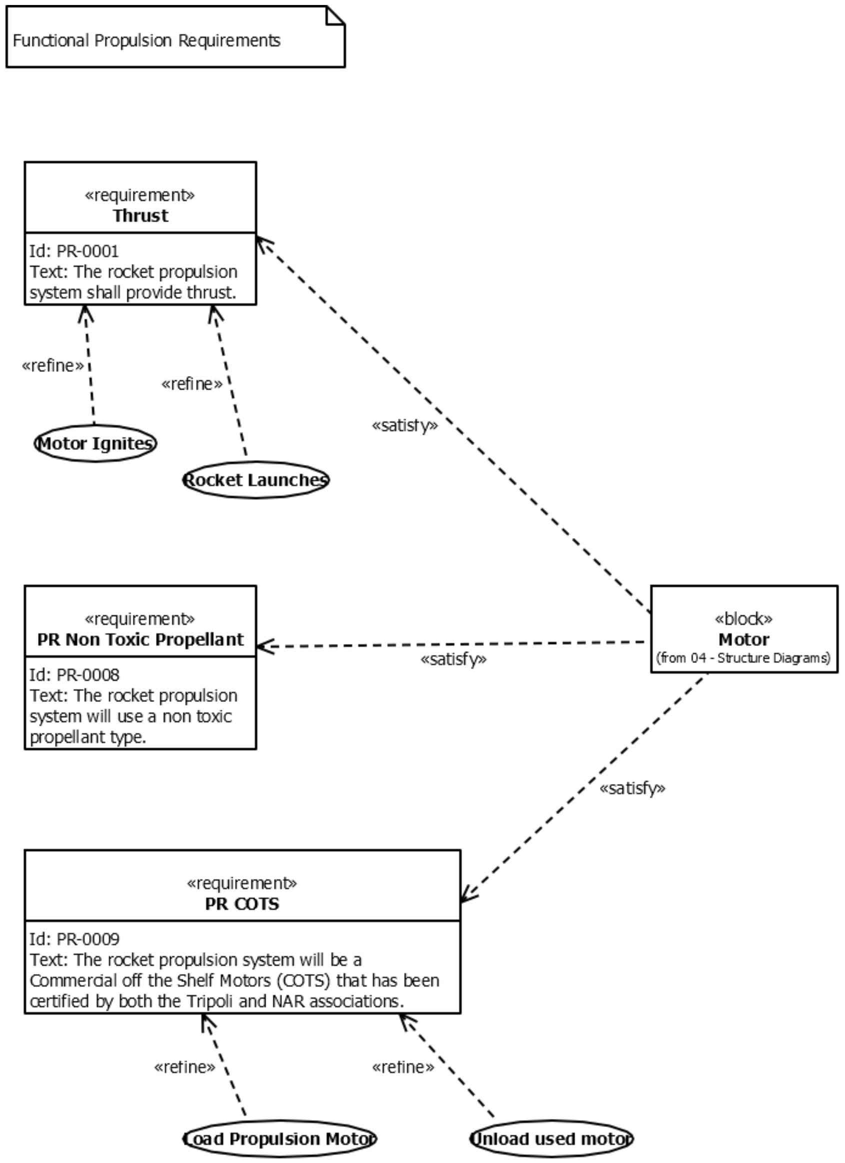
MBSE Requirements Diagram (Payload Performance)

- This chart shows the Payload Performance Requirements Diagrams for the Rocket (which include requirements and tracing to both Requirements and Use Case entries).



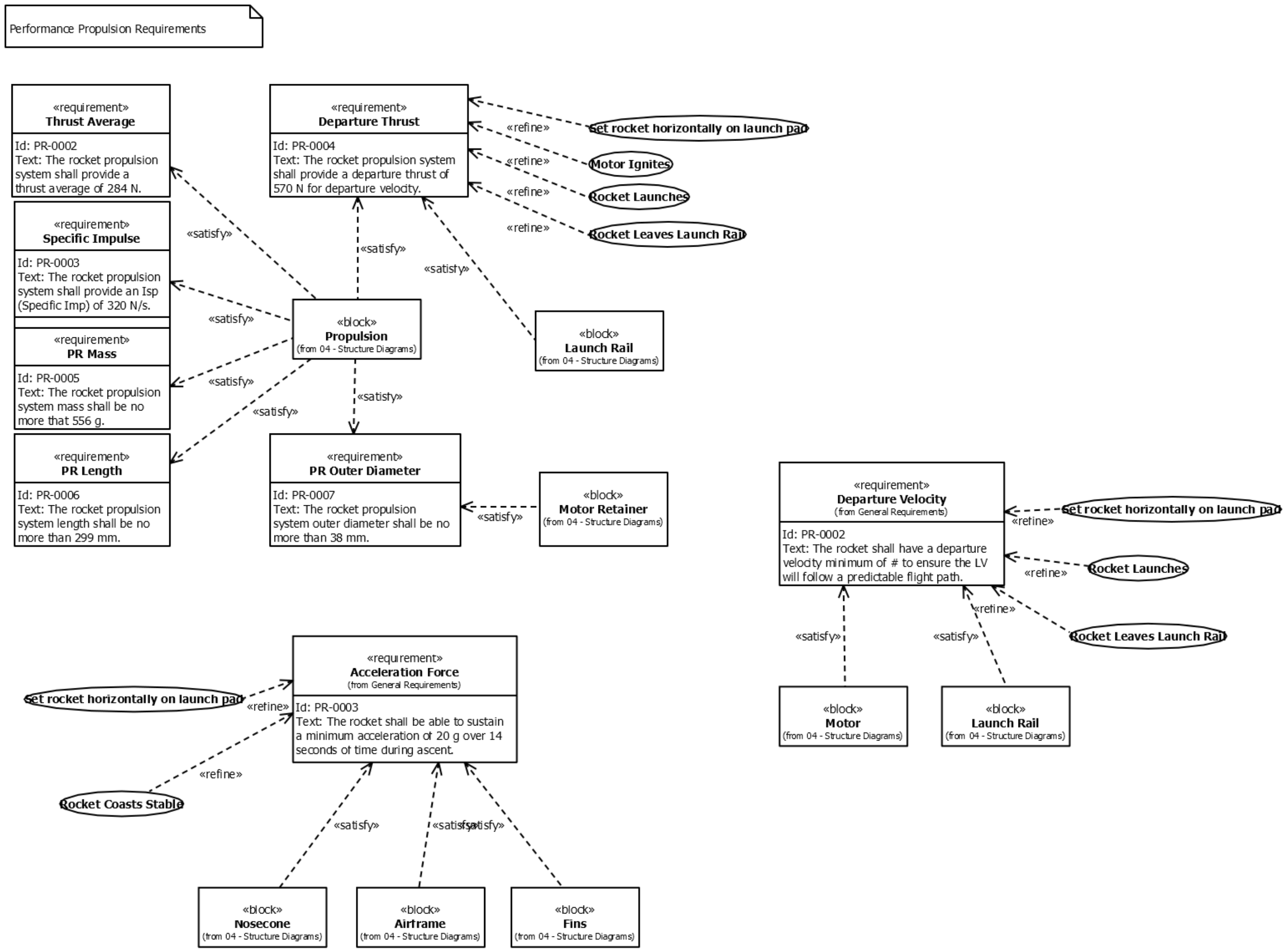
MBSE Requirements Diagram (Functional Propulsion)

- This chart shows the Functional Propulsion Requirements Diagrams for the Rocket (which include requirements and tracing to both Requirements and Use Case entries).



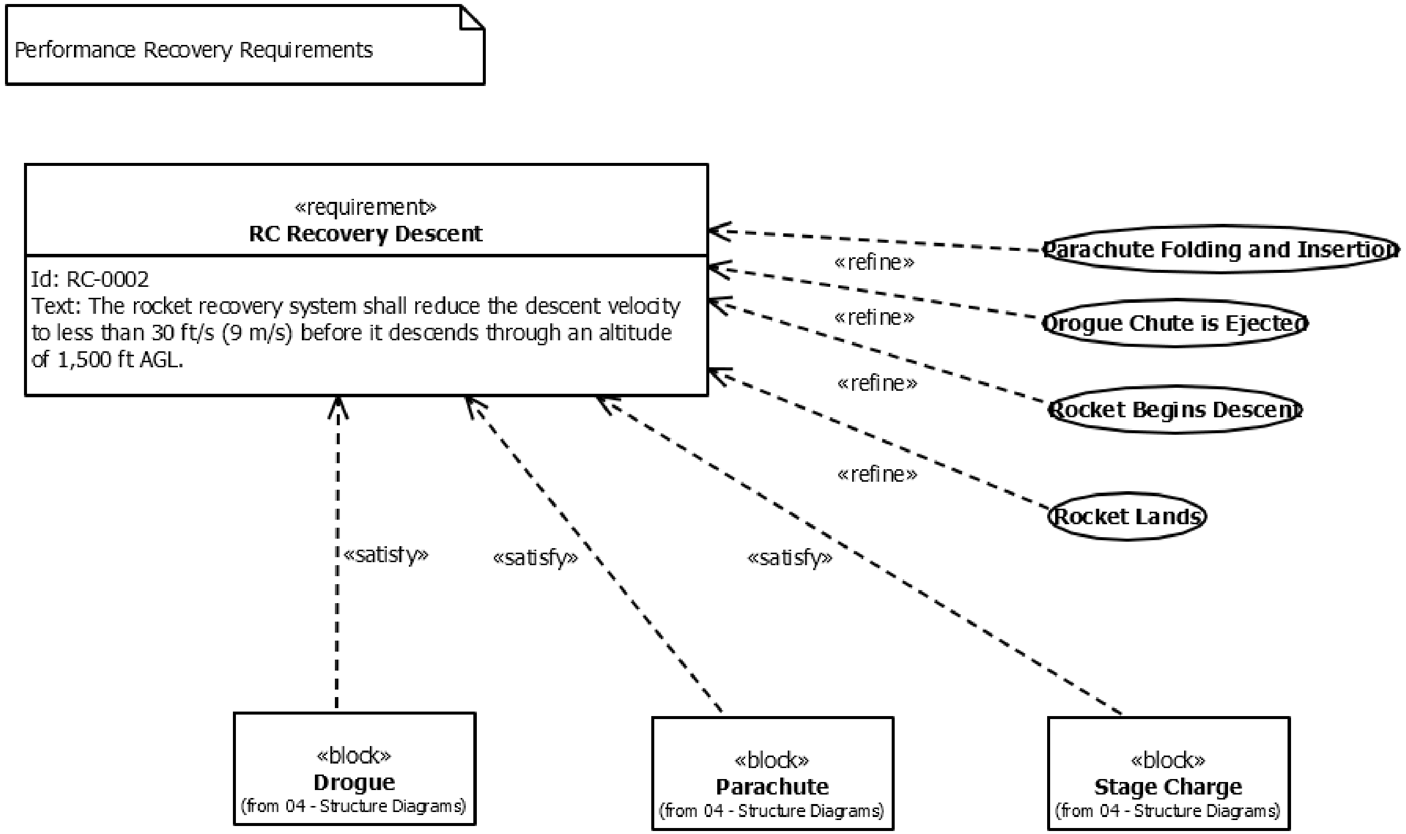
MBSE Requirements Diagram (Performance Propulsion)

- This chart shows the Performance Propulsion Requirements Diagrams for the Rocket (which include requirements and tracing to both Requirements and Use Case entries).



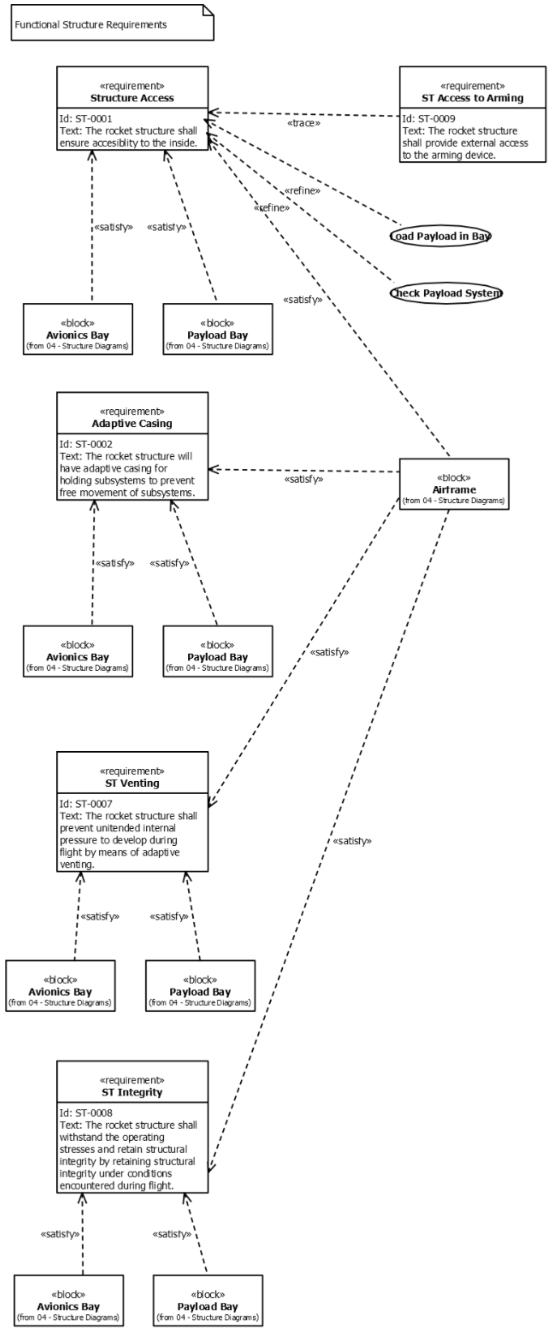
MBSE Requirements Diagram (Performance Recovery)

- This chart shows the Performance Recovery Requirements Diagrams for the Rocket (which include requirements and tracing to both Requirements and Use Case entries).



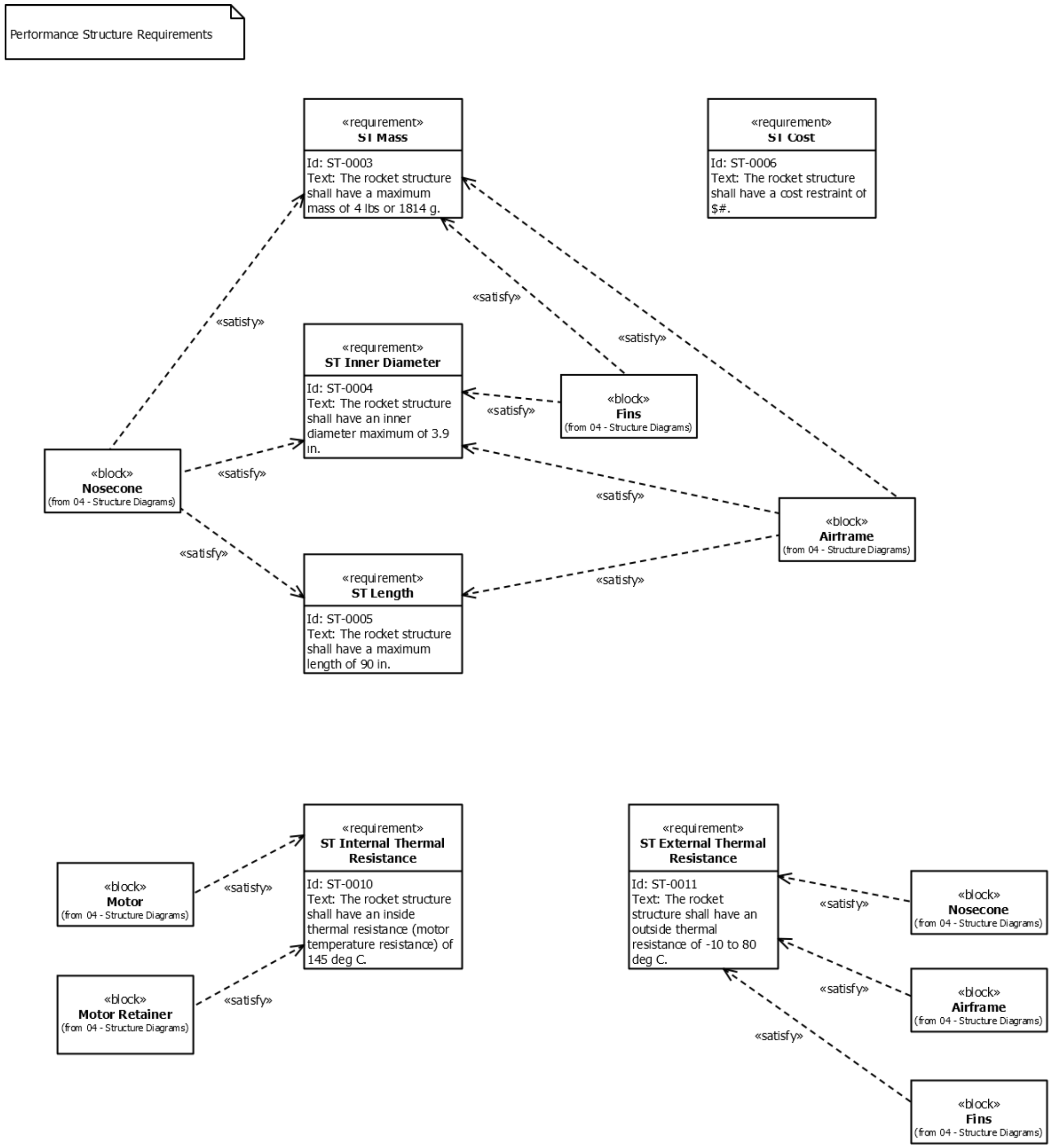
MBSE Requirements Diagram (Functional Structure)

- This chart shows the Functional Structure Requirements Diagrams for the Rocket (which include requirements and tracing to both Requirements and Use Case entries).



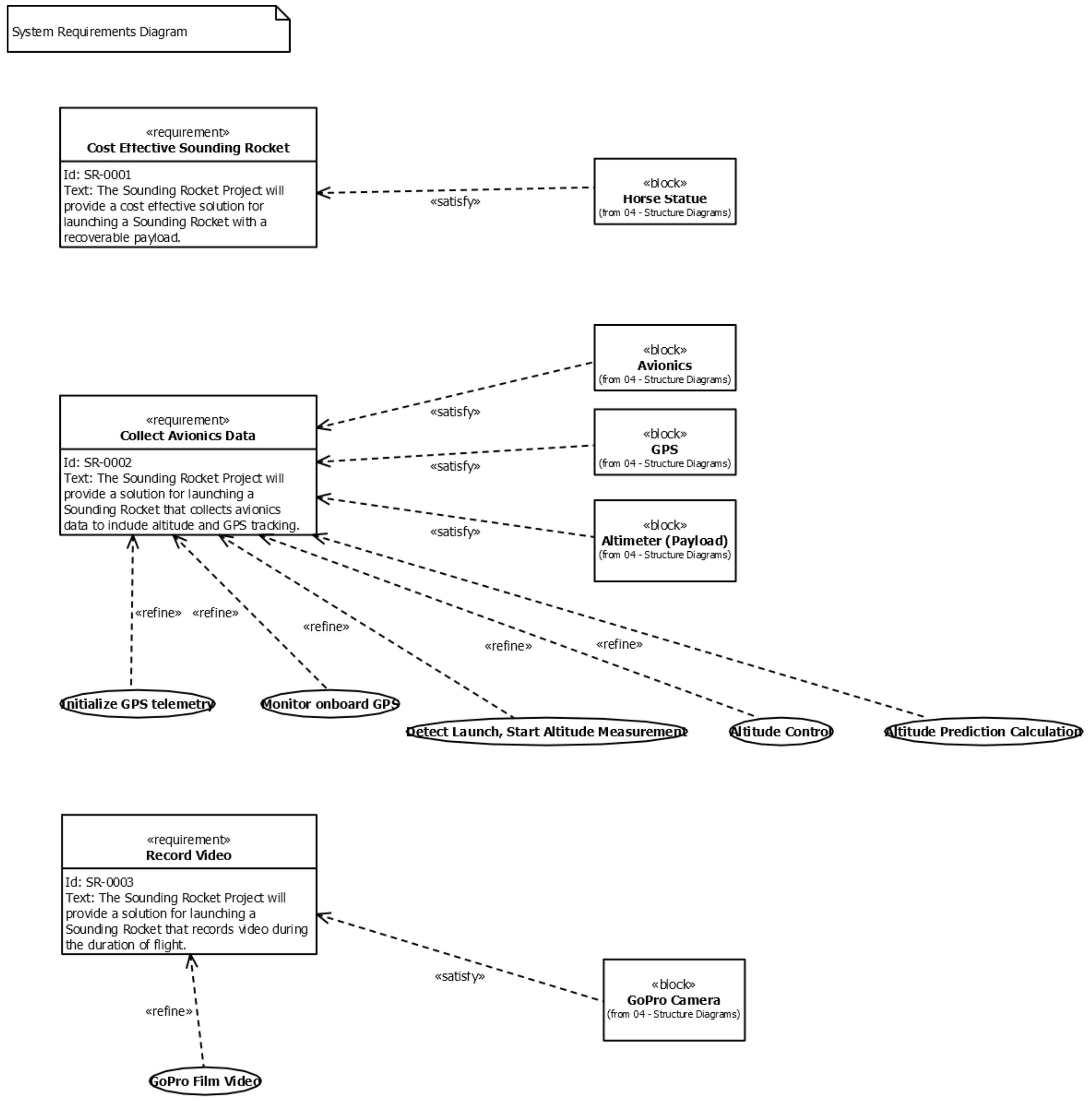
MBSE Requirements Diagram (Performance Structure)

- This chart shows the Performance Structure Requirements Diagrams for the Rocket (which include requirements and tracing to both Requirements and Use Case entries).



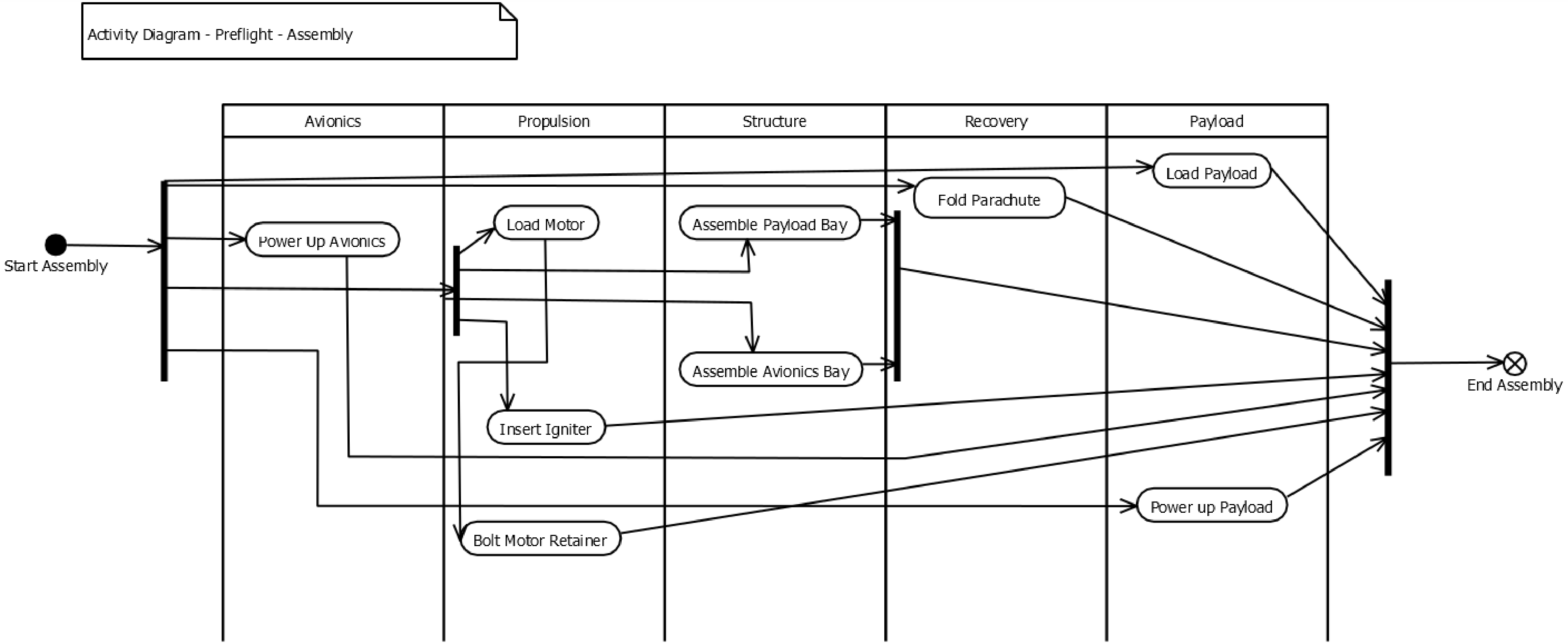
MBSE Requirements Diagram (System Requirements)

- This chart shows the System Requirements Diagrams for the Rocket (which include requirements and tracing to both Requirements and Use Case entries).

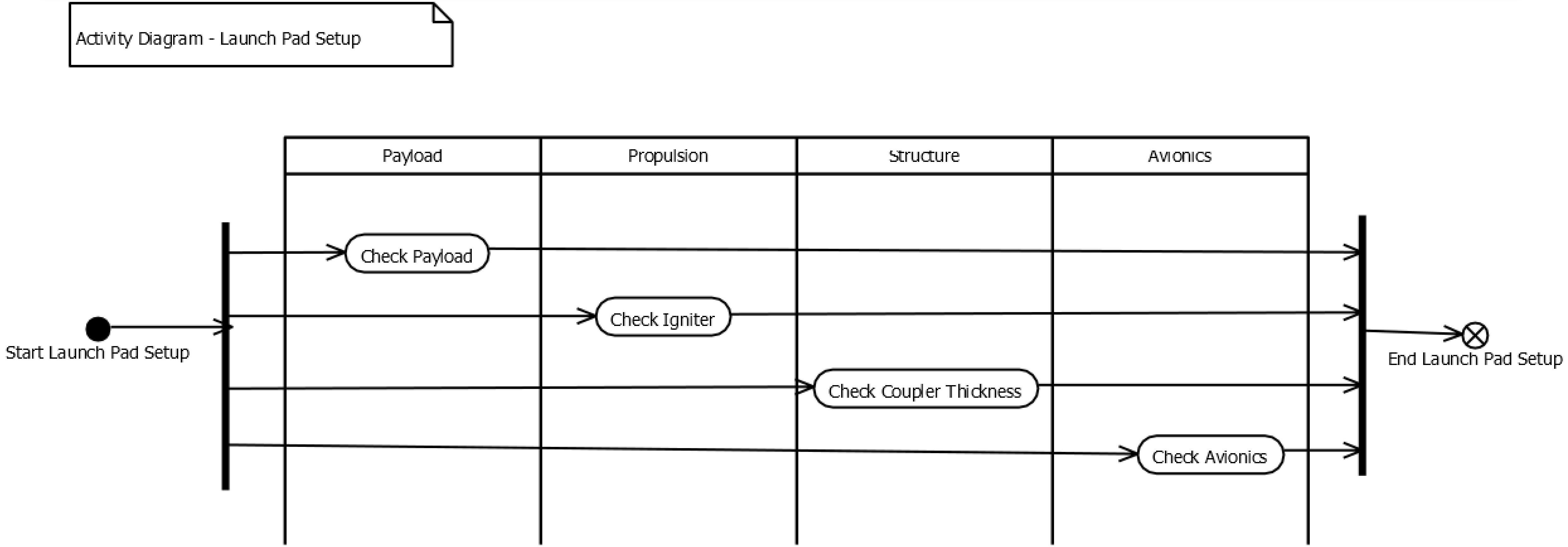


MBSE Activity Diagrams

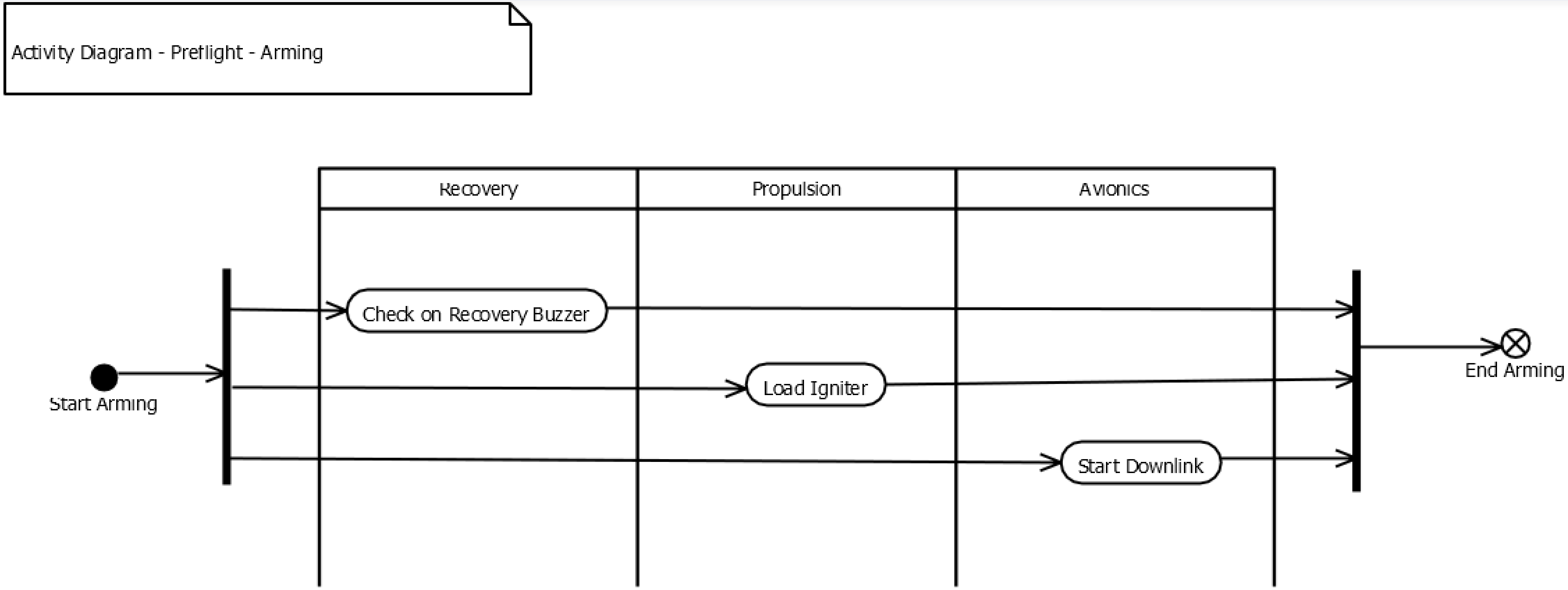
MBSE Activity Diagram (Preflight Assembly)



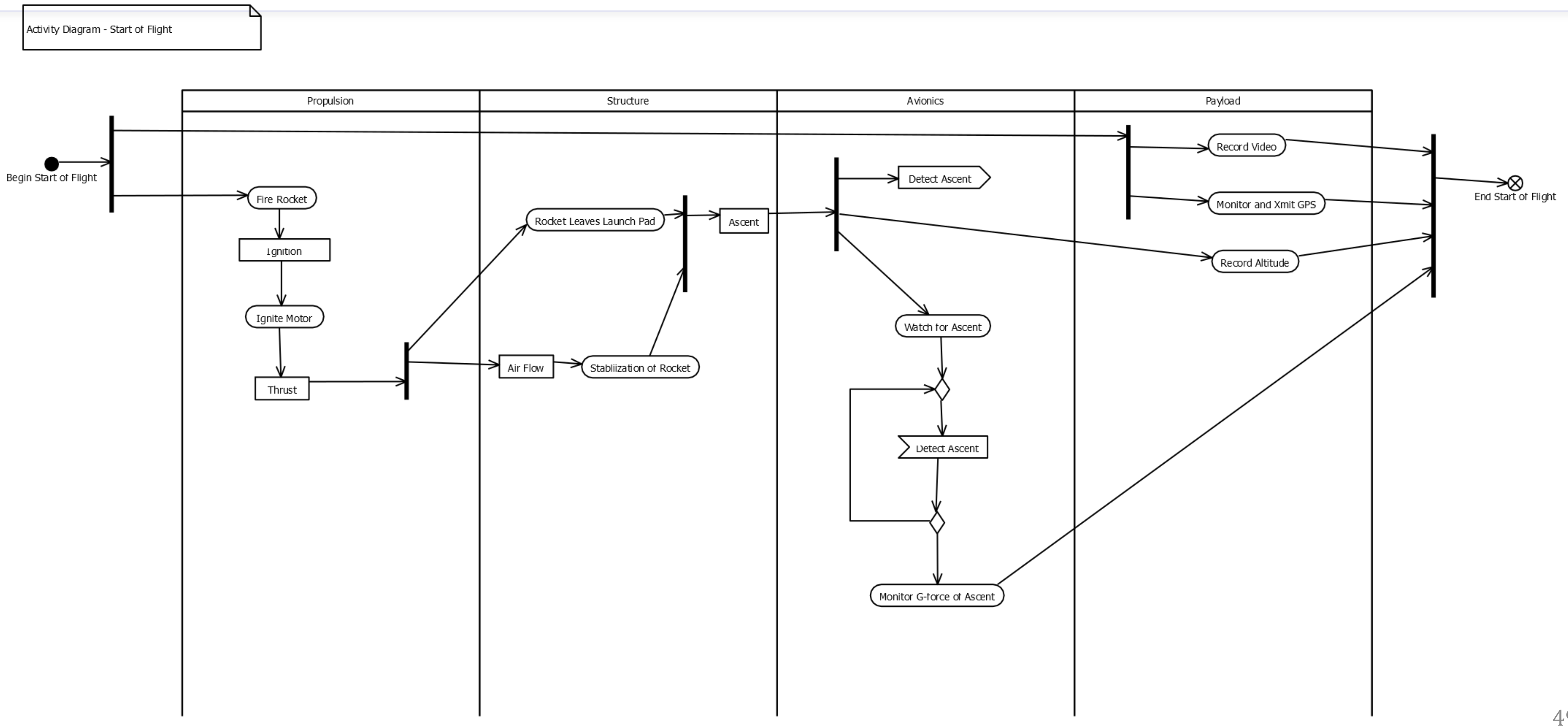
MBSE Activity Diagram (Preflight Launch Pad Setup)



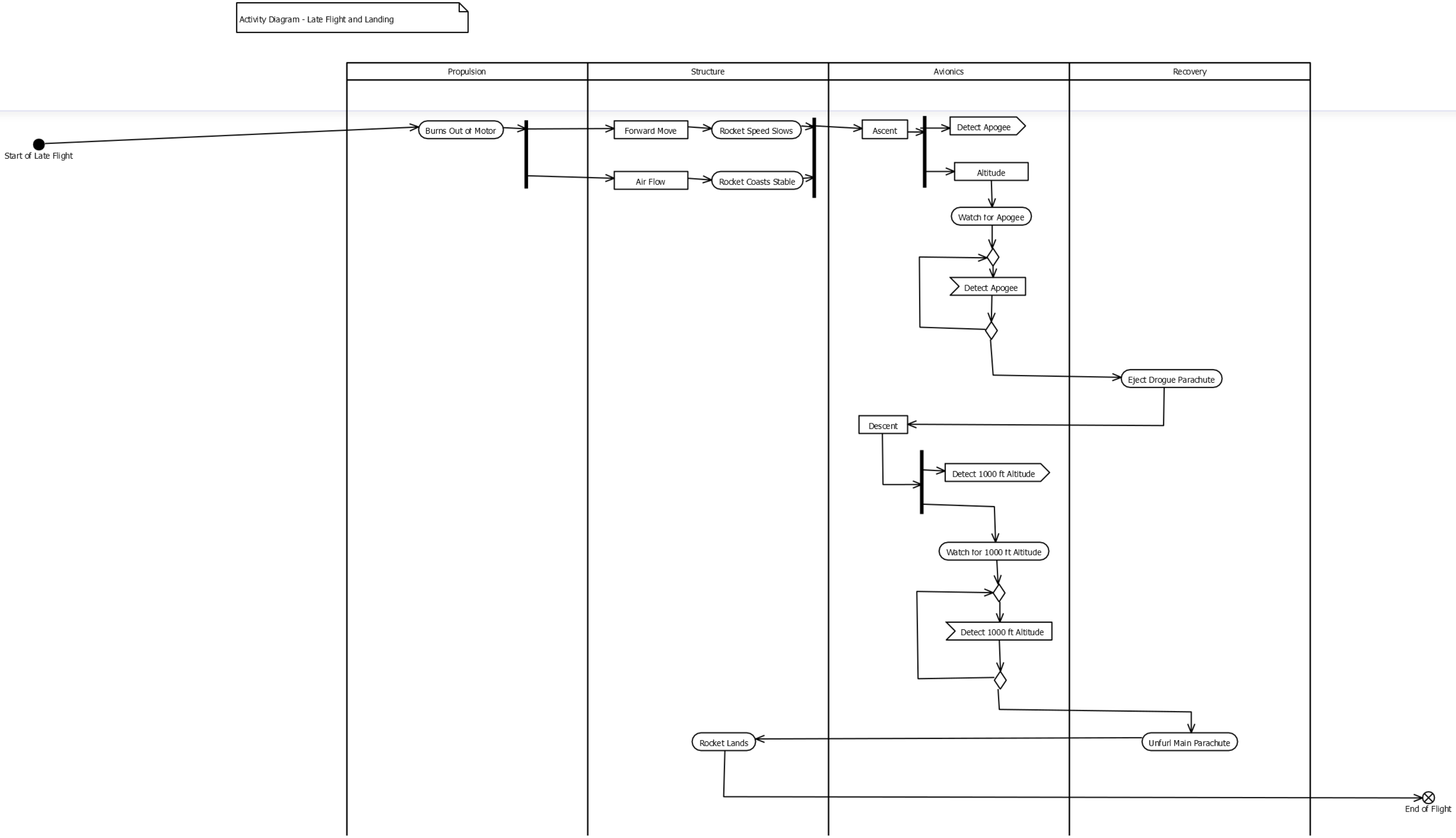
MBSE Activity Diagram (Preflight Rocket Arming)



MBSE Activity Diagram (Start of Flight)



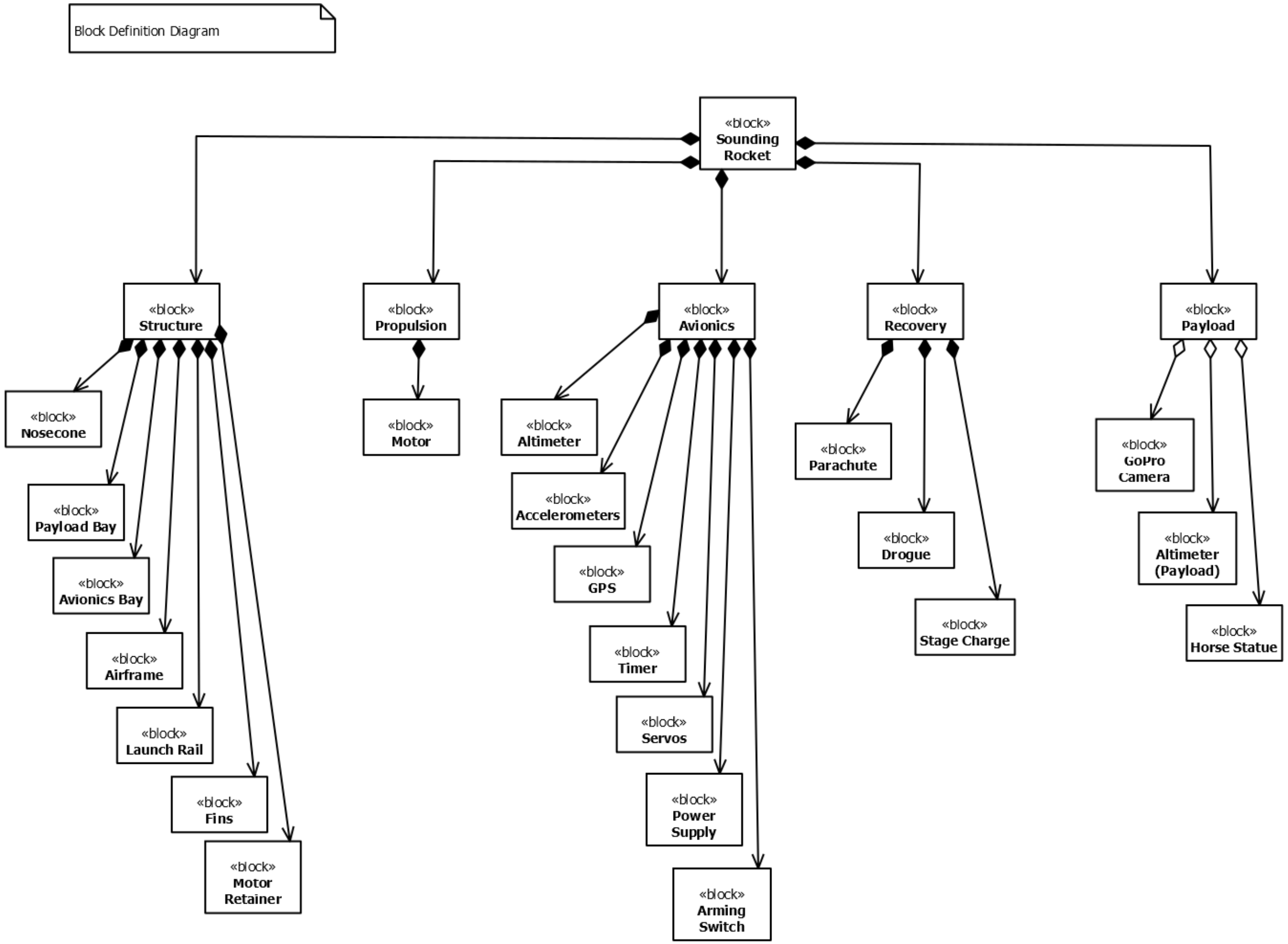
MBSE Activity Diagram (Late Flight)



MBSE Block Definition Diagram

Primary Components of Functional System

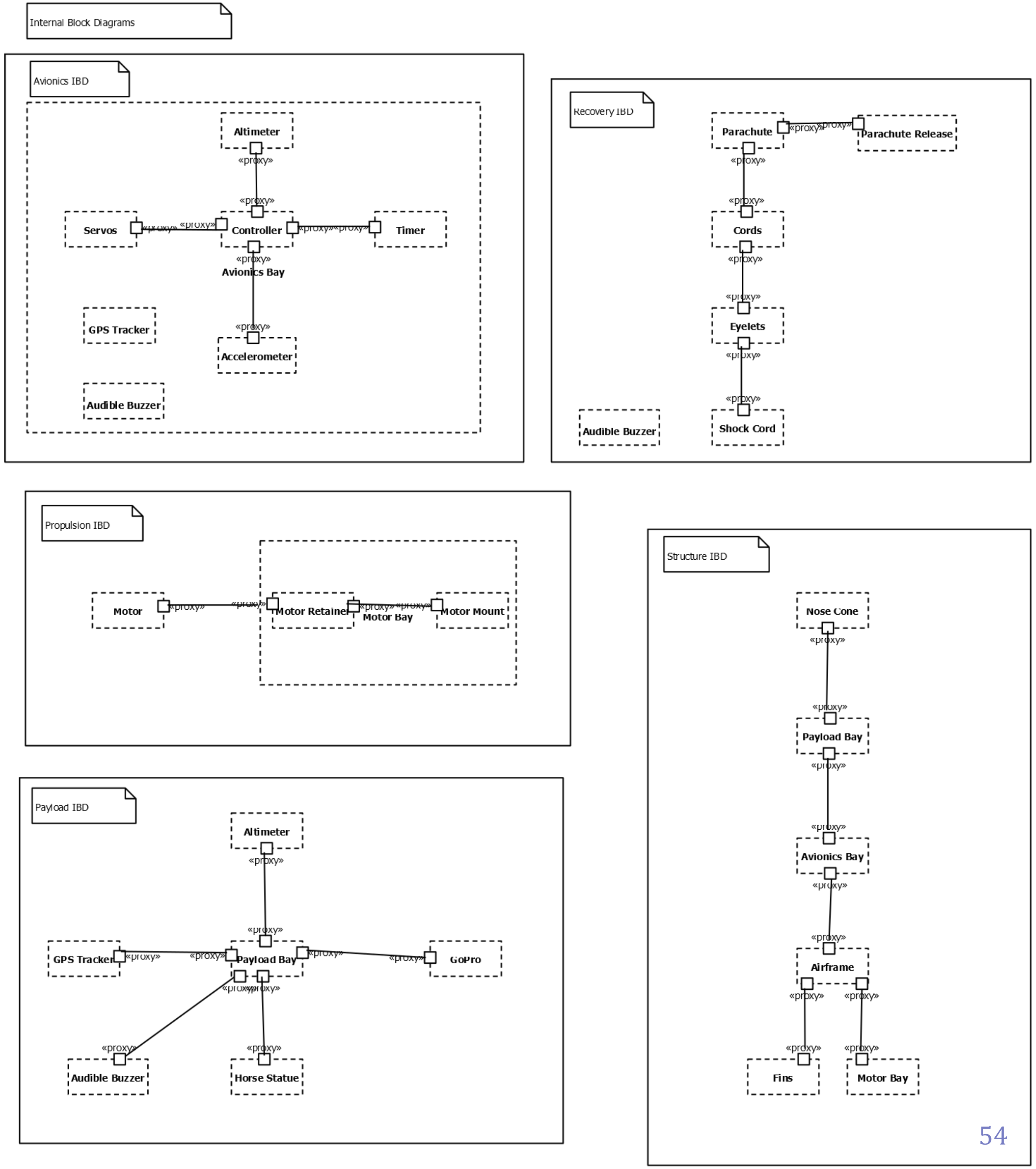
- This chart shows the Functional System MBSE Block Definition Diagram.
- This is a breakdown of the Sounding Rocket's subsystems and Configuration Items in MBSE format.



MBSE Internal Block Diagram

Internal Block Diagram

- This chart shows the Functional System MBSE Internal Block Diagram.
- This is a breakdown of the Sounding Rocket's subsystems and Configuration Items and their connectivity throughout the system.
- The IDB’s are broken into subsystem sections.



Design, Test Models, and Fabrication

Design, Test Models, and Fabrication

- Computer Simulation and Development:
  - Rocksim 10.0 is the platform used by many sport to research-grade launch vehicles (rockets) now.
  - Members of the National Association of Rocketry and Tripoli Rocketry Association use Rocksim for compiling and running flight models and producing new designs.
- Prototype Fabrication and Testing:
  - Actual construction of test rockets to verify the model predictions in Rocksim 10.0.

Design, Test Models, and Fabrication

- Polarity between CONOPS, Requirements, and MBSE models with Rocksim Design:
  - The Rocksim design cross-references between these three documents to ensure design and construction meets requirements.
  - Payload and avionic subsystem CI's are chosen from COTS components that are in accordance with CONOPS, requirements, and MBSE models.
  - Configuration Items for subsystems such as structure, propulsion, and recovery can be easily chosen from the COTS libraries resident on Rocksim and have been used on numerous other rocket designs.

Design, Test Models, and Fabrication

- Analysis of Rocket Size, Mass, Configuration, Bill Of Material and others through Computer Modeling/Simulation:
  - Substantial Time and Financial Cost savings produced through reliable computer models with refreshable COTS rocket material tables, engine type data, and a successful history of testing designs before physical build
  - **Rocksim (v10.0 is current)** has been used for over 13 years to aid the design of effective rocket designs which include thrust/weight ratios, aerodynamics, apogee determinations, and recovery effectiveness.

Design, Test Models, and Fabrication

- The Sounding Rocket depicted was developed with Rocksim 10.0, and the software has flight-simulation and material-mass calculation capability.
- Ultimately, a design verification model shall be made and a PC model for confirmation.
- Benefit: Using effective computer models saves substantial “trial and error” time and expedite the design.

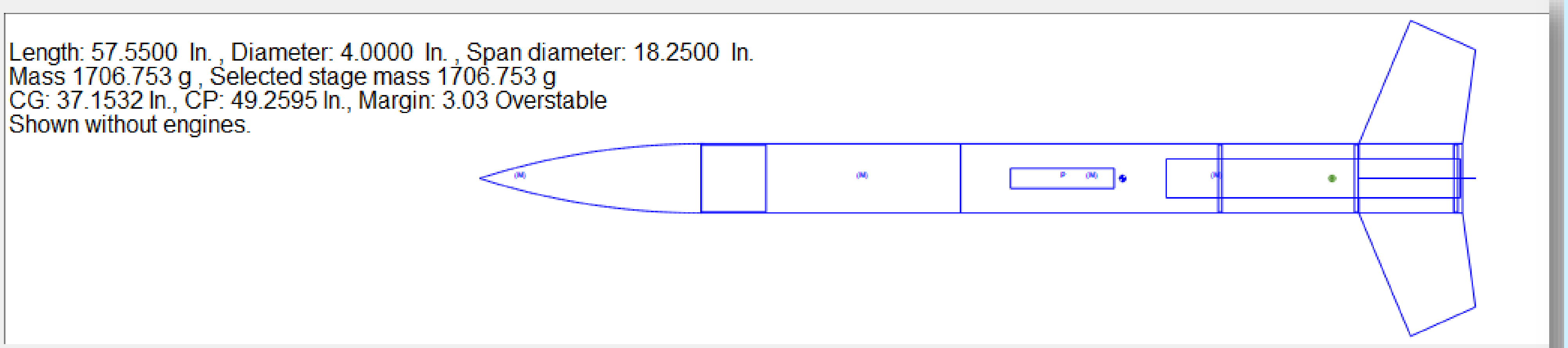
Design, Test Models, and Fabrication

- Small-Grade Sounding Rocket
  - Length: 60.0 In max.
  - Diameter: 4.0 In
  - Span Diameter: 18.25 In
  - Mass: 42 Oz.
  - Maximum Altitude: 4000 ft.

NOTE: These are in accordance with all design documentation, Requirements, CONOPS, and MBSE models.

Design, Test Models, and Fabrication

- The following shows a 2D drawing in Rocksim of the designed sounding rocket.



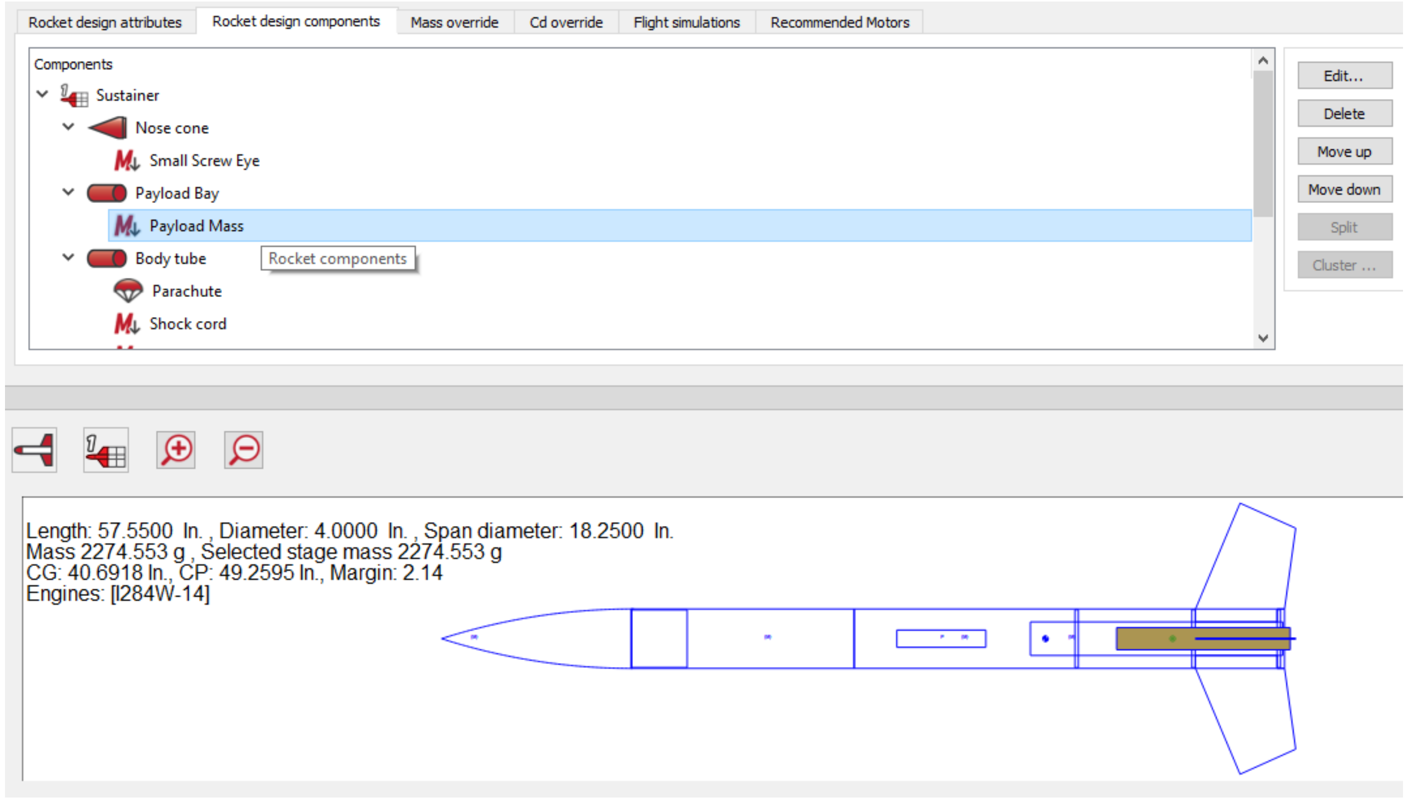
Flight Simulations
(Payload Mass vs Motor Trades)

Flight Simulations (Payload Mass)

Rocksim can permit the use of mass-load objects in different subsystem sections of the rocket to simulate the mass load of payloads, avionics, recovery items, etc.

Rocksim can do hard edits to component mass as well.

The following shows mass-load highlighted that can be adjusted to simulate different payload masses prior to flight.

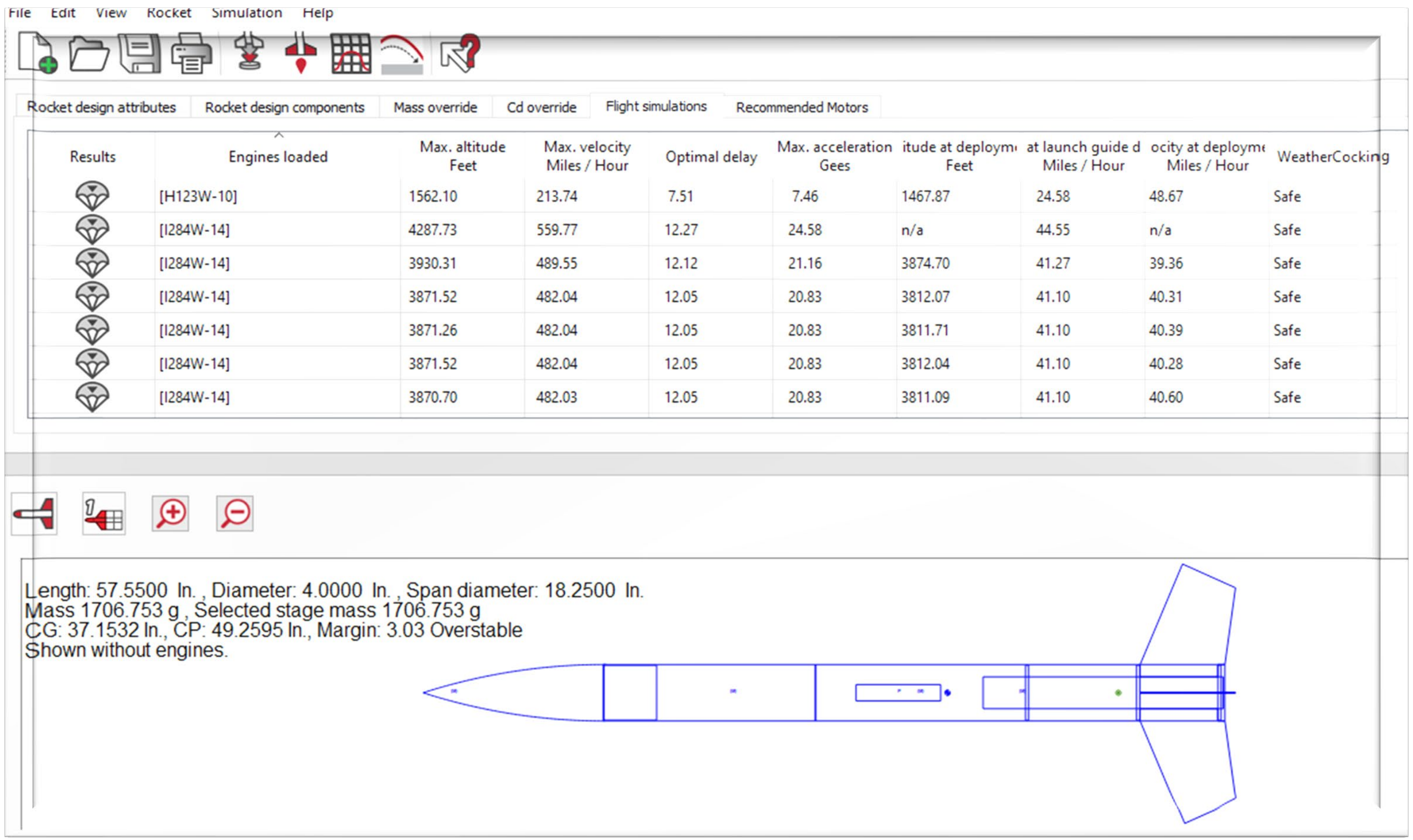


Flight Simulations (Motor Trades)

Rocksim has a large selection of rocket motors built in that can be refreshed online and can be used for simulation-based trade studies of motors that will work with the design.

The best motors for flight simulation are shown and are H and I motors (Class I rocket motors per NAR and Tripoli rocketry standards).

Motor to be used is an I284-14 which will achieve the 4000 ft altitude requirement.

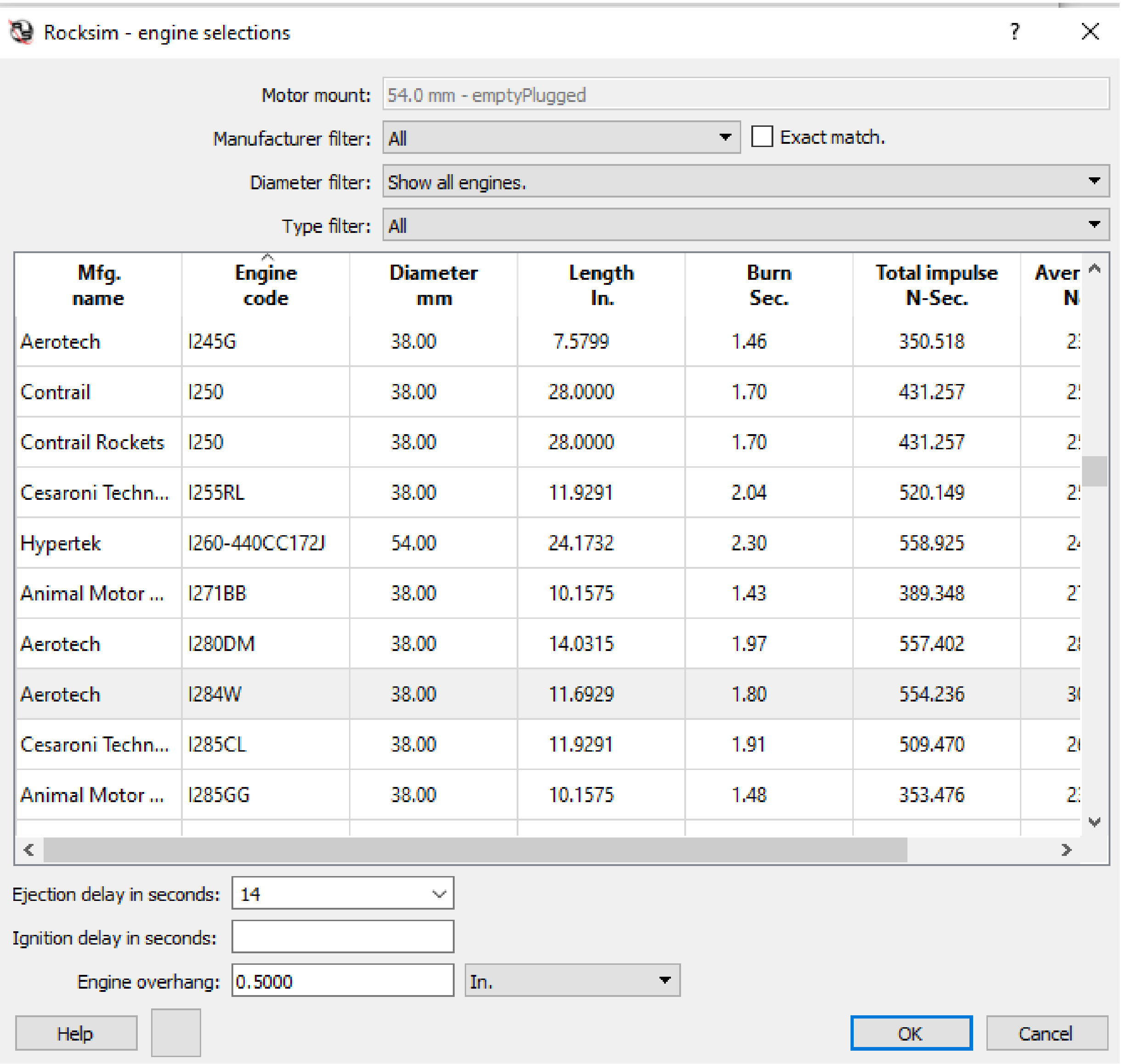


Results	Engines loaded	Max. altitude Feet	Max. velocity Miles / Hour	Optimal delay	Max. acceleration Gees	itude at deployme Feet	at launch guide d Miles / Hour	ocity at deployme Miles / Hour	WeatherCocking
	[H123W-10]	1562.10	213.74	7.51	7.46	1467.87	24.58	48.67	Safe
	[I284W-14]	4287.73	559.77	12.27	24.58	n/a	44.55	n/a	Safe
	[I284W-14]	3930.31	489.55	12.12	21.16	3874.70	41.27	39.36	Safe
	[I284W-14]	3871.52	482.04	12.05	20.83	3812.07	41.10	40.31	Safe
	[I284W-14]	3871.26	482.04	12.05	20.83	3811.71	41.10	40.39	Safe
	[I284W-14]	3871.52	482.04	12.05	20.83	3812.04	41.10	40.28	Safe
	[I284W-14]	3870.70	482.03	12.05	20.83	3811.09	41.10	40.60	Safe

Flight Simulations (Motor Trades)

Rocket motors can be loaded for simulations to determine maximum flight altitude as well as flight stability.

Mass loads of payloads can be added to the rocket which will adjust the center of mass for the rocket relative to mass of the motor.



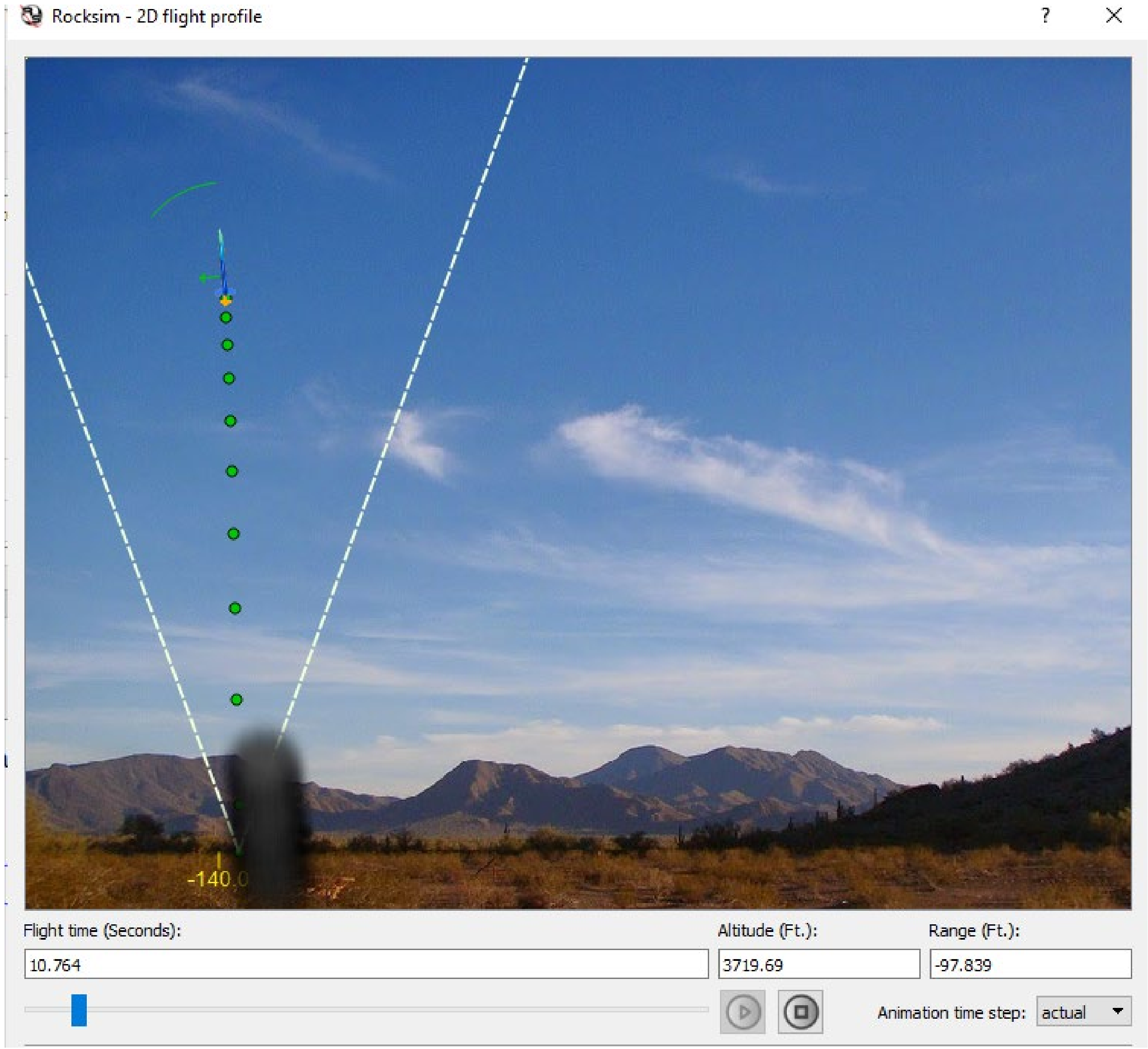
Mfg. name	Engine code	Diameter mm	Length In.	Burn Sec.	Total impulse N-Sec.	Aver N
Aerotech	I245G	38.00	7.5799	1.46	350.518	2
Contrail	I250	38.00	28.0000	1.70	431.257	2
Contrail Rockets	I250	38.00	28.0000	1.70	431.257	2
Cesaroni Techn...	I255RL	38.00	11.9291	2.04	520.149	2
Hypertek	I260-440CC172J	54.00	24.1732	2.30	558.925	2
Animal Motor ...	I271BB	38.00	10.1575	1.43	389.348	2
Aerotech	I280DM	38.00	14.0315	1.97	557.402	2
Aerotech	I284W	38.00	11.6929	1.80	554.236	3
Cesaroni Techn...	I285CL	38.00	11.9291	1.91	509.470	2
Animal Motor ...	I285GG	38.00	10.1575	1.48	353.476	2

Flight Simulations (payload mass versus motor selection)

Rocksim simulation (shown here) utilizes a Class I motor designation I284-14 which is the best motor given the rocket's mass, payload mass, and airframe/fin design.

Altitude achieved is 4000 ft AGL, with drogue deployment at 3800 ft AGL.

Main parachute will deploy at 1000 ft AGL in accordance with System Requirements.

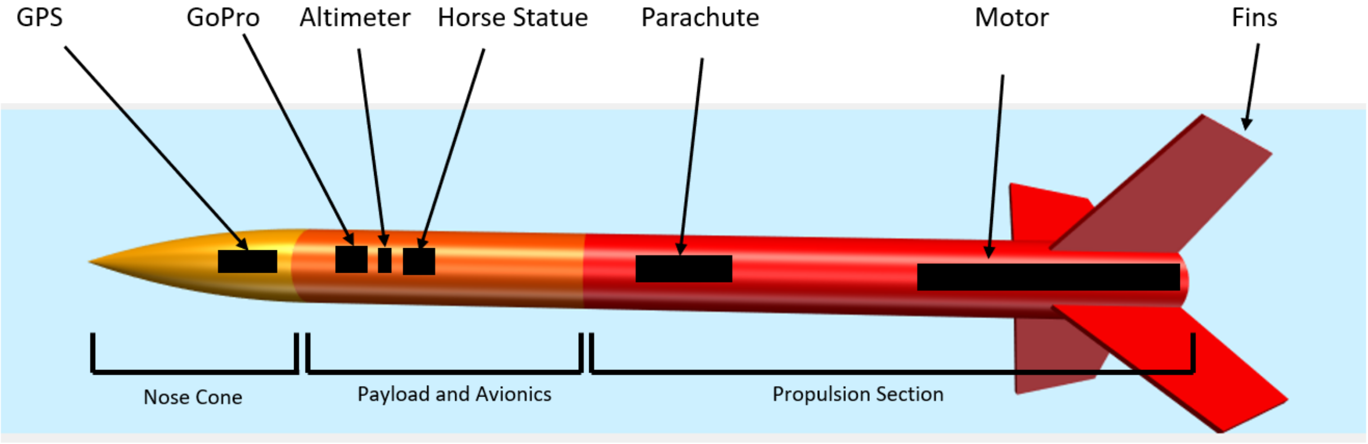


Configuration Items (CIs)

Cindy

CI Allocation – COTS Products

- CI COTS Products have been chosen and satisfy requirements
- Rocksim Trade Study Analysis
- CI Requirement Verification



Structure – LOC Precision

- Satisfies System and CI requirements for Body, Cone, Fins and Frame.
- Houses all components
- Total cost: $100.00.

Propulsion - AEROTECH PROPELLANT KIT

- Apogee Components AEROTECH 38MM PROPELLANT KIT - I284W-14A
- Satisfies all requirements for providing initial thrust and average thrust to the flight vehicle for reaching the desired altitude
- Total Cost: $75.96

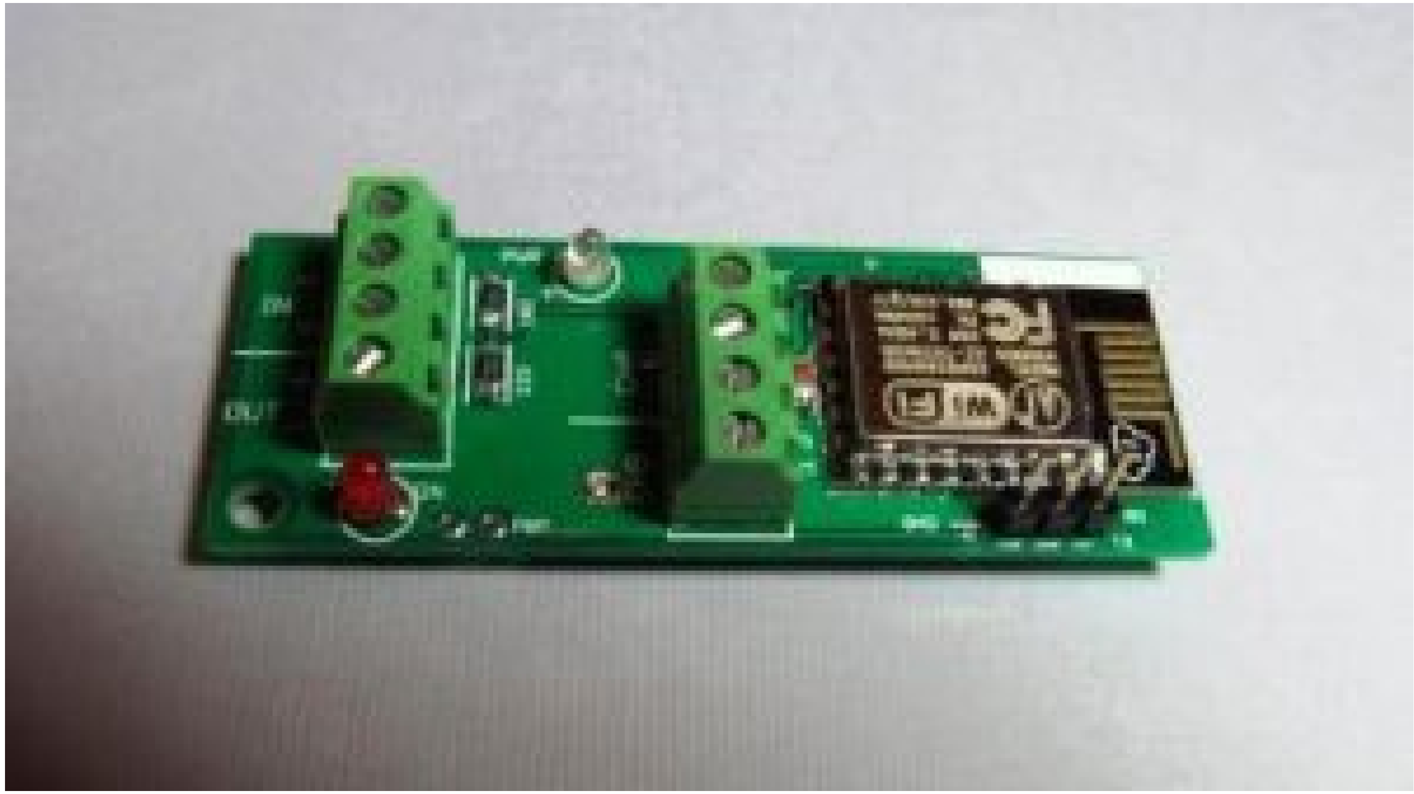
Propulsion - AEROTECH PROPELLANT KIT

- **Model:** 81351
- **Qty per pack:** 1 motor & 1 igniter
- **Size:** 38 mm Reload
- **Delay:** 14 sec
- **Burn Time:** 1.9 sec
- **Total Impulse:** 607.3 Newton-seconds
- **Motor Length:** 288 mm
- **Max Thrust:** 570.6 Newtons
- **Total Mass:** 568.0 g
- **Propellant Mass:** 315.9 g
- **Igniter Included:** First Fire Starter for High Power Motors

Avionics - Eggtimer Quantum Flight Computer

- Satisfies System and CI requirements for flight computer, accelerometer, timer, servos, and altimeter.
- Only option available that combines all of these.
- Total cost: $40.00.

Avionics - Eggtimer Arming Switch



- Satisfies Arming Switch System and CI requirements.
- Permits avionics to be armed remotely via wi-fi connection without complicated switches built into the rocket airframe.
- Total cost: $20.00.

Avionics - Featherweight GPS Tracker

- Satisfies GPS System and CI requirements.
- Between avionics and PC/phone app, provides exact GPS location in X-Y-Z axis space.
- Total cost: $200.00.

Avionics - Power Supply

- Satisfies Power Supply System and CI requirements
- Provides power source to all onboard avionics.
- Total cost: $10.00

Payload - GoPro Hero 9

- Satisfies all requirements for capturing video during rocket flight
- Chosen due to its friendly usability, compact design, and powerful performance for action filming
- Toal Cost: $350.00

Payload - GoPro Hero 9

GoPro Hero 9	Description
Photo	20MP + Super Photo with HDR
Video	5.3K60
100Mbps Bit Rate	5.3K / 4K / 2.7K
Video Stabilization	Hyper Smooth 4.0
Horizon Leveling	In-Camera
Digital Lenses / FOV	Super View, Wide, Linear, Linear + Horizon-Leveling, Narrow
Front Screen	1.4" Color LCD with Live Preview and Status
Mods	Media Mod (HERO10 Black)
Time Warp Video	Time Warp 3.0
Slow-Mo	8x (2.7K, 1080p)
Hindsight	Yes
Scheduled Capture	Yes
Duration Capture	Yes
Compatible Housing	Protective Housing (HERO10 Black)
Processor	GP2

Payload - 002246 Estes Altimeter

- Customer Provided Altimeter
- Satisfies Requirements for capturing Altitude data during rocket flight
- Used purely for collecting altitude data to be collected post flight

Payload - Horse Figurine

- Provided by the customer and is a representation of the school's mascot
- The horse figurine does not have any contributions to the sounding rocket system in a technical sense and will be secured by the payload bay insulation causing no issues concerning space and weight

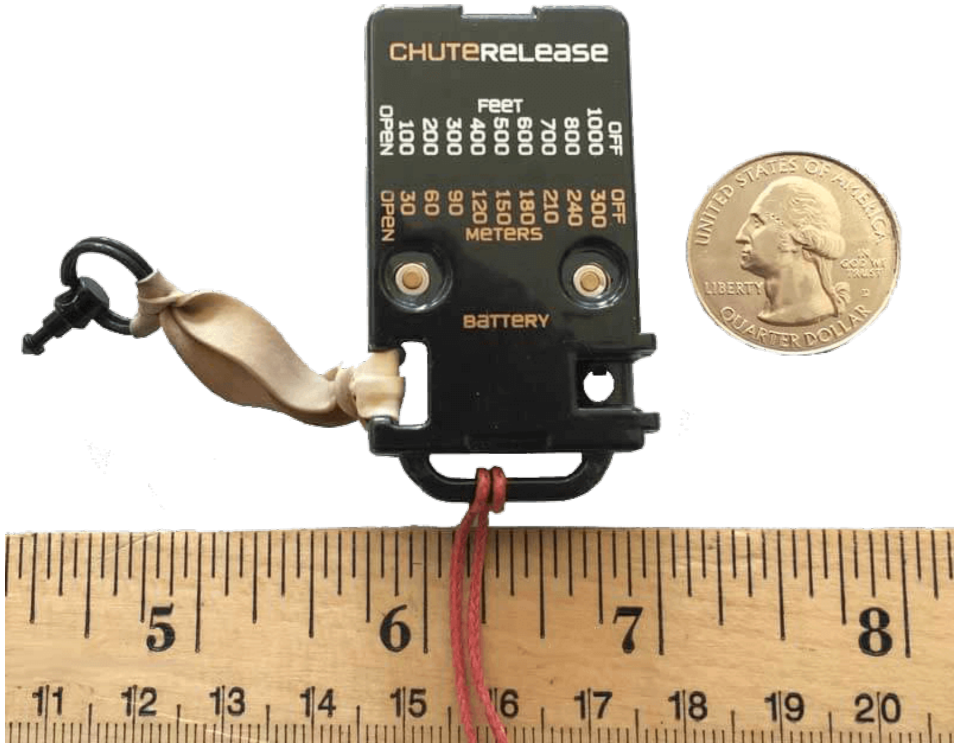
Kino Junior High School

Home of the Kolts

Recovery - Parachute LOC Precision

- Satisfies parachute System and CI requirements.
- Diameter: 36 inches.
- Total Cost: $5.00

Recovery - Drogue Jolly Logic Parachute Release



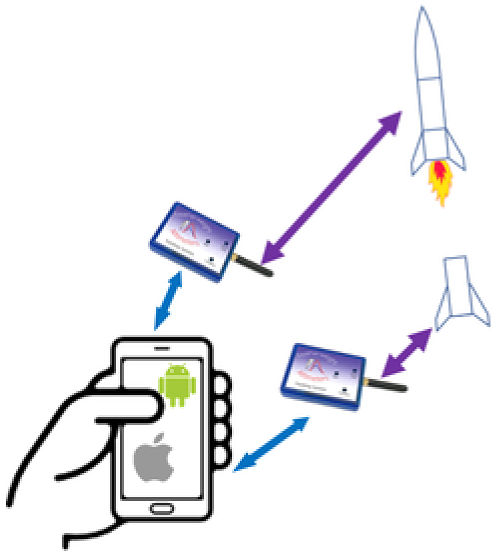
- Satisfies drogue functions via System and CI requirements.
- Holds main parachute closed until rocket descends to low altitude.
- Total Cost: $125.00.

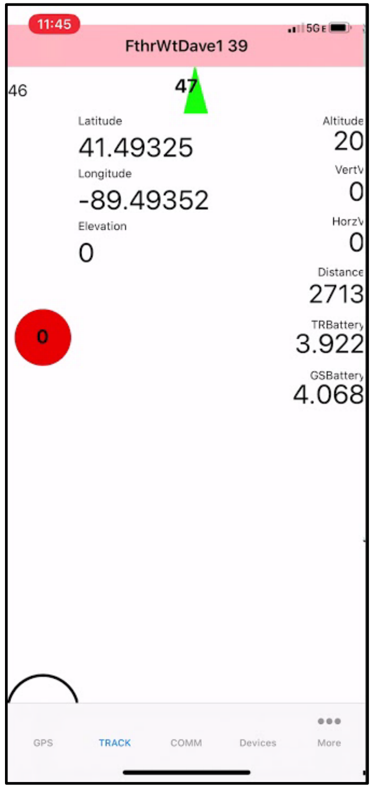
Recovery - Ejection Charge Apogee Rockets

- Satisfies ejection charge via System and CI requirements.
- Ejects drogue and main parachutes when flight computer determines rocket apogee is achieved.
- Total Cost: $20.00

Ground Station - Featherweight GPS Tracker

- Satisfies GPS Tracking CI requirements.
- Tracks Location and Altitude of the rocket while in flight and during recovery
- Cost: Free





Risk

Austin

Risk Mitigation Plan

- Risk Mitigation Plan focuses on:
  - Types of Risk
    - Technical Risk
    - Cost Risk
    - Schedule Risk
    - Programmatic Risk
  - Risk Mitigation
    - Risk Planning
    - Risk Identification
    - Risk Assessment
    - Risk Analysis
    - Risk Handling

Risk Qualitative Assessment Key

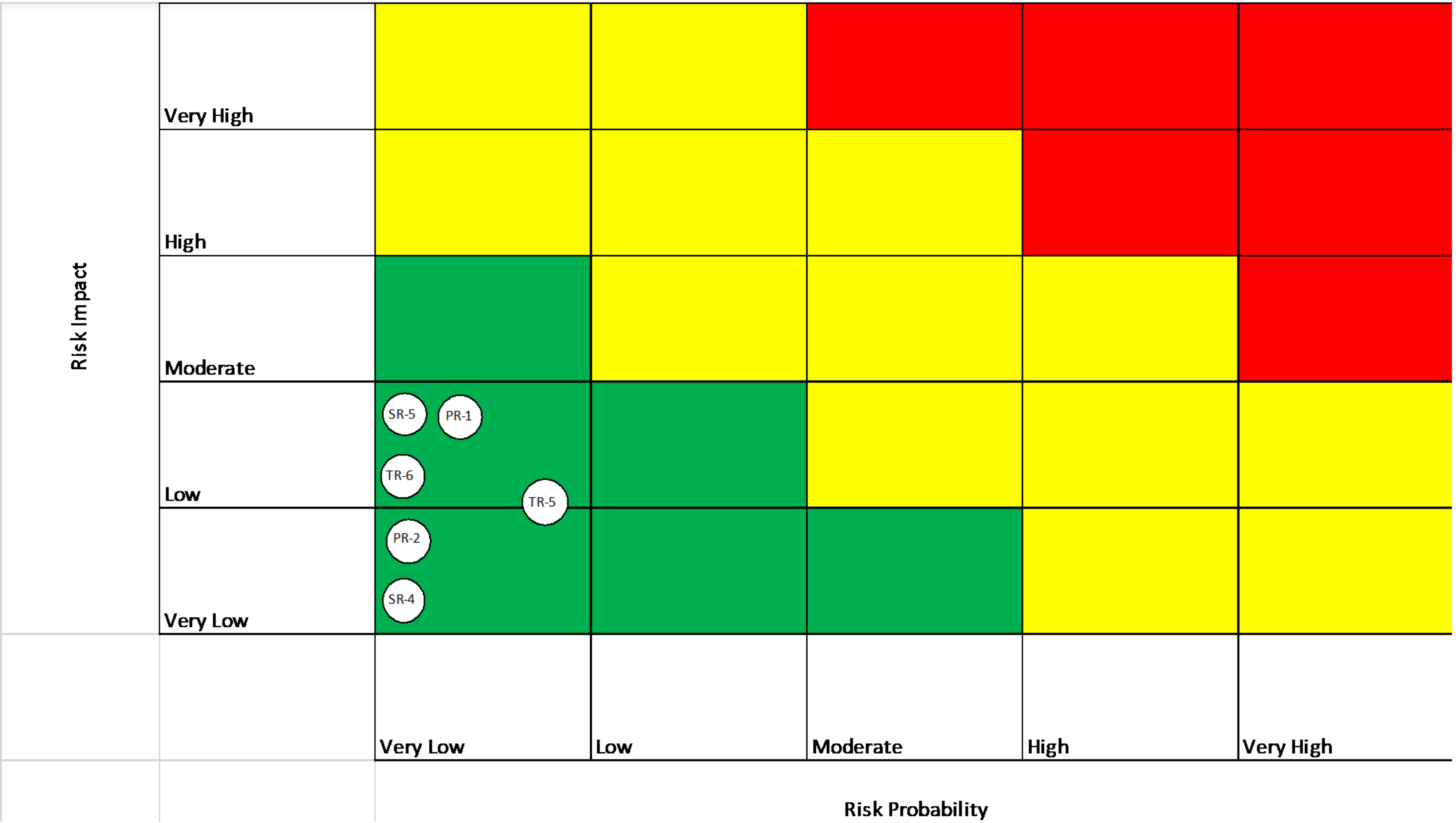
Risk Probablity Key	Probablity Description
Very Low	5% or lower, it is very unlikely to occur.
Low	Between 5 and 20%, it is very unlikely to occur.
Moderate	Between 20 and 50%, unlikely to occur.
High	Between 50 and 75%, likely to occur.
Very High	Greater than 75%, very likely to occur.

Risk Magnitude Key	Impact Description
Very Low	Less than 1% impact on scope, schedule, cost, or quality.
Low	Less than 5% impact on scope, schedule, cost, or quality.
Moderate	Less than 10% impact on scope, schedule, cost, or quality.
High	Less than 20% impact on scope, schedule, cost, or quality.
Very High	Greater than 20% impact on scope, schedule, cost, or quality.

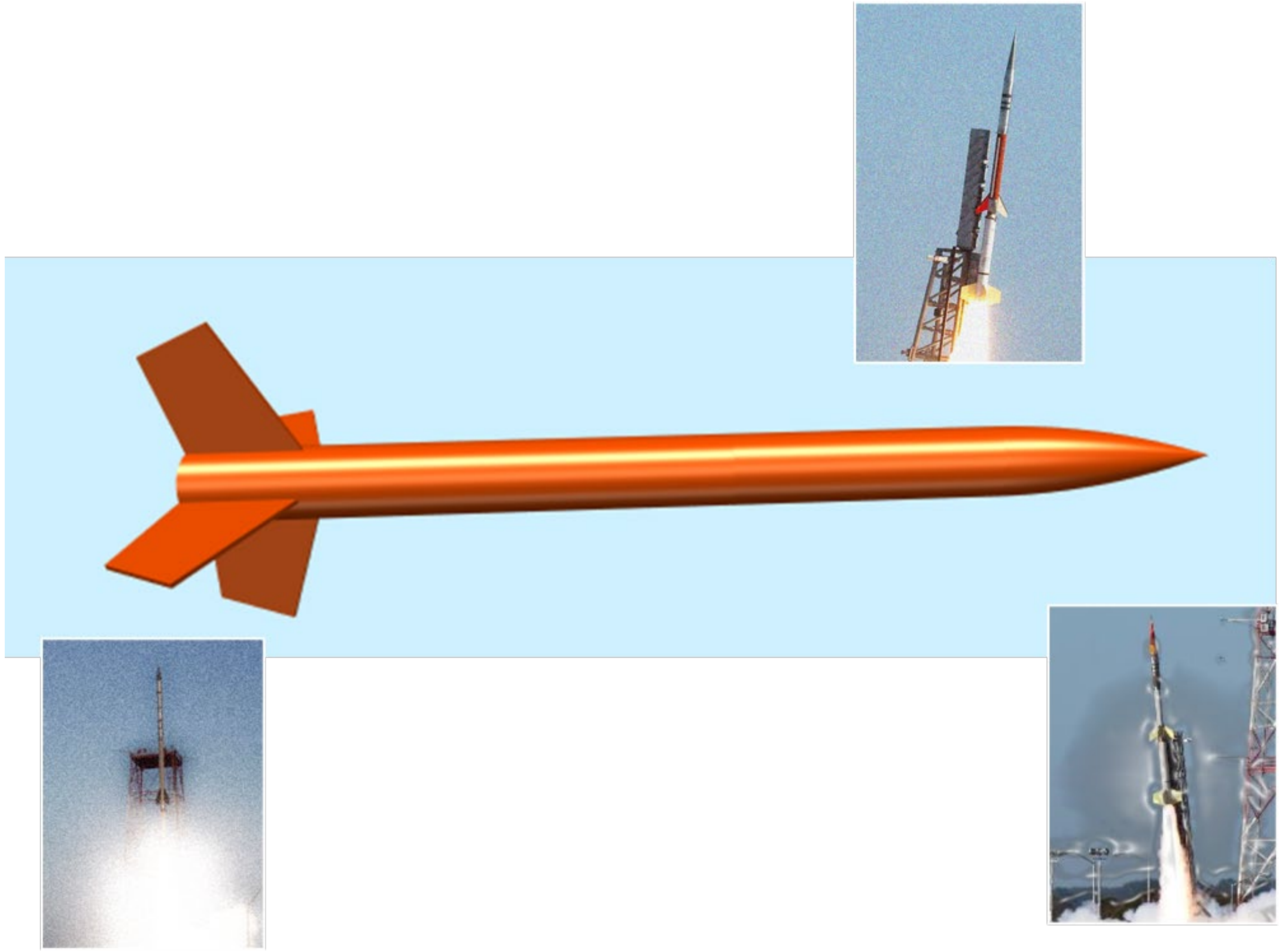
Risk Matrix

ID	Title	Description	Date	Status	Probability of Occurrence	Magnitude of Risk
TR-5	Altimeter	Customer is providing the altimeter to be placed in the payload bay for collecting altitude data. Since this is being given to us, there is the risk the the altimeter does not perform to standard.	4/20/22	Open	3%	5%
TR-6	Avionics Kit	Small risk that the assembly of the avionics kit might be delayed. Once receiving the avionics kit there are minor configuration items that have to be done, there is a risk that these items could be delayed. Communaction has happened for this to be done, it is just whether or not they are available in a timely matter, hence the "Watch" status.	4/20/22	Watch	1%	5%
SR-4	Critical Design Review Slip	The Critical Design Review tasks are not completed by their schedule milestone date.	4/20/22	Watch	1%	1%
SR-5	COTs Product Delays	With current shipping and manufacturing delays there is a risk that the ordered COTs product for the rocket will not arrive on time or be available.	4/20/22	Watch	1%	5%
PR-1	Project Organization	This risk involves the potential for external project organization factors to impact the project as a whole. This would include any UCCS impacts that would hinder or halt the online class working environment or the ability to communicate via UCCS resources.	4/20/22	Watch	1%	5%
PR-2	Health	This is the risk that a team member becomes unable to contribute to the project due to health reasons.	4/20/22	Watch	1%	1%

Risk Heat Map



Conclusion



Summary Conclusion

- The Sounding Rocket's advantage is to provide the most technologically, effective, yet low-cost product to low-budget organizations.
- It conforms to as many known flight/mission standards.
- Is meant to draw heavily on COTS items to make for an effective launch vehicle.
- Can support a wide berth of scientific/other payloads.
- Has a modular design to allow for periodic updates to the design to meet future/unique customer requirements.
    - Reservations for future intended testing of advanced technologies.

Questions