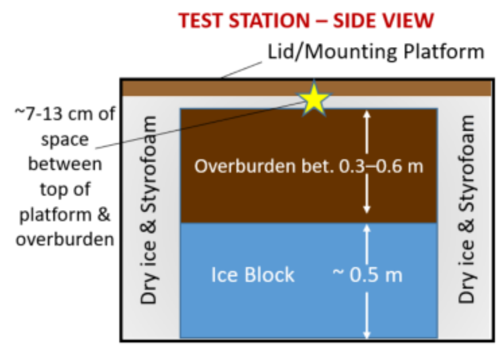
2018 RASC-AL Special Edition: Mars Ice Challenge Q&A Session

Updated rules/regulations/design requirements to be aware of:

1. The Final Scoring Matrix (complete with information on penalties) will be added to the Mars Ice Challenge Website next week.

   Final scores will be determined based on the following categories:

   a. Water extraction – 50% of overall score
   b. Technical paper – 40% of overall score
   c. Technical Poster Session – 10% of total score



2. Allowable drill bit length has been increased to 39" (99.06 cm)

3. Returning teams only:
   a. Returning teams are required to submit a Lessons Learned section in their Project Plans.
   b. The Lessons Learned section should be limited to 1-2 pages max, and will **not** count against their total page count max on the Project Plan.

4. We've updated the side diagram of the test station to include the range of space teams may encounter between the mounting platform and the top of the overburden (see above).

5. Updates to the power:
   a. Teams will be provided with 120 VAC (GFCI protected) power, via an outlet. Water extraction systems shall not exceed 10A current from this source.
   b. Teams will be required to monitor and log their electrical current usage via the same data logger that is monitoring and recording the WOB load limits.

6. Any drilling oil that makes its way to a team's water collection bucket will not be measured (i.e., it will not count toward the total water extracted)

7. Regarding calibration/validation of Weight on Bit: Prior to the competition, we will place a scale underneath each team's drill bit and ask the team to apply 100 N. If their data logger shows 100 N and our scale shows 80 N, we will record the error and take it into account during final evaluations.

8. The current language under "Daily Operations" for Testing on Day Two states, "*On the second day, teams will be allowed as much hands-on time as needed at the start of the day for setup. However, once the team is ready for operation and receives the authorization from a judge, they must operate hands-off to collect any water that counts towards their scoring.*"
   a. Point of clarification: Each team is limited to 6 hours of water collection operations on Day One, and 6 hours on Day Two. Once the established 6-hour water collection time-clock starts on Day

Two (it will be the same time for all teams), any hands-on activity still needed will eat into the team's allotted time to collect water.

b. For example, let's say the 6-hour window starts at 10 a.m. on Day Two, but a team requires 2 more hours of hands on operation before their system is ready to operate autonomously and a judge authorizes them to officially start at noon. Only the water collected between noon and 4 p.m. will count for that team.

9. Please note: all design solutions are subject to review by NASA safety and Center Ops, and as a result, designs may be required to be modified. These reviews will happen immediately following selection of the 10 teams, with mitigations due at the mid-term.

Technical Questions Received in Advance

Power

Q1: What are the power limitations (i.e., the specific limit to current supplied to the power supply)? What amperage from the 120 VAC will be received to the system?

A1: Teams will be provided with 120 VAC (GFCI protected) power. Water extraction systems shall not exceed 10A current from this source.

Q2: What is the means of power supply? Will it be via outlet, or via battery?

A2: Via an outlet

Test Bed/Competition Environment

Q3: How is the clay/gravel mixture packed into the coolers?

A3: It will be packed by hand prior to the competition.

Q4: Do we know any of the physical properties (average density, particle size of the clay, etc.) of the clay/gravel mixture?/ What are the soil properties, i.e. what kind of stone, strength of rock, breakdown of aggregate?

A4: Both the pitching mound clay and the gravel are purchased from local hardware stores; you can likely find similar material to study near you.

Specifically, we will be using drainage gravel and Turface Professional Mound Clay – Red (bag on the left).

Each test bin will have will have 900 lbs of pitchers mound clay (18 50 lb bags), mixed with 50 lbs of 1" angular gravel and a very, very little bit of water to assist with cohesion. This represents pitcher's mound clay with 10% by mass of ~1 angular gravel.

Q5: The project has specified what overburden to drill through, but would putting effort into understanding the composition of the surface be useful? In other words, should we investigate drilling through frozen sand versus solid rock?
A5: For the Earth-demo, the specified overburden (Turface Professional Mound Clay and drainage gravel) is what you will encounter, and it would be in your best interest to investigate drilling through that particular overburden composition that has been chilled, if possible (in the competition environment, the overburden will be sitting on top of the ice block, and surrounded by dry ice). The overburden will not be frozen solid, but previous experience demonstrates that the overburden does get very cold – colder the closer down to the ice block you go – close to freezing temperatures.

For translating your concept to Mars, you should investigate the composition and behavior of the regolith as has been observed (by Curiosity, for example) and describe how your concept will deal with what we expect to find on Mars.

Q6: Do we get a second block of ice for the second day?
A6: No, you'll have the same ice both days (and the same overburden. In the previous year's competition, the ice blocks had not melted even after several days of being in the cooler, in 95 Degree F for 5 days. We put space blankets over the holes each night between competition days.

Water Filtration

Q7: Do you have any other recommendations for water filtration other than membrane absorption? This seems to limit the self-sustainability and regenerative capabilities of the filtration system?
A7: We're looking for teams to come up with new ideas. Start by researching what's been studied in the past on the NASA Technical Reports Server.

Q8: Does the regenerative method for water purification need to be automated, or can there be a manual component to refreshing the filtration system?
A8: We don't anticipate that the water will run clear. For your Earth system, remember that you can be hands-on with the system throughout the first day of the competition, but then need to be autonomous during the second day (when point values triple for water extraction); keep that in mind when designing your filtration system. On Mars, however, systems should be automated, as the system will likely need to operate for long periods of time prior to human intervention.

Miscellaneous

Q9: Since the system is being operated on Earth can we design the specific apparatus to design specifications for Earth and then comment on how the design would change under Mars conditions?
A9: Yes, design your system to operate on Earth. Describing what you would change to operate on Mars is important in your Project Plans, and even more critical part of your technical paper. Please keep in mind that your Earth concept needs to show clear relationship with the Mars concept.

Q10: Is the average force for the drill acceptable at 100 N or does the instantaneous force have to be 100N?
A10: The average force of 100 N is acceptable

Q11: In regards to the weight on bit measurement, should WOB be measured as the force on the system by the bit, or the force on the ice by the bit?
A11: WOB should be measured as the force on the system. The premise is that the system should not apply high enough force to lift itself off the ground.

For example, if you take a Home Depot drill and try to make a hole in a concrete pavement, you can push down with the entire body weight (i.e. your feet will be off the ground - until you lose balance). We want to avoid this. Measuring force on ice by the bit is not exactly the same since in some instances (e.g. fast spinning auger) the auger may provide additional force on ice due to corkscrewing effect (in fact, this was observed by Apollo astronauts during drilling into lunar regolith - the auger was essentially screwing itself into the ground without the need for Astronauts to push on it).

Q12: What can the human interventions allowed on day one entail?
A12: You can start and stop your system, perform maintenance or swap out components, etc. You can't use your own hands to dig regolith or extract ice; that still needs to happen from your system.

Q13: What was a common fatal flaw with past participants systems?
A13: One of the biggest challenges for all of the teams was not integrating their systems prior to coming to the competition. This year, we will require teams to demonstrate that your fully integrated system functions before you arrive on-site at NASA.

Programmatic Questions

Q14: Will you be providing competition results from last years' competitors?
A14: We won't be providing specific scores, but we have provided a number of resources that we encourage you to take advantage of, including technical papers from the top winning teams last year, comments from previous participants, written lessons learned from the judges, and a verbal presentation (with photos) on lessons learned from the judges during the Google Hangout Pre-brief #1 yesterday. All of this wonderful information is available on Resources page of the Mars Ice Challenge website.

Q15: The rules mention that the team must have at least 2 US citizen students to participate. As long as this requirement is fulfilled, are permanent residents allowed to work on the project?
A15: If they are full-time students at your university, then the answer is yes, absolutely. However, please keep in mind that any foreign nationals will not be allowed to participate in the on-site portion of the Mars Ice Challenge at NASA Langley Research Center. (Permanent Residents with Green Cards may, however, be able to attend on a case-by-case basis).

Q16: Is the design proposal submitted our final design? If not, what changes are allowed to be made to the design after the initial report submission?
A16: You may make changes between your initial proposal and final design, but make sure to document what they are and why you made them. There should be a logical reason for the design process changes. Once the Project Plan is submitted, that is what is going to be evaluated. While we do expect you to modify and improve your design as you progress, ***you can't submit something and then made a complete left-turn on it.***

Q17 Are we allowed to use funding from outside sources in addition to the money provided by NASA?
A17: Yes, we highly encourage it and will require you to document all in-kind contributions and funding received in your final Technical Paper.

Q18: What is expected in the Path-to-Flight section of the report?

A18: For the Project Plan proposal, you'll want to include a brief discussion on the concept's anticipated path-to-flight for a Mars mission. The path-to flight description must address the critical modifications that would be made to the design if it were trying to extract water on Mars, based on significant differences between Mars and Earth operations. This includes, but is not limited to, considerations for temperature differences, energy/power limitations, and atmospheric pressure differences (i.e., challenges with sublimation).

The judges are not looking for a lot of detail at this point. They just want to see that you are aware of the types of modifications and design trades you would need to make on Mars and that you are keeping those things in mind as you design your concept. A fairly high-level overview of the trades you'll need to consider, in several paragraphs, will suffice.

Q19: Will we be able to ask additional questions at a later point in the design timeline? Whom will be our point of contact for said questions?
A19: Yes. Please email all questions to rascal@nianet.org and we will respond to you with an answer, as well as post the question and response on the FAQs page. Please check the FAQs page periodically for newly posted questions.

Q20: How in-depth do we need to go for the Project Plan?
A20: You don't need to go super deep (i.e., we don't expect software code), but you need significant detail to let the judges know your team is capable of producing a successful prototype at the Mars Ice Challenge next June.

Questions Received During the Call

Q21: The website and related documents ask us to design for Mars, then modify for Earth. But, on the call, you mentioned designing for Earth, then modifying for Mars. Are we designing for Earth or Mars?
A21: Response from Judge 1: The design we're asking you to describe in the technical paper should be focused on the concept for Mars, and that's what we're ultimately looking for. However, we also want to see what the design looks like for Earth. You'll need to find some common ground between the Earth and Mars designs, and then use both aspects for the Project Proposal. Then, go into more detail as you move forward in the process to a final design. In the technical paper, we want to know about what you built as the Earth design, but a very large section should be exclusively on the Mars system.

Response from Judge 2: The judges are looking for teams to tell us how they would design a system for Mars. There's more gravity, a different atmosphere, different pressure, etc. We're looking for a concept that takes advantage of or compensates for those environmental conditions, but teams will need to demonstrate this in an Earth environment. For the Path-to-flight, we're looking for your understanding and ability to describe how Earth testing validates that your design will also work on Mars. How will you convince us that, just because it works in a hangar on Langley, it'll work on the surface of Mars? You'll need to describe how building and operating on Earth is applicable or translatable to operating on Mars.

Q22: As a green card holder, I've been on a NASA center before. Can I be the sole advisor for my team?
A22: NASA security regulations change frequently, and the competition environment (The NASA Langley Research Center Hangar) has additional security requirements. It is very possible that a Green Card Holder can

receive full access and attend the competition, but there's also a possibility that, based on the security threat level, you may not be permitted. If your team is selected as a finalist, you can certainly still advise your team. However, you may need to be prepared to send another university representative (i.e., 'advisor') to the competition at Langley if your clearance is not approved for any reason.

Q23: Are aerial (flying) concepts allowed? Would the competition area allow those concepts to operate?
A23: Given the competition environment limitations, aerial vehicles will be difficult to get approved by the NASA Safety and Operations team.

Q24: Regarding autonomy on Day 2, what does "hands-off" mean? Does it mean remote operation is possible? Or, should we program our drill to operate entirely without human interference?
A24: Remote operation is allowed. Once a team switches to remote operation on Day 2, teams may no longer touch their system, beyond the computer used to operate the system.

Q25: Can you provide specifics on the amount of water added to the clay?
A25: Last year, we added almost 22 quarts of water to the clay. This year, we will add minimal water, if any, depending on weather conditions. The clay should be much dryer.

Q26: Do we have to provide dimensions on our design for the project plan?
A26: Yes. We'd like to see a 3D viewing or solid model of your design.

Q27: Can you go over the scoring percentages?
A27: You can find complete details on scoring in the Design Constraints document on the Competition Basics page of the Mars Ice Challenge website: http://specialedition.rascal.nianet.org/competition-basics/

Technical Questions Already Addressed on the FAQs page

Q: Are we only allowed to use one bit or could we have multiple bits and swap them?
A: Yes, you may have multiple drills within the system, but the total mass and volume of the entire system must meet the stated design constraints.