National Aeronautics and Space Administration

Human Mars Mission Surface Power Impacts on Timeline and Traverse Capabilities

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Human Mars Mission Surface Power Impacts on Timeline and Traverse Capabilities

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Mars Mission Background

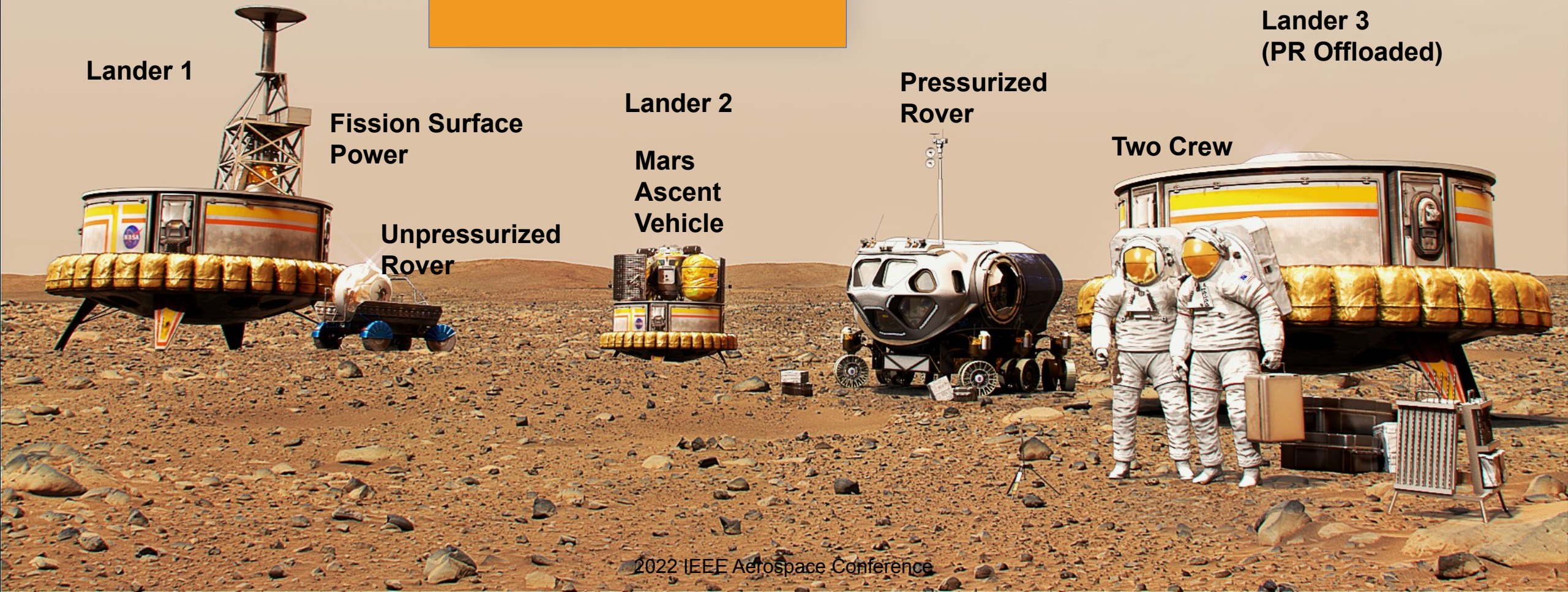
Parameters to conduct this study only, not to be interpreted as NASA “plan”

- Minimal surface mission
  - Two crew on surface
  - Live/work in a pressurized rover only
  - 30 Sol surface mission duration

- Support assets
  - Three 25mT landers for predeployed cargo, crew delivery, and base stations
  - Pressurized rover (PR) for habitation, surface traverse, and operations
  - Unpressurized rover for logistics operations
  - Nuclear fission surface power (FSP) supply for primary power
  - Crewed Mars ascent vehicle (MAV) for departure

Three Lander Minimal Mars Mission

This architecture is for *analysis purposes*, and should not be misconstrued as “the plan”



Foundation

Balance of three primary constraints

1. Power
   - How much power do I have? What all needs power?
2. Operations
   - How much time do I have or need to explore, recharge, and conduct other necessary activities?
3. Pressurized Rover Hardware
   - How much energy can it store? How much energy does it consume when idle/moving?

Ultimate Question: How much exploring (time/distance) can be achieved within these constraints?

Power

- Single 10 kW Fission Surface Power (FSP) supply
  - Backup 10 kW FSP unit only available in contingency
  - Losses are ignored for simplicity, representative of capturing future technology maturity, design uncertainty, and margin

Total Supply = 10 kW

- Margin
  - 30% added to power needs for margin
  - Taken out of the total power available to determine maximum usage capability

Margin = 2.3 kW

- Surface asset power
  - Constant power for landers as base stations (communications, navigation, etc) and keep alive for MAV, remaining can be used for recharge, unpressurized rover recharges non-interference schedule

Surface assets = 2.85 kW

<u>Total available for PR = 4.85 kW</u>

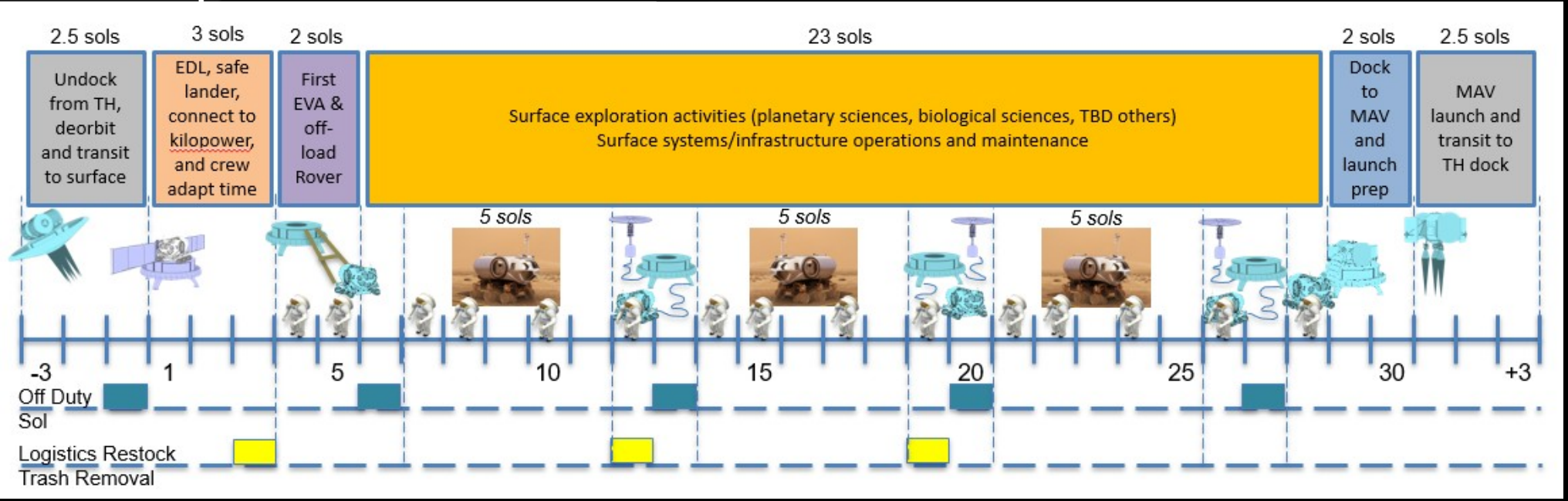
Operations

Representative operations timeline for study purposes

- Initial landing, adjustment, and preparation periods
- Three exploration excursions
  - 5 Sols continuous exploration, 1 Sol logistics resupply, 1 Sol rest day
- Departure preparation and launch period

Time available to recharge between excursions = 2 Sols

Continuous exploration duration = 5 Sols



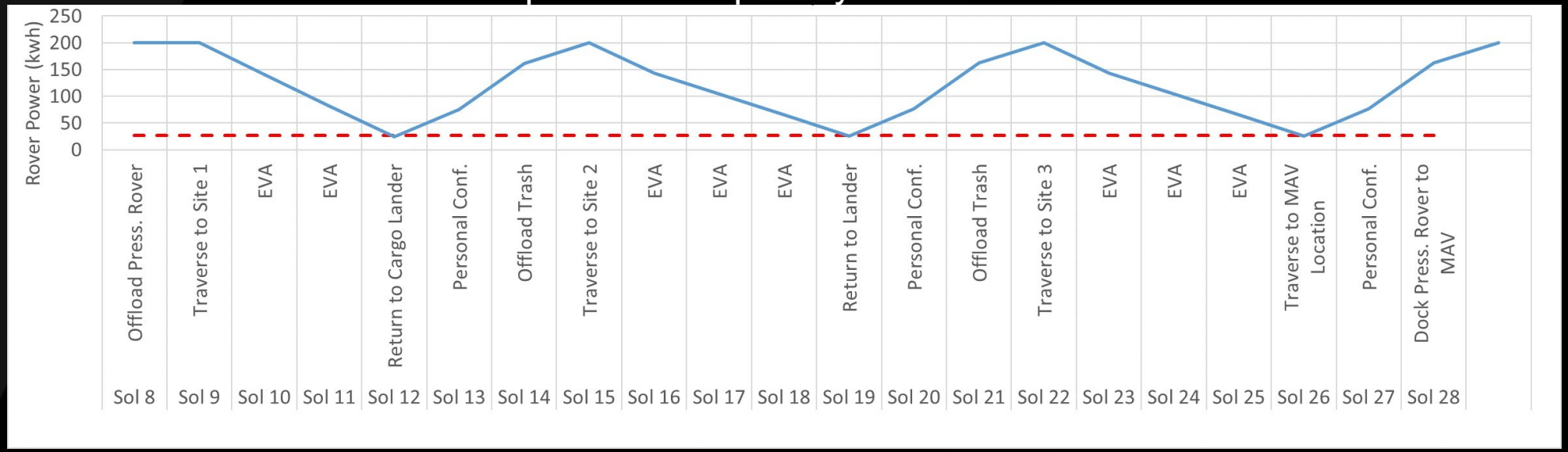
Pressurized Rover

- Power from internal battery
  - 200 kW-hr battery selected to meet continuous operations objectives
- Hotel load 1.85 kW

Total recharge power = 3 kW

Total recharge duration = 48 hrs

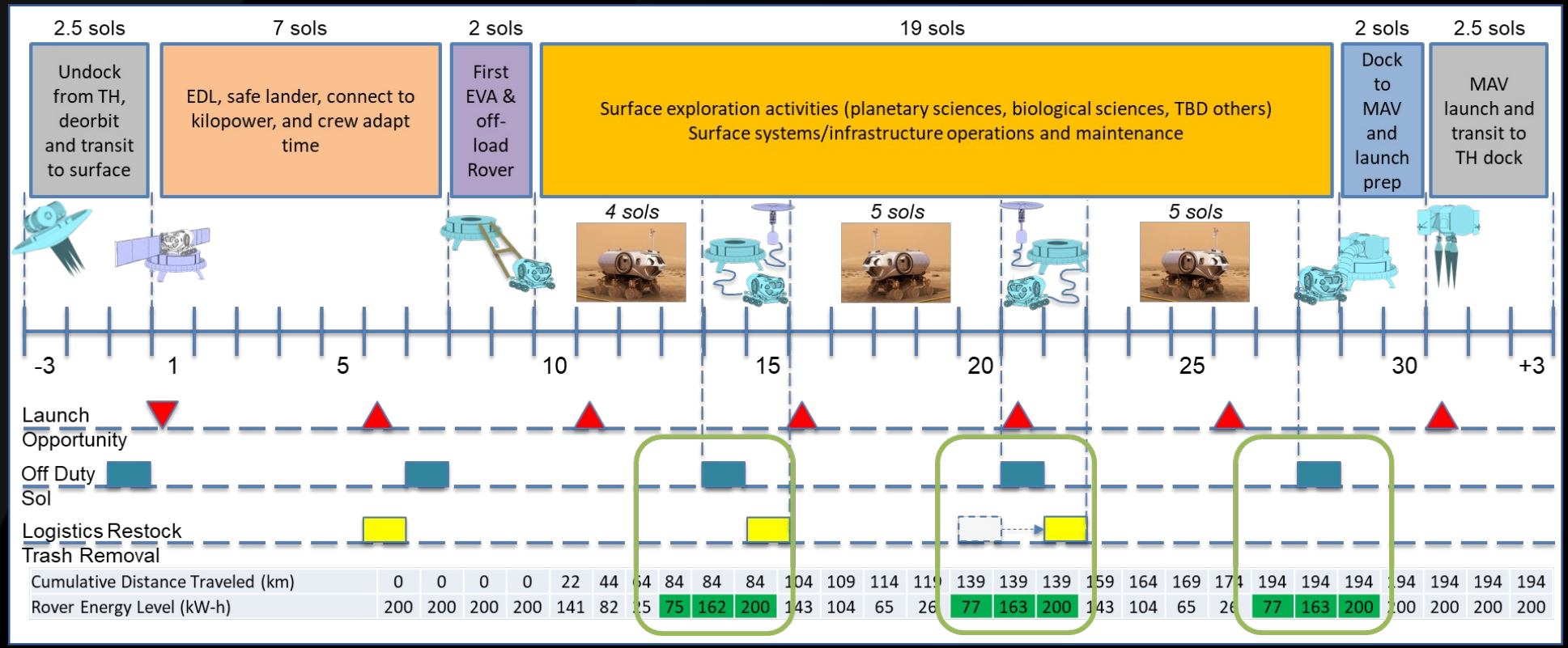
- Integrating recharge capacity with battery capacity and desired operations durations results in the distance and continuous remote operations capability of the rover



Total Exploration

- Integrating power, operations timeline, and rover capabilities, a resulting achievable exploration capability is determined

<u>Total Exploration</u> = <u>279 hrs</u> away from recharge site with <u>112 hrs</u> at exploration sites and cumulative traverse distance of <u>194 km</u>

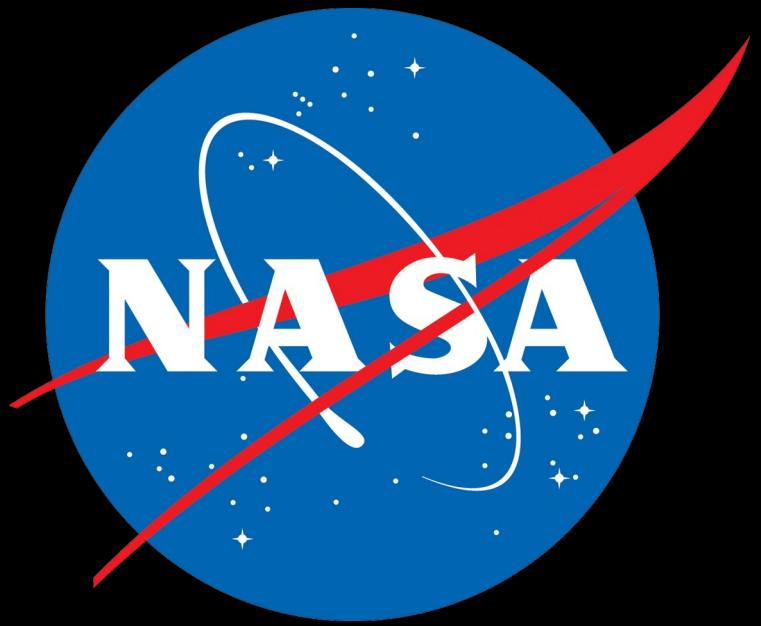


Alternate Opcons

- As part of the study, the team assessed how alternative operations concepts might work with in the bounds of the power and mobility constraints
- While other concepts were achievable, the primary operations described in the study achieved the maximum exploration capability without adding any additional hardware (added mass) or impact to required operational constraints

Opscon Name	General Opscon	Philosophy
Long Stay/Recharge	Drive to exploration site, stay as long as possible on large battery, return to FSP for full recharge	Max duration with no additional hardware
Commuter	Daily (sol-ly?) drive to exploration site, perform exploration activities, return to FSP each sol for full recharge	Frequent recharge with no additional hardware
Battery Swap	Drive to exploration site, perform exploration activities, return to FSP, swap for fully charged battery, leaving behind depleted battery to recharge and return to exploration site	Add hardware to minimize battery turnaround
Mobile PUP	Drive both PR and PUP to exploration site, use the PUP to recharge the PR, PUP can return on its own to the FSP for recharge and return to the exploration site to serve PR	Add hardware to maximize exploration capability


Questions?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