

System Requirements Review

Presented by Lettuce Industries

Table of Contents

- Lettuce Industries Company Organization
- SRR
 - Requirements
 - Questions
- General Questions
- Acronyms

Lettuce Industries Organization

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3.3.1.1 General

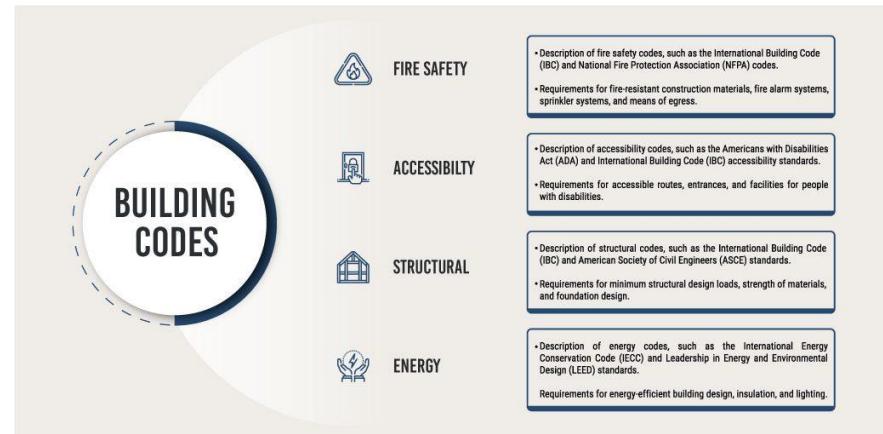
The Contractor will design, build, test, and deliver a Rocket Motor Test Stand, herein referred to as the RMTS, to support the university's Student Rocket Program (SRP). The RMTS includes all subsystems and support equipment necessary for system operation and maintenance, including documentation and training needed to satisfy the requirements listed within this Statement of Work (SoW). The Contractor will conduct a requirements analysis with the User to verify system performance requirements and brief the results in a Systems Requirements Review (SRR).

3.3.1.2 Building/Safety Codes

The Contractor will research building and safety codes involving the use of all system components. The Contractor will present a summary of the applicable requirements at the Alternative Systems Review (aka, Conceptual Design Review). The Contractor will ensure compliance with these codes and submit any necessary paperwork for approval.

Questions/Issues

1. Will the RMTS will only be operated outdoors?
2. Is there a need to review building codes if the RMTS is only outdoors?



<https://www.rdaep.com/infographics/building-codes/>

3.3.1.3 Safety

Safety is of the highest concern in the design of this project. Proper safeguards must be implemented to prevent any reasonable chance of injury to those transporting, erecting, working on or operating the system.

Questions/Issues

1. What level of safety? Can we require training in the assembly and use of the RMTS by all operators?



<https://coakleywilliams.com/cwc-news/cwc-take-your-kids-to-work-day>

3.3.1.4 Workmanship

The RMTS must have a professional and aesthetic appearance, including workmanship and consistency of parts, materials, assembly, and finishes. It will be constructed using best commercial practices (eg, will contain no openly exposed lubricants, sharp edges, loose components, dangling wires...).

Questions/Issues

1. Is it acceptable to prioritize other requirements over appearance?
2. Due to living in Alaska and the timeframe the RMTS must be built in there is a high chance some aesthetics will need to be sacrificed for faster delivery of parts and/or lower cost.



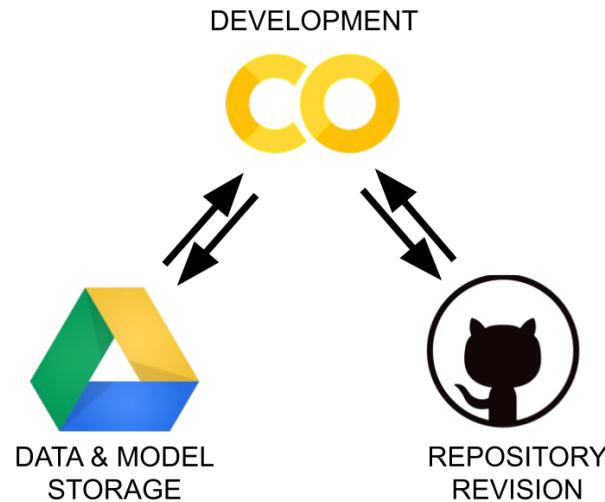
<https://www.deliver2alaska.com/>

3.3.1.5 Documentation

The Contractor will provide a user's manual and maintenance manual, including drawings or sources for all parts and a preventative maintenance schedule. The Contractor will research existing products for suitability and provide results of this research. In addition to copies specified in the Contract Data Requirements List (CDRL), the entire final design must also be submitted in electronic format (including drawings and equations) suitable for archival. Maintenance of the electronic archive will be in accordance with directions to be provided by the PO.

Questions/Issues

1. What format should the documentation be in?



<https://medium.com/geekculture/colab-and-github-201c734e9ac3>

3.3.2.1.1 RMTS Size

The RMTS design will accommodate National Association of Rocketry (NAR) motor sizes, ranging from Model Rocketry motors through High Power Level I motors (Classification 1/8A – I). Contractor will verify structural integrity and safety of the RMTS design with a factor of safety (SF) of 5x all expected forces for normal operation of all motor sizes. The RMTS will safely contain the explosive force of all motor sizes, keeping operators safe and protecting nearby structures/infrastructure.

Questions/Issues

1. Many load cells are rated up to 600 N of thrust and have an accuracy rated in terms of a percent of the rated load, usually between 1% and 0.1%. 1/8 A-class motors may have an impulse less than 0.3 Ns, potentially less than the accuracy of a large load cell. Can we use a swappable design so the RMTS sensors can be changed with the rocket motor thrust?
2. Class I rockets can use motors that add up to a total impulse of 640 Ns, but the maximum instantaneous thrust is not specified. Can we set a limit on the maximum instantaneous thrust so we know the absolute maximum forces the RMTS must withstand?
3. Does the 5x SF apply to all components? Can it be lowered? Load cells become exponentially more expensive the higher the load.
4. Does the rocket motor need to be in a fully contained system or can explosive gases be redirected in a safe direction?



3.3.2.1.2 Performance Envelope

The RMTS will support the operation of up to a High Power Rocketry (HPR) Level I motor, including casing/nozzles and instrumentation with thrust according to a normal duration burn (+10%). The RMTS will be capable of surviving the unplanned rapid deconstruction (URD) of any motor up through HPR Level 1 with minimal damage to components.

Questions/Issues

1. What is the minimum sampling rate needed? 100 Hz seems to be an industry standard, but some motors have very short burn times and may need a higher sampling rate.
2. Is RASP an acceptable file format for rocket motor thrust data?

```
; Rocketvision F32
; from NAR data sheet updated 11/2000
; created by John Coker 5/2006
```

F32 24 124 5-10-15 .0377 .0695 RV

1. motor name
2. diameter
3. length
4. delays
5. prop. weight
6. tot. weight
7. manufacturer

```
; Rocketvision F32
; from NAR data sheet updated 11/2000
; created by John Coker 5/2006
```

F32 24 124 5-10-15 .0377 .0695 RV

0.01 50
0.05 56
0.10 48
2.00 24
2.20 19
2.24 5
2.72 0

;

3.3.2.1.3 Weight and Balance

The RMTS will weigh a maximum of 500 lb, including rocket motor adapters, deflection plates (as appropriate) and instrumentation. Individual items or shipping containers must weigh less than 100 lb to allow safe transportation and assembly. Assembly and transportation will not require undue physical exertion or compromise safety in any way. The RMTS will provide a counterbalance system that allows 1 average size person to lift/stow and secure the RMTS major components or loaded shipping containers.

Questions/Issues

1. The maximum impulse of the class I motor can reach 640Ns. If the RMTS must be a movable platform it will require external fixing or counterweights. Does the 500 lb weight limit refer to the weight of the RMTS structure alone? Is weight added at the test location, like sand or gravel, acceptable?

3.3.2.1.4 Subsystems

The RMTS will incorporate all subsystems and functions necessary to safely accommodate, fire, and test rocket motors throughout the specified motor range. Anticipated subsystems include: base structure, motor holding appliances, thrust measurement, thrust deflection plates (as appropriate), stand-off blast protection, remote ignition, status monitoring, warning lights/sirens, data recording/analysis, and common support tools.

3.3.2.1.5 Assembly and Disassembly

The Contractor will demonstrate that the RMTS may be assembled within 30 min from the transported configuration using 1 person, and vice versa. The Contractor will demonstrate that the RMTS may be 'pre-flighted' and readied for use (or made safe and 'post-flighted') within 30 min from the assembled configuration using 1 person.

3.3.2.2 Weather/Environment

The RMTS will be capable of operation outdoors in the Alaskan environment year-round. This includes temperature, winds, and precipitation variations throughout the year. **This includes rain up to 1 inch/hour and temperatures down to -40F.** Requests for waivers restricting operation in severe weather/environmental conditions will be petitioned by the Contractor and approved by the PO.

Questions/Issues

1. Does the 30-minute one-person disassembly and assembly time mentioned in 3.3.2.1.5 refer to the time in a room temperature environment or in an extreme environment (such as -40 degrees Fahrenheit)?
2. Are 1 inch/hour rain and -40 degrees Fahrenheit separate conditions?
3. Is 1 inch/hour a realistic rate?

3.3.2.3 Reliability & Maintainability

The RMTS will require minimal maintenance. All components of the RMTS will remain operational for a minimum of 20 years. The Contractor will provide individual component and overall system reliability measures.



Questions/Issues

1. How can we demonstrate or test longevity during a one semester class?
2. Can we designate specific components that must be replaced periodically or as needed?
3. What is the standard for "minimal maintenance"? Can maintenance be required after every use of the RMTS or is there a desired minimum time between repairs?
4. Will checks of essential components be considered maintenance?

3.3.2.4 Compatibility

The RMTS will make maximum use of existing like components used at UAF's (1) College of Engineering & Mines (CEM); and (2) Geophysical Institute (GI) for similar assets, balancing the need for compatibility with that of proven performance of newer components. Rationale for component choices will be explained in appropriate discussions, briefings, and written documentation.



Questions/Issues

1. Will we have access to similar systems used by UAF's CEM and GI so we know what components are preferred? Do the CEM and GI have a list of parts they keep in stock we can try to be compatible with?

3.3.2.5 Transportability

The RMTS will be designed such that all individual components may be transported using either a 6.5-foot pickup bed with cab-height bed topper, or a 6 x 14 x 6 ft mobile ground control station trailer. The design of the components and **securing devices** will preclude damage to either the RMTS or the trailer and will not require undue physical exertion. The **RMTS system will include the minimum components necessary to test motors at deployed locations**: (1) Poker Flat Research Range (PFRR); (2) Kodiak Pacific Spaceport Complex (PSC); (3) Remote locations, such as Oliktok Point, Alaska. The RMTS will be capable of being transported in a maximum of 7 major items or hardened cases, each weighing no more than 100 lb.

Questions/Issues

1. Is the team responsible for providing securing devices? Or will the customer use their own hardened cases, ratchet straps, bungee cords, etc.?
2. What amenities can be expected at deployed locations? Will basic tools to assemble the RMTS be provided by the customer? Will AC power be available?



3.3.2.5 Storage

The RMTS will be built and tested within UAF CEM (primary) & GI (secondary) facilities, as necessary. Provisions must be made to ensure adequate space exists for storage and testing throughout the fabrication and testing phases. The storage/retrieval process must be accomplished safely with no damage to the RMTS or lab facilities and not require undue physical exertion.



Questions/Issues

1. The RMTS team does not have control over CEM or GI facilities. Space for storage and testing will have to be provided by the customer.

3.3.2.6.1 Personnel Interfaces/Customer Interface

The Contractor will consult extensively with the User throughout all phases of the contract to ensure the equipment meets their needs. The contractor will invite the User to all formal reviews throughout the semester, providing as much advance notice as possible (4 workdays minimum). All meetings and discussions with the user will be documented, noting any clarifications and/or modifications to the SoW.

SEPTEMBER 2025						
SUN	MON	TUE	WED	THU	FRI	SAT
	1 Labor Day	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

Download & Print Free Calendars From [Wiki Calendar](#)

Questions/Issues

1. Many different types of reviews will be required during the semester. Can the required advanced notice be reduced to 1 or 2 lectures before the review?

3.3.2.6.2 Formal Reviews

The Contractor will invite the User POC and any other designated Very Important Persons (VIP) to all formal reviews throughout the semester, providing as much advance notice as possible (2 lessons minimum). The Contractor will provide copies of all required documentation to the designated VIPs as specified by the PO. All meetings and discussions with the User POC or their designated representative will be documented, noting any clarifications and/or modifications to the SoW.

Questions/Issues

1. When providing copies of all required documentation, does this refer to printing everything for all attending VIPs, or is electronic sharing sufficient?
2. Most customer meeting have been during class time, with zoom lectures. Would recording these lectured be considered appropriate documentation of the meeting, or is there a written document format with which we should use instead?
3. Modifications made to the SoW should be kept separately to documentation of meetings, however when changes are made, they will be noted in the meeting documentation. This note will contain what addendum/change number used in reference to the SoW changes documentation.

3.3.2.7 Time Logs

The Contractor will maintain the Personal Time Logs in the class project notebook. The Contractor will ensure the personal time logs are updated each lesson.

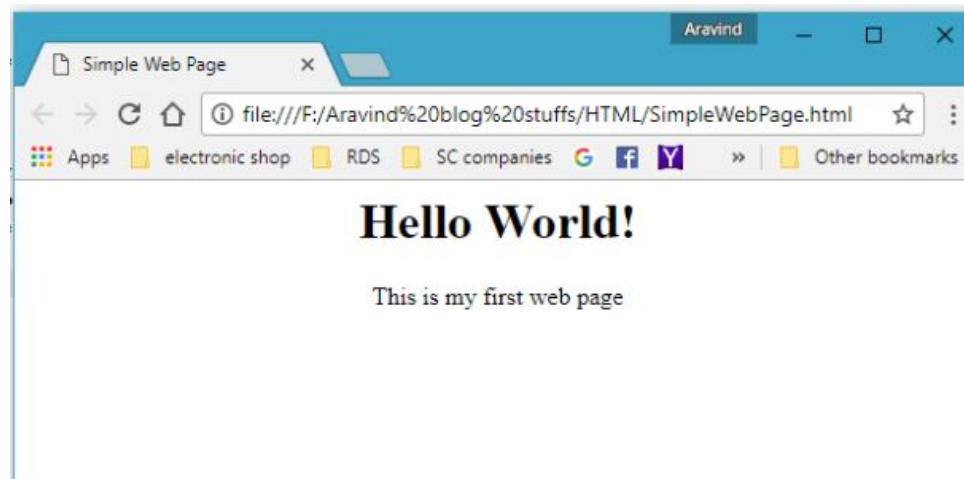


3.3.2.8 Public Affairs

The Contractor will prepare a videotape (5 – 10 minutes) detailing the operation, safety, and maintenance procedures for the RMTS. One copy of the videotape will be shown to the PO NLT Lesson 39 and used at the Final Briefing. In addition, the Contractor will prepare a one-page html file to summarize the project. This file will include one photograph and be used in conjunction with the College of Engineering and Mines (CEM) Aerospace Engineering homepage. Finally, the Contractor will create and maintain a project webpage which will be used to archive project deliverables and media.

Questions/Issues

1. Will the website be hosted by us or UAF? Will we need to provide HTML files, a docker image with a web server, or something else? Can we host the website on Github? Is there another way that these websites have been built and maintained in the past?



3.3.2.9 Total Funding

Funding for the project is **not guaranteed** but may be petitioned through the PO.

Questions/Issues

1. Except for the amount from lab fees.
2. Is there a defined process for petitioning for more funding?
3. Is there a defined process for accessing the funds once procurement is authorized?

3.3.2.10 Subcontracting

The government expects the Contractor to possess sufficient talent to complete all required work. Waivers for this policy may be obtained through the PO.

Questions/Issues

1. It is unclear who the government is in this context. Is it the customer, PO, a VIP, the University, or another entity?

3.3.2.11 Contract Changes

The Contractor will document all changes and additions to these requirements in writing. All changes and additions documentation must be approved and signed by the government and will be appended to the signed contract.

Questions/Issues

1. Same question as before for clarification of the government entity.
2. What is considered the signed contract? Is it the SoW or another document that has not been brought up prior?

3.3.3 Incentives

The Contractor may petition the government for incentive awards (points) for such things as enhanced performance or early milestone completion. Innovative design concepts relating to the flexibility and modularity aspects of the project will be highly rewarded. Specific areas of emphasis for the RMTS are transportation, storage, and the equipment attachment points/devices – other suggestions will be considered based upon merit. Requests for incentive points must be made in writing and will take effect upon receiving approval by the PO. All incentive point requests must be submitted 2 lessons prior to contract submittal and, if approved, included in the contract.

Questions/Issues

1. Who is the government in this context?
2. What is considered the contract? Is it the SoW or another document not yet provided or created?

Questions?

Acronyms

- CEM: College of Engineering and Mines
- CDRL: Contract Data Requirements List
- CEO: Chief Executive Officer
- CFO: Chief Financial Officer
- CMO: Chief Marketing Officer
- COO: Chief Operations Officer
- CSE: Customer Service Executive
- CTE: Chief Test Engineer
- CTO: Chief Technology Officer
- GI: Geophysical Institute
- NAR: National Association of Rocketry
- NTL: NASA Technical Library
- PFRR: Poker Flat Research Range
- PO: Procuring Official
- POC: Point of Contact
- PSC: Pacific Spaceport Complex
- RASP: RockSim Simulation File (used for model rockets)
- RMTS: Rocket Motor Test Stand
- SF: Safety Factor
- SoW: Statement of Work
- SRP: Student Rocket Project
- SRR: Systems Requirement Review
- UAF: University of Alaska Fairbanks
- VIP: Very Important Person