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| 2018 First Nation Launch |
| Preliminary Design Report |
| For Wisconsin Space Grant Consortium |

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| [School Name][Date] |

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# Team Information

School Name: [insert school]

Location: [insert school location]

Team Name: [insert team name]

NAR/TRA Mentor: [insert NAR/TRA mentor name]

School Advisor: [insert school advisor name]

Team Members [insert team member name, major, project role]

# Summary of Preliminary Design Report

## Launch Vehicle Summary

* Vehicle dimensions and mass
* Motor selection
* Recovery system description

## Payload Summary

* Payload description

# Changes Made Since Proposal

Highlight Changes Made Since Proposal

* Changes to vehicle criteria
* Changes to payload criteria
* Changes to project plan

# Vehicle Criteria

## Selection, Design and Verification of Launch Vehicle

* Include mission statement, requirements and mission success criteria
* Review the design at a system level, going through each systems functional requirements (include sketch of options, selection rationale, selected concept and characteristics)
* Describe the subsystems that are required to accomplish the overall mission
* Describe the performance characteristics for the system and subsystems and determine the evaluation and verification metrics
* Describe the verification plan and status. At a minimum, a table should be included that lists each requirement (in the SOW), and for each requirement briefly describe the design feature that will satisfy that requirement and how that requirement will ultimately be verified (such as by inspection, analysis, and/or test)
* Define the risks and the plans for reducing the risks through analysis or testing for each system. A risk plot that clearly portrays the risk mitigation schedule is highly encouraged. Take all factors that might affect the project including risks associated with testing, delivery of parts, adequate personnel, school holidays, budget costs, etc. Demonstrate an understanding of all components needed to complete the project and how risks/delays impact the project.
* Demonstrate planning of manufacturing, verification, integration and operations (including component testing, functional testing, and static testing).
* Include a dimensional drawing of entire assembly. The drawing set should include drawings of the entire launch vehicle, compartments within the launch vehicle (such as parachute bays, payload bays, and electronics bays), and significant structural design features of the launch system (such as fins, bulkheads, motor mount assemblies).
* Include electrical schematics for the recovery system.
* Include a Mass Statement. Discuss the estimated mass of the launch vehicle, its subsystems, and components. What is the basis of the mass estimates and how accurate is it? Discuss how much margin there is before the vehicle becomes too heavy to launch with identified propulsion. Are you holding any mass in reserve (i.e. are you planning for any mass growth as the design matures)? If so, how much? As a point of reference, a reasonable rule of thumb is that the mass of a new product will grow between 25% and 33% between PDR and delivery of final product (launch day).

## Recovery Subsystem

* Demonstrate that analysis has begun to determine recovery system size for current mass, attachment scheme, deployment process, and test results/plans with ejection charges and electronics.
* Discuss the major components of the recovery system (such as the parachutes, parachute harnesses, attachment hardware, and bulkheads), and verify that they will be robust enough to withstand the expected load.

## Avionics Bay

* Demonstrate that preliminary design has begun on the avionics bay that will be used to deploy the recovery system and determine vehicle performance
* Include overall position of avionics bay in the vehicle (sketch), number of altimeters (is the system redundant), description of altimeters, avionics sled material, avionics bay layout, size and number of vent holes, the type of switch to be used to power on the electronics from outside of the vehicle

## Motor Selection

* Discuss current motor selection, rationale for selection and possible alternative options
* What would dictate the need to change motors as the design progresses? How can this be controlled?
* Discuss motor retention plan

## Mission Performance Predictions

* State mission performance criteria.
* Show flight profile simulations, altitude predictions with simulated vehicle data, component weights, and simulated motor thrust curve, and verify that they are robust enough to withstand the expected loads.
* Show stability margin, simulated Center of Pressure (CP) and Center of Gravity (CG) relationship and locations.
* Calculate the kinetic energy at landing for each independent and tethered section of the launch vehicle.
* Calculate the drift for each independent section of the launch vehicle from the launch pad for five different cases; no wind, 5-mp wind, 10-mph wind, 15-mph wind and 20-mph wind.

## Interface and Integration

* Describe payload integration plan with an understanding that the payload must be co-developed with the vehicle, be compatible with stresses placed on the vehicle, and integrate easily and simply.
* Describe the interfaces that are internal to the launch vehicle, such as between compartments and subsystems of the launch vehicle.
* Describe the interfaces between the launch vehicle and the ground (mechanical, electrical, and/or wireless/transmitting)
* Describe the interfaces between the launch vehicle and the ground launch system.

## Launch Operation Procedures

* Develop a checklist of final assembly and launch procedures

## Safety and Environment (Vehicle)

* Identify a safety officer for your team.
* Provide a preliminary analysis of the failure modes of the proposed design of the rocket, payload integration, and launch operations, including proposed and completed mitigations.
* Provide a listing of personnel hazards and data demonstrating that safety hazards have been researched, such as material safety data sheets, operator’s manuals, and NAR regulations, and that hazard mitigations have been addressed and enacted.
* Discuss any environmental concerns.

# Payload Criteria

## Selection, Design and Verification of Payload Experiment

* Review the design at a system level, going through each system’s functional requirements (includes sketches of options, selection rationale, selected concept, and characteristics).
* Describe the payload subsystems that are required to accomplish the payload objectives.
* Describe the performance characteristics for the system and subsystems and determine the evaluation and verification metrics.
* Describe the verification plan and its status. At a minimum, a table should be included that lists each payload requirement and for each requirement briefly describe the design feature that will satisfy that requirement and how that requirement will ultimately be verified (such as by inspection, analysis,
* and/or test).
* Describe preliminary integration plan.
* Determine the precision of instrumentation, repeatability of measurement, and recovery system.
* Include drawings and electrical schematics for the key elements of the payload.
* Discuss the key components of the payload and how they will work together to achieve the desired results for the experiment.

## Payload Concept Features and Definition

* Creativity and originality
* Uniqueness or significance
* Suitable level of challenge

## Science Value

* Describe payload objectives.
* State the payload success criteria.
* Describe the experimental logic, approach, and method of investigation.
* Describe test and measurement, variables, and controls.
* Show relevance of expected data and accuracy/error analysis.
* Describe the preliminary experiment process procedures.

## Safety and Environment (Payload)

* Identify safety officer for your team.
* Provide a preliminary analysis of the failure modes of the proposed design of the rocket, payload integration, and launch operations, including proposed and completed mitigations.
* Provide a listing of personnel hazards and data demonstrating that safety hazards have been researched, such as material safety data sheets, operator’s manuals, and NAR regulations, and that hazard mitigations have been addressed and enacted.
* Discuss any environmental concerns.

# Project Plan

## Project Budget

* Discuss your funding plan
* Discuss your budget plan (include tables, estimates, future forcasts etc.)

## Project Timeline

* Discuss your project timeline (use a Gant chart, or similar spreadsheet method)
* Include parts procurement timeline, component test timeline, build timeline, flight test timeline
* Note that vehicle must be ready (90% complete) to fly two weeks prior to competition launch date

# Conclusion

* Include any other pertinent information here, expected challenges ahead, plans to mitigate etc.

# Appendix

* use the Appendix section if needed to show checklists, budget tables, timelines, MSDS data, and any other large sets of data that would disrupt the flow within the document