



## KuupKulgur wheel requirements

DOCUMENT CHANGE RECORD			
Issue	Revision	Date	Brief description
1	0	2024.01.08	V1.0

*Table 1: Document change record*

The wording of statements in this requirements specification determines the disposition of requirements:

- "SHALL" and "SHALL NOT" are used to indicate a mandatory requirement.
- "SHOULD" and "SHOULD NOT" are used to indicate a recommendation, which is not mandatory.
- "MAY" and "NEED NOT" indicate permission or an option.
- "WILL" indicates a statement of fact or intention.

Abbreviation	Description
FUN	Functional requirement
DES	Design requirement
ENV	Environmental requirement

*Table 2: Requirement Types*

Abbreviation	Description
T	Test
A	Analysis
ROD	Review-of-design
I	Inspection

*Table 3: Types of Verification Methods*



The wheels must fulfil the following systems level requirements:

TN2-FUN-0302	The rover shall be able to operate over a temperature range of -25°C to 60°C. It shall survive non-operating in temperature ranges of -40°C to 100°C.	A, T	N/A	
The rover must support the same temperature ranges, both operating and non-operating, as the payloads.				

TN2-FUN-0400	The rover speed shall be higher than 3 cm/s.	A, T		
The rover shall move on Lunar analog terrain with dedicated speed.				

TN2-FUN-0401	The rover should have a stationary turning rate higher than 5 degrees/s.	A, T		
The rover should be able to turn with dedicated rate at stationary position.				

TN2-FUN-0402	The rover shall be able to climb upwards of at least 15 degrees slope.	A, T		
The wheel's grip and centre of gravity shall support the rover to climb upwards of modest inclination without getting stuck.				

TN2-FUN-0403	The rover shall be able to drive downwards of at least 20 degrees slope.	A, T		
The wheel's grip and centre of gravity shall support the rover to drive downwards of modest inclination without falling over.				



TN2-FUN-0404	The rover shall be able to drive forward with at least 15 degrees side tilt.	A, T		
The suspension system and centre of gravity shall allow the rover to drive forward with modest side tilt.				

TN2-FUN-0405	The rover shall be able to climb over at least 30 mm high obstacles.	A, T		
The wheel design and suspension system shall enable the rover to climb over modest obstacles without getting stuck or fall over.				

TN2-FUN-0406	The rover shall be able to travel at least 2 km.	A, T		
The rover shall move the minimum distance without significant degradation.				

TN2-FUN-0407	The rover should not sink in more than 15 mm while stationary.	A, T		
The rover's wheel design should prevent the rover from sinking too deep into the Lunar surface.				

TN2-ENV-0502	The rover shall survive thermal conduction with the Lunar surface.	ROD, A, T		
The rover wheels and suspension system shall mitigate thermal fluctuation or gradient.				

TN2-ENV-0503	The rover materials shall be chosen to mitigate	ROD, T		
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	galvanic corrosion.			
The rover material shall be chosen in a way to mitigate corrosion and cold welding due to materials' different thermodynamic activities.				

TN2-ENV-0504	The rover materials shall be chosen to withstand the near vacuum of space.	ROD		
The rover material shall be chosen in a way to withstand near vacuum.				

TN2-ENV-2201	The rover shall survive the vibration environment of the launch.	ROD, A, T		
The rover system shall be designed to withstand the vibration profiles of all the ESA and NASA accepted launch vehicles.				

TN2-FUN-2003	The rover system chassis and wheel shall be able to carry the dedicated weight without significant performance drop.	ROD, T		
Due to different payload configurations the final weight of the rover system shall not determine the rover performance.				

TN2-FUN-2004	The factors of safety to be used for dimensioning of mechanical items shall be clearly reported in the documentation. ECSS-E-ST-32-10 and ECSS-E-ST-32-02 shall be used as reference.	ROD		
To mitigate any mismatched tolerance incompatibilities.				



TN2-DES-2000	The rover system should use only Torx head screws.	ROD		
To mitigate any problems with achieving rated screw torques.				

Wheels and suspension shall fulfil the following requirements:

TN2-FUN-2100	The wheels outer diameter should be equal to or less than 150 mm.	ROD		
To stay in the dedicated volume size.				

TN2-FUN-2101	The wheel should be made only out of space compatible materials listed in ECCS-E-ST-32-10.	ROD, I		
To mitigate any issues with compatibility.				

TN2-FUN-2102	The wheels should have enough grip to fulfil the transversability requirements.	ROD, A, T	TN2-FUN-0400 TN2-FUN-0401 TN2-FUN-0402 TN2-FUN-0403 TN2-FUN-0404 TN2-FUN-0405 TN2-FUN-0406 TN2-FUN-0407	
To allow the rover to achieve listed performance.				

TN2-FUN-2103	The wheel should be durable for at least 3 km of drive.	ROD, T	TN2-FUN-0406	
To survive minimum distance according to TN2-FUN-0406.				



TN2-FUN-2104	The wheels and suspension system shall be thermally suitable to prevent cold welding on moveable joints.			
To mitigate cold welding due to relatively low ambient pressure.				

TN2-FUN-2105	The wheels and suspension system shall be able to carry the overall weight of the system.		TN2-PHY-0001 TN2-FUN-2003	
The wheels and suspension system should have sufficient stiffness to handle maximum weight according to TN2-PHY-0001.				

TN2-DES-2500	The rover system and deployment system shall follow the ISO 286 standard for any attachment holes.	ROD		
To mitigate any mismatched tolerances.				

TN2-DES-2501	The rover system and deployment system shall follow the DIN ISO 2768 for any general tolerances.	ROD		
To mitigate any mismatched tolerances.				