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| 2020 First Nations Launch |
| Critical Design Report |
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| [School Name][Date] |

Please use this template as a guide to writing your team design reports. The headers (and bullets) outline the minimum information required. For continuity across teams, do not re-order the sections. You can however, add more information or sections when deemed necessary, or further detail is required.

There are some unique formatting features to this template. Please learn and utilize them. You may add to the formatting, but do not delete any existing formats. Feel free to personalize your report.

Any [square] bracketed text is expected to be filled by your team. Bulleted text is expected to be deleted/replaced with your content.

Delete this text box prior to submission.

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# Team Information

Team Name: [insert team name]

School Name: [insert school name]

School Advisor: [insert school advisor name(s)]

Team Lead: [insert student team lead name]

Safety Lead: [insert student safety lead name]

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

NAR/TRA Prefecture: [provide NAR/TRA Chapter/Prefecture]

NAR/TRA Certification: [provide mentor certification level]

\*Note: it is intended that you find a local NAR or TRA mentor such that they can provide in-person assistance as needed before launch weekend; therefore, it is not recommended that you list Frank Nobile as your NAR or TRA mentor (unless you are a Wisconsin school). See Handbook Appendix C-2 for details.

# Summary of Critical Design Report

## Launch Vehicle Summary

* Summarize final vehicle dimensions, material, mass, etc.
	+ Include diagrams
* Summarize final motor selection
	+ Include more than name/manufacturer (can include burn time, total impulse, max ejection delay, size/weight, etc.)
* Summarize final recovery system
	+ Single or dual deploy, parachute configuration, etc.
	+ Include diagrams
* State rail button size

## Payload/Challenge Summary

* Summarize the final payload/challenge solution
	+ Include diagrams

# Changes Made Since PDR

* Highlight Changes Made Since PDR
	+ Briefly summarize changes to vehicle criteria
	+ Briefly summarize changes to payload criteria
	+ Briefly summarize changes to project plan

# Vehicle Criteria

## Design of Launch Vehicle

* Identify which of the design alternatives from PDR were chosen as the final components for the launch vehicle. Describe why those alternatives are the best choices.
* Demonstrate that the designs are complete and ready to manufacture/procure
* Discuss the integrity of design
	+ Suitability of shape and fin style for mission
	+ Proper use of materials in fins, bulkheads, and structural elements
	+ Sufficient motor mounting and retention
* Using final design, create dimensional drawings (using solid modeler software, or 2-D simulation images at a minimum) to illustrate the final launch vehicle, its subsystems, and its components (Mars Challenge ONLY)\*\*
* If airframe build/fabrication has begun, include pictures of assembly, manufacture and joining steps (especially sealed components that can no longer be examined once joined)
* Update estimated masses for each subsystem (Mars Challenge ONLY)\*\*

## Recovery Subsystem

* Identify which of the design alternatives from PDR were chosen as the final components for the recovery subsystem. Describe why those alternatives are the best choices.
	+ Show that your ground hit velocity / descent rate is reasonable
* Describe all components and attachment hardware and scheme
	+ Components include: shock cords, eyebolts/u-bolts, quicklinks, parachute protection, bulkplates, attachment scheme, etc.
* Include any diagrams, drawings, schematics, sketches, images

## Avionics Subsystem

* Describe the avionics bay structure that will be used to deploy the recovery system
* Discuss the number of altimeters (is the system redundant), and include a description of the altimeters
* Describe the avionics sled material, avionics bay layout, the size/location and number of vent holes
* Describe the switch(es) to be used to power on the electronics from the outside of the vehicle
* Include any diagrams, drawings, schematics, sketches, images

\*note that Section 4.4 – refers to Vehicle Avionics (altimeters); if there are avionics/electronics for your payload, please discuss them in Section 6.1

## Motor Selection

* Describe final motor selection
	+ Include thrust curve, and all other pertinent motor information
	+ Justify why you chose this motor over your alternatives from PDR
* Describe motor retention system
	+ Include any diagrams/images

## Mission Performance Predictions

* Show flight profile simulations, altitude predictions with simulated vehicle data, component weights, and sim­ulated motor thrust curve
	+ Determine/state predicted time to apogee
	+ Determine/state rail exit velocity using either (your choice):
		- a 6’ rail (uses a small 1010 rail button)
		- a 10’ rail (uses a large 1515 rail button)
	+ Determine/state thrust-to-weight ratio and if it is reasonable
* Show stability margin and simulated Center of Pressure (CP)/Center of Gravity (CG) relationship and locations (using simulations).
* Calculate the expected descent time (normally using simulations – hand calculation accepted) for the rocket and any section that descends untethered from the rest of the vehicle
* Calculate the drift (normally using simulations – hand calculations accepted) for each independent section of the launch vehicle from the launch pad for three different cases: no wind, 10-mph wind, and 20-mph wind (Mars Challenge ONLY)\*\*

# Safety

## Launch Concerns and Operation Procedures

* Submit draft of final assembly and launch procedures (checklists can be contained as an Appendix) including:
	+ Recovery preparation checklist
	+ Motor preparation checklist
	+ Setup on launch pad checklist
	+ Troubleshooting checklist
	+ Post-flight inspection checklist
* These procedures/checklists should include specially demarcated steps related to safety. Examples include:
	+ Warnings of hazards that can result from missing a step
	+ PPE required for a step in the procedure (identified BEFORE the step)
	+ Required personnel to complete a step or to witness and sign off verification of a step

# Payload Criteria

## Design of Payload/Challenge Solution

* Identify which of the design alternatives from PDR was chosen for the payload Describe why that alternative and its components were chosen
* Review the final design at a system level
	+ Include specifications for each component of the payload, as well as the entire payload assembly
	+ Describe how the payload components interact with each other
	+ Include any drawings, diagrams, schematics, images
* Demonstrate that the design is complete
* Describe the interfaces between the payload and the launch vehicle
	+ Discuss the integration of the payload
	+ Describe the deployment of the payload in detail (if applicable)
		- Reference any test results that ensure a successful deployment
	+ Include any drawings, diagrams, schematics, images
* If payload build/fabrication has begun, include pictures/description of assembly, manufacture and joining steps
* Update the estimated masses for all components (Mars Challenge ONLY)\*\*

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# Project Plan

## Test Plan (Mars Challenge ONLY)

* Update the test plan, with results for completed tests or any additional tests
* Present results of any completed tests
	+ Describe the test plan and whether or not the test was a success
	+ Discuss how the results drive the design of the launch vehicle and/or payload

## Requirements Compliance (Mars Challenge ONLY)

* Update the verification plan for every requirement from sections 1-5 of the Project Requirements listed in the Competition Handbook. Identify if test, analysis, demonstration, or inspection are required to verify the requirement. After identification, describe the associated plan needed for verification.
	+ A table is appropriate, see Handbook Appendix B-3 for sample
	+ If plan is extensive, this section may be contained as an Appendix

## Project Budget

* Provide an updated line item budget with market values for individual components, material vendors, and applicable taxes or shipping/handling fees
	+ Use a spreadsheet – may be contained as an Appendix if extensive
* Provide an updated funding plan describing sources of funding, allocation of funds, and material acquisition plan

## Project Timeline

* Provide an updated timeline including all team activities and expected activity durations. The schedule should be complete and encompass the full term of the project. Deliverables should be defined with reasonable activity duration.
	+ GANTT charts are encouraged – may be contained as an Appendix if extensive
* Include parts procurement timeline, component test timeline, build timeline and flight test timeline
	+ Recall that vehicle must be ready (90% complete) to fly two weeks prior to competition launch date

# 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