2020 RASC-AL Challenge Q&A Session

October 31, 2019
2:00 – 3:30 PM EST

Join By Phone
1-844-467-6272
Passcode: 819153#

Please mute all phone and computer mics.

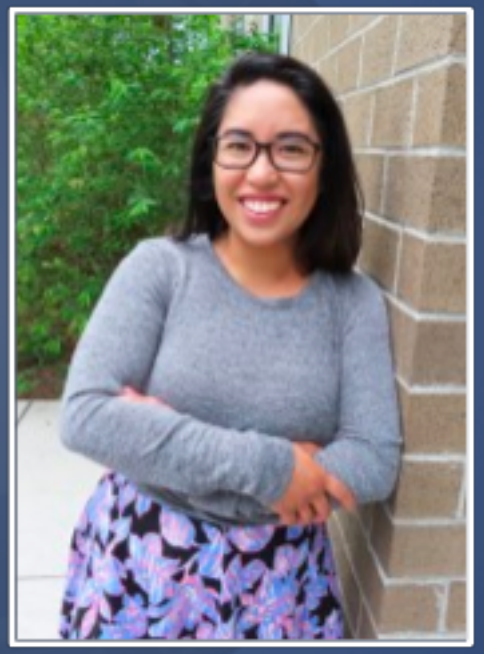
Q&A Session Agenda

- Introductions
- Context for the 2020 RASC-AL Challenge
- Pre-submitted Questions from Interested Teams
  - Questions by Theme
- Additional Questions: Time Permitting
- Wrap Up

RASC-AL Program Team

Shelley Spears
Program Director
shelley.spears@nianet.org

Stacy Dees
Program Manager
stacy.dees@nianet.org



Genevieve Ebarle
Program Coordinator
genevieve.ebarle@nianet.org

Victoria O'Leary
Program Coordinator
victoria.oleary@nianet.org

2020 RASC-AL Steering Committee

RASC-AL
Revolutionary Aerospace Systems Concepts Academic Linkage

Heather Rarick
Chairwoman
NASA Johnson Space Center

Dallas Bienhoff
Cislunar Space Development Company

John Bradford
SpaceWorks Enterprises, Inc.

Ken Bocam
AST & Science, LLC

A.C. Charania
Blue Origin

Lori Costello
SpaceX

Melvin Ferebee
NASA Langley Research Center

Amanda Ireland
Boeing

Christopher Jones
NASA Langley Research Center

Claude "Russ" Joyner, II
Aerojet Rocketdyne

Patrick Troutman
NASA Langley Research Center

Context for the 2020 RASC-AL Challenge

RASC-AL

Revolutionary Aerospace Systems Concepts Academic Linkage

Theme 1 Questions:
South Pole Multi-Purpose Rover

1. What does the 6 day mission include? Can they return back to the hub during the 6 days?

- ✓ Answer: The crew will use the rover to explore from their hub, so yes, they can return during the 6 days.

2. Concerning the power source, does the rover need to be able to operate for 6 days without the recharging of batteries?

- ✓ Answer: Not necessarily, but you need to decide what the power architecture is for both the un-crewed and crewed operations of the rover.

3. Is the rover arriving on the moon before the crew does?

- ✓ Answer: Yes, it will.

4. Where is the rover being stored in the rocket?

- ✓ Answer: You do not need to worry about how the rover is launched.

Theme 1 Questions:
South Pole Multi-Purpose Rover

5. What is included in high priority science? Do we need to include instruments on the rover to conduct this high priority science?

- ✓ Answer: NASA's Decadal Survey on Planetary Science can help define the science priorities for the rover to support. The science you choose to do will determine what instruments to carry on the rover. The rover will also perform reconnaissance to reduce risk for the crew arrival at the South Pole.

6. What specific goals are set for the high priority science between 2023 and 2024?

- ✓ Answer: See the Decadal Survey, which can be found on the RASC-AL website in the Resources' Recommended Reading list

7. What is included in risk reduction activities?

- ✓ Answer: Risk reduction includes testing out key technologies in the operational environment and scouting the area where humans will land to better identify landing sites and potential hazards. The rover can also do some science investigations prior to the crew arrival to identify high value targets for the crew to focus on when they are there.

Theme 1 Questions:
South Pole Multi-Purpose Rover

8. How is it supposed to deploy infrastructure? What is the infrastructure we may need to deploy?

- ✓ Answer: You can determine what infrastructure might need to be deployed (e.g. power cables) and how the rover would deploy it. Other infrastructure could include landing beacons, communication relay towers, or locating solar arrays in better lighting areas.

9. What is the anticipated weight and general shape of planned infrastructure?

- ✓ Answer: That is for you to determine.

10. What sources are available to provide information regarding the necessary sensors?

- ✓ Answer: Start with the Decadal Survey, then look for other documents (e.g. NASA Announcements of Opportunity, international working group documents) that describe science goals and/or instruments. The rover will need sensors to deal with the high contrast lighting conditions at the pole.

Theme 1 Questions:
South Pole Multi-Purpose Rover

11. How detailed should our design be with electrical components (including semi-autonomy, power, navigations, controls)?

- ✓ Answer: Detailed enough to provide credibility to your concept. For the proposal, you will need less detail than your final paper.

12. Will the crew require equipment to sleep? If so, what types of equipment are necessary?

- ✓ Answer: If you plan for the crew to spend multiple days on the rover, yes. However, you can also have the crew use the rover for shorter duration excursions during their 6 day stay on the lunar surface, where the crew sleeps in the ascent module.

13. At what level of autonomy does the rover need to operate: autonomous or semi-autonomous?

- ✓ Answer: You should define the functions the rover can perform and how it performs them. Keep in mind that it needs to be ready to operate in 2023.

Theme 1 Questions:
South Pole Multi-Purpose Rover

14. How much time should we expect the astronauts to use the rover during an EVA?

- ✓ Answer: That's for you to decide.

15. What spacesuit are the astronauts using? Should the xEMU spacesuit be considered as the space suit that astronauts will use while they drive the rover? If so, how can we best assume the dimensions and other factors of this new suit?

- ✓ Answer: The baseline suit for the lunar missions is the xEMU, and there is some information publicly available. It is heavy and bulky, but you should assume that is what the crew is wearing while on the rover. However, if your rover design in conjunction with an Apollo class lunar suit can provide equal or better mission performance than the xEMU, we would love to hear about it.

16. Can the rover rely on an annual swap-out of instruments and payloads that is enabled by the Artemis astronauts? Or does the rover have to have every instrument and payload that it will use during its lifetime from the beginning?

- ✓ Answer: The rover can be upgraded by the astronauts; however, it must also perform some science before the first crew arrives.

Theme 1 Questions:
South Pole Multi-Purpose Rover

17. What are the dimensions and life support duration of the xEMU planetary suits?

- ✓ Answer: The xEMUs are about 200kg each without the crew in them (over twice the Apollo suit mass). You can estimate their size by the pictures available on nasa.gov, but in general slightly larger than the Apollo suits.

18. What other equipment will the crew have to move heavy objects, travel, etc.?

- ✓ Answer: Doesn't matter for this theme.

19. Will the vehicle need to have the ability to enter and exit craters?

- ✓ Answer: If the missions you plan to have the rover perform include crater exploration, then yes.

20. Since the rover is regarded as a transportation tool, will it be used more as a payload carrier or more like a portable workstation?

- ✓ Answer: In un-crewed mode, it should be able to support science, so if the instruments are not included on the rover, you must define how the rover supports those instruments (and those instruments will be counted against your mass and cost limits).

Theme 1 Questions:
South Pole Multi-Purpose Rover

21. How detailed should the Concept of Operations (ConOps) be?

- ✓ Answer: Sufficiently detailed to allow the judges to determine if your proposed concept is both feasible and valuable.

22. Can the ConOps of the rover includes a charging station that is delivered by the crew?

- ✓ Answer: Yes, but keep in mind that the rover must be able to operate without anything delivered by the crew prior to the first crew mission.

23. Is our ConOps limited to one rover that will operate in a specific region like close to a South Pole crater or can we account for a fleet of rovers that are distributed across the South Pole of the Moon?

- ✓ Answer: One rover.

24. Is there a specific landing site or base camp? Does the rover have to land in a specific place chosen by the judges or can the teams decide the initial location of the rover? Can we assume that the rover/robot is going to land at the South Pole?

- ✓ Answer: There is no specific landing site beyond the South Pole.

Theme 1 Questions:
South Pole Multi-Purpose Rover

25. What should be the expected lifetime of the rover in years and/or human missions? Is there a required mission lifespan? Ie: how long is the rover expected to survive? Is this up to our own discretion?

- ✓ Answer: Up to your discretion, but it must operate at least from landing in 2023 through some period after the first crew mission in 2024.

26. How many missions a year? What are the proportions of manned/robotic missions?

- ✓ Answer: Expect one crewed mission per year beginning in 2024.

27. Should the rover provide additional thermal and radiation protection for the astronauts or should it be assumed that those issues will be resolved by other means such as the xEMU spacesuit?

- ✓ Answer: Up to your decision.

Theme 1 Questions:
South Pole Multi-Purpose Rover

28. Will the overall size of our rover be constrained to a volumetric size limit? Be it the Ferring size of the orbiter/spacecraft that will take our rover to the Moon? Is there a minimum volume requirement needed for initial launch?

- ✓ Answer: There is no hard volume constraint; however, realism of the geometry will be taken into account in reviewing your proposal. You may want to consider the fairing geometry of commercial launch vehicles as a starting point.

29. Can we use nuclear power as a means of powering the vehicle?

- ✓ Answer: No.

30. Can we assume the deep space gateway is operational?

- ✓ Answer: Yes.

31. While the rover is planned for 2 people, should we expect more people on the mission?

- ✓ Answer: Only expect 2 on the surface.

Theme 1 Questions:
South Pole Multi-Purpose Rover

32. Do we have to specify the crewed mission as part of the project? (Do we need to come up with mission designs for them too or just the rover?)

- ✓ Answer: Not the entire crewed mission, but you should describe how the rover supports potential crewed operations.

33. Since we have a 300kg weight capacity, can we have multiple launches to get supplies to the moon for modular rover capabilities? Or bring supplies on the crewed missions?

- ✓ Answer: The rover should have a complete initial functionality in a single launch.

34. Is there a required speed of the rover during robotic and manned missions?

- ✓ Answer: No requirement; you determine the speeds.

35. Should we be concerned with crash protection for astronauts?

- ✓ Answer: Modern automobiles have hazard detection capabilities to prevent accidents, so should the rover. One could imagine passive protection like a roll bar or seatbelts, but protection should be tempered by mass and probability of collisions.

Theme 1 Questions:
South Pole Multi-Purpose Rover

36. What types of bearings and lubricants have been developed to withstand extreme cold and resist extremely fine dust?

- ✓ Answer: That is for you to research.

37. Since most of the materials designed for space travel are not published, where can more information about these materials be found? Or should these materials not be considered for design?

- ✓ Answer: The NASA Technical Reports Server is an excellent resource to start your research.

38. "When the crew arrives, they will be able to reconfigure the rover to use as a two-person unpressurized rover during a ~6-day mission." is a line from the theme solicitation. Our team wanted to make sure that this duration is in Earth days, not Lunar days.

- ✓ Answer: Earth days.

39. What kind of communication transmission and receiving should the rover be expected to provide?

- ✓ Answer: The rover should have sufficient communications ability to support commanding, telemetry, and science data.

Theme 2 Questions:
International Space Station (ISS) as a Mars Mission Analog

40. If we were to send the crew back to Earth, how much human interaction should they have?

- ✓ Answer: Plan for minimal human interaction to accurately simulate the experience of a surface mission to Mars.

41. Should we focus on this being completely self-contained, or allow adjustments as needed throughout the mission?

- ✓ Answer: It should be as self-contained as is feasible to more accurately simulate how the real Mars mission would happen.

42. How much should we focus on consumables and waste?

- ✓ Answer: You need to describe your plans for both.

43. Is exercise equipment attached to the nodes they are contained in, or can it be moved around?

- ✓ Answer: You can assume there is a "Mars-class" exercise system available to them where they are on ISS, but not the full=up ISS suite of exercise systems.

Theme 2 Questions:
International Space Station (ISS) as a Mars Mission Analog

44. Can we jettison waste?
- ✓ Answer: Yes.

45. Should we plan for a one-way mission, or an out-and-back?
- ✓ Answer: Out-and-back.

46. Is this a multinational mission?
- ✓ Answer: To be determined; if you think that making it multinational has an impact on the analog, then point that out in your proposal.

47. How in depth should we plan astronaut - ground communications, other than time delays?
- ✓ Answer: You should identify major protocols for communication, but do not need to go to the level of specifying daily operations.

48. Is there a limit to modifications that can be made on spacecraft?
- ✓ Answer: The judges will evaluate the reasonableness of proposed modifications to the ISS.

Theme 2 Questions:
International Space Station (ISS) as a Mars Mission Analog

49. Should the spacecraft used for transportation to the ISS have the capabilities of going to Mars?

- ✓ Answer: No.

Theme 3 Questions:
Short Surface Stay Mars Mission

50. Should our design assume we are leaving from the Earth, the Moon, or already in orbit around Mars?

- ✓ Answer: From the Earth, although you may use the Gateway as a staging location.

51. To clarify, we are not responsible for figuring out transportation from the Earth to Mars, just what happens on Mars. We are responsible for creating the mission for Humans on Mars and the Rover. Is that correct?

- ✓ Answer: No, that is not correct. You are responsible for transportation from Earth to Mars for the crew. You may assume the existence of up to 3 landers, each capable of delivering 22 tons to the surface (including the crew).

52. Is it possible to not consider payload for fuel for returning launch (just checking if we can consider a decreased payload in case designing with current payload requirement becomes complicated) while the vehicle is leaving earth with total payload?

- ✓ Answer: You need to account for the propellant to bring the crew back from Mars to Earth.

Theme 3 Questions:
Short Surface Stay Mars Mission

53. Is this supposed to be commercial or private?

- ✓ Answer: You may propose how commercial systems are used to support your architecture.

54. Are there any specifics for the transportation vehicles or is it a free-for-all?

- ✓ Answer: You may decide what transportation to use; however, keep in mind the timeline and cost constraints mentioned in the theme.

55. Are we required to use Orion/SLS?

- ✓ Answer: Orion & SLS block 1B (8.4-meter shroud, 45-ton TLI) are available at an average of two SLS launches a year. You can assume them, but they will not be enough. You do not have to assume them in your architecture, but assume they will exist and you cannot take credit for cannibalizing the programs to pay for other aspects of your architecture.

Theme 3 Questions:
Short Surface Stay Mars Mission

56. Which launch vehicles can we assume will be in operation for our mission? Which ones can we assume will be human rated?

- ✓ Answer: Beyond existing launch vehicles (e.g. Falcon Heavy, Delta IV Heavy, Atlas V), you may assume the existence of the SLS Block 1B (8.4 meter shroud, 45t TLI capability) and Blue Origin's New Glenn. Starship could be a game changer, but right now we do not know its performance characteristics enough to assess it in an architecture, and it cannot RETURN crews from the surface of Mars unless there is already industrial scale ISRU available, which is inconsistent with this FIRST mission design exercise.

57. How much freedom do we have on exploring the architecture of the launch, for example, can we choose the launch vehicle?

- ✓ Answer: Yes.

58. What is NASA's expected budget for human exploration in this time frame? Are we to use the $500 million for FY 2020?

- ✓ Answer: You can research past and current NASA budgets to make estimates of the available funding in HEOMD. And, NASA's human exploration budget is much larger than $500 million.

Theme 3 Questions:
Short Surface Stay Mars Mission

59. Should we assume ISS will still be present? Can we assume that we will be able to take budget from any space program that may be obsolete in the near future?

✓ Answer: Do not assume you can take budget from another place, just tell us what you think the total mission cost is for development, deployment and operations.

60. Could an existing (or proposed to exist at the time of the mission) vehicle be used as a lander, or should the landers be custom designed by the team?

✓ Answer: Mars will require some customization, but you are free to start with any vehicle, so long as turning it into a Mars lander is technically and programmatically sound.

61. What level of detail is required for vehicle design?

✓ Answer: Enough to convey the feasibility and value of your design.

62. Are we basing the mission length on the length of days on Earth or sols on Mars? Is the surface mission approximately 30 Martian days long, or 30 Earth days long?

✓ Answer: Earth days.

Theme 3 Questions:
Short Surface Stay Mars Mission

63. If the surface mission is 30 days, does that imply that the crew cannot spend a significant amount of time (e.g. months) in orbit around Mars?

- ✓ Answer: It does not imply that. That depends on the concept of operations for your in-space transportation system.

64. Should we be working with the idea that the Moon would be used as a midpoint for the missions?

- ✓ Answer: You may assume the existence of the lunar Gateway.

65. Please clarify "approximately" 30 days?

- ✓ Answer: It need not be exactly 30 days, but you should design your systems to support around that duration of time on the surface.

66. Is the duration of 30 days on Mars surface only for human surface operations? Can we place remotely operated/autonomous objects on the surface to continue mission before crew has arrived or continue operations after crew leaves?

- ✓ Answer: Yes, you can pre-deploy systems. Only the crewed segment is around 30 days.

Theme 3 Questions:
Short Surface Stay Mars Mission

67. Is 30 days only the limitation for the surface mission? Orbit mission can be different?
- ✓ Answer: Correct, 30 days for the surface mission.

68. Are we working under the assumption that private companies' plans to reach Mars do not exist?
- ✓ Answer: You must design a mission from end-to-end, and not assume some other entity addresses half the mission.

69. Should we plan for potential issues while traveling to Mars, or make the assumption that everything will occur as planned?
- ✓ Answer: You should consider potential risks and their mitigations.

70. Do we need to explore the return to Earth, or are we only focusing on getting to Mars?
- ✓ Answer: You need to account for the return to Earth.

71. Do we have to focus evenly on each individual idea, or are we free to go more in depth on certain areas versus others?
- ✓ Answer: Address all the architecture at some level, but feel free to focus where you see your approach is innovative.

Theme 3 Questions:
Short Surface Stay Mars Mission

72. How much focus should be placed on the crew remaining in orbit?

- ✓ Answer: You need to account for it in your design, but the focus is on the surface mission.

73. Other than the fuel required to descend to the surface of Mars, and to return to the orbiter, should we account for any other weight of fuel needed throughout the mission in our 66 ton cap?

- ✓ Answer: Not in the 66-ton landed mass limit, but your architecture should include the propellant for traveling between Earth and Mars and back.

74. Are there any restrictions on using nuclear propulsion and/or nuclear power?

- ✓ Answer: No restrictions, but it has to be technically feasible in the stated timeframe with reasonable engineering assumptions.

75. Can RTGs be used for elements of the architecture that humans are meant to interact with?

- ✓ Answer: If you accommodate crew safety through shielding, fuel type and operations, then, yes, but state the assumptions.

Theme 3 Questions:
Short Surface Stay Mars Mission

76. How much should we consider potential theoretical future inventions that can be used on the mission vs what is currently existing today?

- ✓ Answer: Given the bold timeline for human exploration in this theme, you will need to make a credible case that any technology can be matured by the 2035 launch date.

77. Is the landing site known? Can we choose the landing site? Is there a specific region of Mars established as the destination?

- ✓ Answer: You can choose it the landing side and destination, but, remember, this surface mission is searching for life.

78. Is the 22-ton capacity of each lander a minimum capacity or a maximum capacity? Is 22 tons a high-end limit, minimum requirement, or a specification?

- ✓ Answer: Maximum capacity.

79. How is "lander" defined? Does anything that touches the surface of Mars count as a lander/landing and count as part of the 22-ton mass limit?

- ✓ Answer: No, each lander provides 22 tons of usable payload.

Theme 3 Questions:
Short Surface Stay Mars Mission

80. Does the 22 ton capacity of each lander account for only payload, or does that number include the entire mass delivered to the surface (such as engines, fuel tanks, etc)?

✓ Answer: Payload.

81. Is "tons" in units of force or mass? If force, which gravitational constant should be used (Earth vs Mars)? Landers cannot weigh more than 22 tons as specified in the guidelines, but is that based on weight relative to Mars' gravity or Earth's?

✓ Answer: Tons are a unit of mass, equal to 1000 kg.

82. Are there restrictions on the landers being able to launch and land repeatedly?

✓ Answer: No, just assume that they can deliver 22 tons each.

83. Is there a limit to the number of launches from Earth, regardless of the max number of landings?

✓ Answer: You should describe how realistic your assumed launch cadence is.

84. Are there power constraints in regards to generation method (solar, nuclear, etc.)?

✓ Answer: No restrictions other than make sure your assumed technology is reasonable at the time.

Theme 3 Questions:
Short Surface Stay Mars Mission

85. When considering propulsion and fuel are there any restrictions as to what technology we can use to cut down on the required weight of fuel (i.e., nuclear engines, uranium fuel)?

✓ Answer: No, but make sure crew safety is highlighted if assuming nuclear systems.

86. What degree of automation should we assume the subsystems will be capable of?

✓ Answer: Assume no more capability than a self driving car. Nothing like self assembling out of a box of plastic bits…

87. How important is it to protect the Mars surface from human contamination? Is planetary protection more important than human survival on Mars?

✓ Answer: For this theme, you need to balance keeping the crew alive with conducting an effective mission to search for life.

88. What is the budget for this mission?

✓ Answer: Use recent NASA budgets and the guidelines in the theme to make a credible estimate.

89. What should we assume NASA's future budget will be?

✓ Answer: Use recent NASA budgets and the guidelines in the theme to make a credible estimate.

Theme 3 Questions:
Short Surface Stay Mars Mission

90. How much emphasis should be placed on limiting expenses at the potential risk of mitigating safety and the success of the mission?

- ✓ Answer: That is a tradeoff for you to define.

91. Is it acceptable to consider both foreign and private sector technology in addition to technology currently being developed for NASA for this mission?

- ✓ Answer: Yes, although keep in mind that realistic development schedules and funding profiles are an important part of how your concept will be evaluated.

92. What level of detail is desired for the rover concept design and what specific areas of the rover, if any, should we most consider?

- ✓ Answer: The pressurized rover will be central to the 30-day Mars surface mission. Its ability to traverse 10s to 100s of kilometers may be essential to the mission, and this range is driven by energy utilization/storage. The rover could serve as the only crew habitat on the surface, and the EVA system used to go in and out of the rover needs to optimize crew performance and protect against dust.

Theme 3 Questions:
Short Surface Stay Mars Mission

93. Can it be assumed that all weight constrictions are calculated using Earth's gravity?

- ✓ Answer: The 22 tons limit is a mass limit.

94. Do we need to design for radiation protection for the 7 month journey? (Not sure it's possible to have safe levels.)

- ✓ Answer: You should consider how you can keep the radiation exposure for the crew as low as is reasonably achievable. The only requirement is to protect against solar particle events.

95. Are there constraints to the amount of equipment brought over onto Mars beyond the vehicles?

- ✓ Answer: All of your surface systems must fit within the 3 22t landings.

96. Can there be previous launches to drop off supplies/equipment to support the mission, before the human expedition arrives? Can elements of the architecture be prepositioned?

- ✓ Answer: Prepositioning is allowed, within the constraint of the three landers (one of which must bring the crew to the surface).

Theme 3 Questions:
Short Surface Stay Mars Mission

97. Can we pre-deploy assets (supplies) ahead of time? Follow-up: Can initial pre-deploy assets leave by December 31, 2035, or does the final piece of the mission have to leave Earth by this date?

✓ Answer: Yes, you can pre-deploy.

98. Is there a limit or standard for what equipment can be left on Mars after the mission?

✓ Answer: No.

99. Do all rovers/components return to Earth?

✓ Answer: No.

100. Can we use existing communications networks? What about planning for future communications networks to support our mission concept?

✓ Answer: You can use existing networks, and you can describe how a future network might fit within the budget envelope of your architecture.

Theme 3 Questions:
Short Surface Stay Mars Mission

101. Is it possible to salvage equipment from the rovers on Mars no longer operating?

- ✓ Answer: No, as the surface mission will not necessarily be going where previous rovers have landed.

102. What parts of the architecture need to launch by December 31, 2035?

- ✓ Answer: The crew, as well as anything pre-deployed to the surface.

103. Do the two crew who remain in orbit need to orbit Mars, or would orbiting the Sun be acceptable?

- ✓ Answer: Orbiting the sun while the crew were on the surface (for 30 days) would imply a hyperbolic rendezvous. This is risky but permissible.

104. What is the rationale for leaving two astronauts in orbit?

- ✓ Answer: To reduce the requirements for the surface and ascent systems.

105. What is the real role of the astronauts in orbit?

- ✓ Answer: To support the crew on the surface.

Theme 3 Questions:
Short Surface Stay Mars Mission

106. Is return of the crew to Earth mandatory or optional?

- ✓ Answer: Mandatory.

107. How much are we allowed to plan around for currently-planned NASA investments? (e.g. LOP-G, ISRU, Deep Space Habitat, HIAD/SRP technology, etc.)

- ✓ Answer: It is highly encouraged.

108. If we design a system for reusability of future missions, can we expect that there will be future missions to Mars (i.e. account for future money saving)?

- ✓ Answer: You can mention that a reusable system has benefits after the first mission; however, it must be affordable for the first mission; you cannot shift expenses for the first mission into subsequent years.

Theme 3 Questions:
Short Surface Stay Mars Mission

109. Theme states "prove capabilities needed for longer-duration future missions to Mars." Should we focus on creating infrastructure on surface to be reused for future missions or just prove concepts for future mission to different landing location(s)?

✓ Answer: The focus should be on accomplishing the short duration mission, but you should identify how that mission proves out capabilities for future missions.

110. Should we consider orbital debris creation/risks/limitations when it comes to EDL, stage separation, etc.?

✓ Answer: No.

111. Do we have to design our surface-stay experiments/equipment? If so, what level of detail for experiments performed on the surface?

✓ Answer: You should describe how your mission will support the search for life on Mars.

112. Are there any other scientific goals to design equipment for such as drilling to support the search for life?

✓ Answer: Focus on the search for life.

Theme 3 Questions:
Short Surface Stay Mars Mission

113. Can we use existing commercial technologies to support the mission?

- ✓ Answer: Yes.

114. Are trajectory calculations suggested for conducting this theme?

- ✓ Answer: Yes.

115. How in-depth do the calculations for the rocket trajectory have to be?

- ✓ Answer: Your calculations should be sufficient to have a credible analysis of your concept of operations.

116. Is it recommended to keep track of a parts/ budget list for all the parts?

- ✓ Answer: Yes.

117. Are we to include the itinerary for the list that must be done for the crew during the 30 days?

- ✓ Answer: At a high level, yes.

118. Do we need a timeline of the process of preparation for the mission up until launch day?

- ✓ Answer: At a high level, yes.

Theme 3 Questions:
Short Surface Stay Mars Mission

119. Is there already a habitat on Mars?

- ✓ Answer: No.

120. Do we need to use names and personalities of members in current project group as the four person crew or ambiguous, "ideal" candidates?

- ✓ Answer: Just generic astronauts.

121. Can we use Gateway?

- ✓ Answer: Yes.

122. Should we assume promised deadlines for prototyping technology?

- ✓ Answer: You may, though assessing the risks associated with those technologies is also in scope.

Theme 4 Questions:
Commercial Cislunar Space Development

123. Since it is not possible to use minerals extraction as a prime business idea, is it possible to use it as one of the steps in a more sophisticated business project?

- ✓ Answer: Possibly, although keep in mind the idea still needs to fit within the other constraints of the theme.

124. Level of detail required for the habitation and working environment for astronauts physically present on the moon during the projects development and construction in terms of financials, location and safety?

- ✓ Answer: Enough to make a credible case in your proposal.

125. Level of detail regarding rover/builder-bots in terms of their cost and functionality?

- ✓ Answer: Enough to make a credible case in your proposal.

Miscellaneous Questions:

126. What level of depth is expected for the proposal?

- ✓ Answer: See the proposals section on the Deliverables Page of the RASC-AL website for full details. Robust proposals are expected that demonstrate significant progress in your design and analysis. The judges will be looking for mature mission concepts at the proposal stage. The proposal should reflect the total scope planned for the final paper. All analysis results to-date (in summary form if necessary due to space limitations) should be included (leaving placeholders for analysis not yet completed). It is imperative that you apply all of the criteria from the theme descriptions to show your design details.

127. Can we assume that we will be able to use space systems from foreign organizations? (The RASCAL key elements state that it will be evaluated upon "commercial profitability and ability of international partners to participate…")

- ✓ Answer: Yes, although you should account for the challenges that can come from integrating systems or architectures with contributions from multiple groups.

128. Are all missions intended to be considered as U.S.-only endeavors?

- ✓ Answer: No.

Miscellaneous Questions:

129. For the cost analysis, will an entire financial planner with proper format be necessary, or will bullet points and highlights be sufficient?

- ✓ Answer: The cost analysis should be focused on the development, deployment and operations of all the systems proposed to enable what is proposed in Theme 5. The level of detail should be sufficient enough to assess validity.

130. In the cost analysis, will each material need to be individually itemized or can some products be "in bulk?"

- ✓ Answer: You are probably going into too much detail if you are specifying individual materials in your costs.

131. We are encouraged to collaborate with those currently in industry, do we need to cite information and assistance from engineers and related professionals we may know through personal relationships? (i.e. Reviewing design and analyses for accuracy)

- ✓ Answer: Yes.

Miscellaneous Questions:

132. How much access do we have to NASA technical standards?

- ✓ Answer: Anything publicly available. A good resource is https://aaq.auburn.edu/standards-search.

133. Are teams allowed to approach known NASA employees for advice on their project? Not in a official status though.

- ✓ Answer: Yes, as long as the NASA employees are in no way affiliated with RASC-AL and they are NOT a part of the Systems Analysis and Concepts Division (SACD) at Langley (the team who funds/supports RASC-AL), you may work with/consult connections with NASA in your network. Please ensure they are given proper credit for any support in your proposal.

Questions Received Late:

134. (Theme 2) Our concept proposes an experiment for the effects of microgravity/reduced gravity environments on food resources rather than hypothetical manned missions, I'm wondering if it is adequate for the theme.

- ✓ Answer: No.

135. (Theme 3) For the 4 humans on this mission, while two are in the rover, are the other two in orbit? Are we expected to build a habitat for them?

- ✓ Answer: Yes, the other two are in orbit. No, you are not expected to build a habitat for them.

136. (Theme 3) Would we be able to interact with previously established rovers on the planet?

- ✓ Answer: No. See Question 101.

137. (Theme 3) Do we also need to design the space suits?

- ✓ Answer: No.

138. (Theme 1) Does the rover have to be reconfigurable or can it be dual mode for easy transition between automated rover and manned rover?

- ✓ Answer: Dual mode is permitted if the design can achieve both sets of objectives.

Questions Received Late:

139. (Theme 1) Can we expect a manned mission to strictly take place during the lunar day?

- ✓ Answer: Yes.

140. (Theme 1) What can deployable infrastructure from a rover look like?

- ✓ Answer: See Question 8.

141. (Theme 1) Should consistent human control be assumed for the robotic portion of the rover's mission?

- ✓ Answer: It can be.

142. (Theme 1) Is there a standard range the rover must support when in manual mode?

- ✓ Answer: No, you determine what range your design permits.

143. (Theme 3) What are the maximum dimensions of each lander's cargo space?

- ✓ Answer: No hard constraint, but teams should consider the dimensions of proposed commercial lander providers.

Additional Questions?

Please direct all future questions to the RASC-AL Program Team at rascal@nianet.org.

Each question will be responded to directly as well as posted on the FAQs page for everyone to view.

We encourage interested participants to visit the FAQs page often: http://rascal.nianet.org/faqs/.

RASC-AL Challenge Resources

- **RASC-AL Website: http://rascal.nianet.org**
- **RASC-AL Resources: http://rascal.nianet.org/competition-basics/resources/**
  - Recommended Reading
  - Technical Reports/Data Searching
  - Project Management/Systems Engineering
  - Costing
  - Human Health
  - Software
  - Orbital Mechanics
  - Proposals
  - Oral Presentation
  - Poster Presentation
  - Logos

Important Upcoming Dates

(ALL TEAMS)

March 5
Deadline to Submit Proposals & Videos

March 30
Selection Status Notification

May 13
Deadline for Online Registration and Payment

May 28
Deadline to Submit Technical Paper

June 15
Deadline to Submit Oral Presentation

(FINALIST TEAMS)

June 15-18, 2020
2020 RASC-AL Challenge

RASC-AL
Revolutionary Aerospace Systems Concepts Academic Linkage

Thank you, and best of luck to all of the teams!