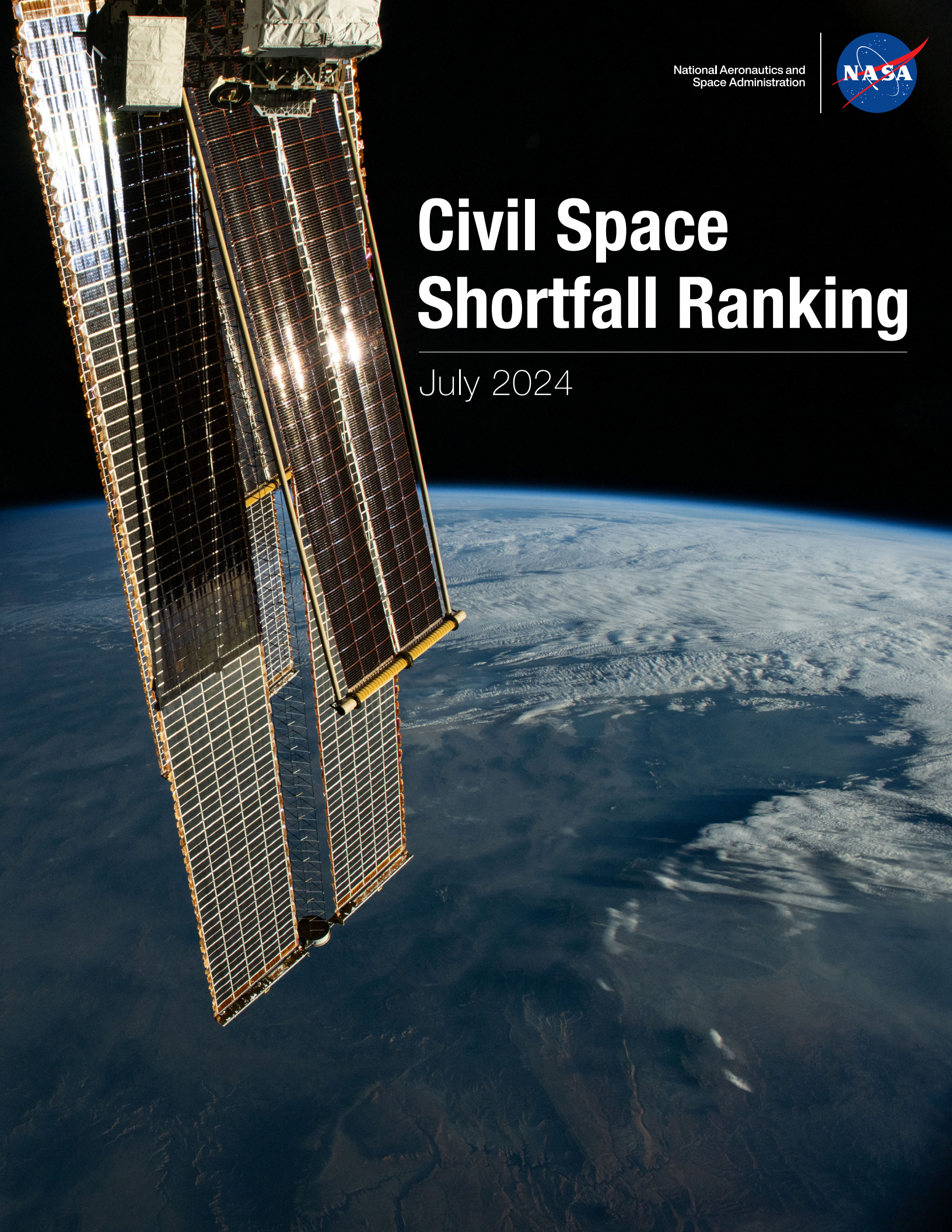


National Aeronautics and Space Administration

# Civil Space Shortfall Ranking

July 2024

# Table of Contents

# Background

In April 2024, NASA published a document overviewing 187 shortfalls – technology areas requiring further development to meet future exploration, science, and other mission needs – and asked the aerospace community to rate their importance. The effort led by the Space Technology Mission Directorate (STMD) aims to better integrate the community's most pervasive technical problems to help guide its space technology development and investments.

The 187 shortfalls span 20 capability categories:

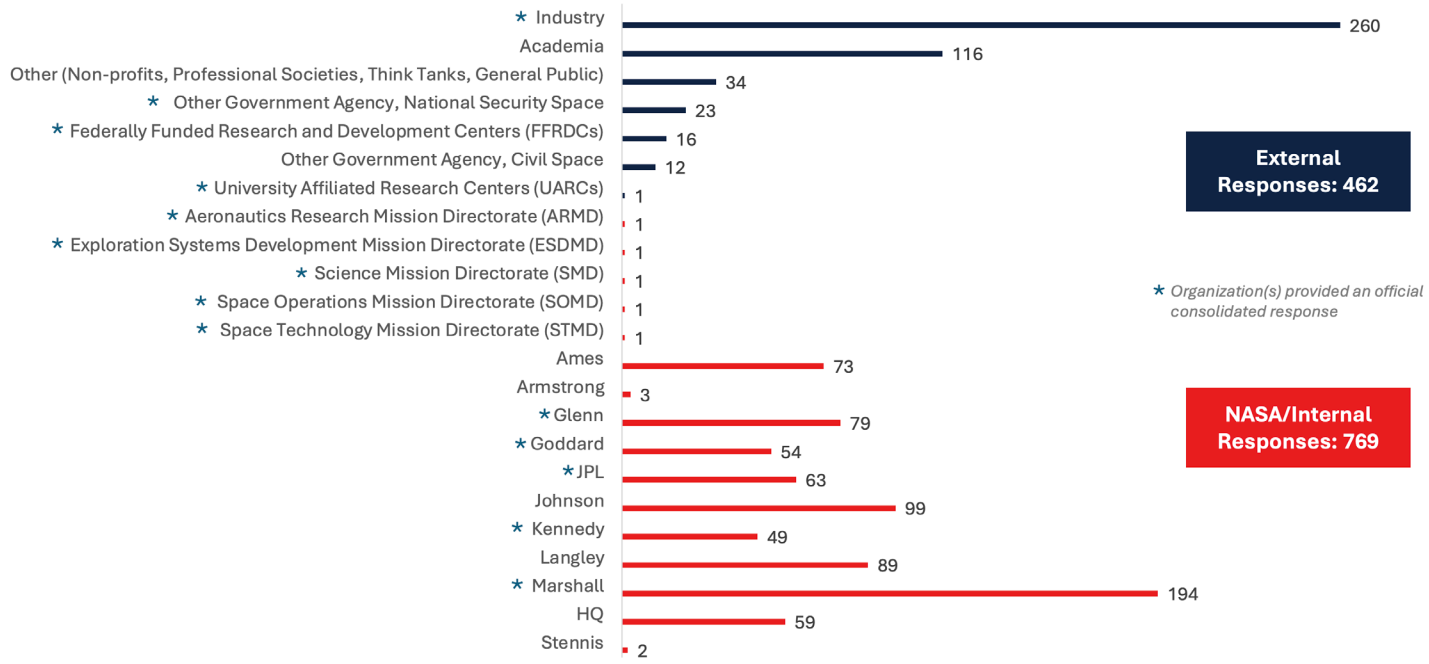
- Advanced Habitation Systems
- Advanced Manufacturing
- Advanced Materials & Structures
- Autonomous Systems & Robotics
- Avionics
- Communication & Navigation
- Cryogenic Fluid Management
- Dust Mitigation
- Entry, Descent & Landing
- Excavation, Construction & Outfitting
- In-Situ Resource Utilization
- In-Space Servicing, Assembly & Manufacturing
- Orbital Debris
- Power
- Propulsion
- Sensors & Instruments
- Small Spacecraft
- Surface Systems
- Thermal Management Systems
- Miscellaneous

This document summarizes the 2024 feedback received and the resulting **integrated ranked civil space shortfall list** as well as the **ranked shortfall lists by stakeholder group**.

# Feedback

NASA received 1,231 total responses, including 769 internal and 462 external responses. Twenty submissions were consolidated responses, representing multiple individuals from the same organization. Each NASA mission directorate, five NASA centers, and 10 external organizations submitted an official consolidated response.

The graph below shows the detailed breakdown of the responses.




# Scoring

The responses scored shortfalls with 0, 1, 3, 5, 7, 9, or N/A. Blanks were treated as N/A.

The ranked lists are based on the numerical shortfall scores received and not responses to the open-ended questions. NASA is still processing the qualitative feedback and anticipates it will provide additional context, uncover other shortfalls, and more.

# Stakeholder Groups

STMD sorted the responses into nine stakeholder groups, including four NASA and five external groups listed below. The bullets further define and/or denote additional feedback included within each stakeholder group.

## NASA Stakeholders

**Exploration Systems Development Mission Directorate (ESDMD)**

**Science Mission Directorate (SMD)**

**Centers**
- Ames Research Center
- Armstrong Flight Research Center
- Glenn Research Center
- Goddard Space Flight Center
- Headquarters
- Jet Propulsion Laboratory
- Johnson Space Center
- Kennedy Space Center
- Langley Research Center
- Marshall Space Flight Center
- Stennis Space Center

**Other Mission Directorates**
- Aeronautics Research Mission Directorate (ARMD)
- Space Operations Mission Directorate (SOMD)
- Space Technology Mission Directorate (STMD)

## External Stakeholders

**Large Industry (> 500 employees)**, including:
- Federally Funded Research and Development Centers (FFRDCs)
- University Affiliated Research Centers (UARCs)

**Small Industry (≤ 500 employees)**

**Other Government Agencies**

**Academia**

**Other**, including:
- Non-profits
- Professional Societies
- Think Tanks
- General Public

# Ranking Methodology

Below is a description of how STMD processed the responses into ranked shortfall lists by stakeholder group.

1. Grouped feedback by respondents' affiliated organization.
2. Averaged the scores for each shortfall by organization.
   - If an organization submitted an official consolidated response, the scores on that response were multiplied by a factor based on the size of the organization it represented.
   - One consolidated response was obtained for each NASA mission directorate.
   - All individual NASA responses were associated with their respective NASA centers.
3. Grouped the organizations into nine stakeholder groups.
4. Averaged scores for each shortfall for each stakeholder group.
5. Using the average shortfall scores, ranked the shortfalls from highest to lowest for each stakeholder group.
   - ESDMD and SMD provided ranked lists in addition to shortfall scores.

After STMD grouped, totaled, and averaged shortfall scores for nine stakeholder groups, it applied pre-determined stakeholder group weights to determine the integrated civil space shortfall ranking from 1 (highest ranking) to 187 (lowest ranking).

The integrated ranked shortfall list utilized weights that reflect STMD's primary customers and their demand for future capabilities as well as other stakeholders' roles in partnering to provide solutions for such capabilities. NASA inputs received 2/3 of the overall weight and external scores received the remaining 1/3. STMD values the inputs from all stakeholders. Independent of weights, NASA needs the whole tech base's energy and innovation to deliver new capabilities we can't even imagine today.

STMD considered the following tenets of its investment strategy, in priority order, and developed a percentage weight for each stakeholder group.

1. Align with the Administration and the NASA Administrator's priorities that address the Blueprint Objectives (Artemis).
2. Focus on investments that support science priorities identified in the Decadal Surveys.
3. Foster creation and growth of the space economy through partnering with industry and supporting small business innovation.
4. Engage NASA's workforce to deliver innovative solutions to the nation's toughest technology challenges.
5. Encourage transformative, cross-cutting technologies that benefit NASA as well as other government agencies.
6. Empower a broad community of innovators and academia through emphasis on early-stage investments.

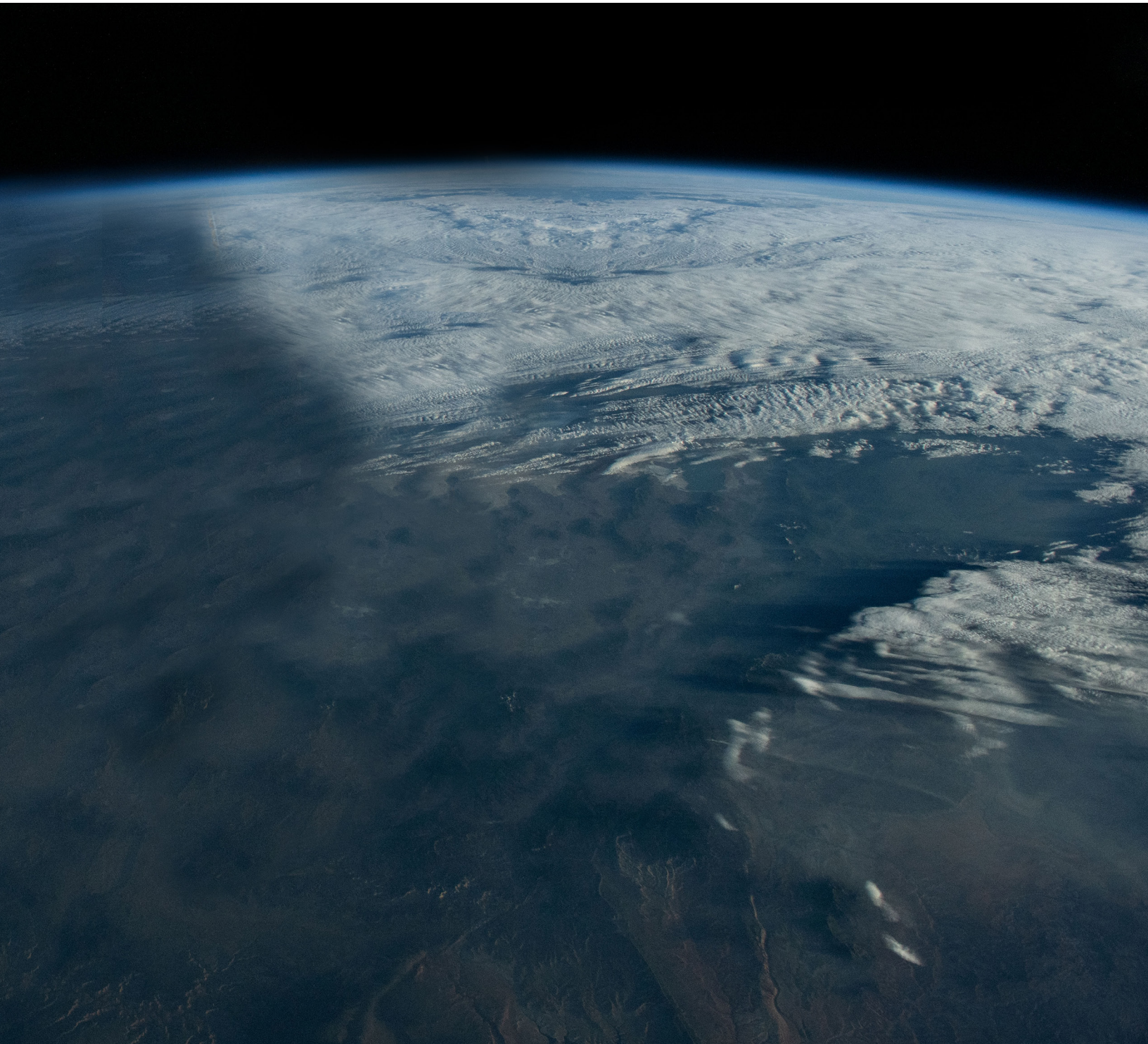
# Next Steps

STMD plans to use the integrated ranked list and annual updates as one of many factors to guide its technology development projects and investments, beginning with its fiscal year 2026 Planning, Programming, Budgeting, and Execution (PPBE) process. These results will also inform the development of technology roadmaps. STMD hopes the integrated list and stakeholder group lists are useful tools for the broader community as well.

More information about the next feedback opportunity will be posted to www.nasa.gov/spacetechpriorities when available.

If you have questions, please contact hq-techport@mail.nasa.gov.

# INTEGRATED LIST
# CIVIL SPACE SHORTFALL RANKING



# Civil Space Shortfall Ranking: Integrated List

Using the methodology described, the Civil Space Shortfall Ranking integrates inputs from NASA mission directorates and centers, small and large industry organizations, other government agencies, academia, and other interested individuals. The list is ranked from highest (1) to lowest (187).

The **bolded black text** in the table indicates the shortfall is within the top three ranked shortfalls in its capability category.

| Integrated Rank | Average Integrated Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 1 | 8.1035 | **1618: Survive and operate through the lunar night** | Thermal Management Systems |
| 2 | 7.6118 | **1596: High Power Energy Generation on Moon and Mars Surfaces** | Power |
| 3 | 7.4345 | **1554: High Performance Onboard Computing to Enable Increasingly Complex Operations** | Avionics |
| 4 | 7.3831 | **1557: Position, Navigation, and Timing (PNT) for In-Orbit and Surface Applications** | Communication and Navigation |
| 5 | 7.2473 | **1545: Robotic Actuation, Subsystem Components, and System Architectures for Long-Duration and Extreme Environment Operation** | Autonomous Systems and Robotics |
| 6 | 7.2076 | **1552: Extreme Environment Avionics** | Avionics |
| 7 | 7.1961 | **1519: Environmental Monitoring for Habitation** | Advanced Habitation Systems |
| 8 | 7.1679 | **709: Nuclear Electric Propulsion for Human Exploration** | Propulsion: Nuclear |
| 9 | 7.1145 | **1304: Robust, High-Progress-Rate, and Long-Distance Autonomous Surface Mobility** | Autonomous Systems and Robotics |

| Integrated Rank | Average Integrated Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 10 | 7.0946 | **1520: Fire Safety for Habitation** | Advanced Habitation Systems |
| 11 | 7.0517 | **1531: Autonomous Guidance and Navigation for Deep Space Missions** | Autonomous Systems and Robotics |
| 12 | 7.0449 | **1591: Power Management Systems for Long Duration Lunar and Martian Missions** | Power |
| 13 | 7.0341 | **702: Nuclear Thermal Propulsion for Human Exploration** | Propulsion: Nuclear |
| 14 | 7.0315 | **1559: Deep Space Autonomous Navigation** | Communication and Navigation |
| 15 | 6.9684 | **1527: Radiation Countermeasures (Crew and Habitat)** | Advanced Habitation Systems |
| 16 | 6.9478 | 1526: Radiation Monitoring and Modeling (Crew and Habitat) | Advanced Habitation Systems |
| 17 | 6.9465 | **879: In-space and On-surface, Long-duration Storage of Cryogenic Propellant** | Cryogenic Fluid Management |
| 18 | 6.8425 | 1548: Sensing for Autonomous Robotic Operations in Challenging Environmental Conditions | Autonomous Systems and Robotics |
| 19 | 6.8039 | **1558: High-Rate Communications Across The Lunar Surface** | Communication and Navigation |
| 20 | 6.7919 | **1626: Advanced Sensor Components: Imaging** | Sensors and Instruments |
| 21 | 6.7837 | **792: In-space and On-surface Transfer of Cryogenic Fluids** | Cryogenic Fluid Management |
| 22 | 6.7199 | **1569: High-Mass Mars Entry and Descent Systems** | Entry Descent and Landing |
| 23 | 6.7110 | 1525: Food and Nutrition for Mars and Sustained Lunar | Advanced Habitation Systems |

| Integrated Rank | Average Integrated Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 24 | 6.6953 | **1571: Navigation Sensors for Precision Landing** | Entry Descent and Landing |
| 25 | 6.6892 | **1573: Terrain Mapping Capabilities for Precision Landing and Hazard Avoidance** | Entry Descent and Landing |
| 26 | 6.6618 | 1562: Advanced Algorithms and Computing for Precision Landing | Entry Descent and Landing |
| 27 | 6.5927 | **1597: Power for Non-Solar-Illuminated Small Systems** | Power |
| 28 | 6.5922 | 1568: Entry Modeling and Simulation for EDL Missions | Entry Descent and Landing |
| 29 | 6.5842 | 1516: Water and Dormancy Management for Habitation | Advanced Habitation Systems |
| 30 | 6.5694 | 1524: Crew Medical Care for Mars and Sustained Lunar | Advanced Habitation Systems |
| 31 | 6.5659 | 1546: Robotic Mobile Manipulation for Autonomous Large-Scale Logistics, Payload Handling, and Surface Transport | Autonomous Systems and Robotics |
| 32 | 6.4985 | 1592: High Power, Long Distance Energy Transmission Across Distributed Surface Assets | Power |
| 33 | 6.4521 | 1542: Metrics and Processes for Establishing Trust and Certifying the Trustworthiness of Autonomous Systems | Autonomous Systems and Robotics |
| 34 | 6.4434 | 1390: Power and Data Transfer in Dusty Environments | Power |
| 35 | 6.4170 | 1532: Autonomous Planning, Scheduling, and Decision-Support to Enable Sustained Earth-Independent Missions | Autonomous Systems and Robotics |
| 36 | 6.4155 | **610: Solar Electric Propulsion - High Specific Impulse** | Propulsion: Non Nuclear |
| 37 | 6.3832 | 1563: Aerocapture for Spacecraft Deceleration and Orbit Insertion | Entry Descent and Landing |
| 38 | 6.3135 | 1560: High-Rate Deep Space Communications | Communication and Navigation |

| Integrated Rank | Average Integrated Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 39 | 6.3088 | **1194: Prediction Modeling of Cryogenic Fluid Dynamics and Operations** | Cryogenic Fluid Management |
| 40 | 6.2932 | **498: Broad and dependable supply chain for space-qualified robotic hardware, electronics, and associated software** | ISAM and RPOC |
| 41 | 6.2747 | **1430: Small Spacecraft Propulsion** | Small Spacecraft |
| 42 | 6.2668 | **1588: Protect Earth from Destructive Natural Impacts (Planetary Defense)** | Miscellaneous |
| 43 | 6.2439 | 1565: Assessment and Validation Capabilities for Integrated Precision Landing Systems | Entry Descent and Landing |
| 44 | 6.2410 | **1608: Surface-based lunar logistics management for near/mid-term missions** | Surface Systems |
| 45 | 6.2297 | **1610: Surface-based food management for sustained lunar evolution** | Surface Systems |
| 46 | 6.2273 | **361: Surface Mating Mechanisms** | ISAM and RPOC |
| 47 | 6.2202 | **844: Passive Dust Mitigation Technologies for Diverse Applications** | Dust Mitigation |
| 48 | 6.2096 | **1438: Autonomy, Edge Computation, and Interoperable Networking for Small Spacecraft** | Small Spacecraft |
| 49 | 6.2061 | **1553: Foundational Technologies for Future Avionics Devices and Systems** | Avionics |
| 50 | 6.2023 | **1138: In-Space Transfer of Electric Propulsion Propellant** | ISAM and RPOC |
| 51 | 6.1992 | 1529: EVA and IVA Suit System Capabilities for Mars Missions | Advanced Habitation Systems |
| 52 | 6.1786 | 1523: Earth Independent Human Operations within Habitat Elements | Advanced Habitation Systems |
| 53 | 6.1779 | **1578: Extraction and separation of water from extraterrestrial surface material** | ISRU |

| Integrated Rank | Average Integrated Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 54 | 6.1514 | **1613: Surface-based fluid management for sustained lunar evolution** | Surface Systems |
| 55 | 6.1509 | **1586: Enhanced Access to Orbital and Suborbital Space for Flight Demonstration and Test** | Miscellaneous |
| 56 | 6.1362 | **1047: Active Dust Mitigation Technologies for Diverse Applications** | Dust Mitigation |
| 57 | 6.1356 | 1595: Energy Storage to Enable Robust and Long Duration Operations on Moon and Mars | Power |
| 58 | 6.1308 | **1221: Mars Ascent Vehicle Propulsion** | Propulsion: Non Nuclear |
| 59 | 6.1197 | **1603: Situational Awareness Sensors and Tools for Astronauts** | Sensors and Instruments |
| 60 | 6.1171 | 1612: Surface-based fluid management for near/mid-term missions | Surface Systems |
| 61 | 6.0245 | 1609: Surface-based lunar logistics management for sustained lunar evolution | Surface Systems |
| 62 | 5.9940 | **1589: Space Situational Awareness** | Miscellaneous |
| 63 | 5.9911 | **1561: Advanced Modeling and Test Capabilities to Characterize Dust Effects on Hardware** | Dust Mitigation |
| 64 | 5.9908 | **1577: Perform resource reconnaissance to locate and characterize resources and estimate reserves** | ISRU |
| 65 | 5.9710 | 1538: General-Purpose Robotic Manipulation to Perform Human-Scale Logistics, Maintenance, Outfitting, and Utilization | Autonomous Systems and Robotics |
| 66 | 5.9451 | **1620: Conditioned stowage to maintain science and/or nutritional integrity** | Thermal Management Systems |
| 67 | 5.9391 | **1599: Quantum Sensors That Use Atoms, Ions, and Spins** | Sensors and Instruments |
| 68 | 5.9363 | **1580: Extraction and separation of oxygen from extraterrestrial minerals** | ISRU |

| Integrated Rank | Average Integrated Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 69 | 5.9320 | **1431: Access Beyond LEO for Small Spacecraft** | Small Spacecraft |
| 70 | 5.9286 | 1590: Planetary Protection | Miscellaneous |
| 71 | 5.9220 | **611: Sub-kW and kW Class Electric Propulsion Systems** | Propulsion: Non Nuclear |
| 72 | 5.9065 | 1535: Autonomous Vehicle, System, Habitat, and Infrastructure Health Monitoring and Management | Autonomous Systems and Robotics |
| 73 | 5.8983 | 1598: Quantum Sensors That Use Photons | Sensors and Instruments |
| 74 | 5.8717 | 1566: Characterization of Plume Surface Interaction | Entry Descent and Landing |
| 75 | 5.8643 | 1336: Robotic Mobility for Robust, Repeatable Access To and Through Extreme Terrain, Surface Topography, and Harsh Environmental Conditions | Autonomous Systems and Robotics |
| 76 | 5.8302 | 1226: Cryogenic Liquefaction | Cryogenic Fluid Management |
| 77 | 5.8287 | **1621: Cryogenic cooling for science instrumentation** | Thermal Management Systems |
| 78 | 5.8267 | 1483: Enable commercially-provided Rendezvous, Proximity Operations, and Capture (RPOC) products and services | ISAM and RPOC |
| 79 | 5.8252 | 1583: Produce propellants and mission consumables from extracted in-situ resources | ISRU |
| 80 | 5.7795 | 1625: Intelligent Multi-Agent Constellations for Cooperative Operations | Autonomous Systems and Robotics |
| 81 | 5.7580 | **1576: Micrometeoroid-Robust Protection of In-space Observatories** | Advanced Materials and Structures |
| 82 | 5.7484 | 1619: High temperature heat rejection for nuclear applications | Thermal Management Systems |

| Integrated Rank | Average Integrated Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 83 | 5.7072 | 1541: Intuitive and Efficient Human-Robot Interaction for Safe Teaming and Remote Supervisory Control | Autonomous Systems and Robotics |
| 84 | 5.6803 | 1617: Autonomous on-surface maintenance and repair for sustained lunar evolution | Surface Systems |
| 85 | 5.6619 | 680: Robust Robotic Intelligence for High-Tempo Autonomous Operations in Dynamic Mission Conditions | Autonomous Systems and Robotics |
| 86 | 5.6023 | 1615: Common tools for on-surface maintenance and repair for reduced crew interaction | Surface Systems |
| 87 | 5.6017 | 1518: Logistics Tracking, Clothing, and Trash Management for Habitation | Advanced Habitation Systems |
| 88 | 5.5988 | **1575: Thermal and Vibrational Isolation for Ultra-stable Science Payloads** | Advanced Materials and Structures |
| 89 | 5.5786 | 1611: Surface-based end-of-life equipment management | Surface Systems |
| 90 | 5.5381 | 1616: Dissipation of electrical charge on surface assets | Surface Systems |
| 91 | 5.5326 | 1522: Crew Health Countermeasures – Non-Exercise | Advanced Habitation Systems |
| 92 | 5.5088 | **1485: In-Space and On-Surface Manufacturing of Parts/Products from Surface and Terrestrial Feedstocks** | Advanced Manufacturing |
| 93 | 5.4992 | 1432: Rendezvous, Proximity Operations, and Debris Remediation using Small Spacecraft | Small Spacecraft |
| 94 | 5.4897 | 1528: Spacesuit Physiology | Advanced Habitation Systems |
| 95 | 5.4553 | **1477: Mitigation of New Orbital Debris Generation** | Orbital Debris |

| Integrated Rank | Average Integrated Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 96 | 5.4513 | 1521: Crew Exercise and Sensorimotor Countermeasures | Advanced Habitation Systems |
| 97 | 5.4441 | 672: Long-life thermal control for surface suits capable of extreme access | Thermal Management Systems |
| 98 | 5.3922 | 1623: Advanced thermal modeling capabilities | Thermal Management Systems |
| 99 | 5.3787 | 1555: Next Generation Avionics Architectures | Avionics |
| 100 | 5.3439 | 1506: In-Space & Surface Transfer of High-Pressure Gases | ISAM and RPOC |
| 101 | 5.3355 | 512: Cooperative interfaces, aids, and standards | ISAM and RPOC |
| 102 | 5.3268 | **662: Robotic regolith manipulation and site preparation** | Excavation Construction and Outfitting |
| 103 | 5.3171 | 1585: Extraterrestrial surface environmental simulators, test facilities, and test sites | ISRU |
| 104 | 5.2725 | **384: Excavation of hard/compacted/icy material** | Excavation Construction and Outfitting |
| 105 | 5.2711 | 1533: Autonomous Robotic Sample Identification, Classification, Collection, Manipulation, Verification, and Transport | Autonomous Systems and Robotics |
| 106 | 5.2485 | 1574: Validated Performance Models for Planetary Parachutes | Entry Descent and Landing |
| 107 | 5.2409 | 1581: Extraction and separation of extraterrestrial atmospheric resources and gaseous products/reactants | ISRU |
| 108 | 5.2217 | **369: Excavation of granular (surface) regolith for ISRU commodities production** | Excavation Construction and Outfitting |
| 109 | 5.2127 | 376: Modular design for in-space installation | ISAM and RPOC |

| Integrated Rank | Average Integrated Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 110 | 5.2125 | 1582: Extraction and separation of metals/metalloids from extraterrestrial minerals | ISRU |
| 111 | 5.2061 | 1224: In-Space & Surface Transfer of Earth Storable Propellants | Propulsion: Non Nuclear |
| 112 | 5.1952 | 1514: Atmospheric Metabolic Constituent Management for Habitation | Advanced Habitation Systems |
| 113 | 5.1824 | 700: Solar Sails for Propellant-less Propulsion | Propulsion: Non Nuclear |
| 114 | 5.1598 | 1624: Advanced thermal management technologies for diverse applications | Thermal Management Systems |
| 115 | 5.1554 | 1627: Advanced Sensor Components for Heliophysics and Lunar-Based Astronomy | Sensors and Instruments |
| 116 | 5.1497 | **1486: In-Space and On-Surface NDE and Qualification of Components for Manufacturing, Assembly, and Construction** | Advanced Manufacturing |
| 117 | 5.1095 | 581: ISRU System Modeling | ISRU |
| 118 | 5.1006 | 385: Regolith and resource delivery system | Excavation Construction and Outfitting |
| 119 | 5.0870 | 1434: Communication Technology and Capabilities for Small Spacecraft | Small Spacecraft |
| 120 | 5.0865 | 1600: Enable Paradigm for System Science to Include Interactions Between Subsystems | Sensors and Instruments |
| 121 | 5.0666 | 1515: Atmospheric Non-Metabolic Constituent Management for Habitation | Advanced Habitation Systems |
| 122 | 5.0443 | **705: Low Power Nuclear Electric Propulsion** | Propulsion: Nuclear |
| 123 | 5.0280 | **1262: Remediation of Small Debris** | Orbital Debris |
| 124 | 5.0274 | 707: Transformational Advanced Energetic Propulsion (AEP) | Propulsion: Non Nuclear |

| Integrated Rank | Average Integrated Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 125 | 5.0194 | 379: Upgrade or Install Instruments on Large Space Observatories | ISAM and RPOC |
| 126 | 5.0163 | 544: Solar Electric Propulsion to Support Orbital Platforms | Propulsion: Non Nuclear |
| 127 | 4.9967 | 1614: Surface-based planning and scheduling technologies for sustained lunar evolution | Surface Systems |
| 128 | 4.9962 | 1530: Aerial Robotic Mobility and Onboard Intelligence for Expanded Capabilities on Mars, Venus, and Titan | Autonomous Systems and Robotics |
| 129 | 4.9858 | 1587: Wildfire Integrated Effect Chain | Miscellaneous |
| 130 | 4.9389 | 1547: Robotic Systems for Sub-Surface Access | Autonomous Systems and Robotics |
| 131 | 4.9270 | 1564: Aeroshell In-Situ Flight Performance Data During EDL | Entry Descent and Landing |
| 132 | 4.9158 | **767: Advanced designs for lightweight inflatable surface elements** | Advanced Materials and Structures |
| 133 | 4.9120 | 1540: Intelligent Robots for the Servicing, Assembly, and Outfitting of In-Space Assets and Industrial-Scale Surface Infrastructure | Autonomous Systems and Robotics |
| 134 | 4.9063 | 1539: Intelligent Robotic Systems for Crew Health and Performance During Long-Duration Missions | Autonomous Systems and Robotics |
| 135 | 4.9054 | **1476: Remediation of Large Debris** | Orbital Debris |
| 136 | 4.8606 | 1550: Crew Audio/Visual Interfaces for Long Duration Missions Beyond LEO | Avionics |
| 137 | 4.8445 | 1602: 3D/3D+ Imaging and Tomography of Complex Features and Dynamical Processes | Sensors and Instruments |
| 138 | 4.8017 | 1480: On-surface Outfitting of Lunar Structures | Excavation Construction and Outfitting |

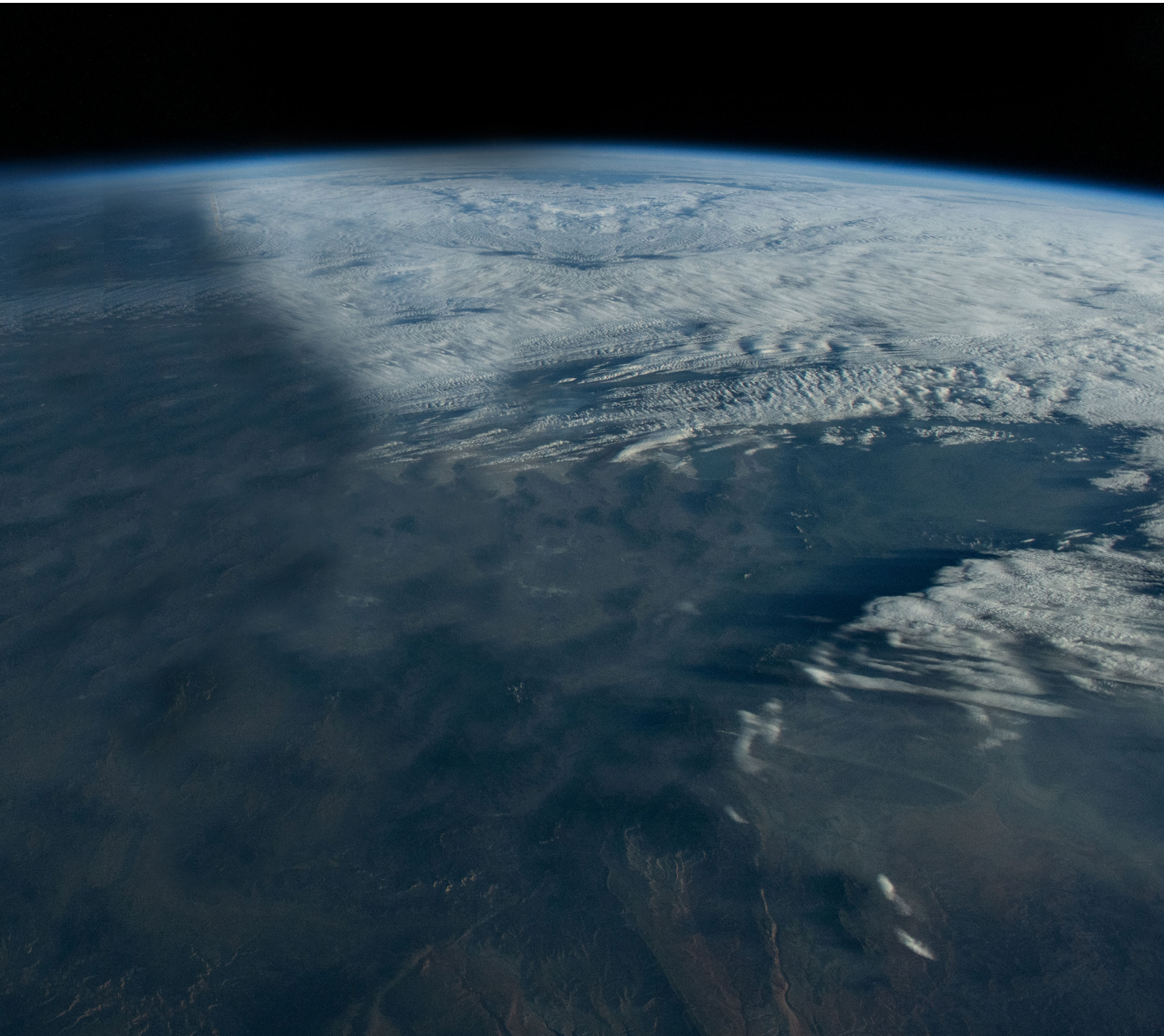
| Integrated Rank | Average Integrated Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 139 | 4.7856 | 1543: Multi-Agent Robotic Coordination and Interoperability for Cooperative Task Planning and Performance | Autonomous Systems and Robotics |
| 140 | 4.7840 | 1551: Distributed Avionics to Enable Improved Performance and SWaP Efficiency | Avionics |
| 141 | 4.7776 | 1604: Find, Study Habitable Zone Earth-like Exoplanets and Search for Biosignatures | Sensors and Instruments |
| 142 | 4.7660 | 1584: Produce manufacturing and construction feedstock from extracted in-situ resources | ISRU |
| 143 | 4.7572 | 1570: Lander Capabilities for Soft Touchdown | Entry Descent and Landing |
| 144 | 4.7544 | 1517: Metabolic Waste Management for Habitation | Advanced Habitation Systems |
| 145 | 4.6999 | 425: On-Surface In-situ Construction of Vertical Structures | Excavation Construction and Outfitting |
| 146 | 4.6761 | 1567: Entry Capabilities for Small-Scale and Commercial Spacecraft | Entry Descent and Landing |
| 147 | 4.6694 | 1433: Position, Navigation, and Timing for Small Spacecraft | Small Spacecraft |
| 148 | 4.6511 | 617: On-surface robotic assembly of vertical structures | Excavation Construction and Outfitting |
| 149 | 4.6454 | **1490: Additive Manufacturing for New and High-Performance Materials** | Advanced Manufacturing |
| 150 | 4.6350 | 1408: Advanced deployable load-bearing structures | Advanced Materials and Structures |
| 151 | 4.5955 | 1549: Advanced Data Acquisition Systems for Diverse Applications | Avionics |
| 152 | 4.5733 | 1601: Enable Observation of Whole Top-to-Bottom Dynamic Ecosystems | Sensors and Instruments |

| Integrated Rank | Average Integrated Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 153 | 4.5437 | 513: Robotic Assembly and Construction of Modular Systems for Sustained In-Space Infrastructure | ISAM and RPOC |
| 154 | 4.5432 | 1491: Additive Manufacturing of Large-Scale Components | Advanced Manufacturing |
| 155 | 4.5333 | 1537: Free-Flying Systems for Robotic Inspection, Data Collection, and Servicing of In-Space Assets | Autonomous Systems and Robotics |
| 156 | 4.5246 | 1437: Dynamic and Capable Thermal Control for Small Spacecraft | Small Spacecraft |
| 157 | 4.5128 | 1511: Advanced Computational Fluid Dynamics Tools / Capabilities | Propulsion: Non Nuclear |
| 158 | 4.4926 | 696: Enable Storable Propulsion Systems in Low Temperature Environments | Propulsion: Non Nuclear |
| 159 | 4.4918 | 1400: On-surface robotic assembly of horizontal structures | Excavation Construction and Outfitting |
| 160 | 4.4363 | 666: On-Surface In-situ Construction of Horizontal Structures | Excavation Construction and Outfitting |
| 161 | 4.4023 | 1605: Peer Back Farther in Time to the Early Universe | Sensors and Instruments |
| 162 | 4.3772 | 1607: Detect New Astronomical Messenger - Gravitational Waves | Sensors and Instruments |
| 163 | 4.3541 | 1488: Additive Manufacturing for Propulsion | Advanced Manufacturing |
| 164 | 4.3352 | 755: Cross-Discipline Cryogenic Fluid Management Technologies | Cryogenic Fluid Management |
| 165 | 4.3234 | 1436: Efficient and Safe Higher Power Systems for Small Spacecraft | Small Spacecraft |
| 166 | 4.3084 | 1534: Autonomous Robotics for Sustained In-Space Manufacturing Operations | Autonomous Systems and Robotics |

| Integrated Rank | Average Integrated Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 167 | 4.2945 | 703: Rotating Detonation Rocket Engine (RDRE) | Propulsion: Non Nuclear |
| 168 | 4.2749 | 1606: Observe Some of the Most Energetic Phenomena in the Universe | Sensors and Instruments |
| 169 | 4.2665 | 1579: Extraction and separation of non-water volatile resources from Lunar regolith | ISRU |
| 170 | 4.1533 | 1492: Materials and Process Modeling for In-Space and On-Surface Manufacturing | Advanced Manufacturing |
| 171 | 4.1513 | 1495: Advanced Manufacturing for Improved Dimensional Control of Large-Scale Space Structures | Advanced Manufacturing |
| 172 | 4.1431 | 1489: In-Space and On-Surface Manufacturing from Recycled and Reused Materials and Components | Advanced Manufacturing |
| 173 | 4.1423 | 612: In-Space Diagnostics for Electric Propulsion | Propulsion: Non Nuclear |
| 174 | 4.1280 | 1496: In-Space and On-Surface Manufacturing, Assembly, and Repair of Composite Structures | Advanced Manufacturing |
| 175 | 4.0730 | 1622: Novel thermal technologies to improve environmental control of habitats | Thermal Management Systems |
| 176 | 4.0204 | 1494: Digital Transformation Technologies for Terrestrial, In-Space, On-Surface Manufacturing, and Operations | Advanced Manufacturing |
| 177 | 3.9682 | 1544: Resilient Agency: Adaptable Intelligence and Robust Online Learning for Long-Duration and Dynamic Missions | Autonomous Systems and Robotics |
| 178 | 3.9458 | 1593: Lunar Surface Power Generation from ISRU Derived Resources | Power |
| 179 | 3.9353 | 1487: In-Space and On-Surface Welding Technologies for Manufacturing, Assembly, and Construction | Advanced Manufacturing |
| 180 | 3.8944 | 1513: Advanced Solid Propulsion Systems | Propulsion: Non Nuclear |
| 181 | 3.8813 | 1572: Performance-Optimized Low-Cost Aeroshells for EDL Missions | Entry Descent and Landing |

| Integrated Rank | Average Integrated Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 182 | 3.8091 | 1052: EVA/IVA Support Propulsion Development | Propulsion: Non Nuclear |
| 183 | 3.6367 | 1594: Martian Surface Power Generation from ISRU Derived Resources | Power |
| 184 | 3.6049 | 1493: Computational Materials-Informed Qualification and Certification for In-Space and On-Surface Manufacturing | Advanced Manufacturing |
| 185 | 3.4893 | 701: Green Propellant Propulsion Systems | Propulsion: Non Nuclear |
| 186 | 3.4305 | 1536: Free-Flying Mobility Aids for Crew EVA | Autonomous Systems and Robotics |
| 187 | 3.0722 | 1512: Modern Solid Motor Design and Analysis Tools / Capabilities | Propulsion: Non Nuclear |

# NASA STAKEHOLDER GROUPS RANKED LISTS



# Stakeholder Group Ranked List: NASA Exploration Systems Development Mission Directorate (ESDMD)

ESDMD submitted a ranked shortfall list (below) and provided shortfall scores in the second column as inputs for the integrated list. In its response, ESDMD did not score every shortfall (NS). Unscored shortfalls were also not ranked (NR). Several shortfalls ranked equally.

The NASA Centers stakeholder group included ESDMD employees who submitted individual responses.

| ESDMD Rank | ESDMD Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 1 | 9.000 | 844: Passive Dust Mitigation Technologies for Diverse Applications | Dust Mitigation |
| 1 | 9.000 | 1047: Active Dust Mitigation Technologies for Diverse Applications | Dust Mitigation |
| 1 | 9.000 | 1561: Advanced Modeling and Test Capabilities to Characterize Dust Effects on Hardware | Dust Mitigation |
| 4 | 9.000 | 1618: Survive and operate through the lunar night | Thermal Management Systems |
| 5 | 9.000 | 1558: High-Rate Communications Across The Lunar Surface | Communication and Navigation |
| 6 | 9.000 | 1552: Extreme Environment Avionics | Avionics |
| 7 | 9.000 | 610: Solar Electric Propulsion - High Specific Impulse | Propulsion: Non Nuclear |
| 7 | 9.000 | 709: Nuclear Electric Propulsion for Human Exploration | Propulsion: Nuclear |
| 7 | 9.000 | 702: Nuclear Thermal Propulsion for Human Exploration | Propulsion: Nuclear |
| 7 | 9.000 | 1138: In-Space Transfer of Electric Propulsion Propellant | ISAM and RPOC |
| 11 | 9.000 | 1525: Food and Nutrition for Mars and Sustained Lunar | Advanced Habitation Systems |
| 11 | 9.000 | 1610: Surface-based food management for sustained lunar evolution | Surface Systems |

| ESDMD Rank | ESDMD Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 13 | 9.000 | 1545: Robotic Actuation, Subsystem Components, and System Architectures for Long-Duration and Extreme Environment Operation | Autonomous Systems and Robotics |
| 14 | 9.000 | 1548: Sensing for Autonomous Robotic Operations in Challenging Environmental Conditions | Autonomous Systems and Robotics |
| 14 | 9.000 | 1336: Robotic Mobility for Robust, Repeatable Access To and Through Extreme Terrain, Surface Topography, and Harsh Environmental Conditions | Autonomous Systems and Robotics |
| 16 | 9.000 | 1569: High-Mass Mars Entry and Descent Systems | Entry Descent and Landing |
| 17 | 9.000 | 1519: Environmental Monitoring for Habitation | Advanced Habitation Systems |
| 18 | 9.000 | 1532: Autonomous Planning, Scheduling, and Decision-Support to Enable Sustained Earth-Independent Missions | Autonomous Systems and Robotics |
| 19 | 9.000 | 1538: General-Purpose Robotic Manipulation to Perform Human-Scale Logistics, Maintenance, Outfitting, and Utilization | Autonomous Systems and Robotics |
| 20 | 9.000 | 1221: Mars Ascent Vehicle Propulsion | Propulsion: Non Nuclear |
| 21 | 9.000 | 1596: High Power Energy Generation on Moon and Mars Surfaces | Power |
| 22 | 9.000 | 361: Surface Mating Mechanisms | ISAM and RPOC |
| 23 | 9.000 | 1613: Surface-based fluid management for sustained lunar evolution | Surface Systems |
| 23 | 9.000 | 1612: Surface-based fluid management for near/mid-term missions | Surface Systems |
| 25 | 9.000 | 1304: Robust, High-Progress-Rate, and Long-Distance Autonomous Surface Mobility | Autonomous Systems and Robotics |
| 26 | 9.000 | 1516: Water and Dormancy Management for Habitation | Advanced Habitation Systems |
| 27 | 9.000 | 1526: Radiation Monitoring and Modeling (Crew and Habitat) | Advanced Habitation Systems |

| ESDMD Rank | ESDMD Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 28 | 9.000 | 1557: Position, Navigation, and Timing (PNT) for In-Orbit and Surface Applications | Communication and Navigation |
| 29 | 9.000 | 1520: Fire Safety for Habitation | Advanced Habitation Systems |
| 29 | 9.000 | 1518: Logistics Tracking, Clothing, and Trash Management for Habitation | Advanced Habitation Systems |
| 31 | 9.000 | 1608: Surface-based lunar logistics management for near/mid-term missions | Surface Systems |
| 31 | 9.000 | 1611: Surface-based end-of-life equipment management | Surface Systems |
| 33 | 9.000 | 1546: Robotic Mobile Manipulation for Autonomous Large-Scale Logistics, Payload Handling, and Surface Transport | Autonomous Systems and Robotics |
| 34 | 9.000 | 1554: High Performance Onboard Computing to Enable Increasingly Complex Operations | Avionics |
| 35 | 9.000 | 1591: Power Management Systems for Long Duration Lunar and Martian Missions | Power |
| 35 | 9.000 | 1592: High Power, Long Distance Energy Transmission Across Distributed Surface Assets | Power |
| 35 | 9.000 | 1390: Power and Data Transfer in Dusty Environments | Power |
| 38 | 9.000 | 1609: Surface-based lunar logistics management for sustained lunar evolution | Surface Systems |
| 39 | 9.000 | 1541: Intuitive and Efficient Human-Robot Interaction for Safe Teaming and Remote Supervisory Control | Autonomous Systems and Robotics |
| 40 | 9.000 | 1529: EVA and IVA Suit System Capabilities for Mars Missions | Advanced Habitation Systems |
| 41 | 7.000 | 1542: Metrics and Processes for Establishing Trust and Certifying the Trustworthiness of Autonomous Systems | Autonomous Systems and Robotics |
| 41 | 7.000 | 1523: Earth Independent Human Operations within Habitat Elements | Advanced Habitation Systems |
| 41 | 7.000 | 1614: Surface-based planning and scheduling technologies for sustained lunar evolution | Surface Systems |

| ESDMD Rank | ESDMD Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 44 | 7.000 | 1535: Autonomous Vehicle, System, Habitat, and Infrastructure Health Monitoring and Management | Autonomous Systems and Robotics |
| 45 | 7.000 | 1568: Entry Modeling and Simulation for EDL Missions | Entry Descent and Landing |
| 45 | 7.000 | 1571: Navigation Sensors for Precision Landing | Entry Descent and Landing |
| 45 | 7.000 | 1573: Terrain Mapping Capabilities for Precision Landing and Hazard Avoidance | Entry Descent and Landing |
| 45 | 7.000 | 1562: Advanced Algorithms and Computing for Precision Landing | Entry Descent and Landing |
| 45 | 7.000 | 1565: Assessment and Validation Capabilities for Integrated Precision Landing Systems | Entry Descent and Landing |
| 45 | 7.000 | 1566: Characterization of Plume Surface Interaction | Entry Descent and Landing |
| 51 | 7.000 | 1617: Autonomous on-surface maintenance and repair for sustained lunar evolution | Surface Systems |
| 51 | 7.000 | 1615: Common tools for on-surface maintenance and repair for reduced crew interaction | Surface Systems |
| 53 | 7.000 | 1620: Conditioned stowage to maintain science and/or nutritional integrity | Thermal Management Systems |
| 54 | 7.000 | 1521: Crew Exercise and Sensorimotor Countermeasures | Advanced Habitation Systems |
| 55 | 7.000 | 1522: Crew Health Countermeasures – Non-Exercise | Advanced Habitation Systems |
| 56 | 7.000 | 1528: Spacesuit Physiology | Advanced Habitation Systems |
| 57 | 7.000 | 1590: Planetary Protection | Miscellaneous |
| 58 | 7.000 | 1524: Crew Medical Care for Mars and Sustained Lunar | Advanced Habitation Systems |
| 59 | 7.000 | 1194: Prediction Modeling of Cryogenic Fluid Dynamics and Operations | Cryogenic Fluid Management |

| ESDMD Rank | ESDMD Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 59 | 7.000 | 879: In-space and On-surface, Long-duration Storage of Cryogenic Propellant | Cryogenic Fluid Management |
| 59 | 7.000 | 1226: Cryogenic Liquefaction | Cryogenic Fluid Management |
| 62 | 7.000 | 792: In-space and On-surface Transfer of Cryogenic Fluids | Cryogenic Fluid Management |
| 63 | 7.000 | 1527: Radiation Countermeasures (Crew and Habitat) | Advanced Habitation Systems |
| 64 | 7.000 | 1531: Autonomous Guidance and Navigation for Deep Space Missions | Autonomous Systems and Robotics |
| 64 | 7.000 | 1559: Deep Space Autonomous Navigation | Communication and Navigation |
| 66 | 5.000 | 767: Advanced designs for lightweight inflatable surface elements | Advanced Materials and Structures |
| 67 | 5.000 | 1577: Perform resource reconnaissance to locate and characterize resources and estimate reserves | ISRU |
| 68 | 5.000 | 1224: In-Space & Surface Transfer of Earth Storable Propellants | Propulsion: Non Nuclear |
| 68 | 5.000 | 1506: In-Space & Surface Transfer of High-Pressure Gases | ISAM and RPOC |
| 70 | 5.000 | 1560: High-Rate Deep Space Communications | Communication and Navigation |
| 71 | 5.000 | 662: Robotic regolith manipulation and site preparation | Excavation Construction and Outfitting |
| 71 | 5.000 | 384: Excavation of hard/compacted/icy material | Excavation Construction and Outfitting |
| 71 | 5.000 | 369: Excavation of granular (surface) regolith for ISRU commodities production | Excavation Construction and Outfitting |
| 71 | 5.000 | 385: Regolith and resource delivery system | Excavation Construction and Outfitting |

| ESDMD Rank | ESDMD Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 75 | 5.000 | 1578: Extraction and separation of water from extraterrestrial surface material | ISRU |
| 75 | 5.000 | 1580: Extraction and separation of oxygen from extraterrestrial minerals | ISRU |
| 75 | 5.000 | 1585: Extraterrestrial surface environmental simulators, test facilities, and test sites | ISRU |
| 75 | 5.000 | 1582: Extraction and separation of metals/metalloids from extraterrestrial minerals | ISRU |
| 75 | 5.000 | 581: ISRU System Modeling | ISRU |
| 80 | 5.000 | 1485: In-Space and On-Surface Manufacturing of Parts/Products from Surface and Terrestrial Feedstocks | Advanced Manufacturing |
| 80 | 5.000 | 1486: In-Space and On-Surface NDE and Qualification of Components for Manufacturing, Assembly, and Construction | Advanced Manufacturing |
| 82 | 5.000 | 1583: Produce propellants and mission consumables from extracted in-situ resources | ISRU |
| 82 | 5.000 | 1581: Extraction and separation of extraterrestrial atmospheric resources and gaseous products/reactants | ISRU |
| 84 | 5.000 | 544: Solar Electric Propulsion to Support Orbital Platforms | Propulsion: Non Nuclear |
| 85 | 5.000 | 1595: Energy Storage to Enable Robust and Long Duration Operations on Moon and Mars | Power |
| 86 | 5.000 | 1616: Dissipation of electrical charge on surface assets | Surface Systems |
| 87 | 5.000 | 1515: Atmospheric Non-Metabolic Constituent Management for Habitation | Advanced Habitation Systems |
| 88 | 5.000 | 1603: Situational Awareness Sensors and Tools for Astronauts | Sensors and Instruments |
| 89 | 5.000 | 1514: Atmospheric Metabolic Constituent Management for Habitation | Advanced Habitation Systems |
| 90 | 5.000 | 1624: Advanced thermal management technologies for diverse applications | Thermal Management Systems |

| ESDMD Rank | ESDMD Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 91 | 5.000 | 680: Robust Robotic Intelligence for High-Tempo Autonomous Operations in Dynamic Mission Conditions | Autonomous Systems and Robotics |
| 92 | 5.000 | 1550: Crew Audio/Visual Interfaces for Long Duration Missions Beyond LEO | Avionics |
| 93 | 5.000 | 1597: Power for Non-Solar-Illuminated Small Systems | Power |
| 94 | 5.000 | 376: Modular design for in-space installation | ISAM and RPOC |
| 95 | 5.000 | 1574: Validated Performance Models for Planetary Parachutes | Entry Descent and Landing |
| 96 | 5.000 | 672: Long-life thermal control for surface suits capable of extreme access | Thermal Management Systems |
| 97 | 5.000 | 1539: Intelligent Robotic Systems for Crew Health and Performance During Long-Duration Missions | Autonomous Systems and Robotics |
| 98 | 3.000 | 1533: Autonomous Robotic Sample Identification, Classification, Collection, Manipulation, Verification, and Transport | Autonomous Systems and Robotics |
| 99 | 3.000 | 1517: Metabolic Waste Management for Habitation | Advanced Habitation Systems |
| 100 | 3.000 | 1537: Free-Flying Systems for Robotic Inspection, Data Collection, and Servicing of In-Space Assets | Autonomous Systems and Robotics |
| 101 | 3.000 | 1400: On-surface robotic assembly of horizontal structures | Excavation Construction and Outfitting |
| 102 | 3.000 | 1564: Aeroshell In-Situ Flight Performance Data During EDL | Entry Descent and Landing |
| 103 | 3.000 | 1543: Multi-Agent Robotic Coordination and Interoperability for Cooperative Task Planning and Performance | Autonomous Systems and Robotics |
| 104 | 3.000 | 666: On-Surface In-situ Construction of Horizontal Structures | Excavation Construction and Outfitting |
| 105 | 3.000 | 1584: Produce manufacturing and construction feedstock from extracted in-situ resources | ISRU |

| ESDMD Rank | ESDMD Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 106 | 3.000 | 1408: Advanced deployable load-bearing structures | Advanced Materials and Structures |
| 107 | 3.000 | 1540: Intelligent Robots for the Servicing, Assembly, and Outfitting of In-Space Assets and Industrial-Scale Surface Infrastructure | Autonomous Systems and Robotics |
| 108 | 3.000 | 612: In-Space Diagnostics for Electric Propulsion | Propulsion: Non Nuclear |
| 109 | 3.000 | 696: Enable Storable Propulsion Systems in Low Temperature Environments | Propulsion: Non Nuclear |
| 110 | 3.000 | 617: On-surface robotic assembly of vertical structures | Excavation Construction and Outfitting |
| 111 | 3.000 | 703: Rotating Detonation Rocket Engine (RDRE) | Propulsion: Non Nuclear |
| 112 | 3.000 | 1511: Advanced Computational Fluid Dynamics Tools / Capabilities | Propulsion: Non Nuclear |
| 113 | 3.000 | 1619: High temperature heat rejection for nuclear applications | Thermal Management Systems |
| 114 | 3.000 | 425: On-Surface In-situ Construction of Vertical Structures | Excavation Construction and Outfitting |
| 115 | 3.000 | 1491: Additive Manufacturing of Large-Scale Components | Advanced Manufacturing |
| 116 | 3.000 | 1480: On-surface Outfitting of Lunar Structures | Excavation Construction and Outfitting |
| 117 | 1.000 | 755: Cross-Discipline Cryogenic Fluid Management Technologies | Cryogenic Fluid Management |
| 118 | 1.000 | 1477: Mitigation of New Orbital Debris Generation | Orbital Debris |
| 119 | 1.000 | 1551: Distributed Avionics to Enable Improved Performance and SWaP Efficiency | Avionics |
| 120 | 1.000 | 1489: In-Space and On-Surface Manufacturing from Recycled and Reused Materials and Components | Advanced Manufacturing |

| ESDMD Rank | ESDMD Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 121 | 1.000 | 1622: Novel thermal technologies to improve environmental control of habitats | Thermal Management Systems |
| 122 | 1.000 | 1487: In-Space and On-Surface Welding Technologies for Manufacturing, Assembly, and Construction | Advanced Manufacturing |
| 123 | 1.000 | 1496: In-Space and On-Surface Manufacturing, Assembly, and Repair of Composite Structures | Advanced Manufacturing |
| 124 | 1.000 | 1572: Performance-Optimized Low-Cost Aeroshells for EDL Missions | Entry Descent and Landing |
| 125 | 1.000 | 1544: Resilient Agency: Adaptable Intelligence and Robust Online Learning for Long-Duration and Dynamic Missions | Autonomous Systems and Robotics |
| 126 | 1.000 | 1490: Additive Manufacturing for New and High-Performance Materials | Advanced Manufacturing |
| 127 | 1.000 | 1536: Free-Flying Mobility Aids for Crew EVA | Autonomous Systems and Robotics |
| 128 | 1.000 | 513: Robotic Assembly and Construction of Modular Systems for Sustained In-Space Infrastructure | ISAM and RPOC |
| 129 | 1.000 | 1579: Extraction and separation of non-water volatile resources from Lunar regolith | ISRU |
| 130 | 1.000 | 1493: Computational Materials-Informed Qualification and Certification for In-Space and On-Surface Manufacturing | Advanced Manufacturing |
| 131 | 1.000 | 1570: Lander Capabilities for Soft Touchdown | Entry Descent and Landing |
| 132 | 1.000 | 1512: Modern Solid Motor Design and Analysis Tools / Capabilities | Propulsion: Non Nuclear |
| 133 | 1.000 | 1534: Autonomous Robotics for Sustained In-Space Manufacturing Operations | Autonomous Systems and Robotics |
| 134 | 1.000 | 1492: Materials and Process Modeling for In-Space and On-Surface Manufacturing | Advanced Manufacturing |
| 135 | 1.000 | 1593: Lunar Surface Power Generation from ISRU Derived Resources | Power |

| ESDMD Rank | ESDMD Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 136 | 1.000 | 1494: Digital Transformation Technologies for Terrestrial, In-Space, On-Surface Manufacturing, and Operations | Advanced Manufacturing |
| 137 | 1.000 | 1488: Additive Manufacturing for Propulsion | Advanced Manufacturing |
| 138 | 1.000 | 1594: Martian Surface Power Generation from ISRU Derived Resources | Power |
| 139 | 1.000 | 1495: Advanced Manufacturing for Improved Dimensional Control of Large-Scale Space Structures | Advanced Manufacturing |
| NR | NS | 1553: Foundational Technologies for Future Avionics Devices and Systems | Avionics |
| NR | NS | 1430: Small Spacecraft Propulsion | Small Spacecraft |
| NR | NS | 611: Sub-kW and kW Class Electric Propulsion Systems | Propulsion: Non Nuclear |
| NR | NS | 1563: Aerocapture for Spacecraft Deceleration and Orbit Insertion | Entry Descent and Landing |
| NR | NS | 1599: Quantum Sensors That Use Atoms, Ions, and Spins | Sensors and Instruments |
| NR | NS | 1598: Quantum Sensors That Use Photons | Sensors and Instruments |
| NR | NS | 1575: Thermal and Vibrational Isolation for Ultra-stable Science Payloads | Advanced Materials and Structures |
| NR | NS | 700: Solar Sails for Propellant-less Propulsion | Propulsion: Non Nuclear |
| NR | NS | 1621: Cryogenic cooling for science instrumentation | Thermal Management Systems |
| NR | NS | 1626: Advanced Sensor Components: Imaging | Sensors and Instruments |
| NR | NS | 1438: Autonomy, Edge Computation, and Interoperable Networking for Small Spacecraft | Small Spacecraft |
| NR | NS | 1625: Intelligent Multi-Agent Constellations for Cooperative Operations | Autonomous Systems and Robotics |

| ESDMD Rank | ESDMD Score | Shortfall ID | Capability Category |
|---|---|---|---|
| NR | NS | 1576: Micrometeoroid-Robust Protection of In-space Observatories | Advanced Materials and Structures |
| NR | NS | 1600: Enable Paradigm for System Science to Include Interactions Between Subsystems | Sensors and Instruments |
| NR | NS | 498: Broad and dependable supply chain for space-qualified robotic hardware, electronics, and associated software | ISAM and RPOC |
| NR | NS | 1586: Enhanced Access to Orbital and Suborbital Space for Flight Demonstration and Test | Miscellaneous |
| NR | NS | 1627: Advanced Sensor Components for Heliophysics and Lunar-Based Astronomy | Sensors and Instruments |
| NR | NS | 1587: Wildfire Integrated Effect Chain | Miscellaneous |
| NR | NS | 379: Upgrade or Install Instruments on Large Space Observatories | ISAM and RPOC |
| NR | NS | 1588: Protect Earth from Destructive Natural Impacts (Planetary Defense) | Miscellaneous |
| NR | NS | 1547: Robotic Systems for Sub-Surface Access | Autonomous Systems and Robotics |
| NR | NS | 1431: Access Beyond LEO for Small Spacecraft | Small Spacecraft |
| NR | NS | 1530: Aerial Robotic Mobility and Onboard Intelligence for Expanded Capabilities on Mars, Venus, and Titan | Autonomous Systems and Robotics |
| NR | NS | 1602: 3D/3D+ Imaging and Tomography of Complex Features and Dynamical Processes | Sensors and Instruments |
| NR | NS | 1601: Enable Observation of Whole Top-to-Bottom Dynamic Ecosystems | Sensors and Instruments |
| NR | NS | 1604: Find, Study Habitable Zone Earth-like Exoplanets and Search for Biosignatures | Sensors and Instruments |
| NR | NS | 1605: Peer Back Farther in Time to the Early Universe | Sensors and Instruments |
| NR | NS | 1607: Detect New Astronomical Messenger - Gravitational Waves | Sensors and Instruments |

| ESDMD Rank | ESDMD Score | Shortfall ID | Capability Category |
|---|---|---|---|
| NR | NS | 1606: Observe Some of the Most Energetic Phenomena in the Universe | Sensors and Instruments |
| NR | NS | 1589: Space Situational Awareness | Miscellaneous |
| NR | NS | 512: Cooperative interfaces, aids, and standards | ISAM and RPOC |
| NR | NS | 1434: Communication Technology and Capabilities for Small Spacecraft | Small Spacecraft |
| NR | NS | 705: Low Power Nuclear Electric Propulsion | Propulsion: Nuclear |
| NR | NS | 1262: Remediation of Small Debris | Orbital Debris |
| NR | NS | 707: Transformational Advanced Energetic Propulsion (AEP) | Propulsion: Non Nuclear |
| NR | NS | 1567: Entry Capabilities for Small-Scale and Commercial Spacecraft | Entry Descent and Landing |
| NR | NS | 1549: Advanced Data Acquisition Systems for Diverse Applications | Avionics |
| NR | NS | 1437: Dynamic and Capable Thermal Control for Small Spacecraft | Small Spacecraft |
| NR | NS | 1513: Advanced Solid Propulsion Systems | Propulsion: Non Nuclear |
| NR | NS | 1476: Remediation of Large Debris | Orbital Debris |
| NR | NS | 1433: Position, Navigation, and Timing for Small Spacecraft | Small Spacecraft |
| NR | NS | 1436: Efficient and Safe Higher Power Systems for Small Spacecraft | Small Spacecraft |
| NR | NS | 701: Green Propellant Propulsion Systems | Propulsion: Non Nuclear |
| NR | NS | 1483: Enable commercially-provided Rendezvous, Proximity Operations, and Capture (RPOC) products and services | ISAM and RPOC |
| NR | NS | 1432: Rendezvous, Proximity Operations, and Debris Remediation using Small Spacecraft | Small Spacecraft |
| NR | NS | 1623: Advanced thermal modeling capabilities | Thermal Management Systems |

| ESDMD Rank | ESDMD Score | Shortfall ID | Capability Category |
|---|---|---|---|
| NR | NS | 1555: Next Generation Avionics Architectures | Avionics |
| NR | NS | 1052: EVA/IVA Support Propulsion Development | Propulsion: Non Nuclear |

# Stakeholder Group Ranked List: NASA Science Mission Directorate (SMD)

SMD submitted a ranked shortfall list (below) and provided shortfall scores in the second column as inputs for the integrated list. In its response, SMD did not score every shortfall (NS). Unscored shortfalls were also not ranked (NR). Several shortfalls ranked equally.

The NASA Centers stakeholder group included SMD employees who submitted individual responses.

| SMD Rank | SMD Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 1 | 9.000 | 1554: High Performance Onboard Computing to Enable Increasingly Complex Operations | Avionics |
| 1 | 9.000 | 1553: Foundational Technologies for Future Avionics Devices and Systems | Avionics |
| 3 | 9.000 | 1430: Small Spacecraft Propulsion | Small Spacecraft |
| 3 | 9.000 | 611: Sub-kW and kW Class Electric Propulsion Systems | Propulsion: Non Nuclear |
| 5 | 9.000 | 1568: Entry Modeling and Simulation for EDL Missions | Entry Descent and Landing |
| 6 | 9.000 | 1563: Aerocapture for Spacecraft Deceleration and Orbit Insertion | Entry Descent and Landing |
| 7 | 9.000 | 1599: Quantum Sensors That Use Atoms, Ions, and Spins | Sensors and Instruments |
| 7 | 9.000 | 1598: Quantum Sensors That Use Photons | Sensors and Instruments |
| 9 | 9.000 | 1618: Survive and operate through the lunar night | Thermal Management Systems |
| 9 | 9.000 | 1552: Extreme Environment Avionics | Avionics |
| 9 | 9.000 | 1545: Robotic Actuation, Subsystem Components, and System Architectures for Long-Duration and Extreme Environment Operation | Autonomous Systems and Robotics |
| 12 | 9.000 | 1597: Power for Non-Solar-Illuminated Small Systems | Power |

| SMD Rank | SMD Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 13 | 9.000 | 1575: Thermal and Vibrational Isolation for Ultra-stable Science Payloads | Advanced Materials and Structures |
| 14 | 9.000 | 700: Solar Sails for Propellant-less Propulsion | Propulsion: Non Nuclear |
| 15 | 9.000 | 1533: Autonomous Robotic Sample Identification, Classification, Collection, Manipulation, Verification, and Transport | Autonomous Systems and Robotics |
| 16 | 9.000 | 1621: Cryogenic cooling for science instrumentation | Thermal Management Systems |
| 17 | 9.000 | 1194: Prediction Modeling of Cryogenic Fluid Dynamics and Operations | Cryogenic Fluid Management |
| 18 | 9.000 | 1626: Advanced Sensor Components: Imaging | Sensors and Instruments |
| 19 | 9.000 | 1519: Environmental Monitoring for Habitation | Advanced Habitation Systems |
| 20 | 9.000 | 1438: Autonomy, Edge Computation, and Interoperable Networking for Small Spacecraft | Small Spacecraft |
| 20 | 9.000 | 1625: Intelligent Multi-Agent Constellations for Cooperative Operations | Autonomous Systems and Robotics |
| 22 | 9.000 | 1576: Micrometeoroid-Robust Protection of In-space Observatories | Advanced Materials and Structures |
| 23 | 9.000 | 1531: Autonomous Guidance and Navigation for Deep Space Missions | Autonomous Systems and Robotics |
| 23 | 9.000 | 1559: Deep Space Autonomous Navigation | Communication and Navigation |
| 25 | 9.000 | 1304: Robust, High-Progress-Rate, and Long-Distance Autonomous Surface Mobility | Autonomous Systems and Robotics |
| 26 | 7.000 | 1548: Sensing for Autonomous Robotic Operations in Challenging Environmental Conditions | Autonomous Systems and Robotics |
| 27 | 7.000 | 1560: High-Rate Deep Space Communications | Communication and Navigation |
| 28 | 7.000 | 1571: Navigation Sensors for Precision Landing | Entry Descent and Landing |

| SMD Rank | SMD Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 28 | 7.000 | 1573: Terrain Mapping Capabilities for Precision Landing and Hazard Avoidance | Entry Descent and Landing |
| 28 | 7.000 | 1562: Advanced Algorithms and Computing for Precision Landing | Entry Descent and Landing |
| 28 | 7.000 | 1565: Assessment and Validation Capabilities for Integrated Precision Landing Systems | Entry Descent and Landing |
| 28 | 7.000 | 1574: Validated Performance Models for Planetary Parachutes | Entry Descent and Landing |
| 28 | 7.000 | 1564: Aeroshell In-Situ Flight Performance Data During EDL | Entry Descent and Landing |
| 34 | 7.000 | 1600: Enable Paradigm for System Science to Include Interactions Between Subsystems | Sensors and Instruments |
| 35 | 7.000 | 498: Broad and dependable supply chain for space-qualified robotic hardware, electronics, and associated software | ISAM and RPOC |
| 36 | 7.000 | 1586: Enhanced Access to Orbital and Suborbital Space for Flight Demonstration and Test | Miscellaneous |
| 37 | 7.000 | 1542: Metrics and Processes for Establishing Trust and Certifying the Trustworthiness of Autonomous Systems | Autonomous Systems and Robotics |
| 38 | 7.000 | 1526: Radiation Monitoring and Modeling (Crew and Habitat) | Advanced Habitation Systems |
| 39 | 7.000 | 1603: Situational Awareness Sensors and Tools for Astronauts | Sensors and Instruments |
| 40 | 7.000 | 1627: Advanced Sensor Components for Heliophysics and Lunar-Based Astronomy | Sensors and Instruments |
| 41 | 7.000 | 1587: Wildfire Integrated Effect Chain | Miscellaneous |
| 42 | 7.000 | 379: Upgrade or Install Instruments on Large Space Observatories | ISAM and RPOC |
| 43 | 7.000 | 1620: Conditioned stowage to maintain science and/or nutritional integrity | Thermal Management Systems |
| 44 | 7.000 | 1590: Planetary Protection | Miscellaneous |

| SMD Rank | SMD Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 45 | 7.000 | 680: Robust Robotic Intelligence for High-Tempo Autonomous Operations in Dynamic Mission Conditions | Autonomous Systems and Robotics |
| 46 | 7.000 | 1588: Protect Earth from Destructive Natural Impacts (Planetary Defense) | Miscellaneous |
| 47 | 7.000 | 610: Solar Electric Propulsion - High Specific Impulse | Propulsion: Non Nuclear |
| 48 | 7.000 | 1547: Robotic Systems for Sub-Surface Access | Autonomous Systems and Robotics |
| 49 | 7.000 | 1551: Distributed Avionics to Enable Improved Performance and SWaP Efficiency | Avionics |
| 50 | 7.000 | 1431: Access Beyond LEO for Small Spacecraft | Small Spacecraft |
| 51 | 7.000 | 1516: Water and Dormancy Management for Habitation | Advanced Habitation Systems |
| 52 | 7.000 | 1577: Perform resource reconnaissance to locate and characterize resources and estimate reserves | ISRU |
| 53 | 7.000 | 1477: Mitigation of New Orbital Debris Generation | Orbital Debris |
| 54 | 7.000 | 1530: Aerial Robotic Mobility and Onboard Intelligence for Expanded Capabilities on Mars, Venus, and Titan | Autonomous Systems and Robotics |
| 55 | 7.000 | 1520: Fire Safety for Habitation | Advanced Habitation Systems |
| 56 | 5.000 | 1224: In-Space & Surface Transfer of Earth Storable Propellants | Propulsion: Non Nuclear |
| 57 | 5.000 | 696: Enable Storable Propulsion Systems in Low Temperature Environments | Propulsion: Non Nuclear |
| 58 | 5.000 | 1566: Characterization of Plume Surface Interaction | Entry Descent and Landing |
| 59 | 5.000 | 1602: 3D/3D+ Imaging and Tomography of Complex Features and Dynamical Processes | Sensors and Instruments |
| 60 | 5.000 | 1601: Enable Observation of Whole Top-to-Bottom Dynamic Ecosystems | Sensors and Instruments |

| SMD Rank | SMD Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 61 | 5.000 | 1544: Resilient Agency: Adaptable Intelligence and Robust Online Learning for Long-Duration and Dynamic Missions | Autonomous Systems and Robotics |
| 62 | 5.000 | 1604: Find, Study Habitable Zone Earth-like Exoplanets and Search for Biosignatures | Sensors and Instruments |
| 62 | 5.000 | 1605: Peer Back Farther in Time to the Early Universe | Sensors and Instruments |
| 62 | 5.000 | 1607: Detect New Astronomical Messenger - Gravitational Waves | Sensors and Instruments |
| 62 | 5.000 | 1606: Observe Some of the Most Energetic Phenomena in the Universe | Sensors and Instruments |
| 66 | 5.000 | 1494: Digital Transformation Technologies for Terrestrial, In-Space, On-Surface Manufacturing, and Operations | Advanced Manufacturing |
| 67 | 5.000 | 767: Advanced designs for lightweight inflatable surface elements | Advanced Materials and Structures |
| 68 | 5.000 | 1495: Advanced Manufacturing for Improved Dimensional Control of Large-Scale Space Structures | Advanced Manufacturing |
| 69 | 5.000 | 1535: Autonomous Vehicle, System, Habitat, and Infrastructure Health Monitoring and Management | Autonomous Systems and Robotics |
| 70 | 5.000 | 1595: Energy Storage to Enable Robust and Long Duration Operations on Moon and Mars | Power |
| 71 | 5.000 | 1589: Space Situational Awareness | Miscellaneous |
| 72 | 3.000 | 844: Passive Dust Mitigation Technologies for Diverse Applications | Dust Mitigation |
| 72 | 3.000 | 1047: Active Dust Mitigation Technologies for Diverse Applications | Dust Mitigation |
| 72 | 3.000 | 1561: Advanced Modeling and Test Capabilities to Characterize Dust Effects on Hardware | Dust Mitigation |
| 72 | 3.000 | 1336: Robotic Mobility for Robust, Repeatable Access To and Through Extreme Terrain, Surface Topography, and Harsh Environmental Conditions | Autonomous Systems and Robotics |
| 72 | 3.000 | 1538: General-Purpose Robotic Manipulation to Perform Human-Scale Logistics, Maintenance, Outfitting, and Utilization | Autonomous Systems and Robotics |

| SMD Rank | SMD Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 72 | 3.000 | 1541: Intuitive and Efficient Human-Robot Interaction for Safe Teaming and Remote Supervisory Control | Autonomous Systems and Robotics |
| 72 | 3.000 | 1514: Atmospheric Metabolic Constituent Management for Habitation | Advanced Habitation Systems |
| 72 | 3.000 | 1624: Advanced thermal management technologies for diverse applications | Thermal Management Systems |
| 72 | 3.000 | 376: Modular design for in-space installation | ISAM and RPOC |
| 72 | 3.000 | 1491: Additive Manufacturing of Large-Scale Components | Advanced Manufacturing |
| 72 | 3.000 | 1622: Novel thermal technologies to improve environmental control of habitats | Thermal Management Systems |
| 72 | 3.000 | 1487: In-Space and On-Surface Welding Technologies for Manufacturing, Assembly, and Construction | Advanced Manufacturing |
| 72 | 3.000 | 1572: Performance-Optimized Low-Cost Aeroshells for EDL Missions | Entry Descent and Landing |
| 72 | 3.000 | 512: Cooperative interfaces, aids, and standards | ISAM and RPOC |
| 72 | 3.000 | 1434: Communication Technology and Capabilities for Small Spacecraft | Small Spacecraft |
| 72 | 3.000 | 705: Low Power Nuclear Electric Propulsion | Propulsion: Nuclear |
| 72 | 3.000 | 1262: Remediation of Small Debris | Orbital Debris |
| 72 | 3.000 | 707: Transformational Advanced Energetic Propulsion (AEP) | Propulsion: Non Nuclear |
| 72 | 3.000 | 1567: Entry Capabilities for Small-Scale and Commercial Spacecraft | Entry Descent and Landing |
| 72 | 3.000 | 1549: Advanced Data Acquisition Systems for Diverse Applications | Avionics |
| 72 | 3.000 | 1437: Dynamic and Capable Thermal Control for Small Spacecraft | Small Spacecraft |
| 72 | 3.000 | 1513: Advanced Solid Propulsion Systems | Propulsion: Non Nuclear |
| 95 | 1.000 | 1476: Remediation of Large Debris | Orbital Debris |

| SMD Rank | SMD Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 95 | 1.000 | 1433: Position, Navigation, and Timing for Small Spacecraft | Small Spacecraft |
| 95 | 1.000 | 1436: Efficient and Safe Higher Power Systems for Small Spacecraft | Small Spacecraft |
| 95 | 1.000 | 701: Green Propellant Propulsion Systems | Propulsion: Non Nuclear |
| NR | NS | 1558: High-Rate Communications Across The Lunar Surface | Communication and Navigation |
| NR | NS | 709: Nuclear Electric Propulsion for Human Exploration | Propulsion: Nuclear |
| NR | NS | 702: Nuclear Thermal Propulsion for Human Exploration | Propulsion: Nuclear |
| NR | NS | 1138: In-Space Transfer of Electric Propulsion Propellant | ISAM and RPOC |
| NR | NS | 1525: Food and Nutrition for Mars and Sustained Lunar | Advanced Habitation Systems |
| NR | NS | 1610: Surface-based food management for sustained lunar evolution | Surface Systems |
| NR | NS | 1569: High-Mass Mars Entry and Descent Systems | Entry Descent and Landing |
| NR | NS | 1532: Autonomous Planning, Scheduling, and Decision-Support to Enable Sustained Earth-Independent Missions | Autonomous Systems and Robotics |
| NR | NS | 1221: Mars Ascent Vehicle Propulsion | Propulsion: Non Nuclear |
| NR | NS | 1596: High Power Energy Generation on Moon and Mars Surfaces | Power |
| NR | NS | 361: Surface Mating Mechanisms | ISAM and RPOC |
| NR | NS | 1613: Surface-based fluid management for sustained lunar evolution | Surface Systems |
| NR | NS | 1612: Surface-based fluid management for near/mid-term missions | Surface Systems |
| NR | NS | 1557: Position, Navigation, and Timing (PNT) for In-Orbit and Surface Applications | Communication and Navigation |

| SMD Rank | SMD Score | Shortfall ID | Capability Category |
|---|---|---|---|
| NR | NS | 1518: Logistics Tracking, Clothing, and Trash Management for Habitation | Advanced Habitation Systems |
| NR | NS | 1608: Surface-based lunar logistics management for near/mid-term missions | Surface Systems |
| NR | NS | 1611: Surface-based end-of-life equipment management | Surface Systems |
| NR | NS | 1546: Robotic Mobile Manipulation for Autonomous Large-Scale Logistics, Payload Handling, and Surface Transport | Autonomous Systems and Robotics |
| NR | NS | 1591: Power Management Systems for Long Duration Lunar and Martian Missions | Power |
| NR | NS | 1592: High Power, Long Distance Energy Transmission Across Distributed Surface Assets | Power |
| NR | NS | 1390: Power and Data Transfer in Dusty Environments | Power |
| NR | NS | 1609: Surface-based lunar logistics management for sustained lunar evolution | Surface Systems |
| NR | NS | 1529: EVA and IVA Suit System Capabilities for Mars Missions | Advanced Habitation Systems |
| NR | NS | 1523: Earth Independent Human Operations within Habitat Elements | Advanced Habitation Systems |
| NR | NS | 1614: Surface-based planning and scheduling technologies for sustained lunar evolution | Surface Systems |
| NR | NS | 1617: Autonomous on-surface maintenance and repair for sustained lunar evolution | Surface Systems |
| NR | NS | 1615: Common tools for on-surface maintenance and repair for reduced crew interaction | Surface Systems |
| NR | NS | 1521: Crew Exercise and Sensorimotor Countermeasures | Advanced Habitation Systems |
| NR | NS | 1522: Crew Health Countermeasures – Non-Exercise | Advanced Habitation Systems |
| NR | NS | 1528: Spacesuit Physiology | Advanced Habitation Systems |

| SMD Rank | SMD Score | Shortfall ID | Capability Category |
|---|---|---|---|
| NR | NS | 1524: Crew Medical Care for Mars and Sustained Lunar | Advanced Habitation Systems |
| NR | NS | 879: In-space and On-surface, Long-duration Storage of Cryogenic Propellant | Cryogenic Fluid Management |
| NR | NS | 1226: Cryogenic Liquefaction | Cryogenic Fluid Management |
| NR | NS | 792: In-space and On-surface Transfer of Cryogenic Fluids | Cryogenic Fluid Management |
| NR | NS | 1527: Radiation Countermeasures (Crew and Habitat) | Advanced Habitation Systems |
| NR | NS | 1506: In-Space & Surface Transfer of High-Pressure Gases | ISAM and RPOC |
| NR | NS | 662: Robotic regolith manipulation and site preparation | Excavation Construction and Outfitting |
| NR | NS | 384: Excavation of hard/compacted/icy material | Excavation Construction and Outfitting |
| NR | NS | 369: Excavation of granular (surface) regolith for ISRU commodities production | Excavation Construction and Outfitting |
| NR | NS | 385: Regolith and resource delivery system | Excavation Construction and Outfitting |
| NR | NS | 1578: Extraction and separation of water from extraterrestrial surface material | ISRU |
| NR | NS | 1580: Extraction and separation of oxygen from extraterrestrial minerals | ISRU |
| NR | NS | 1585: Extraterrestrial surface environmental simulators, test facilities, and test sites | ISRU |
| NR | NS | 1582: Extraction and separation of metals/metalloids from extraterrestrial minerals | ISRU |
| NR | NS | 581: ISRU System Modeling | ISRU |

| SMD Rank | SMD Score | Shortfall ID | Capability Category |
|---|---|---|---|
| NR | NS | 1485: In-Space and On-Surface Manufacturing of Parts/Products from Surface and Terrestrial Feedstocks | Advanced Manufacturing |
| NR | NS | 1486: In-Space and On-Surface NDE and Qualification of Components for Manufacturing, Assembly, and Construction | Advanced Manufacturing |
| NR | NS | 1583: Produce propellants and mission consumables from extracted in-situ resources | ISRU |
| NR | NS | 1581: Extraction and separation of extraterrestrial atmospheric resources and gaseous products/reactants | ISRU |
| NR | NS | 544: Solar Electric Propulsion to Support Orbital Platforms | Propulsion: Non Nuclear |
| NR | NS | 1616: Dissipation of electrical charge on surface assets | Surface Systems |
| NR | NS | 1515: Atmospheric Non-Metabolic Constituent Management for Habitation | Advanced Habitation Systems |
| NR | NS | 1550: Crew Audio/Visual Interfaces for Long Duration Missions Beyond LEO | Avionics |
| NR | NS | 672: Long-life thermal control for surface suits capable of extreme access | Thermal Management Systems |
| NR | NS | 1539: Intelligent Robotic Systems for Crew Health and Performance During Long-Duration Missions | Autonomous Systems and Robotics |
| NR | NS | 1517: Metabolic Waste Management for Habitation | Advanced Habitation Systems |
| NR | NS | 1537: Free-Flying Systems for Robotic Inspection, Data Collection, and Servicing of In-Space Assets | Autonomous Systems and Robotics |
| NR | NS | 1400: On-surface robotic assembly of horizontal structures | Excavation Construction and Outfitting |
| NR | NS | 1543: Multi-Agent Robotic Coordination and Interoperability for Cooperative Task Planning and Performance | Autonomous Systems and Robotics |
| NR | NS | 666: On-Surface In-situ Construction of Horizontal Structures | Excavation Construction and Outfitting |

| SMD Rank | SMD Score | Shortfall ID | Capability Category |
|---|---|---|---|
| NR | NS | 1584: Produce manufacturing and construction feedstock from extracted in-situ resources | ISRU |
| NR | NS | 1408: Advanced deployable load-bearing structures | Advanced Materials and Structures |
| NR | NS | 1540: Intelligent Robots for the Servicing, Assembly, and Outfitting of In-Space Assets and Industrial-Scale Surface Infrastructure | Autonomous Systems and Robotics |
| NR | NS | 612: In-Space Diagnostics for Electric Propulsion | Propulsion: Non Nuclear |
| NR | NS | 617: On-surface robotic assembly of vertical structures | Excavation Construction and Outfitting |
| NR | NS | 703: Rotating Detonation Rocket Engine (RDRE) | Propulsion: Non Nuclear |
| NR | NS | 1511: Advanced Computational Fluid Dynamics Tools / Capabilities | Propulsion: Non Nuclear |
| NR | NS | 1619: High temperature heat rejection for nuclear applications | Thermal Management Systems |
| NR | NS | 425: On-Surface In-situ Construction of Vertical Structures | Excavation Construction and Outfitting |
| NR | NS | 1480: On-surface Outfitting of Lunar Structures | Excavation Construction and Outfitting |
| NR | NS | 755: Cross-Discipline Cryogenic Fluid Management Technologies | Cryogenic Fluid Management |
| NR | NS | 1489: In-Space and On-Surface Manufacturing from Recycled and Reused Materials and Components | Advanced Manufacturing |
| NR | NS | 1496: In-Space and On-Surface Manufacturing, Assembly, and Repair of Composite Structures | Advanced Manufacturing |
| NR | NS | 1490: Additive Manufacturing for New and High-Performance Materials | Advanced Manufacturing |
| NR | NS | 1536: Free-Flying Mobility Aids for Crew EVA | Autonomous Systems and Robotics |

| SMD Rank | SMD Score | Shortfall ID | Capability Category |
|---|---|---|---|
| NR | NS | 513: Robotic Assembly and Construction of Modular Systems for Sustained In-Space Infrastructure | ISAM and RPOC |
| NR | NS | 1579: Extraction and separation of non-water volatile resources from Lunar regolith | ISRU |
| NR | NS | 1493: Computational Materials-Informed Qualification and Certification for In-Space and On-Surface Manufacturing | Advanced Manufacturing |
| NR | NS | 1570: Lander Capabilities for Soft Touchdown | Entry Descent and Landing |
| NR | NS | 1512: Modern Solid Motor Design and Analysis Tools / Capabilities | Propulsion: Non Nuclear |
| NR | NS | 1534: Autonomous Robotics for Sustained In-Space Manufacturing Operations | Autonomous Systems and Robotics |
| NR | NS | 1492: Materials and Process Modeling for In-Space and On-Surface Manufacturing | Advanced Manufacturing |
| NR | NS | 1593: Lunar Surface Power Generation from ISRU Derived Resources | Power |
| NR | NS | 1488: Additive Manufacturing for Propulsion | Advanced Manufacturing |
| NR | NS | 1594: Martian Surface Power Generation from ISRU Derived Resources | Power |
| NR | NS | 1483: Enable commercially-provided Rendezvous, Proximity Operations, and Capture (RPOC) products and services | ISAM and RPOC |
| NR | NS | 1432: Rendezvous, Proximity Operations, and Debris Remediation using Small Spacecraft | Small Spacecraft |
| NR | NS | 1623: Advanced thermal modeling capabilities | Thermal Management Systems |
| NR | NS | 1555: Next Generation Avionics Architectures | Avionics |
| NR | NS | 1052: EVA/IVA Support Propulsion Development | Propulsion: Non Nuclear |

# Stakeholder Group Ranked List: NASA Centers

The NASA Centers ranked shortfall list used the average shortfall scores from individuals – government employees and contractors – working at a NASA center. It also included official consolidated responses from NASA Glenn, Goddard, JPL, Kennedy and Marshall.

| NASA Centers Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 1 | 7.8655 | 879: In-space and On-surface, Long-duration Storage of Cryogenic Propellant | Cryogenic Fluid Management |
| 2 | 7.7992 | 792: In-space and On-surface Transfer of Cryogenic Fluids | Cryogenic Fluid Management |
| 3 | 7.5451 | 1554: High Performance Onboard Computing to Enable Increasingly Complex Operations | Avionics |
| 4 | 7.4548 | 1596: High Power Energy Generation on Moon and Mars Surfaces | Power |
| 5 | 7.4064 | 1527: Radiation Countermeasures (Crew and Habitat) | Advanced Habitation Systems |
| 6 | 7.4022 | 1618: Survive and operate through the lunar night | Thermal Management Systems |
| 7 | 7.2576 | 1477: Mitigation of New Orbital Debris Generation | Orbital Debris |
| 8 | 7.2528 | 1578: Extraction and separation of water from extraterrestrial surface material | ISRU |
| 9 | 7.2174 | 1560: High-Rate Deep Space Communications | Communication and Navigation |
| 10 | 7.0197 | 1557: Position, Navigation, and Timing (PNT) for In-Orbit and Surface Applications | Communication and Navigation |
| 11 | 6.9931 | 1573: Terrain Mapping Capabilities for Precision Landing and Hazard Avoidance | Entry Descent and Landing |
| 12 | 6.9633 | 1520: Fire Safety for Habitation | Advanced Habitation Systems |

| NASA Centers Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 13 | 6.9538 | 1526: Radiation Monitoring and Modeling (Crew and Habitat) | Advanced Habitation Systems |
| 14 | 6.9510 | 1580: Extraction and separation of oxygen from extraterrestrial minerals | ISRU |
| 15 | 6.9202 | 1595: Energy Storage to Enable Robust and Long Duration Operations on Moon and Mars | Power |
| 16 | 6.9146 | 844: Passive Dust Mitigation Technologies for Diverse Applications | Dust Mitigation |
| 17 | 6.8409 | 1577: Perform resource reconnaissance to locate and characterize resources and estimate reserves | ISRU |
| 18 | 6.8283 | 1476: Remediation of Large Debris | Orbital Debris |
| 19 | 6.8173 | 1619: High temperature heat rejection for nuclear applications | Thermal Management Systems |
| 20 | 6.8078 | 1558: High-Rate Communications Across The Lunar Surface | Communication and Navigation |
| 21 | 6.8016 | 1524: Crew Medical Care for Mars and Sustained Lunar | Advanced Habitation Systems |
| 22 | 6.7628 | 1626: Advanced Sensor Components: Imaging | Sensors and Instruments |
| 23 | 6.7150 | 1262: Remediation of Small Debris | Orbital Debris |
| 24 | 6.7149 | 1047: Active Dust Mitigation Technologies for Diverse Applications | Dust Mitigation |
| 25 | 6.6818 | 1562: Advanced Algorithms and Computing for Precision Landing | Entry Descent and Landing |
| 26 | 6.6753 | 1585: Extraterrestrial surface environmental simulators, test facilities, and test sites | ISRU |
| 27 | 6.6555 | 1583: Produce propellants and mission consumables from extracted in-situ resources | ISRU |
| 28 | 6.6495 | 1561: Advanced Modeling and Test Capabilities to Characterize Dust Effects on Hardware | Dust Mitigation |

| NASA Centers Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 29 | 6.6472 | 755: Cross-Discipline Cryogenic Fluid Management Technologies | Cryogenic Fluid Management |
| 30 | 6.6174 | 1525: Food and Nutrition for Mars and Sustained Lunar | Advanced Habitation Systems |
| 31 | 6.61572 | 1571: Navigation Sensors for Precision Landing | Entry Descent and Landing |
| 32 | 6.61568 | 709: Nuclear Electric Propulsion for Human Exploration | Propulsion: Nuclear |
| 33 | 6.6095 | 1569: High-Mass Mars Entry and Descent Systems | Entry Descent and Landing |
| 34 | 6.6083 | 1304: Robust, High-Progress-Rate, and Long-Distance Autonomous Surface Mobility | Autonomous Systems and Robotics |
| 35 | 6.5942 | 1194: Prediction Modeling of Cryogenic Fluid Dynamics and Operations | Cryogenic Fluid Management |
| 36 | 6.5927 | 662: Robotic regolith manipulation and site preparation | Excavation Construction and Outfitting |
| 37 | 6.5427 | 384: Excavation of hard/compacted/icy material | Excavation Construction and Outfitting |
| 38 | 6.5328 | 1559: Deep Space Autonomous Navigation | Communication and Navigation |
| 39 | 6.5288 | 1566: Characterization of Plume Surface Interaction | Entry Descent and Landing |
| 40 | 6.5215 | 1545: Robotic Actuation, Subsystem Components, and System Architectures for Long-Duration and Extreme Environment Operation | Autonomous Systems and Robotics |
| 41 | 6.4759 | 1480: On-surface Outfitting of Lunar Structures | Excavation Construction and Outfitting |
| 42 | 6.4717 | 1531: Autonomous Guidance and Navigation for Deep Space Missions | Autonomous Systems and Robotics |
| 43 | 6.4388 | 1431: Access Beyond LEO for Small Spacecraft | Small Spacecraft |

| NASA Centers Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 44 | 6.4358 | 1548: Sensing for Autonomous Robotic Operations in Challenging Environmental Conditions | Autonomous Systems and Robotics |
| 45 | 6.4325 | 1608: Surface-based lunar logistics management for near/mid-term missions | Surface Systems |
| 46 | 6.4139 | 1523: Earth Independent Human Operations within Habitat Elements | Advanced Habitation Systems |
| 47 | 6.3886 | 1597: Power for Non-Solar-Illuminated Small Systems | Power |
| 48 | 6.3873 | 1490: Additive Manufacturing for New and High-Performance Materials | Advanced Manufacturing |
| 49 | 6.3865 | 1519: Environmental Monitoring for Habitation | Advanced Habitation Systems |
| 50 | 6.3645 | 1568: Entry Modeling and Simulation for EDL Missions | Entry Descent and Landing |
| 51 | 6.3636 | 1624: Advanced thermal management technologies for diverse applications | Thermal Management Systems |
| 52 | 6.3562 | 1603: Situational Awareness Sensors and Tools for Astronauts | Sensors and Instruments |
| 53 | 6.3246 | 385: Regolith and resource delivery system | Excavation Construction and Outfitting |
| 54 | 6.3158 | 1552: Extreme Environment Avionics | Avionics |
| 55 | 6.3095 | 1491: Additive Manufacturing of Large-Scale Components | Advanced Manufacturing |
| 56 | 6.3050 | 1616: Dissipation of electrical charge on surface assets | Surface Systems |
| 57 | 6.2883 | 1555: Next Generation Avionics Architectures | Avionics |
| 58 | 6.2821 | 1542: Metrics and Processes for Establishing Trust and Certifying the Trustworthiness of Autonomous Systems | Autonomous Systems and Robotics |
| 59 | 6.2780 | 1506: In-Space & Surface Transfer of High-Pressure Gases | ISAM and RPOC |
| 60 | 6.2689 | 1433: Position, Navigation, and Timing for Small Spacecraft | Small Spacecraft |

| NASA Centers Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 61 | 6.2672 | 1579: Extraction and separation of non-water volatile resources from Lunar regolith | ISRU |
| 62 | 6.2565 | 702: Nuclear Thermal Propulsion for Human Exploration | Propulsion: Nuclear |
| 63 | 6.2472 | 610: Solar Electric Propulsion - High Specific Impulse | Propulsion: Non Nuclear |
| 64 | 6.2449 | 1430: Small Spacecraft Propulsion | Small Spacecraft |
| 65 | 6.2423 | 1514: Atmospheric Metabolic Constituent Management for Habitation | Advanced Habitation Systems |
| 66 | 6.2344 | 1546: Robotic Mobile Manipulation for Autonomous Large-Scale Logistics, Payload Handling, and Surface Transport | Autonomous Systems and Robotics |
| 67 | 6.2283 | 680: Robust Robotic Intelligence for High-Tempo Autonomous Operations in Dynamic Mission Conditions | Autonomous Systems and Robotics |
| 68 | 6.2146 | 1591: Power Management Systems for Long Duration Lunar and Martian Missions | Power |
| 69 | 6.1924 | 1516: Water and Dormancy Management for Habitation | Advanced Habitation Systems |
| 70 | 6.1904 | 1485: In-Space and On-Surface Manufacturing of Parts/Products from Surface and Terrestrial Feedstocks | Advanced Manufacturing |
| 71 | 6.1903 | 1570: Lander Capabilities for Soft Touchdown | Entry Descent and Landing |
| 72 | 6.1887 | 1535: Autonomous Vehicle, System, Habitat, and Infrastructure Health Monitoring and Management | Autonomous Systems and Robotics |
| 73 | 6.1812 | 1602: 3D/3D+ Imaging and Tomography of Complex Features and Dynamical Processes | Sensors and Instruments |
| 74 | 6.1781 | 1592: High Power, Long Distance Energy Transmission Across Distributed Surface Assets | Power |
| 75 | 6.1704 | 512: Cooperative interfaces, aids, and standards | ISAM and RPOC |
| 76 | 6.1675 | 1551: Distributed Avionics to Enable Improved Performance and SWaP Efficiency | Avionics |

| NASA Centers Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 77 | 6.1503 | 1540: Intelligent Robots for the Servicing, Assembly, and Outfitting of In-Space Assets and Industrial-Scale Surface Infrastructure | Autonomous Systems and Robotics |
| 78 | 6.1369 | 1565: Assessment and Validation Capabilities for Integrated Precision Landing Systems | Entry Descent and Landing |
| 79 | 6.1276 | 1532: Autonomous Planning, Scheduling, and Decision-Support to Enable Sustained Earth-Independent Missions | Autonomous Systems and Robotics |
| 80 | 6.1193 | 1226: Cryogenic Liquefaction | Cryogenic Fluid Management |
| 81 | 6.1145 | 1517: Metabolic Waste Management for Habitation | Advanced Habitation Systems |
| 82 | 6.1111 | 1390: Power and Data Transfer in Dusty Environments | Power |
| 83 | 6.1107 | 1589: Space Situational Awareness | Miscellaneous |
| 84 | 6.1047 | 1336: Robotic Mobility for Robust, Repeatable Access To and Through Extreme Terrain, Surface Topography, and Harsh Environmental Conditions | Autonomous Systems and Robotics |
| 85 | 6.1004 | 1543: Multi-Agent Robotic Coordination and Interoperability for Cooperative Task Planning and Performance | Autonomous Systems and Robotics |
| 86 | 6.0981 | 1528: Spacesuit Physiology | Advanced Habitation Systems |
| 87 | 6.0846 | 369: Excavation of granular (surface) regolith for ISRU commodities production | Excavation Construction and Outfitting |
| 88 | 6.0532 | 1492: Materials and Process Modeling for In-Space and On-Surface Manufacturing | Advanced Manufacturing |
| 89 | 6.0493 | 1613: Surface-based fluid management for sustained lunar evolution | Surface Systems |
| 90 | 6.0416 | 1432: Rendezvous, Proximity Operations, and Debris Remediation using Small Spacecraft | Small Spacecraft |
| 91 | 6.0325 | 1621: Cryogenic cooling for science instrumentation | Thermal Management Systems |

| NASA Centers Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 92 | 6.0314 | 1623: Advanced thermal modeling capabilities | Thermal Management Systems |
| 93 | 6.0310 | 1522: Crew Health Countermeasures – Non-Exercise | Advanced Habitation Systems |
| 94 | 6.0270 | 544: Solar Electric Propulsion to Support Orbital Platforms | Propulsion: Non Nuclear |
| 95 | 6.0248 | 1610: Surface-based food management for sustained lunar evolution | Surface Systems |
| 96 | 6.0104 | 1622: Novel thermal technologies to improve environmental control of habitats | Thermal Management Systems |
| 97 | 6.0036 | 1588: Protect Earth from Destructive Natural Impacts (Planetary Defense) | Miscellaneous |
| 98 | 5.9998 | 1529: EVA and IVA Suit System Capabilities for Mars Missions | Advanced Habitation Systems |
| 99 | 5.9846 | 672: Long-life thermal control for surface suits capable of extreme access | Thermal Management Systems |
| 100 | 5.9734 | 513: Robotic Assembly and Construction of Modular Systems for Sustained In-Space Infrastructure | ISAM and RPOC |
| 101 | 5.9682 | 376: Modular design for in-space installation | ISAM and RPOC |
| 102 | 5.9583 | 1563: Aerocapture for Spacecraft Deceleration and Orbit Insertion | Entry Descent and Landing |
| 103 | 5.9226 | 361: Surface Mating Mechanisms | ISAM and RPOC |
| 104 | 5.9165 | 1488: Additive Manufacturing for Propulsion | Advanced Manufacturing |
| 105 | 5.9018 | 1400: On-surface robotic assembly of horizontal structures | Excavation Construction and Outfitting |
| 106 | 5.8888 | 1590: Planetary Protection | Miscellaneous |
| 107 | 5.8587 | 666: On-Surface In-situ Construction of Horizontal Structures | Excavation Construction and Outfitting |

| NASA Centers Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 108 | 5.8584 | 1487: In-Space and On-Surface Welding Technologies for Manufacturing, Assembly, and Construction | Advanced Manufacturing |
| 109 | 5.8548 | 1620: Conditioned stowage to maintain science and/or nutritional integrity | Thermal Management Systems |
| 110 | 5.8520 | 1581: Extraction and separation of extraterrestrial atmospheric resources and gaseous products/reactants | ISRU |
| 111 | 5.8413 | 1582: Extraction and separation of metals/metalloids from extraterrestrial minerals | ISRU |
| 112 | 5.8327 | 1538: General-Purpose Robotic Manipulation to Perform Human-Scale Logistics, Maintenance, Outfitting, and Utilization | Autonomous Systems and Robotics |
| 113 | 5.7997 | 617: On-surface robotic assembly of vertical structures | Excavation Construction and Outfitting |
| 114 | 5.7970 | 425: On-Surface In-situ Construction of Vertical Structures | Excavation Construction and Outfitting |
| 115 | 5.7946 | 1612: Surface-based fluid management for near/mid-term missions | Surface Systems |
| 116 | 5.7643 | 1486: In-Space and On-Surface NDE and Qualification of Components for Manufacturing, Assembly, and Construction | Advanced Manufacturing |
| 117 | 5.7633 | 1408: Advanced deployable load-bearing structures | Advanced Materials and Structures |
| 118 | 5.7569 | 1599: Quantum Sensors That Use Atoms, Ions, and Spins | Sensors and Instruments |
| 119 | 5.7441 | 1553: Foundational Technologies for Future Avionics Devices and Systems | Avionics |
| 120 | 5.7337 | 1598: Quantum Sensors That Use Photons | Sensors and Instruments |
| 121 | 5.7301 | 1574: Validated Performance Models for Planetary Parachutes | Entry Descent and Landing |

| NASA Centers Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 122 | 5.6893 | 1544: Resilient Agency: Adaptable Intelligence and Robust Online Learning for Long-Duration and Dynamic Missions | Autonomous Systems and Robotics |
| 123 | 5.6801 | 1434: Communication Technology and Capabilities for Small Spacecraft | Small Spacecraft |
| 124 | 5.6715 | 1604: Find, Study Habitable Zone Earth-like Exoplanets and Search for Biosignatures | Sensors and Instruments |
| 125 | 5.6415 | 1533: Autonomous Robotic Sample Identification, Classification, Collection, Manipulation, Verification, and Transport | Autonomous Systems and Robotics |
| 126 | 5.6401 | 1584: Produce manufacturing and construction feedstock from extracted in-situ resources | ISRU |
| 127 | 5.6291 | 705: Low Power Nuclear Electric Propulsion | Propulsion: Nuclear |
| 128 | 5.6270 | 1494: Digital Transformation Technologies for Terrestrial, In-Space, On-Surface Manufacturing, and Operations | Advanced Manufacturing |
| 129 | 5.6141 | 1489: In-Space and On-Surface Manufacturing from Recycled and Reused Materials and Components | Advanced Manufacturing |
| 130 | 5.5970 | 1586: Enhanced Access to Orbital and Suborbital Space for Flight Demonstration and Test | Miscellaneous |
| 131 | 5.5774 | 581: ISRU System Modeling | ISRU |
| 132 | 5.5768 | 1534: Autonomous Robotics for Sustained In-Space Manufacturing Operations | Autonomous Systems and Robotics |
| 133 | 5.5498 | 1627: Advanced Sensor Components for Heliophysics and Lunar-Based Astronomy | Sensors and Instruments |
| 134 | 5.5393 | 1511: Advanced Computational Fluid Dynamics Tools / Capabilities | Propulsion: Non Nuclear |
| 135 | 5.5284 | 611: Sub-kW and kW Class Electric Propulsion Systems | Propulsion: Non Nuclear |
| 136 | 5.5183 | 1224: In-Space & Surface Transfer of Earth Storable Propellants | Propulsion: Non Nuclear |
| 137 | 5.5166 | 379: Upgrade or Install Instruments on Large Space Observatories | ISAM and RPOC |

| NASA Centers Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 138 | 5.5116 | 1521: Crew Exercise and Sensorimotor Countermeasures | Advanced Habitation Systems |
| 139 | 5.5078 | 1496: In-Space and On-Surface Manufacturing, Assembly, and Repair of Composite Structures | Advanced Manufacturing |
| 140 | 5.5055 | 1567: Entry Capabilities for Small-Scale and Commercial Spacecraft | Entry Descent and Landing |
| 141 | 5.5035 | 1617: Autonomous on-surface maintenance and repair for sustained lunar evolution | Surface Systems |
| 142 | 5.4926 | 1138: In-Space Transfer of Electric Propulsion Propellant | ISAM and RPOC |
| 143 | 5.4903 | 1564: Aeroshell In-Situ Flight Performance Data During EDL | Entry Descent and Landing |
| 144 | 5.4485 | 1221: Mars Ascent Vehicle Propulsion | Propulsion: Non Nuclear |
| 145 | 5.4357 | 1572: Performance-Optimized Low-Cost Aeroshells for EDL Missions | Entry Descent and Landing |
| 146 | 5.4347 | 1438: Autonomy, Edge Computation, and Interoperable Networking for Small Spacecraft | Small Spacecraft |
| 147 | 5.4313 | 1609: Surface-based lunar logistics management for sustained lunar evolution | Surface Systems |
| 148 | 5.4265 | 1601: Enable Observation of Whole Top-to-Bottom Dynamic Ecosystems | Sensors and Instruments |
| 149 | 5.4106 | 1518: Logistics Tracking, Clothing, and Trash Management for Habitation | Advanced Habitation Systems |
| 150 | 5.3756 | 707: Transformational Advanced Energetic Propulsion (AEP) | Propulsion: Non Nuclear |
| 151 | 5.3453 | 1541: Intuitive and Efficient Human-Robot Interaction for Safe Teaming and Remote Supervisory Control | Autonomous Systems and Robotics |
| 152 | 5.3381 | 498: Broad and dependable supply chain for space-qualified robotic hardware, electronics, and associated software | ISAM and RPOC |

| NASA Centers Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 153 | 5.3340 | 1539: Intelligent Robotic Systems for Crew Health and Performance During Long-Duration Missions | Autonomous Systems and Robotics |
| 154 | 5.3211 | 1594: Martian Surface Power Generation from ISRU Derived Resources | Power |
| 155 | 5.2786 | 1576: Micrometeoroid-Robust Protection of In-space Observatories | Advanced Materials and Structures |
| 156 | 5.2718 | 1495: Advanced Manufacturing for Improved Dimensional Control of Large-Scale Space Structures | Advanced Manufacturing |
| 157 | 5.2717 | 1515: Atmospheric Non-Metabolic Constituent Management for Habitation | Advanced Habitation Systems |
| 158 | 5.2522 | 1587: Wildfire Integrated Effect Chain | Miscellaneous |
| 159 | 5.2492 | 1607: Detect New Astronomical Messenger - Gravitational Waves | Sensors and Instruments |
| 160 | 5.2418 | 1605: Peer Back Farther in Time to the Early Universe | Sensors and Instruments |
| 161 | 5.2376 | 767: Advanced designs for lightweight inflatable surface elements | Advanced Materials and Structures |
| 162 | 5.2222 | 1606: Observe Some of the Most Energetic Phenomena in the Universe | Sensors and Instruments |
| 163 | 5.1855 | 1537: Free-Flying Systems for Robotic Inspection, Data Collection, and Servicing of In-Space Assets | Autonomous Systems and Robotics |
| 164 | 5.1784 | 1600: Enable Paradigm for System Science to Include Interactions Between Subsystems | Sensors and Instruments |
| 165 | 5.1630 | 1615: Common tools for on-surface maintenance and repair for reduced crew interaction | Surface Systems |
| 166 | 5.1473 | 1625: Intelligent Multi-Agent Constellations for Cooperative Operations | Autonomous Systems and Robotics |
| 167 | 5.1340 | 1436: Efficient and Safe Higher Power Systems for Small Spacecraft | Small Spacecraft |
| 168 | 5.0990 | 1483: Enable commercially-provided Rendezvous, Proximity Operations, and Capture (RPOC) products and services | ISAM and RPOC |

| NASA Centers Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 169 | 5.0835 | 612: In-Space Diagnostics for Electric Propulsion | Propulsion: Non Nuclear |
| 170 | 5.0597 | 1593: Lunar Surface Power Generation from ISRU Derived Resources | Power |
| 171 | 5.0570 | 1549: Advanced Data Acquisition Systems for Diverse Applications | Avionics |
| 172 | 5.0176 | 1547: Robotic Systems for Sub-Surface Access | Autonomous Systems and Robotics |
| 173 | 4.9906 | 1437: Dynamic and Capable Thermal Control for Small Spacecraft | Small Spacecraft |
| 174 | 4.9530 | 1575: Thermal and Vibrational Isolation for Ultra-stable Science Payloads | Advanced Materials and Structures |
| 175 | 4.9392 | 1530: Aerial Robotic Mobility and Onboard Intelligence for Expanded Capabilities on Mars, Venus, and Titan | Autonomous Systems and Robotics |
| 176 | 4.9122 | 696: Enable Storable Propulsion Systems in Low Temperature Environments | Propulsion: Non Nuclear |
| 177 | 4.9000 | 1614: Surface-based planning and scheduling technologies for sustained lunar evolution | Surface Systems |
| 178 | 4.8644 | 1611: Surface-based end-of-life equipment management | Surface Systems |
| 179 | 4.8470 | 1550: Crew Audio/Visual Interfaces for Long Duration Missions Beyond LEO | Avionics |
| 180 | 4.8356 | 703: Rotating Detonation Rocket Engine (RDRE) | Propulsion: Non Nuclear |
| 181 | 4.7513 | 1493: Computational Materials-Informed Qualification and Certification for In-Space and On-Surface Manufacturing | Advanced Manufacturing |
| 182 | 4.6602 | 700: Solar Sails for Propellant-less Propulsion | Propulsion: Non Nuclear |
| 183 | 4.5647 | 701: Green Propellant Propulsion Systems | Propulsion: Non Nuclear |

| NASA Centers Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 184 | 4.3131 | 1536: Free-Flying Mobility Aids for Crew EVA | Autonomous Systems and Robotics |
| 185 | 4.3014 | 1513: Advanced Solid Propulsion Systems | Propulsion: Non Nuclear |
| 186 | 4.0124 | 1052: EVA/IVA Support Propulsion Development | Propulsion: Non Nuclear |
| 187 | 3.6456 | 1512: Modern Solid Motor Design and Analysis Tools / Capabilities | Propulsion: Non Nuclear |

# Stakeholder Group Ranked List: Other NASA Mission Directorates

## (Aeronautics, Space Operations, Space Technology)

Each NASA mission directorate submitted a consolidated response. The Other NASA Mission Directorates ranked shortfall list used the average shortfall scores from the Aeronautics Research Mission Directorate (ARMD), Space Operations Mission Directorate (SOMD), and Space Technology Mission Directorate (STMD). Two shortfalls ranked equally at #54.

The NASA Centers stakeholder group included ARMD, SOMD, and STMD employees who submitted individual responses.

| Other NASA MD Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 1 | 8.3657 | 1618: Survive and operate through the lunar night | Thermal Management Systems |
| 2 | 8.0824 | 879: In-space and On-surface, Long-duration Storage of Cryogenic Propellant | Cryogenic Fluid Management |
| 3 | 7.8789 | 1557: Position, Navigation, and Timing (PNT) for In-Orbit and Surface Applications | Communication and Navigation |
| 4 | 7.8333 | 1595: Energy Storage to Enable Robust and Long Duration Operations on Moon and Mars | Power |
| 5 | 7.7357 | 1619: High temperature heat rejection for nuclear applications | Thermal Management Systems |
| 6 | 7.6645 | 1527: Radiation Countermeasures (Crew and Habitat) | Advanced Habitation Systems |
| 7 | 7.6552 | 709: Nuclear Electric Propulsion for Human Exploration | Propulsion: Nuclear |
| 8 | 7.6500 | 1562: Advanced Algorithms and Computing for Precision Landing | Entry Descent and Landing |
| 9 | 7.6059 | 1571: Navigation Sensors for Precision Landing | Entry Descent and Landing |

| Other NASA MD Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 10 | 7.5632 | 1559: Deep Space Autonomous Navigation | Communication and Navigation |
| 11 | 7.5310 | 702: Nuclear Thermal Propulsion for Human Exploration | Propulsion: Nuclear |
| 12 | 7.4118 | 1569: High-Mass Mars Entry and Descent Systems | Entry Descent and Landing |
| 13 | 7.3680 | 1519: Environmental Monitoring for Habitation | Advanced Habitation Systems |
| 14 | 7.2231 | 1520: Fire Safety for Habitation | Advanced Habitation Systems |
| 15 | 7.1833 | 1531: Autonomous Guidance and Navigation for Deep Space Missions | Autonomous Systems and Robotics |
| 16 | 7.1765 | 1596: High Power Energy Generation on Moon and Mars Surfaces | Power |
| 17 | 7.1586 | 1524: Crew Medical Care for Mars and Sustained Lunar | Advanced Habitation Systems |
| 18 | 7.1333 | 1514: Atmospheric Metabolic Constituent Management for Habitation | Advanced Habitation Systems |
| 19 | 7.1000 | 1570: Lander Capabilities for Soft Touchdown | Entry Descent and Landing |
| 20 | 7.0400 | 1597: Power for Non-Solar-Illuminated Small Systems | Power |
| 21 | 7.0000 | 1221: Mars Ascent Vehicle Propulsion | Propulsion: Non Nuclear |
| 22 | 6.9913 | 1516: Water and Dormancy Management for Habitation | Advanced Habitation Systems |
| 23 | 6.9871 | 1603: Situational Awareness Sensors and Tools for Astronauts | Sensors and Instruments |
| 24 | 6.9684 | 1560: High-Rate Deep Space Communications | Communication and Navigation |
| 25 | 6.9455 | 512: Cooperative interfaces, aids, and standards | ISAM and RPOC |
| 26 | 6.9273 | 376: Modular design for in-space installation | ISAM and RPOC |

| Other NASA MD Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 27 | 6.8941 | 1591: Power Management Systems for Long Duration Lunar and Martian Missions | Power |
| 28 | 6.8333 | 1542: Metrics and Processes for Establishing Trust and Certifying the Trustworthiness of Autonomous Systems | Autonomous Systems and Robotics |
| 29 | 6.7549 | 792: In-space and On-surface Transfer of Cryogenic Fluids | Cryogenic Fluid Management |
| 30 | 6.7467 | 707: Transformational Advanced Energetic Propulsion (AEP) | Propulsion: Non Nuclear |
| 31 | 6.7364 | 1517: Metabolic Waste Management for Habitation | Advanced Habitation Systems |
| 32 | 6.6618 | 1535: Autonomous Vehicle, System, Habitat, and Infrastructure Health Monitoring and Management | Autonomous Systems and Robotics |
| 33 | 6.6400 | 844: Passive Dust Mitigation Technologies for Diverse Applications | Dust Mitigation |
| 34 | 6.5573 | 1541: Intuitive and Efficient Human-Robot Interaction for Safe Teaming and Remote Supervisory Control | Autonomous Systems and Robotics |
| 35 | 6.5548 | 1526: Radiation Monitoring and Modeling (Crew and Habitat) | Advanced Habitation Systems |
| 36 | 6.5029 | 1047: Active Dust Mitigation Technologies for Diverse Applications | Dust Mitigation |
| 37 | 6.4529 | 1561: Advanced Modeling and Test Capabilities to Characterize Dust Effects on Hardware | Dust Mitigation |
| 38 | 6.4353 | 1483: Enable commercially-provided Rendezvous, Proximity Operations, and Capture (RPOC) products and services | ISAM and RPOC |
| 39 | 6.4333 | 513: Robotic Assembly and Construction of Modular Systems for Sustained In-Space Infrastructure | ISAM and RPOC |
| 40 | 6.3250 | 1532: Autonomous Planning, Scheduling, and Decision-Support to Enable Sustained Earth-Independent Missions | Autonomous Systems and Robotics |
| 41 | 6.3111 | 1523: Earth Independent Human Operations within Habitat Elements | Advanced Habitation Systems |

| Other NASA MD Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 42 | 6.3000 | 1515: Atmospheric Non-Metabolic Constituent Management for Habitation | Advanced Habitation Systems |
| 43 | 6.2600 | 1565: Assessment and Validation Capabilities for Integrated Precision Landing Systems | Entry Descent and Landing |
| 44 | 6.1600 | 1336: Robotic Mobility for Robust, Repeatable Access To and Through Extreme Terrain, Surface Topography, and Harsh Environmental Conditions | Autonomous Systems and Robotics |
| 45 | 6.1322 | 1568: Entry Modeling and Simulation for EDL Missions | Entry Descent and Landing |
| 46 | 6.1188 | 1616: Dissipation of electrical charge on surface assets | Surface Systems |
| 47 | 6.1118 | 1566: Characterization of Plume Surface Interaction | Entry Descent and Landing |
| 48 | 6.0897 | 1620: Conditioned stowage to maintain science and/or nutritional integrity | Thermal Management Systems |
| 49 | 6.0824 | 1545: Robotic Actuation, Subsystem Components, and System Architectures for Long-Duration and Extreme Environment Operation | Autonomous Systems and Robotics |
| 50 | 6.0769 | 705: Low Power Nuclear Electric Propulsion | Propulsion: Nuclear |
| 51 | 6.0216 | 1558: High-Rate Communications Across The Lunar Surface | Communication and Navigation |
| 52 | 6.0215 | 680: Robust Robotic Intelligence for High-Tempo Autonomous Operations in Dynamic Mission Conditions | Autonomous Systems and Robotics |
| 53 | 6.0048 | 1573: Terrain Mapping Capabilities for Precision Landing and Hazard Avoidance | Entry Descent and Landing |
| 54 | 6.0000 | 672: Long-life thermal control for surface suits capable of extreme access | Thermal Management Systems |
| 54 | 6.0000 | 1538: General-Purpose Robotic Manipulation to Perform Human-Scale Logistics, Maintenance, Outfitting, and Utilization | Autonomous Systems and Robotics |
| 56 | 5.9865 | 1554: High Performance Onboard Computing to Enable Increasingly Complex Operations | Avionics |

| Other NASA MD Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 57 | 5.9861 | 1548: Sensing for Autonomous Robotic Operations in Challenging Environmental Conditions | Autonomous Systems and Robotics |
| 58 | 5.9500 | 1525: Food and Nutrition for Mars and Sustained Lunar | Advanced Habitation Systems |
| 59 | 5.9250 | 1522: Crew Health Countermeasures – Non-Exercise | Advanced Habitation Systems |
| 60 | 5.9091 | 1592: High Power, Long Distance Energy Transmission Across Distributed Surface Assets | Power |
| 61 | 5.8710 | 1390: Power and Data Transfer in Dusty Environments | Power |
| 62 | 5.8429 | 1552: Extreme Environment Avionics | Avionics |
| 63 | 5.8364 | 361: Surface Mating Mechanisms | ISAM and RPOC |
| 64 | 5.7818 | 1431: Access Beyond LEO for Small Spacecraft | Small Spacecraft |
| 65 | 5.7182 | 703: Rotating Detonation Rocket Engine (RDRE) | Propulsion: Non Nuclear |
| 66 | 5.7121 | 1304: Robust, High-Progress-Rate, and Long-Distance Autonomous Surface Mobility | Autonomous Systems and Robotics |
| 67 | 5.7000 | 1521: Crew Exercise and Sensorimotor Countermeasures | Advanced Habitation Systems |
| 68 | 5.6782 | 1626: Advanced Sensor Components: Imaging | Sensors and Instruments |
| 69 | 5.6774 | 1586: Enhanced Access to Orbital and Suborbital Space for Flight Demonstration and Test | Miscellaneous |
| 70 | 5.6563 | 498: Broad and dependable supply chain for space-qualified robotic hardware, electronics, and associated software | ISAM and RPOC |
| 71 | 5.6381 | 1543: Multi-Agent Robotic Coordination and Interoperability for Cooperative Task Planning and Performance | Autonomous Systems and Robotics |
| 72 | 5.6310 | 1624: Advanced thermal management technologies for diverse applications | Thermal Management Systems |

| Other NASA MD Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 73 | 5.6188 | 1433: Position, Navigation, and Timing for Small Spacecraft | Small Spacecraft |
| 74 | 5.6029 | 1589: Space Situational Awareness | Miscellaneous |
| 75 | 5.5913 | 696: Enable Storable Propulsion Systems in Low Temperature Environments | Propulsion: Non Nuclear |
| 76 | 5.5813 | 1434: Communication Technology and Capabilities for Small Spacecraft | Small Spacecraft |
| 77 | 5.5778 | 1529: EVA and IVA Suit System Capabilities for Mars Missions | Advanced Habitation Systems |
| 78 | 5.5250 | 1138: In-Space Transfer of Electric Propulsion Propellant | ISAM and RPOC |
| 79 | 5.5189 | 617: On-surface robotic assembly of vertical structures | Excavation Construction and Outfitting |
| 80 | 5.5143 | 1546: Robotic Mobile Manipulation for Autonomous Large-Scale Logistics, Payload Handling, and Surface Transport | Autonomous Systems and Robotics |
| 81 | 5.4649 | 1578: Extraction and separation of water from extraterrestrial surface material | ISRU |
| 82 | 5.4545 | 1496: In-Space and On-Surface Manufacturing, Assembly, and Repair of Composite Structures | Advanced Manufacturing |
| 83 | 5.4427 | 1488: Additive Manufacturing for Propulsion | Advanced Manufacturing |
| 84 | 5.4353 | 1577: Perform resource reconnaissance to locate and characterize resources and estimate reserves | ISRU |
| 85 | 5.4323 | 1550: Crew Audio/Visual Interfaces for Long Duration Missions Beyond LEO | Avionics |
| 86 | 5.4316 | 1580: Extraction and separation of oxygen from extraterrestrial minerals | ISRU |
| 87 | 5.3939 | 1492: Materials and Process Modeling for In-Space and On-Surface Manufacturing | Advanced Manufacturing |

| Other NASA MD Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 88 | 5.3931 | 1224: In-Space & Surface Transfer of Earth Storable Propellants | Propulsion: Non Nuclear |
| 89 | 5.3889 | 1490: Additive Manufacturing for New and High-Performance Materials | Advanced Manufacturing |
| 90 | 5.3833 | 1549: Advanced Data Acquisition Systems for Diverse Applications | Avionics |
| 91 | 5.3750 | 1563: Aerocapture for Spacecraft Deceleration and Orbit Insertion | Entry Descent and Landing |
| 92 | 5.3742 | 1539: Intelligent Robotic Systems for Crew Health and Performance During Long-Duration Missions | Autonomous Systems and Robotics |
| 93 | 5.3710 | 1551: Distributed Avionics to Enable Improved Performance and SWaP Efficiency | Avionics |
| 94 | 5.3529 | 1430: Small Spacecraft Propulsion | Small Spacecraft |
| 95 | 5.3455 | 1608: Surface-based lunar logistics management for near/mid-term missions | Surface Systems |
| 96 | 5.3429 | 1585: Extraterrestrial surface environmental simulators, test facilities, and test sites | ISRU |
| 97 | 5.3314 | 1477: Mitigation of New Orbital Debris Generation | Orbital Debris |
| 98 | 5.3276 | 1408: Advanced deployable load-bearing structures | Advanced Materials and Structures |
| 99 | 5.3148 | 1623: Advanced thermal modeling capabilities | Thermal Management Systems |
| 100 | 5.2919 | 1480: On-surface Outfitting of Lunar Structures | Excavation Construction and Outfitting |
| 101 | 5.2903 | 1613: Surface-based fluid management for sustained lunar evolution | Surface Systems |
| 102 | 5.2757 | 1617: Autonomous on-surface maintenance and repair for sustained lunar evolution | Surface Systems |

| Other NASA MD Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 103 | 5.2743 | 1540: Intelligent Robots for the Servicing, Assembly, and Outfitting of In-Space Assets and Industrial-Scale Surface Infrastructure | Autonomous Systems and Robotics |
| 104 | 5.2500 | 1226: Cryogenic Liquefaction | Cryogenic Fluid Management |
| 105 | 5.2471 | 1506: In-Space & Surface Transfer of High-Pressure Gases | ISAM and RPOC |
| 106 | 5.2432 | 1534: Autonomous Robotics for Sustained In-Space Manufacturing Operations | Autonomous Systems and Robotics |
| 107 | 5.2333 | 1493: Computational Materials-Informed Qualification and Certification for In-Space and On-Surface Manufacturing | Advanced Manufacturing |
| 108 | 5.2000 | 1588: Protect Earth from Destructive Natural Impacts (Planetary Defense) | Miscellaneous |
| 109 | 5.1964 | 1194: Prediction Modeling of Cryogenic Fluid Dynamics and Operations | Cryogenic Fluid Management |
| 110 | 5.1714 | 1612: Surface-based fluid management for near/mid-term missions | Surface Systems |
| 111 | 5.1458 | 1491: Additive Manufacturing of Large-Scale Components | Advanced Manufacturing |
| 112 | 5.1412 | 1533: Autonomous Robotic Sample Identification, Classification, Collection, Manipulation, Verification, and Transport | Autonomous Systems and Robotics |
| 113 | 5.1235 | 1537: Free-Flying Systems for Robotic Inspection, Data Collection, and Servicing of In-Space Assets | Autonomous Systems and Robotics |
| 114 | 5.1200 | 1609: Surface-based lunar logistics management for sustained lunar evolution | Surface Systems |
| 115 | 5.1161 | 1567: Entry Capabilities for Small-Scale and Commercial Spacecraft | Entry Descent and Landing |
| 116 | 5.0947 | 425: On-Surface In-situ Construction of Vertical Structures | Excavation Construction and Outfitting |

| Other NASA MD Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 117 | 5.0938 | 1625: Intelligent Multi-Agent Constellations for Cooperative Operations | Autonomous Systems and Robotics |
| 118 | 5.0833 | 1555: Next Generation Avionics Architectures | Avionics |
| 119 | 5.0766 | 1486: In-Space and On-Surface NDE and Qualification of Components for Manufacturing, Assembly, and Construction | Advanced Manufacturing |
| 120 | 5.0333 | 1615: Common tools for on-surface maintenance and repair for reduced crew interaction | Surface Systems |
| 121 | 5.0167 | 1489: In-Space and On-Surface Manufacturing from Recycled and Reused Materials and Components | Advanced Manufacturing |
| 122 | 5.0000 | 1485: In-Space and On-Surface Manufacturing of Parts/Products from Surface and Terrestrial Feedstocks | Advanced Manufacturing |
| 123 | 4.9999 | 662: Robotic regolith manipulation and site preparation | Excavation Construction and Outfitting |
| 124 | 4.9379 | 1610: Surface-based food management for sustained lunar evolution | Surface Systems |
| 125 | 4.9333 | 1622: Novel thermal technologies to improve environmental control of habitats | Thermal Management Systems |
| 126 | 4.9200 | 1583: Produce propellants and mission consumables from extracted in-situ resources | ISRU |
| 127 | 4.9107 | 755: Cross-Discipline Cryogenic Fluid Management Technologies | Cryogenic Fluid Management |
| 128 | 4.8846 | 1511: Advanced Computational Fluid Dynamics Tools / Capabilities | Propulsion: Non Nuclear |
| 129 | 4.8703 | 1487: In-Space and On-Surface Welding Technologies for Manufacturing, Assembly, and Construction | Advanced Manufacturing |
| 130 | 4.8629 | 767: Advanced designs for lightweight inflatable surface elements | Advanced Materials and Structures |
| 131 | 4.8343 | 1579: Extraction and separation of non-water volatile resources from Lunar regolith | ISRU |

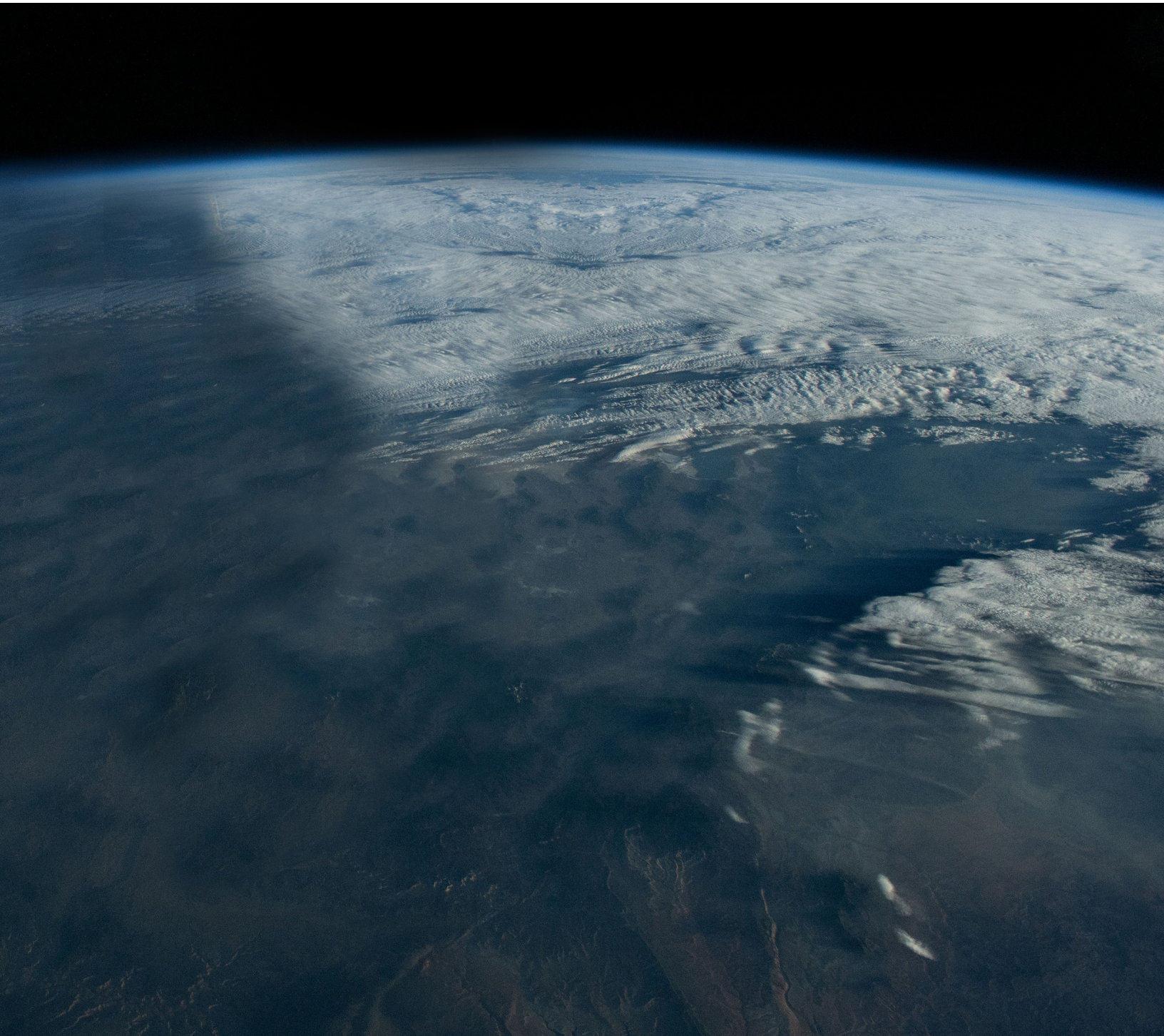
| Other NASA MD Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 132 | 4.8286 | 1574: Validated Performance Models for Planetary Parachutes | Entry Descent and Landing |
| 133 | 4.8276 | 1536: Free-Flying Mobility Aids for Crew EVA | Autonomous Systems and Robotics |
| 134 | 4.8125 | 1544: Resilient Agency: Adaptable Intelligence and Robust Online Learning for Long-Duration and Dynamic Missions | Autonomous Systems and Robotics |
| 135 | 4.7667 | 1599: Quantum Sensors That Use Atoms, Ions, and Spins | Sensors and Instruments |
| 136 | 4.7613 | 1438: Autonomy, Edge Computation, and Interoperable Networking for Small Spacecraft | Small Spacecraft |
| 137 | 4.7143 | 1476: Remediation of Large Debris | Orbital Debris |
| 138 | 4.7000 | 1494: Digital Transformation Technologies for Terrestrial, In-Space, On-Surface Manufacturing, and Operations | Advanced Manufacturing |
| 139 | 4.6894 | 1598: Quantum Sensors That Use Photons | Sensors and Instruments |
| 140 | 4.6769 | 1572: Performance-Optimized Low-Cost Aeroshells for EDL Missions | Entry Descent and Landing |
| 141 | 4.6688 | 384: Excavation of hard/compacted/icy material | Excavation Construction and Outfitting |
| 142 | 4.6483 | 1495: Advanced Manufacturing for Improved Dimensional Control of Large-Scale Space Structures | Advanced Manufacturing |
| 143 | 4.6250 | 1553: Foundational Technologies for Future Avionics Devices and Systems | Avionics |
| 144 | 4.6167 | 1564: Aeroshell In-Situ Flight Performance Data During EDL | Entry Descent and Landing |
| 145 | 4.6000 | 581: ISRU System Modeling | ISRU |
| 146 | 4.5938 | 369: Excavation of granular (surface) regolith for ISRU commodities production | Excavation Construction and Outfitting |

| Other NASA MD Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 147 | 4.5826 | 1518: Logistics Tracking, Clothing, and Trash Management for Habitation | Advanced Habitation Systems |
| 148 | 4.5484 | 1581: Extraction and separation of extraterrestrial atmospheric resources and gaseous products/reactants | ISRU |
| 149 | 4.5429 | 1262: Remediation of Small Debris | Orbital Debris |
| 150 | 4.4909 | 1611: Surface-based end-of-life equipment management | Surface Systems |
| 151 | 4.4375 | 1614: Surface-based planning and scheduling technologies for sustained lunar evolution | Surface Systems |
| 152 | 4.3765 | 385: Regolith and resource delivery system | Excavation Construction and Outfitting |
| 153 | 4.3714 | 1584: Produce manufacturing and construction feedstock from extracted in-situ resources | ISRU |
| 154 | 4.3200 | 1400: On-surface robotic assembly of horizontal structures | Excavation Construction and Outfitting |
| 155 | 4.2949 | 1528: Spacesuit Physiology | Advanced Habitation Systems |
| 156 | 4.2909 | 1436: Efficient and Safe Higher Power Systems for Small Spacecraft | Small Spacecraft |
| 157 | 4.2167 | 666: On-Surface In-situ Construction of Horizontal Structures | Excavation Construction and Outfitting |
| 158 | 4.1793 | 1593: Lunar Surface Power Generation from ISRU Derived Resources | Power |
| 159 | 4.1667 | 1582: Extraction and separation of metals/metalloids from extraterrestrial minerals | ISRU |
| 160 | 4.1471 | 1437: Dynamic and Capable Thermal Control for Small Spacecraft | Small Spacecraft |
| 161 | 4.0800 | 1621: Cryogenic cooling for science instrumentation | Thermal Management Systems |

| Other NASA MD Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 162 | 4.0417 | 1530: Aerial Robotic Mobility and Onboard Intelligence for Expanded Capabilities on Mars, Venus, and Titan | Autonomous Systems and Robotics |
| 163 | 4.0308 | 1513: Advanced Solid Propulsion Systems | Propulsion: Non Nuclear |
| 164 | 3.9826 | 1512: Modern Solid Motor Design and Analysis Tools / Capabilities | Propulsion: Non Nuclear |
| 165 | 3.9613 | 544: Solar Electric Propulsion to Support Orbital Platforms | Propulsion: Non Nuclear |
| 166 | 3.9563 | 1590: Planetary Protection | Miscellaneous |
| 167 | 3.9425 | 611: Sub-kW and kW Class Electric Propulsion Systems | Propulsion: Non Nuclear |
| 168 | 3.9273 | 1432: Rendezvous, Proximity Operations, and Debris Remediation using Small Spacecraft | Small Spacecraft |
| 169 | 3.9216 | 701: Green Propellant Propulsion Systems | Propulsion: Non Nuclear |
| 170 | 3.9097 | 1576: Micrometeoroid-Robust Protection of In-space Observatories | Advanced Materials and Structures |
| 171 | 3.8333 | 1587: Wildfire Integrated Effect Chain | Miscellaneous |
| 172 | 3.7161 | 1547: Robotic Systems for Sub-Surface Access | Autonomous Systems and Robotics |
| 173 | 3.7000 | 1575: Thermal and Vibrational Isolation for Ultra-stable Science Payloads | Advanced Materials and Structures |
| 174 | 3.6600 | 1594: Martian Surface Power Generation from ISRU Derived Resources | Power |
| 175 | 3.5692 | 1052: EVA/IVA Support Propulsion Development | Propulsion: Non Nuclear |
| 176 | 3.5440 | 612: In-Space Diagnostics for Electric Propulsion | Propulsion: Non Nuclear |
| 177 | 3.4355 | 610: Solar Electric Propulsion - High Specific Impulse | Propulsion: Non Nuclear |

| Other NASA MD Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 178 | 3.2000 | 1604: Find, Study Habitable Zone Earth-like Exoplanets and Search for Biosignatures | Sensors and Instruments |
| 179 | 3.1000 | 1627: Advanced Sensor Components for Heliophysics and Lunar-Based Astronomy | Sensors and Instruments |
| 180 | 3.0000 | 1600: Enable Paradigm for System Science to Include Interactions Between Subsystems | Sensors and Instruments |
| 181 | 2.8857 | 700: Solar Sails for Propellant-less Propulsion | Propulsion: Non Nuclear |
| 182 | 2.8300 | 1601: Enable Observation of Whole Top-to-Bottom Dynamic Ecosystems | Sensors and Instruments |
| 183 | 2.8261 | 1602: 3D/3D+ Imaging and Tomography of Complex Features and Dynamical Processes | Sensors and Instruments |
| 184 | 2.7833 | 379: Upgrade or Install Instruments on Large Space Observatories | ISAM and RPOC |
| 185 | 2.5250 | 1606: Observe Some of the Most Energetic Phenomena in the Universe | Sensors and Instruments |
| 186 | 2.5130 | 1607: Detect New Astronomical Messenger - Gravitational Waves | Sensors and Instruments |
| 187 | 2.4160 | 1605: Peer Back Farther in Time to the Early Universe | Sensors and Instruments |

# EXTERNAL STAKEHOLDER GROUPS RANKED LISTS



# Stakeholder Group Ranked List: Large Industry

The Large Industry ranked shortfall list used the average shortfall scores from responses affiliated with companies that employ more than 500 people. This stakeholder group also included responses from individuals associated with University Affiliated Research Centers (UARCs) and Federally Funded Research and Development Centers (FFRDCs). Two shortfalls ranked equally at #104.

While a FFRDC, responses affiliated with the Jet Propulsion Laboratory were included in the NASA Centers stakeholder group.

| Large Industry Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 1 | 7.5942 | 1596: High Power Energy Generation on Moon and Mars Surfaces | Power |
| 2 | 7.2747 | 1618: Survive and operate through the lunar night | Thermal Management Systems |
| 3 | 6.9869 | 879: In-space and On-surface, Long-duration Storage of Cryogenic Propellant | Cryogenic Fluid Management |
| 4 | 6.7002 | 792: In-space and On-surface Transfer of Cryogenic Fluids | Cryogenic Fluid Management |
| 5 | 6.6422 | 1597: Power for Non-Solar-Illuminated Small Systems | Power |
| 6 | 6.6284 | 1552: Extreme Environment Avionics | Avionics |
| 7 | 6.6075 | 1589: Space Situational Awareness | Miscellaneous |
| 8 | 6.4755 | 1595: Energy Storage to Enable Robust and Long Duration Operations on Moon and Mars | Power |
| 9 | 6.4489 | 1573: Terrain Mapping Capabilities for Precision Landing and Hazard Avoidance | Entry Descent and Landing |
| 10 | 6.4068 | 1591: Power Management Systems for Long Duration Lunar and Martian Missions | Power |
| 11 | 6.4021 | 1560: High-Rate Deep Space Communications | Communication and Navigation |

| Large Industry Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 12 | 6.3791 | 1626: Advanced Sensor Components: Imaging | Sensors and Instruments |
| 13 | 6.3733 | 1477: Mitigation of New Orbital Debris Generation | Orbital Debris |
| 14 | 6.3260 | 1603: Situational Awareness Sensors and Tools for Astronauts | Sensors and Instruments |
| 15 | 6.2559 | 1557: Position, Navigation, and Timing (PNT) for In-Orbit and Surface Applications | Communication and Navigation |
| 16 | 6.2515 | 1490: Additive Manufacturing for New and High-Performance Materials | Advanced Manufacturing |
| 17 | 6.2286 | 1588: Protect Earth from Destructive Natural Impacts (Planetary Defense) | Miscellaneous |
| 18 | 6.1957 | 1619: High temperature heat rejection for nuclear applications | Thermal Management Systems |
| 19 | 6.1646 | 498: Broad and dependable supply chain for space-qualified robotic hardware, electronics, and associated software | ISAM and RPOC |
| 20 | 6.1603 | 1578: Extraction and separation of water from extraterrestrial surface material | ISRU |
| 21 | 6.1401 | 1554: High Performance Onboard Computing to Enable Increasingly Complex Operations | Avionics |
| 22 | 6.0936 | 1527: Radiation Countermeasures (Crew and Habitat) | Advanced Habitation Systems |
| 23 | 6.0924 | 709: Nuclear Electric Propulsion for Human Exploration | Propulsion: Nuclear |
| 24 | 6.0606 | 1531: Autonomous Guidance and Navigation for Deep Space Missions | Autonomous Systems and Robotics |
| 25 | 6.0446 | 1583: Produce propellants and mission consumables from extracted in-situ resources | ISRU |
| 26 | 6.0276 | 1548: Sensing for Autonomous Robotic Operations in Challenging Environmental Conditions | Autonomous Systems and Robotics |
| 27 | 6.0256 | 1559: Deep Space Autonomous Navigation | Communication and Navigation |

| Large Industry Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 28 | 6.0238 | 1545: Robotic Actuation, Subsystem Components, and System Architectures for Long-Duration and Extreme Environment Operation | Autonomous Systems and Robotics |
| 29 | 6.0202 | 1558: High-Rate Communications Across The Lunar Surface | Communication and Navigation |
| 30 | 5.9973 | 1304: Robust, High-Progress-Rate, and Long-Distance Autonomous Surface Mobility | Autonomous Systems and Robotics |
| 31 | 5.9805 | 1538: General-Purpose Robotic Manipulation to Perform Human-Scale Logistics, Maintenance, Outfitting, and Utilization | Autonomous Systems and Robotics |
| 32 | 5.9466 | 1577: Perform resource reconnaissance to locate and characterize resources and estimate reserves | ISRU |
| 33 | 5.9459 | 1563: Aerocapture for Spacecraft Deceleration and Orbit Insertion | Entry Descent and Landing |
| 34 | 5.9263 | 1483: Enable commercially-provided Rendezvous, Proximity Operations, and Capture (RPOC) products and services | ISAM and RPOC |
| 35 | 5.8979 | 1476: Remediation of Large Debris | Orbital Debris |
| 36 | 5.8501 | 702: Nuclear Thermal Propulsion for Human Exploration | Propulsion: Nuclear |
| 37 | 5.8329 | 1571: Navigation Sensors for Precision Landing | Entry Descent and Landing |
| 38 | 5.8076 | 755: Cross-Discipline Cryogenic Fluid Management Technologies | Cryogenic Fluid Management |
| 39 | 5.8044 | 1226: Cryogenic Liquefaction | Cryogenic Fluid Management |
| 40 | 5.7428 | 1047: Active Dust Mitigation Technologies for Diverse Applications | Dust Mitigation |
| 41 | 5.7183 | 1526: Radiation Monitoring and Modeling (Crew and Habitat) | Advanced Habitation Systems |
| 42 | 5.7031 | 1534: Autonomous Robotics for Sustained In-Space Manufacturing Operations | Autonomous Systems and Robotics |

| Large Industry Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 43 | 5.6990 | 1485: In-Space and On-Surface Manufacturing of Parts/Products from Surface and Terrestrial Feedstocks | Advanced Manufacturing |
| 44 | 5.6705 | 1592: High Power, Long Distance Energy Transmission Across Distributed Surface Assets | Power |
| 45 | 5.6565 | 1562: Advanced Algorithms and Computing for Precision Landing | Entry Descent and Landing |
| 46 | 5.6416 | 844: Passive Dust Mitigation Technologies for Diverse Applications | Dust Mitigation |
| 47 | 5.6272 | 1546: Robotic Mobile Manipulation for Autonomous Large-Scale Logistics, Payload Handling, and Surface Transport | Autonomous Systems and Robotics |
| 48 | 5.6187 | 1569: High-Mass Mars Entry and Descent Systems | Entry Descent and Landing |
| 49 | 5.5638 | 1624: Advanced thermal management technologies for diverse applications | Thermal Management Systems |
| 50 | 5.5585 | 1570: Lander Capabilities for Soft Touchdown | Entry Descent and Landing |
| 51 | 5.5486 | 1540: Intelligent Robots for the Servicing, Assembly, and Outfitting of In-Space Assets and Industrial-Scale Surface Infrastructure | Autonomous Systems and Robotics |
| 52 | 5.5457 | 1542: Metrics and Processes for Establishing Trust and Certifying the Trustworthiness of Autonomous Systems | Autonomous Systems and Robotics |
| 53 | 5.5230 | 1553: Foundational Technologies for Future Avionics Devices and Systems | Avionics |
| 54 | 5.5144 | 1586: Enhanced Access to Orbital and Suborbital Space for Flight Demonstration and Test | Miscellaneous |
| 55 | 5.5098 | 662: Robotic regolith manipulation and site preparation | Excavation Construction and Outfitting |
| 56 | 5.4726 | 1565: Assessment and Validation Capabilities for Integrated Precision Landing Systems | Entry Descent and Landing |
| 57 | 5.4260 | 512: Cooperative interfaces, aids, and standards | ISAM and RPOC |

| Large Industry Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 58 | 5.4073 | 705: Low Power Nuclear Electric Propulsion | Propulsion: Nuclear |
| 59 | 5.3916 | 369: Excavation of granular (surface) regolith for ISRU commodities production | Excavation Construction and Outfitting |
| 60 | 5.3905 | 1514: Atmospheric Metabolic Constituent Management for Habitation | Advanced Habitation Systems |
| 61 | 5.3895 | 1506: In-Space & Surface Transfer of High-Pressure Gases | ISAM and RPOC |
| 62 | 5.3771 | 1262: Remediation of Small Debris | Orbital Debris |
| 63 | 5.3463 | 1432: Rendezvous, Proximity Operations, and Debris Remediation using Small Spacecraft | Small Spacecraft |
| 64 | 5.3424 | 1488: Additive Manufacturing for Propulsion | Advanced Manufacturing |
| 65 | 5.3213 | 1617: Autonomous on-surface maintenance and repair for sustained lunar evolution | Surface Systems |
| 66 | 5.3134 | 1555: Next Generation Avionics Architectures | Avionics |
| 67 | 5.3025 | 1491: Additive Manufacturing of Large-Scale Components | Advanced Manufacturing |
| 68 | 5.3020 | 1436: Efficient and Safe Higher Power Systems for Small Spacecraft | Small Spacecraft |
| 69 | 5.2938 | 1580: Extraction and separation of oxygen from extraterrestrial minerals | ISRU |
| 70 | 5.2849 | 1622: Novel thermal technologies to improve environmental control of habitats | Thermal Management Systems |
| 71 | 5.2805 | 1438: Autonomy, Edge Computation, and Interoperable Networking for Small Spacecraft | Small Spacecraft |
| 72 | 5.2581 | 1519: Environmental Monitoring for Habitation | Advanced Habitation Systems |
| 73 | 5.2570 | 1433: Position, Navigation, and Timing for Small Spacecraft | Small Spacecraft |

| Large Industry Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 74 | 5.2355 | 1566: Characterization of Plume Surface Interaction | Entry Descent and Landing |
| 75 | 5.2163 | 384: Excavation of hard/compacted/icy material | Excavation Construction and Outfitting |
| 76 | 5.1893 | 1568: Entry Modeling and Simulation for EDL Missions | Entry Descent and Landing |
| 77 | 5.1833 | 1194: Prediction Modeling of Cryogenic Fluid Dynamics and Operations | Cryogenic Fluid Management |
| 78 | 5.1645 | 1520: Fire Safety for Habitation | Advanced Habitation Systems |
| 79 | 5.1580 | 1535: Autonomous Vehicle, System, Habitat, and Infrastructure Health Monitoring and Management | Autonomous Systems and Robotics |
| 80 | 5.1272 | 513: Robotic Assembly and Construction of Modular Systems for Sustained In-Space Infrastructure | ISAM and RPOC |
| 81 | 5.1230 | 1572: Performance-Optimized Low-Cost Aeroshells for EDL Missions | Entry Descent and Landing |
| 82 | 5.1104 | 376: Modular design for in-space installation | ISAM and RPOC |
| 83 | 5.1004 | 1224: In-Space & Surface Transfer of Earth Storable Propellants | Propulsion: Non Nuclear |
| 84 | 5.0946 | 1434: Communication Technology and Capabilities for Small Spacecraft | Small Spacecraft |
| 85 | 5.0867 | 425: On-Surface In-situ Construction of Vertical Structures | Excavation Construction and Outfitting |
| 86 | 5.0326 | 1543: Multi-Agent Robotic Coordination and Interoperability for Cooperative Task Planning and Performance | Autonomous Systems and Robotics |
| 87 | 5.0222 | 1336: Robotic Mobility for Robust, Repeatable Access To and Through Extreme Terrain, Surface Topography, and Harsh Environmental Conditions | Autonomous Systems and Robotics |
| 88 | 5.0085 | 610: Solar Electric Propulsion - High Specific Impulse | Propulsion: Non Nuclear |

| Large Industry Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 89 | 4.9989 | 1431: Access Beyond LEO for Small Spacecraft | Small Spacecraft |
| 90 | 4.9935 | 1582: Extraction and separation of metals/metalloids from extraterrestrial minerals | ISRU |
| 91 | 4.9809 | 1523: Earth Independent Human Operations within Habitat Elements | Advanced Habitation Systems |
| 92 | 4.9788 | 1390: Power and Data Transfer in Dusty Environments | Power |
| 93 | 4.9702 | 1533: Autonomous Robotic Sample Identification, Classification, Collection, Manipulation, Verification, and Transport | Autonomous Systems and Robotics |
| 94 | 4.9677 | 1524: Crew Medical Care for Mars and Sustained Lunar | Advanced Habitation Systems |
| 95 | 4.9664 | 680: Robust Robotic Intelligence for High-Tempo Autonomous Operations in Dynamic Mission Conditions | Autonomous Systems and Robotics |
| 96 | 4.9624 | 385: Regolith and resource delivery system | Excavation Construction and Outfitting |
| 97 | 4.9594 | 1495: Advanced Manufacturing for Improved Dimensional Control of Large-Scale Space Structures | Advanced Manufacturing |
| 98 | 4.9538 | 1551: Distributed Avionics to Enable Improved Performance and SWaP Efficiency | Avionics |
| 99 | 4.9436 | 1579: Extraction and separation of non-water volatile resources from Lunar regolith | ISRU |
| 100 | 4.9326 | 1561: Advanced Modeling and Test Capabilities to Characterize Dust Effects on Hardware | Dust Mitigation |
| 101 | 4.9155 | 1575: Thermal and Vibrational Isolation for Ultra-stable Science Payloads | Advanced Materials and Structures |
| 102 | 4.9117 | 1615: Common tools for on-surface maintenance and repair for reduced crew interaction | Surface Systems |
| 103 | 4.9063 | 1585: Extraterrestrial surface environmental simulators, test facilities, and test sites | ISRU |

| Large Industry Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 104 | 4.8911 | 617: On-surface robotic assembly of vertical structures | Excavation Construction and Outfitting |
| 104 | 4.8911 | 1400: On-surface robotic assembly of horizontal structures | Excavation Construction and Outfitting |
| 106 | 4.8835 | 1408: Advanced deployable load-bearing structures | Advanced Materials and Structures |
| 107 | 4.8667 | 1576: Micrometeoroid-Robust Protection of In-space Observatories | Advanced Materials and Structures |
| 108 | 4.8549 | 1437: Dynamic and Capable Thermal Control for Small Spacecraft | Small Spacecraft |
| 109 | 4.8533 | 1602: 3D/3D+ Imaging and Tomography of Complex Features and Dynamical Processes | Sensors and Instruments |
| 110 | 4.8504 | 1487: In-Space and On-Surface Welding Technologies for Manufacturing, Assembly, and Construction | Advanced Manufacturing |
| 111 | 4.8495 | 1529: EVA and IVA Suit System Capabilities for Mars Missions | Advanced Habitation Systems |
| 112 | 4.8345 | 1584: Produce manufacturing and construction feedstock from extracted in-situ resources | ISRU |
| 113 | 4.8313 | 379: Upgrade or Install Instruments on Large Space Observatories | ISAM and RPOC |
| 114 | 4.8268 | 611: Sub-kW and kW Class Electric Propulsion Systems | Propulsion: Non Nuclear |
| 115 | 4.8211 | 1541: Intuitive and Efficient Human-Robot Interaction for Safe Teaming and Remote Supervisory Control | Autonomous Systems and Robotics |
| 116 | 4.8006 | 1525: Food and Nutrition for Mars and Sustained Lunar | Advanced Habitation Systems |
| 117 | 4.7865 | 1593: Lunar Surface Power Generation from ISRU Derived Resources | Power |
| 118 | 4.7832 | 1610: Surface-based food management for sustained lunar evolution | Surface Systems |

| Large Industry Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 119 | 4.7801 | 1492: Materials and Process Modeling for In-Space and On-Surface Manufacturing | Advanced Manufacturing |
| 120 | 4.7671 | 1537: Free-Flying Systems for Robotic Inspection, Data Collection, and Servicing of In-Space Assets | Autonomous Systems and Robotics |
| 121 | 4.7634 | 767: Advanced designs for lightweight inflatable surface elements | Advanced Materials and Structures |
| 122 | 4.7580 | 1616: Dissipation of electrical charge on surface assets | Surface Systems |
| 123 | 4.7486 | 1623: Advanced thermal modeling capabilities | Thermal Management Systems |
| 124 | 4.7339 | 1532: Autonomous Planning, Scheduling, and Decision-Support to Enable Sustained Earth-Independent Missions | Autonomous Systems and Robotics |
| 125 | 4.7263 | 1608: Surface-based lunar logistics management for near/mid-term missions | Surface Systems |
| 126 | 4.7233 | 1489: In-Space and On-Surface Manufacturing from Recycled and Reused Materials and Components | Advanced Manufacturing |
| 127 | 4.7039 | 1516: Water and Dormancy Management for Habitation | Advanced Habitation Systems |
| 128 | 4.6983 | 1581: Extraction and separation of extraterrestrial atmospheric resources and gaseous products/reactants | ISRU |
| 129 | 4.6964 | 1496: In-Space and On-Surface Manufacturing, Assembly, and Repair of Composite Structures | Advanced Manufacturing |
| 130 | 4.6948 | 1627: Advanced Sensor Components for Heliophysics and Lunar-Based Astronomy | Sensors and Instruments |
| 131 | 4.6562 | 707: Transformational Advanced Energetic Propulsion (AEP) | Propulsion: Non Nuclear |
| 132 | 4.6347 | 1511: Advanced Computational Fluid Dynamics Tools / Capabilities | Propulsion: Non Nuclear |
| 133 | 4.6229 | 1494: Digital Transformation Technologies for Terrestrial, In-Space, On-Surface Manufacturing, and Operations | Advanced Manufacturing |

| Large Industry Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 134 | 4.6141 | 1486: In-Space and On-Surface NDE and Qualification of Components for Manufacturing, Assembly, and Construction | Advanced Manufacturing |
| 135 | 4.5926 | 1612: Surface-based fluid management for near/mid-term missions | Surface Systems |
| 136 | 4.5867 | 581: ISRU System Modeling | ISRU |
| 137 | 4.5760 | 1613: Surface-based fluid management for sustained lunar evolution | Surface Systems |
| 138 | 4.5703 | 1539: Intelligent Robotic Systems for Crew Health and Performance During Long-Duration Missions | Autonomous Systems and Robotics |
| 139 | 4.5465 | 1609: Surface-based lunar logistics management for sustained lunar evolution | Surface Systems |
| 140 | 4.5335 | 1138: In-Space Transfer of Electric Propulsion Propellant | ISAM and RPOC |
| 141 | 4.5181 | 1517: Metabolic Waste Management for Habitation | Advanced Habitation Systems |
| 142 | 4.5055 | 1567: Entry Capabilities for Small-Scale and Commercial Spacecraft | Entry Descent and Landing |
| 143 | 4.5025 | 361: Surface Mating Mechanisms | ISAM and RPOC |
| 144 | 4.4830 | 1621: Cryogenic cooling for science instrumentation | Thermal Management Systems |
| 145 | 4.4765 | 1549: Advanced Data Acquisition Systems for Diverse Applications | Avionics |
| 146 | 4.4273 | 1598: Quantum Sensors That Use Photons | Sensors and Instruments |
| 147 | 4.4091 | 1600: Enable Paradigm for System Science to Include Interactions Between Subsystems | Sensors and Instruments |
| 148 | 4.3946 | 1522: Crew Health Countermeasures – Non-Exercise | Advanced Habitation Systems |
| 149 | 4.3927 | 1521: Crew Exercise and Sensorimotor Countermeasures | Advanced Habitation Systems |

| Large Industry Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 150 | 4.3650 | 1590: Planetary Protection | Miscellaneous |
| 151 | 4.3031 | 1430: Small Spacecraft Propulsion | Small Spacecraft |
| 152 | 4.2953 | 544: Solar Electric Propulsion to Support Orbital Platforms | Propulsion: Non Nuclear |
| 153 | 4.2921 | 1594: Martian Surface Power Generation from ISRU Derived Resources | Power |
| 154 | 4.2778 | 1620: Conditioned stowage to maintain science and/or nutritional integrity | Thermal Management Systems |
| 155 | 4.2657 | 1480: On-surface Outfitting of Lunar Structures | Excavation Construction and Outfitting |
| 156 | 4.2354 | 1601: Enable Observation of Whole Top-to-Bottom Dynamic Ecosystems | Sensors and Instruments |
| 157 | 4.2296 | 1528: Spacesuit Physiology | Advanced Habitation Systems |
| 158 | 4.2177 | 1599: Quantum Sensors That Use Atoms, Ions, and Spins | Sensors and Instruments |
| 159 | 4.2118 | 672: Long-life thermal control for surface suits capable of extreme access | Thermal Management Systems |
| 160 | 4.2013 | 666: On-Surface In-situ Construction of Horizontal Structures | Excavation Construction and Outfitting |
| 161 | 4.1804 | 1564: Aeroshell In-Situ Flight Performance Data During EDL | Entry Descent and Landing |
| 162 | 4.1721 | 1493: Computational Materials-Informed Qualification and Certification for In-Space and On-Surface Manufacturing | Advanced Manufacturing |
| 163 | 4.1482 | 1604: Find, Study Habitable Zone Earth-like Exoplanets and Search for Biosignatures | Sensors and Instruments |
| 164 | 4.1371 | 1530: Aerial Robotic Mobility and Onboard Intelligence for Expanded Capabilities on Mars, Venus, and Titan | Autonomous Systems and Robotics |

| Large Industry Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 165 | 4.1301 | 1625: Intelligent Multi-Agent Constellations for Cooperative Operations | Autonomous Systems and Robotics |
| 166 | 4.0892 | 1605: Peer Back Farther in Time to the Early Universe | Sensors and Instruments |
| 167 | 4.0682 | 1544: Resilient Agency: Adaptable Intelligence and Robust Online Learning for Long-Duration and Dynamic Missions | Autonomous Systems and Robotics |
| 168 | 4.0516 | 1550: Crew Audio/Visual Interfaces for Long Duration Missions Beyond LEO | Avionics |
| 169 | 4.0196 | 1614: Surface-based planning and scheduling technologies for sustained lunar evolution | Surface Systems |
| 170 | 3.9572 | 612: In-Space Diagnostics for Electric Propulsion | Propulsion: Non Nuclear |
| 171 | 3.9153 | 1221: Mars Ascent Vehicle Propulsion | Propulsion: Non Nuclear |
| 172 | 3.8727 | 1515: Atmospheric Non-Metabolic Constituent Management for Habitation | Advanced Habitation Systems |
| 173 | 3.8681 | 703: Rotating Detonation Rocket Engine (RDRE) | Propulsion: Non Nuclear |
| 174 | 3.8583 | 1574: Validated Performance Models for Planetary Parachutes | Entry Descent and Landing |
| 175 | 3.8031 | 1547: Robotic Systems for Sub-Surface Access | Autonomous Systems and Robotics |
| 176 | 3.7916 | 700: Solar Sails for Propellant-less Propulsion | Propulsion: Non Nuclear |
| 177 | 3.7762 | 1611: Surface-based end-of-life equipment management | Surface Systems |
| 178 | 3.7432 | 701: Green Propellant Propulsion Systems | Propulsion: Non Nuclear |
| 179 | 3.6746 | 1518: Logistics Tracking, Clothing, and Trash Management for Habitation | Advanced Habitation Systems |

| Large Industry Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 180 | 3.6395 | 1607: Detect New Astronomical Messenger - Gravitational Waves | Sensors and Instruments |
| 181 | 3.6085 | 1587: Wildfire Integrated Effect Chain | Miscellaneous |
| 182 | 3.5347 | 696: Enable Storable Propulsion Systems in Low Temperature Environments | Propulsion: Non Nuclear |
| 183 | 3.4835 | 1536: Free-Flying Mobility Aids for Crew EVA | Autonomous Systems and Robotics |
| 184 | 3.4710 | 1512: Modern Solid Motor Design and Analysis Tools / Capabilities | Propulsion: Non Nuclear |
| 185 | 3.4593 | 1513: Advanced Solid Propulsion Systems | Propulsion: Non Nuclear |
| 186 | 3.3417 | 1606: Observe Some of the Most Energetic Phenomena in the Universe | Sensors and Instruments |
| 187 | 3.2462 | 1052: EVA/IVA Support Propulsion Development | Propulsion: Non Nuclear |

# Stakeholder Group Ranked List: Small Industry

The Small Industry ranked shortfall list used the average shortfall scores from responses affiliated with companies that employ 500 or fewer people. Several shortfalls ranked equally.

| Small Industry Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 1 | 7.3621 | 1596: High Power Energy Generation on Moon and Mars Surfaces | Power |
| 2 | 7.2606 | 1618: Survive and operate through the lunar night | Thermal Management Systems |
| 3 | 7.1754 | 1578: Extraction and separation of water from extraterrestrial surface material | ISRU |
| 4 | 7.0363 | 1595: Energy Storage to Enable Robust and Long Duration Operations on Moon and Mars | Power |
| 5 | 6.9202 | 1583: Produce propellants and mission consumables from extracted in-situ resources | ISRU |
| 6 | 6.8647 | 1477: Mitigation of New Orbital Debris Generation | Orbital Debris |
| 7 | 6.8328 | 1580: Extraction and separation of oxygen from extraterrestrial minerals | ISRU |
| 8 | 6.7945 | 498: Broad and dependable supply chain for space-qualified robotic hardware, electronics, and associated software | ISAM and RPOC |
| 9 | 6.6742 | 1577: Perform resource reconnaissance to locate and characterize resources and estimate reserves | ISRU |
| 10 | 6.6712 | 1586: Enhanced Access to Orbital and Suborbital Space for Flight Demonstration and Test | Miscellaneous |
| 11 | 6.6184 | 1557: Position, Navigation, and Timing (PNT) for In-Orbit and Surface Applications | Communication and Navigation |
| 12 | 6.5346 | 1591: Power Management Systems for Long Duration Lunar and Martian Missions | Power |

| Small Industry Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 13 | 6.4506 | 1485: In-Space and On-Surface Manufacturing of Parts/Products from Surface and Terrestrial Feedstocks | Advanced Manufacturing |
| 14 | 6.4118 | 844: Passive Dust Mitigation Technologies for Diverse Applications | Dust Mitigation |
| 15 | 6.3929 | 1476: Remediation of Large Debris | Orbital Debris |
| 16 | 6.3875 | 1589: Space Situational Awareness | Miscellaneous |
| 17 | 6.3171 | 1548: Sensing for Autonomous Robotic Operations in Challenging Environmental Conditions | Autonomous Systems and Robotics |
| 18 | 6.3039 | 1432: Rendezvous, Proximity Operations, and Debris Remediation using Small Spacecraft | Small Spacecraft |
| 19 | 6.2404 | 1483: Enable commercially-provided Rendezvous, Proximity Operations, and Capture (RPOC) products and services | ISAM and RPOC |
| 20 | 6.2292 | 672: Long-life thermal control for surface suits capable of extreme access | Thermal Management Systems |
| 21 | 6.2273 | 1047: Active Dust Mitigation Technologies for Diverse Applications | Dust Mitigation |
| 22 | 6.2254 | 1584: Produce manufacturing and construction feedstock from extracted in-situ resources | ISRU |
| 23 | 6.2239 | 1527: Radiation Countermeasures (Crew and Habitat) | Advanced Habitation Systems |
| 24 | 6.1897 | 1520: Fire Safety for Habitation | Advanced Habitation Systems |
| 25 | 6.1875 | 1588: Protect Earth from Destructive Natural Impacts (Planetary Defense) | Miscellaneous |
| 26 | 6.1840 | 1597: Power for Non-Solar-Illuminated Small Systems | Power |
| 27 | 6.1750 | 1545: Robotic Actuation, Subsystem Components, and System Architectures for Long-Duration and Extreme Environment Operation | Autonomous Systems and Robotics |
| 28 | 6.1644 | 1554: High Performance Onboard Computing to Enable Increasingly Complex Operations | Avionics |

| Small Industry Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 29 | 6.1636 | 792: In-space and On-surface Transfer of Cryogenic Fluids | Cryogenic Fluid Management |
| 30 | 6.1538 | 1603: Situational Awareness Sensors and Tools for Astronauts | Sensors and Instruments |
| 31 | 6.1296 | 1573: Terrain Mapping Capabilities for Precision Landing and Hazard Avoidance | Entry Descent and Landing |
| 32 | 6.0000 | 1525: Food and Nutrition for Mars and Sustained Lunar | Advanced Habitation Systems |
| 32 | 6.0000 | 1480: On-surface Outfitting of Lunar Structures | Excavation Construction and Outfitting |
| 34 | 5.9861 | 1433: Position, Navigation, and Timing for Small Spacecraft | Small Spacecraft |
| 35 | 5.9848 | 512: Cooperative interfaces, aids, and standards | ISAM and RPOC |
| 36 | 5.9753 | 610: Solar Electric Propulsion - High Specific Impulse | Propulsion: Non Nuclear |
| 37 | 5.9711 | 879: In-space and On-surface, Long-duration Storage of Cryogenic Propellant | Cryogenic Fluid Management |
| 38 | 5.9561 | 1619: High temperature heat rejection for nuclear applications | Thermal Management Systems |
| 39 | 5.9296 | 1592: High Power, Long Distance Energy Transmission Across Distributed Surface Assets | Power |
| 40 | 5.9091 | 666: On-Surface In-situ Construction of Horizontal Structures | Excavation Construction and Outfitting |
| 41 | 5.9067 | 1593: Lunar Surface Power Generation from ISRU Derived Resources | Power |
| 42 | 5.8903 | 1304: Robust, High-Progress-Rate, and Long-Distance Autonomous Surface Mobility | Autonomous Systems and Robotics |
| 43 | 5.8852 | 1579: Extraction and separation of non-water volatile resources from Lunar regolith | ISRU |

| Small Industry Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 44 | 5.8842 | 544: Solar Electric Propulsion to Support Orbital Platforms | Propulsion: Non Nuclear |
| 45 | 5.8810 | 1262: Remediation of Small Debris | Orbital Debris |
| 46 | 5.8795 | 1540: Intelligent Robots for the Servicing, Assembly, and Outfitting of In-Space Assets and Industrial-Scale Surface Infrastructure | Autonomous Systems and Robotics |
| 47 | 5.8788 | 1624: Advanced thermal management technologies for diverse applications | Thermal Management Systems |
| 48 | 5.8719 | 369: Excavation of granular (surface) regolith for ISRU commodities production | Excavation Construction and Outfitting |
| 49 | 5.8571 | 1552: Extreme Environment Avionics | Avionics |
| 50 | 5.8553 | 1560: High-Rate Deep Space Communications | Communication and Navigation |
| 51 | 5.8481 | 1336: Robotic Mobility for Robust, Repeatable Access To and Through Extreme Terrain, Surface Topography, and Harsh Environmental Conditions | Autonomous Systems and Robotics |
| 52 | 5.8375 | 1538: General-Purpose Robotic Manipulation to Perform Human-Scale Logistics, Maintenance, Outfitting, and Utilization | Autonomous Systems and Robotics |
| 53 | 5.8308 | 1526: Radiation Monitoring and Modeling (Crew and Habitat) | Advanced Habitation Systems |
| 54 | 5.8182 | 513: Robotic Assembly and Construction of Modular Systems for Sustained In-Space Infrastructure | ISAM and RPOC |
| 55 | 5.8161 | 1582: Extraction and separation of metals/metalloids from extraterrestrial minerals | ISRU |
| 56 | 5.8118 | 1585: Extraterrestrial surface environmental simulators, test facilities, and test sites | ISRU |
| 57 | 5.8070 | 1617: Autonomous on-surface maintenance and repair for sustained lunar evolution | Surface Systems |
| 58 | 5.8030 | 617: On-surface robotic assembly of vertical structures | Excavation Construction and Outfitting |

| Small Industry Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 58 | 5.8030 | 1400: On-surface robotic assembly of horizontal structures | Excavation Construction and Outfitting |
| 60 | 5.7929 | 376: Modular design for in-space installation | ISAM and RPOC |
| 61 | 5.7895 | 581: ISRU System Modeling | ISRU |
| 62 | 5.7885 | 1571: Navigation Sensors for Precision Landing | Entry Descent and Landing |
| 63 | 5.7818 | 662: Robotic regolith manipulation and site preparation | Excavation Construction and Outfitting |
| 64 | 5.7797 | 1524: Crew Medical Care for Mars and Sustained Lunar | Advanced Habitation Systems |
| 65 | 5.7778 | 1562: Advanced Algorithms and Computing for Precision Landing | Entry Descent and Landing |
| 66 | 5.7656 | 1390: Power and Data Transfer in Dusty Environments | Power |
| 67 | 5.7500 | 1531: Autonomous Guidance and Navigation for Deep Space Missions | Autonomous Systems and Robotics |
| 68 | 5.7321 | 1622: Novel thermal technologies to improve environmental control of habitats | Thermal Management Systems |
| 69 | 5.73134 | 425: On-Surface In-situ Construction of Vertical Structures | Excavation Construction and Outfitting |
| 70 | 5.73125 | 1486: In-Space and On-Surface NDE and Qualification of Components for Manufacturing, Assembly, and Construction | Advanced Manufacturing |
| 71 | 5.7302 | 1436: Efficient and Safe Higher Power Systems for Small Spacecraft | Small Spacecraft |
| 72 | 5.7164 | 1434: Communication Technology and Capabilities for Small Spacecraft | Small Spacecraft |
| 73 | 5.6933 | 1558: High-Rate Communications Across The Lunar Surface | Communication and Navigation |

| Small Industry Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 74 | 5.6912 | 385: Regolith and resource delivery system | Excavation Construction and Outfitting |
| 75 | 5.6901 | 1626: Advanced Sensor Components: Imaging | Sensors and Instruments |
| 76 | 5.6875 | 1566: Characterization of Plume Surface Interaction | Entry Descent and Landing |
| 77 | 5.6563 | 1561: Advanced Modeling and Test Capabilities to Characterize Dust Effects on Hardware | Dust Mitigation |
| 78 | 5.6557 | 1616: Dissipation of electrical charge on surface assets | Surface Systems |
| 79 | 5.6250 | 1528: Spacesuit Physiology | Advanced Habitation Systems |
| 80 | 5.6041 | 1431: Access Beyond LEO for Small Spacecraft | Small Spacecraft |
| 81 | 5.6024 | 1546: Robotic Mobile Manipulation for Autonomous Large-Scale Logistics, Payload Handling, and Surface Transport | Autonomous Systems and Robotics |
| 82 | 5.5871 | 1490: Additive Manufacturing for New and High-Performance Materials | Advanced Manufacturing |
| 83 | 5.5818 | 1570: Lander Capabilities for Soft Touchdown | Entry Descent and Landing |
| 84 | 5.5528 | 1138: In-Space Transfer of Electric Propulsion Propellant | ISAM and RPOC |
| 85 | 5.5471 | 1226: Cryogenic Liquefaction | Cryogenic Fluid Management |
| 86 | 5.5091 | 1567: Entry Capabilities for Small-Scale and Commercial Spacecraft | Entry Descent and Landing |
| 87 | 5.5079 | 1615: Common tools for on-surface maintenance and repair for reduced crew interaction | Surface Systems |
| 88 | 5.4906 | 1599: Quantum Sensors That Use Atoms, Ions, and Spins | Sensors and Instruments |
| 89 | 5.4810 | 755: Cross-Discipline Cryogenic Fluid Management Technologies | Cryogenic Fluid Management |

| Small Industry Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 90 | 5.4709 | 384: Excavation of hard/compacted/icy material | Excavation Construction and Outfitting |
| 91 | 5.4255 | 1565: Assessment and Validation Capabilities for Integrated Precision Landing Systems | Entry Descent and Landing |
| 92 | 5.4194 | 1438: Autonomy, Edge Computation, and Interoperable Networking for Small Spacecraft | Small Spacecraft |
| 93 | 5.4177 | 1489: In-Space and On-Surface Manufacturing from Recycled and Reused Materials and Components | Advanced Manufacturing |
| 94 | 5.4156 | 1487: In-Space and On-Surface Welding Technologies for Manufacturing, Assembly, and Construction | Advanced Manufacturing |
| 95 | 5.4024 | 1534: Autonomous Robotics for Sustained In-Space Manufacturing Operations | Autonomous Systems and Robotics |
| 96 | 5.4000 | 1551: Distributed Avionics to Enable Improved Performance and SWaP Efficiency | Avionics |
| 96 | 5.4000 | 1601: Enable Observation of Whole Top-to-Bottom Dynamic Ecosystems | Sensors and Instruments |
| 98 | 5.3966 | 1516: Water and Dormancy Management for Habitation | Advanced Habitation Systems |
| 99 | 5.3842 | 361: Surface Mating Mechanisms | ISAM and RPOC |
| 100 | 5.3810 | 1608: Surface-based lunar logistics management for near/mid-term missions | Surface Systems |
| 101 | 5.3793 | 1519: Environmental Monitoring for Habitation | Advanced Habitation Systems |
| 102 | 5.3750 | 1541: Intuitive and Efficient Human-Robot Interaction for Safe Teaming and Remote Supervisory Control | Autonomous Systems and Robotics |
| 103 | 5.3725 | 696: Enable Storable Propulsion Systems in Low Temperature Environments | Propulsion: Non Nuclear |
| 104 | 5.3678 | 611: Sub-kW and kW Class Electric Propulsion Systems | Propulsion: Non Nuclear |
| 105 | 5.3604 | 1590: Planetary Protection | Miscellaneous |

| Small Industry Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 106 | 5.3585 | 1623: Advanced thermal modeling capabilities | Thermal Management Systems |
| 107 | 5.3525 | 1581: Extraction and separation of extraterrestrial atmospheric resources and gaseous products/reactants | ISRU |
| 108 | 5.3443 | 1549: Advanced Data Acquisition Systems for Diverse Applications | Avionics |
| 109 | 5.3438 | 1609: Surface-based lunar logistics management for sustained lunar evolution | Surface Systems |
| 110 | 5.3333 | 1514: Atmospheric Metabolic Constituent Management for Habitation | Advanced Habitation Systems |
| 111 | 5.3231 | 1437: Dynamic and Capable Thermal Control for Small Spacecraft | Small Spacecraft |
| 112 | 5.3145 | 1224: In-Space & Surface Transfer of Earth Storable Propellants | Propulsion: Non Nuclear |
| 113 | 5.2927 | 1543: Multi-Agent Robotic Coordination and Interoperability for Cooperative Task Planning and Performance | Autonomous Systems and Robotics |
| 114 | 5.2851 | 702: Nuclear Thermal Propulsion for Human Exploration | Propulsion: Nuclear |
| 115 | 5.2727 | 1568: Entry Modeling and Simulation for EDL Missions | Entry Descent and Landing |
| 116 | 5.2714 | 1430: Small Spacecraft Propulsion | Small Spacecraft |
| 117 | 5.2625 | 680: Robust Robotic Intelligence for High-Tempo Autonomous Operations in Dynamic Mission Conditions | Autonomous Systems and Robotics |
| 118 | 5.2500 | 1542: Metrics and Processes for Establishing Trust and Certifying the Trustworthiness of Autonomous Systems | Autonomous Systems and Robotics |
| 118 | 5.2500 | 1576: Micrometeoroid-Robust Protection of In-space Observatories | Advanced Materials and Structures |
| 120 | 5.2459 | 1610: Surface-based food management for sustained lunar evolution | Surface Systems |
| 121 | 5.2351 | 1194: Prediction Modeling of Cryogenic Fluid Dynamics and Operations | Cryogenic Fluid Management |

| Small Industry Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 122 | 5.2281 | 1523: Earth Independent Human Operations within Habitat Elements | Advanced Habitation Systems |
| 123 | 5.2245 | 1563: Aerocapture for Spacecraft Deceleration and Orbit Insertion | Entry Descent and Landing |
| 124 | 5.2125 | 707: Transformational Advanced Energetic Propulsion (AEP) | Propulsion: Non Nuclear |
| 125 | 5.2037 | 1598: Quantum Sensors That Use Photons | Sensors and Instruments |
| 126 | 5.1818 | 1613: Surface-based fluid management for sustained lunar evolution | Surface Systems |
| 127 | 5.1810 | 1506: In-Space & Surface Transfer of High-Pressure Gases | ISAM and RPOC |
| 128 | 5.1719 | 1553: Foundational Technologies for Future Avionics Devices and Systems | Avionics |
| 129 | 5.1549 | 1559: Deep Space Autonomous Navigation | Communication and Navigation |
| 130 | 5.1538 | 1491: Additive Manufacturing of Large-Scale Components | Advanced Manufacturing |
| 131 | 5.1380 | 709: Nuclear Electric Propulsion for Human Exploration | Propulsion: Nuclear |
| 132 | 5.1373 | 1620: Conditioned stowage to maintain science and/or nutritional integrity | Thermal Management Systems |
| 133 | 5.1321 | 1517: Metabolic Waste Management for Habitation | Advanced Habitation Systems |
| 134 | 5.1020 | 1600: Enable Paradigm for System Science to Include Interactions Between Subsystems | Sensors and Instruments |
| 135 | 5.0926 | 1529: EVA and IVA Suit System Capabilities for Mars Missions | Advanced Habitation Systems |
| 136 | 5.0797 | 612: In-Space Diagnostics for Electric Propulsion | Propulsion: Non Nuclear |
| 137 | 5.0625 | 767: Advanced designs for lightweight inflatable surface elements | Advanced Materials and Structures |

| Small Industry Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 138 | 5.0526 | 1612: Surface-based fluid management for near/mid-term missions | Surface Systems |
| 139 | 5.0392 | 1621: Cryogenic cooling for science instrumentation | Thermal Management Systems |
| 140 | 5.0328 | 1555: Next Generation Avionics Architectures | Avionics |
| 141 | 5.0225 | 1533: Autonomous Robotic Sample Identification, Classification, Collection, Manipulation, Verification, and Transport | Autonomous Systems and Robotics |
| 142 | 5.0154 | 1408: Advanced deployable load-bearing structures | Advanced Materials and Structures |
| 143 | 5.0000 | 1537: Free-Flying Systems for Robotic Inspection, Data Collection, and Servicing of In-Space Assets | Autonomous Systems and Robotics |
| 143 | 5.0000 | 1515: Atmospheric Non-Metabolic Constituent Management for Habitation | Advanced Habitation Systems |
| 145 | 4.9867 | 1492: Materials and Process Modeling for In-Space and On-Surface Manufacturing | Advanced Manufacturing |
| 146 | 4.9855 | 1539: Intelligent Robotic Systems for Crew Health and Performance During Long-Duration Missions | Autonomous Systems and Robotics |
| 147 | 4.9459 | 1488: Additive Manufacturing for Propulsion | Advanced Manufacturing |
| 148 | 4.9403 | 1495: Advanced Manufacturing for Improved Dimensional Control of Large-Scale Space Structures | Advanced Manufacturing |
| 149 | 4.9388 | 1572: Performance-Optimized Low-Cost Aeroshells for EDL Missions | Entry Descent and Landing |
| 150 | 4.9375 | 1550: Crew Audio/Visual Interfaces for Long Duration Missions Beyond LEO | Avionics |
| 151 | 4.9245 | 1602: 3D/3D+ Imaging and Tomography of Complex Features and Dynamical Processes | Sensors and Instruments |
| 152 | 4.9167 | 1496: In-Space and On-Surface Manufacturing, Assembly, and Repair of Composite Structures | Advanced Manufacturing |
| 153 | 4.8910 | 1547: Robotic Systems for Sub-Surface Access | Autonomous Systems and Robotics |

| Small Industry Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 154 | 4.8806 | 1494: Digital Transformation Technologies for Terrestrial, In-Space, On-Surface Manufacturing, and Operations | Advanced Manufacturing |
| 155 | 4.8621 | 705: Low Power Nuclear Electric Propulsion | Propulsion: Nuclear |
| 156 | 4.8519 | 1569: High-Mass Mars Entry and Descent Systems | Entry Descent and Landing |
| 157 | 4.8197 | 1604: Find, Study Habitable Zone Earth-like Exoplanets and Search for Biosignatures | Sensors and Instruments |
| 158 | 4.7931 | 1627: Advanced Sensor Components for Heliophysics and Lunar-Based Astronomy | Sensors and Instruments |
| 159 | 4.7917 | 379: Upgrade or Install Instruments on Large Space Observatories | ISAM and RPOC |
| 160 | 4.7826 | 1564: Aeroshell In-Situ Flight Performance Data During EDL | Entry Descent and Landing |
| 161 | 4.7654 | 1594: Martian Surface Power Generation from ISRU Derived Resources | Power |
| 162 | 4.7241 | 1575: Thermal and Vibrational Isolation for Ultra-stable Science Payloads | Advanced Materials and Structures |
| 163 | 4.7021 | 1511: Advanced Computational Fluid Dynamics Tools / Capabilities | Propulsion: Non Nuclear |
| 164 | 4.6986 | 1221: Mars Ascent Vehicle Propulsion | Propulsion: Non Nuclear |
| 165 | 4.6761 | 1535: Autonomous Vehicle, System, Habitat, and Infrastructure Health Monitoring and Management | Autonomous Systems and Robotics |
| 166 | 4.6533 | 1625: Intelligent Multi-Agent Constellations for Cooperative Operations | Autonomous Systems and Robotics |
| 167 | 4.5893 | 1614: Surface-based planning and scheduling technologies for sustained lunar evolution | Surface Systems |
| 168 | 4.5690 | 1607: Detect New Astronomical Messenger - Gravitational Waves | Sensors and Instruments |
| 169 | 4.4426 | 1611: Surface-based end-of-life equipment management | Surface Systems |

| Small Industry Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 170 | 4.4348 | 1522: Crew Health Countermeasures – Non-Exercise | Advanced Habitation Systems |
| 171 | 4.4286 | 1493: Computational Materials-Informed Qualification and Certification for In-Space and On-Surface Manufacturing | Advanced Manufacturing |
| 172 | 4.4255 | 1574: Validated Performance Models for Planetary Parachutes | Entry Descent and Landing |
| 173 | 4.3571 | 1536: Free-Flying Mobility Aids for Crew EVA | Autonomous Systems and Robotics |
| 174 | 4.3514 | 1532: Autonomous Planning, Scheduling, and Decision-Support to Enable Sustained Earth-Independent Missions | Autonomous Systems and Robotics |
| 175 | 4.3465 | 700: Solar Sails for Propellant-less Propulsion | Propulsion: Non Nuclear |
| 176 | 4.3194 | 1530: Aerial Robotic Mobility and Onboard Intelligence for Expanded Capabilities on Mars, Venus, and Titan | Autonomous Systems and Robotics |
| 177 | 4.3190 | 701: Green Propellant Propulsion Systems | Propulsion: Non Nuclear |
| 178 | 4.3019 | 1521: Crew Exercise and Sensorimotor Countermeasures | Advanced Habitation Systems |
| 179 | 4.3000 | 1052: EVA/IVA Support Propulsion Development | Propulsion: Non Nuclear |
| 180 | 4.2181 | 703: Rotating Detonation Rocket Engine (RDRE) | Propulsion: Non Nuclear |
| 181 | 4.1786 | 1518: Logistics Tracking, Clothing, and Trash Management for Habitation | Advanced Habitation Systems |
| 182 | 4.1731 | 1606: Observe Some of the Most Energetic Phenomena in the Universe | Sensors and Instruments |
| 183 | 4.1707 | 1587: Wildfire Integrated Effect Chain | Miscellaneous |
| 184 | 4.1184 | 1544: Resilient Agency: Adaptable Intelligence and Robust Online Learning for Long-Duration and Dynamic Missions | Autonomous Systems and Robotics |

| Small Industry Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 185 | 4.0877 | 1605: Peer Back Farther in Time to the Early Universe | Sensors and Instruments |
| 186 | 3.9704 | 1513: Advanced Solid Propulsion Systems | Propulsion: Non Nuclear |
| 187 | 3.6364 | 1512: Modern Solid Motor Design and Analysis Tools / Capabilities | Propulsion: Non Nuclear |

# Stakeholder Group Ranked List: Other Government Agencies

The Other Government Agencies ranked shortfall list used the average shortfall scores from responses affiliated with U.S. government agencies other than NASA, including national security and civil space agencies. Several shortfalls ranked equally.

| OGA Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 1 | 7.6667 | 1524: Crew Medical Care for Mars and Sustained Lunar | Advanced Habitation Systems |
| 2 | 7.5000 | 1618: Survive and operate through the lunar night | Thermal Management Systems |
| 3 | 7.4242 | 1531: Autonomous Guidance and Navigation for Deep Space Missions | Autonomous Systems and Robotics |
| 4 | 7.3667 | 709: Nuclear Electric Propulsion for Human Exploration | Propulsion: Nuclear |
| 5 | 7.3333 | 1559: Deep Space Autonomous Navigation | Communication and Navigation |
| 6 | 7.2500 | 1527: Radiation Countermeasures (Crew and Habitat) | Advanced Habitation Systems |
| 7 | 7.2376 | 1589: Space Situational Awareness | Miscellaneous |
| 8 | 7.1190 | 1588: Protect Earth from Destructive Natural Impacts (Planetary Defense) | Miscellaneous |
| 9 | 7.0625 | 1477: Mitigation of New Orbital Debris Generation | Orbital Debris |
| 10 | 7.0455 | 1619: High temperature heat rejection for nuclear applications | Thermal Management Systems |
| 11 | 7.0033 | 498: Broad and dependable supply chain for space-qualified robotic hardware, electronics, and associated software | ISAM and RPOC |
| 12 | 7.0000 | 1520: Fire Safety for Habitation | Advanced Habitation Systems |
| 12 | 7.0000 | 1573: Terrain Mapping Capabilities for Precision Landing and Hazard Avoidance | Entry Descent and Landing |

| OGA Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 14 | 6.9697 | 702: Nuclear Thermal Propulsion for Human Exploration | Propulsion: Nuclear |
| 15 | 6.7619 | 1434: Communication Technology and Capabilities for Small Spacecraft | Small Spacecraft |
| 16 | 6.7273 | 707: Transformational Advanced Energetic Propulsion (AEP) | Propulsion: Non Nuclear |
| 17 | 6.7190 | 1542: Metrics and Processes for Establishing Trust and Certifying the Trustworthiness of Autonomous Systems | Autonomous Systems and Robotics |
| 18 | 6.6457 | 1590: Planetary Protection | Miscellaneous |
| 19 | 6.6410 | 1476: Remediation of Large Debris | Orbital Debris |
| 20 | 6.6364 | 1578: Extraction and separation of water from extraterrestrial surface material | ISRU |
| 21 | 6.5500 | 1580: Extraction and separation of oxygen from extraterrestrial minerals | ISRU |
| 22 | 6.4667 | 1438: Autonomy, Edge Computation, and Interoperable Networking for Small Spacecraft | Small Spacecraft |
| 23 | 6.4615 | 1571: Navigation Sensors for Precision Landing | Entry Descent and Landing |
| 23 | 6.4615 | 1562: Advanced Algorithms and Computing for Precision Landing | Entry Descent and Landing |
| 25 | 6.4444 | 1586: Enhanced Access to Orbital and Suborbital Space for Flight Demonstration and Test | Miscellaneous |
| 25 | 6.4444 | 1523: Earth Independent Human Operations within Habitat Elements | Advanced Habitation Systems |
| 27 | 6.4380 | 1554: High Performance Onboard Computing to Enable Increasingly Complex Operations | Avionics |
| 28 | 6.4167 | 705: Low Power Nuclear Electric Propulsion | Propulsion: Nuclear |
| 29 | 6.3560 | 1557: Position, Navigation, and Timing (PNT) for In-Orbit and Surface Applications | Communication and Navigation |
| 30 | 6.3333 | 1436: Efficient and Safe Higher Power Systems for Small Spacecraft | Small Spacecraft |
| 31 | 6.2727 | 1553: Foundational Technologies for Future Avionics Devices and Systems | Avionics |

| OGA Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 32 | 6.2619 | 610: Solar Electric Propulsion - High Specific Impulse | Propulsion: Non Nuclear |
| 33 | 6.2381 | 1560: High-Rate Deep Space Communications | Communication and Navigation |
| 34 | 6.1026 | 1430: Small Spacecraft Propulsion | Small Spacecraft |
| 35 | 6.1000 | 1535: Autonomous Vehicle, System, Habitat, and Infrastructure Health Monitoring and Management | Autonomous Systems and Robotics |
| 36 | 6.0952 | 1432: Rendezvous, Proximity Operations, and Debris Remediation using Small Spacecraft | Small Spacecraft |
| 37 | 6.0909 | 1532: Autonomous Planning, Scheduling, and Decision-Support to Enable Sustained Earth-Independent Missions | Autonomous Systems and Robotics |
| 38 | 6.0833 | 1552: Extreme Environment Avionics | Avionics |
| 39 | 6.0711 | 1597: Power for Non-Solar-Illuminated Small Systems | Power |
| 40 | 6.0167 | 1596: High Power Energy Generation on Moon and Mars Surfaces | Power |
| 41 | 6.0000 | 1525: Food and Nutrition for Mars and Sustained Lunar | Advanced Habitation Systems |
| 42 | 5.9667 | 1595: Energy Storage to Enable Robust and Long Duration Operations on Moon and Mars | Power |
| 43 | 5.9583 | 1262: Remediation of Small Debris | Orbital Debris |
| 44 | 5.9500 | 1581: Extraction and separation of extraterrestrial atmospheric resources and gaseous products/reactants | ISRU |
| 45 | 5.9497 | 1626: Advanced Sensor Components: Imaging | Sensors and Instruments |
| 46 | 5.8667 | 1551: Distributed Avionics to Enable Improved Performance and SWaP Efficiency | Avionics |
| 47 | 5.8492 | 1624: Advanced thermal management technologies for diverse applications | Thermal Management Systems |
| 48 | 5.8462 | 1587: Wildfire Integrated Effect Chain | Miscellaneous |
| 49 | 5.7692 | 376: Modular design for in-space installation | ISAM and RPOC |

| OGA Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 50 | 5.7500 | 1483: Enable commercially-provided Rendezvous, Proximity Operations, and Capture (RPOC) products and services | ISAM and RPOC |
| 51 | 5.7407 | 792: In-space and On-surface Transfer of Cryogenic Fluids | Cryogenic Fluid Management |
| 52 | 5.7333 | 1591: Power Management Systems for Long Duration Lunar and Martian Missions | Power |
| 53 | 5.7000 | 1616: Dissipation of electrical charge on surface assets | Surface Systems |
| 54 | 5.6923 | 1570: Lander Capabilities for Soft Touchdown | Entry Descent and Landing |
| 55 | 5.6695 | 1490: Additive Manufacturing for New and High-Performance Materials | Advanced Manufacturing |
| 56 | 5.6000 | 1433: Position, Navigation, and Timing for Small Spacecraft | Small Spacecraft |
| 57 | 5.5897 | 611: Sub-kW and kW Class Electric Propulsion Systems | Propulsion: Non Nuclear |
| 58 | 5.5833 | 1564: Aeroshell In-Situ Flight Performance Data During EDL | Entry Descent and Landing |
| 59 | 5.5556 | 512: Cooperative interfaces, aids, and standards | ISAM and RPOC |
| 60 | 5.5455 | 1584: Produce manufacturing and construction feedstock from extracted in-situ resources | ISRU |
| 60 | 5.5455 | 1568: Entry Modeling and Simulation for EDL Missions | Entry Descent and Landing |
| 62 | 5.5417 | 1604: Find, Study Habitable Zone Earth-like Exoplanets and Search for Biosignatures | Sensors and Instruments |
| 63 | 5.5385 | 1545: Robotic Actuation, Subsystem Components, and System Architectures for Long-Duration and Extreme Environment Operation | Autonomous Systems and Robotics |
| 64 | 5.5128 | 1437: Dynamic and Capable Thermal Control for Small Spacecraft | Small Spacecraft |
| 65 | 5.5000 | 1563: Aerocapture for Spacecraft Deceleration and Orbit Insertion | Entry Descent and Landing |

| OGA Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 66 | 5.4667 | 1583: Produce propellants and mission consumables from extracted in-situ resources | ISRU |
| 67 | 5.4545 | 672: Long-life thermal control for surface suits capable of extreme access | Thermal Management Systems |
| 68 | 5.4286 | 1491: Additive Manufacturing of Large-Scale Components | Advanced Manufacturing |
| 69 | 5.4167 | 1546: Robotic Mobile Manipulation for Autonomous Large-Scale Logistics, Payload Handling, and Surface Transport | Autonomous Systems and Robotics |
| 69 | 5.4167 | 1567: Entry Capabilities for Small-Scale and Commercial Spacecraft | Entry Descent and Landing |
| 69 | 5.4167 | 1511: Advanced Computational Fluid Dynamics Tools / Capabilities | Propulsion: Non Nuclear |
| 72 | 5.4000 | 1488: Additive Manufacturing for Propulsion | Advanced Manufacturing |
| 73 | 5.3636 | 1549: Advanced Data Acquisition Systems for Diverse Applications | Avionics |
| 74 | 5.3611 | 1572: Performance-Optimized Low-Cost Aeroshells for EDL Missions | Entry Descent and Landing |
| 75 | 5.3333 | 1519: Environmental Monitoring for Habitation | Advanced Habitation Systems |
| 76 | 5.3182 | 1582: Extraction and separation of metals/metalloids from extraterrestrial minerals | ISRU |
| 77 | 5.3030 | 1558: High-Rate Communications Across The Lunar Surface | Communication and Navigation |
| 78 | 5.3000 | 844: Passive Dust Mitigation Technologies for Diverse Applications | Dust Mitigation |
| 78 | 5.3000 | 1561: Advanced Modeling and Test Capabilities to Characterize Dust Effects on Hardware | Dust Mitigation |
| 80 | 5.2857 | 513: Robotic Assembly and Construction of Modular Systems for Sustained In-Space Infrastructure | ISAM and RPOC |
| 81 | 5.2222 | 1526: Radiation Monitoring and Modeling (Crew and Habitat) | Advanced Habitation Systems |

| OGA Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 82 | 5.2116 | 1623: Advanced thermal modeling capabilities | Thermal Management Systems |
| 83 | 5.2000 | 581: ISRU System Modeling | ISRU |
| 83 | 5.2000 | 1534: Autonomous Robotics for Sustained In-Space Manufacturing Operations | Autonomous Systems and Robotics |
| 83 | 5.2000 | 1537: Free-Flying Systems for Robotic Inspection, Data Collection, and Servicing of In-Space Assets | Autonomous Systems and Robotics |
| 86 | 5.1853 | 1625: Intelligent Multi-Agent Constellations for Cooperative Operations | Autonomous Systems and Robotics |
| 87 | 5.1818 | 1480: On-surface Outfitting of Lunar Structures | Excavation Construction and Outfitting |
| 87 | 5.1818 | 1496: In-Space and On-Surface Manufacturing, Assembly, and Repair of Composite Structures | Advanced Manufacturing |
| 89 | 5.1750 | 1599: Quantum Sensors That Use Atoms, Ions, and Spins | Sensors and Instruments |
| 90 | 5.1538 | 1548: Sensing for Autonomous Robotic Operations in Challenging Environmental Conditions | Autonomous Systems and Robotics |
| 91 | 5.1389 | 1487: In-Space and On-Surface Welding Technologies for Manufacturing, Assembly, and Construction | Advanced Manufacturing |
| 92 | 5.1212 | 1138: In-Space Transfer of Electric Propulsion Propellant | ISAM and RPOC |
| 93 | 5.0909 | 1555: Next Generation Avionics Architectures | Avionics |
| 94 | 5.0833 | 1566: Characterization of Plume Surface Interaction | Entry Descent and Landing |
| 95 | 5.0741 | 879: In-space and On-surface, Long-duration Storage of Cryogenic Propellant | Cryogenic Fluid Management |
| 96 | 5.0500 | 1605: Peer Back Farther in Time to the Early Universe | Sensors and Instruments |
| 97 | 5.0444 | 1431: Access Beyond LEO for Small Spacecraft | Small Spacecraft |
| 98 | 5.0256 | 1600: Enable Paradigm for System Science to Include Interactions Between Subsystems | Sensors and Instruments |

| OGA Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 99 | 5.0139 | 1390: Power and Data Transfer in Dusty Environments | Power |
| 100 | 5.0000 | 1538: General-Purpose Robotic Manipulation to Perform Human-Scale Logistics, Maintenance, Outfitting, and Utilization | Autonomous Systems and Robotics |
| 100 | 5.0000 | 1565: Assessment and Validation Capabilities for Integrated Precision Landing Systems | Entry Descent and Landing |
| 100 | 5.0000 | 1489: In-Space and On-Surface Manufacturing from Recycled and Reused Materials and Components | Advanced Manufacturing |
| 100 | 5.0000 | 1514: Atmospheric Metabolic Constituent Management for Habitation | Advanced Habitation Systems |
| 104 | 4.9972 | 1495: Advanced Manufacturing for Improved Dimensional Control of Large-Scale Space Structures | Advanced Manufacturing |
| 105 | 4.9545 | 1577: Perform resource reconnaissance to locate and characterize resources and estimate reserves | ISRU |
| 106 | 4.9167 | 1543: Multi-Agent Robotic Coordination and Interoperability for Cooperative Task Planning and Performance | Autonomous Systems and Robotics |
| 106 | 4.9167 | 1607: Detect New Astronomical Messenger - Gravitational Waves | Sensors and Instruments |
| 106 | 4.9167 | 1574: Validated Performance Models for Planetary Parachutes | Entry Descent and Landing |
| 109 | 4.9091 | 1224: In-Space & Surface Transfer of Earth Storable Propellants | Propulsion: Non Nuclear |
| 110 | 4.8889 | 1610: Surface-based food management for sustained lunar evolution | Surface Systems |
| 111 | 4.8750 | 1603: Situational Awareness Sensors and Tools for Astronauts | Sensors and Instruments |
| 112 | 4.8485 | 1598: Quantum Sensors That Use Photons | Sensors and Instruments |
| 113 | 4.8462 | 1513: Advanced Solid Propulsion Systems | Propulsion: Non Nuclear |
| 114 | 4.8333 | 1606: Observe Some of the Most Energetic Phenomena in the Universe | Sensors and Instruments |

| OGA Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 115 | 4.8182 | 1047: Active Dust Mitigation Technologies for Diverse Applications | Dust Mitigation |
| 116 | 4.8000 | 1506: In-Space & Surface Transfer of High-Pressure Gases | ISAM and RPOC |
| 117 | 4.7778 | 1485: In-Space and On-Surface Manufacturing of Parts/Products from Surface and Terrestrial Feedstocks | Advanced Manufacturing |
| 117 | 4.7778 | 1569: High-Mass Mars Entry and Descent Systems | Entry Descent and Landing |
| 119 | 4.7692 | 544: Solar Electric Propulsion to Support Orbital Platforms | Propulsion: Non Nuclear |
| 119 | 4.7692 | 1622: Novel thermal technologies to improve environmental control of habitats | Thermal Management Systems |
| 121 | 4.7500 | 1304: Robust, High-Progress-Rate, and Long-Distance Autonomous Surface Mobility | Autonomous Systems and Robotics |
| 121 | 4.7500 | 1515: Atmospheric Non-Metabolic Constituent Management for Habitation | Advanced Habitation Systems |
| 123 | 4.7273 | 1601: Enable Observation of Whole Top-to-Bottom Dynamic Ecosystems | Sensors and Instruments |
| 123 | 4.7273 | 1620: Conditioned stowage to maintain science and/or nutritional integrity | Thermal Management Systems |
| 125 | 4.7000 | 1615: Common tools for on-surface maintenance and repair for reduced crew interaction | Surface Systems |
| 126 | 4.6923 | 1540: Intelligent Robots for the Servicing, Assembly, and Outfitting of In-Space Assets and Industrial-Scale Surface Infrastructure | Autonomous Systems and Robotics |
| 126 | 4.6923 | 1486: In-Space and On-Surface NDE and Qualification of Components for Manufacturing, Assembly, and Construction | Advanced Manufacturing |
| 126 | 4.6923 | 696: Enable Storable Propulsion Systems in Low Temperature Environments | Propulsion: Non Nuclear |
| 126 | 4.6923 | 703: Rotating Detonation Rocket Engine (RDRE) | Propulsion: Non Nuclear |

| OGA Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 130 | 4.6922 | 1575: Thermal and Vibrational Isolation for Ultra-stable Science Payloads | Advanced Materials and Structures |
| 131 | 4.6667 | 1336: Robotic Mobility for Robust, Repeatable Access To and Through Extreme Terrain, Surface Topography, and Harsh Environmental Conditions | Autonomous Systems and Robotics |
| 131 | 4.6667 | 680: Robust Robotic Intelligence for High-Tempo Autonomous Operations in Dynamic Mission Conditions | Autonomous Systems and Robotics |
| 131 | 4.6667 | 1550: Crew Audio/Visual Interfaces for Long Duration Missions Beyond LEO | Avionics |
| 131 | 4.6667 | 1627: Advanced Sensor Components for Heliophysics and Lunar-Based Astronomy | Sensors and Instruments |
| 135 | 4.6636 | 1602: 3D/3D+ Imaging and Tomography of Complex Features and Dynamical Processes | Sensors and Instruments |
| 136 | 4.6444 | 700: Solar Sails for Propellant-less Propulsion | Propulsion: Non Nuclear |
| 137 | 4.5714 | 1492: Materials and Process Modeling for In-Space and On-Surface Manufacturing | Advanced Manufacturing |
| 138 | 4.5556 | 1576: Micrometeoroid-Robust Protection of In-space Observatories | Advanced Materials and Structures |
| 139 | 4.5238 | 1408: Advanced deployable load-bearing structures | Advanced Materials and Structures |
| 140 | 4.5000 | 361: Surface Mating Mechanisms | ISAM and RPOC |
| 140 | 4.5000 | 1612: Surface-based fluid management for near/mid-term missions | Surface Systems |
| 142 | 4.4833 | 1593: Lunar Surface Power Generation from ISRU Derived Resources | Power |
| 143 | 4.4615 | 612: In-Space Diagnostics for Electric Propulsion | Propulsion: Non Nuclear |
| 144 | 4.4545 | 425: On-Surface In-situ Construction of Vertical Structures | Excavation Construction and Outfitting |
| 144 | 4.4545 | 1541: Intuitive and Efficient Human-Robot Interaction for Safe Teaming and Remote Supervisory Control | Autonomous Systems and Robotics |

| OGA Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 146 | 4.4510 | 1544: Resilient Agency: Adaptable Intelligence and Robust Online Learning for Long-Duration and Dynamic Missions | Autonomous Systems and Robotics |
| 147 | 4.4167 | 1594: Martian Surface Power Generation from ISRU Derived Resources | Power |
| 148 | 4.3636 | 384: Excavation of hard/compacted/icy material | Excavation Construction and Outfitting |
| 149 | 4.3000 | 1579: Extraction and separation of non-water volatile resources from Lunar regolith | ISRU |
| 149 | 4.3000 | 1608: Surface-based lunar logistics management for near/mid-term missions | Surface Systems |
| 149 | 4.3000 | 1609: Surface-based lunar logistics management for sustained lunar evolution | Surface Systems |
| 152 | 4.2500 | 1529: EVA and IVA Suit System Capabilities for Mars Missions | Advanced Habitation Systems |
| 153 | 4.2424 | 1592: High Power, Long Distance Energy Transmission Across Distributed Surface Assets | Power |
| 154 | 4.1875 | 1226: Cryogenic Liquefaction | Cryogenic Fluid Management |
| 155 | 4.1818 | 1621: Cryogenic cooling for science instrumentation | Thermal Management Systems |
| 155 | 4.1818 | 379: Upgrade or Install Instruments on Large Space Observatories | ISAM and RPOC |
| 157 | 4.1481 | 1536: Free-Flying Mobility Aids for Crew EVA | Autonomous Systems and Robotics |
| 158 | 4.1429 | 1516: Water and Dormancy Management for Habitation | Advanced Habitation Systems |
| 159 | 4.1000 | 1613: Surface-based fluid management for sustained lunar evolution | Surface Systems |
| 160 | 4.0909 | 666: On-Surface In-situ Construction of Horizontal Structures | Excavation Construction and Outfitting |

| OGA Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 161 | 4.0333 | 767: Advanced designs for lightweight inflatable surface elements | Advanced Materials and Structures |
| 162 | 4.0000 | 369: Excavation of granular (surface) regolith for ISRU commodities production | Excavation Construction and Outfitting |
| 162 | 4.0000 | 1528: Spacesuit Physiology | Advanced Habitation Systems |
| 162 | 4.0000 | 755: Cross-Discipline Cryogenic Fluid Management Technologies | Cryogenic Fluid Management |
| 162 | 4.0000 | 1221: Mars Ascent Vehicle Propulsion | Propulsion: Non Nuclear |
| 162 | 4.0000 | 1521: Crew Exercise and Sensorimotor Countermeasures | Advanced Habitation Systems |
| 167 | 3.8500 | 1547: Robotic Systems for Sub-Surface Access | Autonomous Systems and Robotics |
| 168 | 3.8333 | 1530: Aerial Robotic Mobility and Onboard Intelligence for Expanded Capabilities on Mars, Venus, and Titan | Autonomous Systems and Robotics |
| 168 | 3.8333 | 1512: Modern Solid Motor Design and Analysis Tools / Capabilities | Propulsion: Non Nuclear |
| 170 | 3.8000 | 1617: Autonomous on-surface maintenance and repair for sustained lunar evolution | Surface Systems |
| 170 | 3.8000 | 662: Robotic regolith manipulation and site preparation | Excavation Construction and Outfitting |
| 172 | 3.7000 | 1585: Extraterrestrial surface environmental simulators, test facilities, and test sites | ISRU |
| 172 | 3.7000 | 1494: Digital Transformation Technologies for Terrestrial, In-Space, On-Surface Manufacturing, and Operations | Advanced Manufacturing |
| 172 | 3.7000 | 1611: Surface-based end-of-life equipment management | Surface Systems |
| 172 | 3.7000 | 1518: Logistics Tracking, Clothing, and Trash Management for Habitation | Advanced Habitation Systems |
| 176 | 3.6667 | 1194: Prediction Modeling of Cryogenic Fluid Dynamics and Operations | Cryogenic Fluid Management |

| OGA Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 177 | 3.6429 | 701: Green Propellant Propulsion Systems | Propulsion: Non Nuclear |
| 178 | 3.6364 | 617: On-surface robotic assembly of vertical structures | Excavation Construction and Outfitting |
| 178 | 3.6364 | 1400: On-surface robotic assembly of horizontal structures | Excavation Construction and Outfitting |
| 178 | 3.6364 | 385: Regolith and resource delivery system | Excavation Construction and Outfitting |
| 181 | 3.6250 | 1539: Intelligent Robotic Systems for Crew Health and Performance During Long-Duration Missions | Autonomous Systems and Robotics |
| 182 | 3.5556 | 1493: Computational Materials-Informed Qualification and Certification for In-Space and On-Surface Manufacturing | Advanced Manufacturing |
| 183 | 3.4545 | 1533: Autonomous Robotic Sample Identification, Classification, Collection, Manipulation, Verification, and Transport | Autonomous Systems and Robotics |
| 183 | 3.4545 | 1052: EVA/IVA Support Propulsion Development | Propulsion: Non Nuclear |
| 185 | 3.4286 | 1522: Crew Health Countermeasures – Non-Exercise | Advanced Habitation Systems |
| 186 | 3.3750 | 1517: Metabolic Waste Management for Habitation | Advanced Habitation Systems |
| 187 | 2.7000 | 1614: Surface-based planning and scheduling technologies for sustained lunar evolution | Surface Systems |

# Stakeholder Group Ranked List: Academia

The Academia ranked shortfall list used the average shortfall scores from responses affiliated with a U.S. college or university. Several shortfalls ranked equally.

| Academia Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 1 | 7.3108 | 1578: Extraction and separation of water from extraterrestrial surface material | ISRU |
| 2 | 7.2571 | 1580: Extraction and separation of oxygen from extraterrestrial minerals | ISRU |
| 3 | 7.0857 | 1583: Produce propellants and mission consumables from extracted in-situ resources | ISRU |
| 4 | 7.0500 | 1618: Survive and operate through the lunar night | Thermal Management Systems |
| 5 | 6.9225 | 1527: Radiation Countermeasures (Crew and Habitat) | Advanced Habitation Systems |
| 6 | 6.7556 | 1526: Radiation Monitoring and Modeling (Crew and Habitat) | Advanced Habitation Systems |
| 7 | 6.5135 | 1595: Energy Storage to Enable Robust and Long Duration Operations on Moon and Mars | Power |
| 8 | 6.5122 | 1525: Food and Nutrition for Mars and Sustained Lunar | Advanced Habitation Systems |
| 9 | 6.4409 | 1557: Position, Navigation, and Timing (PNT) for In-Orbit and Surface Applications | Communication and Navigation |
| 10 | 6.4286 | 1477: Mitigation of New Orbital Debris Generation | Orbital Debris |
| 11 | 6.4194 | 1584: Produce manufacturing and construction feedstock from extracted in-situ resources | ISRU |
| 12 | 6.3810 | 1524: Crew Medical Care for Mars and Sustained Lunar | Advanced Habitation Systems |
| 13 | 6.3421 | 1596: High Power Energy Generation on Moon and Mars Surfaces | Power |

| Academia Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 14 | 6.3226 | 1571: Navigation Sensors for Precision Landing | Entry Descent and Landing |
| 15 | 6.3056 | 1579: Extraction and separation of non-water volatile resources from Lunar regolith | ISRU |
| 16 | 6.2741 | 1590: Planetary Protection | Miscellaneous |
| 17 | 6.2315 | 792: In-space and On-surface Transfer of Cryogenic Fluids | Cryogenic Fluid Management |
| 18 | 6.2286 | 1626: Advanced Sensor Components: Imaging | Sensors and Instruments |
| 19 | 6.2043 | 376: Modular design for in-space installation | ISAM and RPOC |
| 20 | 6.2033 | 1519: Environmental Monitoring for Habitation | Advanced Habitation Systems |
| 21 | 6.2000 | 879: In-space and On-surface, Long-duration Storage of Cryogenic Propellant | Cryogenic Fluid Management |
| 22 | 6.1818 | 1603: Situational Awareness Sensors and Tools for Astronauts | Sensors and Instruments |
| 23 | 6.1789 | 1520: Fire Safety for Habitation | Advanced Habitation Systems |
| 24 | 6.1579 | 1523: Earth Independent Human Operations within Habitat Elements | Advanced Habitation Systems |
| 25 | 6.1290 | 1558: High-Rate Communications Across The Lunar Surface | Communication and Navigation |
| 26 | 6.1176 | 1581: Extraction and separation of extraterrestrial atmospheric resources and gaseous products/reactants | ISRU |
| 27 | 6.1154 | 1304: Robust, High-Progress-Rate, and Long-Distance Autonomous Surface Mobility | Autonomous Systems and Robotics |
| 28 | 6.0935 | 1430: Small Spacecraft Propulsion | Small Spacecraft |
| 29 | 6.0857 | 1560: High-Rate Deep Space Communications | Communication and Navigation |
| 30 | 6.0606 | 1573: Terrain Mapping Capabilities for Precision Landing and Hazard Avoidance | Entry Descent and Landing |

| Academia Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 30 | 6.0606 | 1582: Extraction and separation of metals/metalloids from extraterrestrial minerals | ISRU |
| 32 | 6.0571 | 672: Long-life thermal control for surface suits capable of extreme access | Thermal Management Systems |
| 33 | 6.0511 | 1488: Additive Manufacturing for Propulsion | Advanced Manufacturing |
| 34 | 6.0476 | 1545: Robotic Actuation, Subsystem Components, and System Architectures for Long-Duration and Extreme Environment Operation | Autonomous Systems and Robotics |
| 35 | 6.0370 | 498: Broad and dependable supply chain for space-qualified robotic hardware, electronics, and associated software | ISAM and RPOC |
| 36 | 6.0357 | 702: Nuclear Thermal Propulsion for Human Exploration | Propulsion: Nuclear |
| 37 | 6.0294 | 1476: Remediation of Large Debris | Orbital Debris |
| 38 | 6.0286 | 1514: Atmospheric Metabolic Constituent Management for Habitation | Advanced Habitation Systems |
| 39 | 6.0278 | 1622: Novel thermal technologies to improve environmental control of habitats | Thermal Management Systems |
| 40 | 6.0000 | 1591: Power Management Systems for Long Duration Lunar and Martian Missions | Power |
| 40 | 6.0000 | 1577: Perform resource reconnaissance to locate and characterize resources and estimate reserves | ISRU |
| 42 | 5.9762 | 1548: Sensing for Autonomous Robotic Operations in Challenging Environmental Conditions | Autonomous Systems and Robotics |
| 43 | 5.9421 | 709: Nuclear Electric Propulsion for Human Exploration | Propulsion: Nuclear |
| 44 | 5.9333 | 844: Passive Dust Mitigation Technologies for Diverse Applications | Dust Mitigation |
| 45 | 5.9091 | 513: Robotic Assembly and Construction of Modular Systems for Sustained In-Space Infrastructure | ISAM and RPOC |

| Academia Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 46 | 5.9048 | 1047: Active Dust Mitigation Technologies for Diverse Applications | Dust Mitigation |
| 47 | 5.8919 | 1531: Autonomous Guidance and Navigation for Deep Space Missions | Autonomous Systems and Robotics |
| 48 | 5.8772 | 1586: Enhanced Access to Orbital and Suborbital Space for Flight Demonstration and Test | Miscellaneous |
| 49 | 5.8708 | 1516: Water and Dormancy Management for Habitation | Advanced Habitation Systems |
| 50 | 5.8649 | 1589: Space Situational Awareness | Miscellaneous |
| 51 | 5.8547 | 1619: High temperature heat rejection for nuclear applications | Thermal Management Systems |
| 52 | 5.8529 | 1610: Surface-based food management for sustained lunar evolution | Surface Systems |
| 53 | 5.8495 | 701: Green Propellant Propulsion Systems | Propulsion: Non Nuclear |
| 54 | 5.8448 | 1562: Advanced Algorithms and Computing for Precision Landing | Entry Descent and Landing |
| 55 | 5.8214 | 512: Cooperative interfaces, aids, and standards | ISAM and RPOC |
| 56 | 5.8182 | 1616: Dissipation of electrical charge on surface assets | Surface Systems |
| 57 | 5.7941 | 1621: Cryogenic cooling for science instrumentation | Thermal Management Systems |
| 58 | 5.7889 | 1588: Protect Earth from Destructive Natural Impacts (Planetary Defense) | Miscellaneous |
| 59 | 5.7857 | 1538: General-Purpose Robotic Manipulation to Perform Human-Scale Logistics, Maintenance, Outfitting, and Utilization | Autonomous Systems and Robotics |
| 60 | 5.7838 | 1623: Advanced thermal modeling capabilities | Thermal Management Systems |

| Academia Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 61 | 5.7701 | 1565: Assessment and Validation Capabilities for Integrated Precision Landing Systems | Entry Descent and Landing |
| 62 | 5.7647 | 1559: Deep Space Autonomous Navigation | Communication and Navigation |
| 63 | 5.7623 | 610: Solar Electric Propulsion - High Specific Impulse | Propulsion: Non Nuclear |
| 64 | 5.7572 | 1485: In-Space and On-Surface Manufacturing of Parts/Products from Surface and Terrestrial Feedstocks | Advanced Manufacturing |
| 65 | 5.7500 | 1432: Rendezvous, Proximity Operations, and Debris Remediation using Small Spacecraft | Small Spacecraft |
| 65 | 5.7500 | 1593: Lunar Surface Power Generation from ISRU Derived Resources | Power |
| 67 | 5.7297 | 1535: Autonomous Vehicle, System, Habitat, and Infrastructure Health Monitoring and Management | Autonomous Systems and Robotics |
| 68 | 5.7185 | 1490: Additive Manufacturing for New and High-Performance Materials | Advanced Manufacturing |
| 69 | 5.7148 | 1224: In-Space & Surface Transfer of Earth Storable Propellants | Propulsion: Non Nuclear |
| 70 | 5.7073 | 1546: Robotic Mobile Manipulation for Autonomous Large-Scale Logistics, Payload Handling, and Surface Transport | Autonomous Systems and Robotics |
| 71 | 5.6957 | 1489: In-Space and On-Surface Manufacturing from Recycled and Reused Materials and Components | Advanced Manufacturing |
| 72 | 5.6773 | 1491: Additive Manufacturing of Large-Scale Components | Advanced Manufacturing |
| 73 | 5.6765 | 1434: Communication Technology and Capabilities for Small Spacecraft | Small Spacecraft |
| 74 | 5.6705 | 612: In-Space Diagnostics for Electric Propulsion | Propulsion: Non Nuclear |
| 75 | 5.6667 | 1433: Position, Navigation, and Timing for Small Spacecraft | Small Spacecraft |

| Academia Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 75 | 5.6667 | 1585: Extraterrestrial surface environmental simulators, test facilities, and test sites | ISRU |
| 77 | 5.6579 | 1624: Advanced thermal management technologies for diverse applications | Thermal Management Systems |
| 77 | 5.6579 | 1336: Robotic Mobility for Robust, Repeatable Access To and Through Extreme Terrain, Surface Topography, and Harsh Environmental Conditions | Autonomous Systems and Robotics |
| 79 | 5.6571 | 1561: Advanced Modeling and Test Capabilities to Characterize Dust Effects on Hardware | Dust Mitigation |
| 80 | 5.6420 | 1554: High Performance Onboard Computing to Enable Increasingly Complex Operations | Avionics |
| 81 | 5.6417 | 1517: Metabolic Waste Management for Habitation | Advanced Habitation Systems |
| 82 | 5.6389 | 1528: Spacesuit Physiology | Advanced Habitation Systems |
| 83 | 5.6250 | 1564: Aeroshell In-Situ Flight Performance Data During EDL | Entry Descent and Landing |
| 84 | 5.6111 | 1515: Atmospheric Non-Metabolic Constituent Management for Habitation | Advanced Habitation Systems |
| 85 | 5.5946 | 1597: Power for Non-Solar-Illuminated Small Systems | Power |
| 86 | 5.5938 | 1570: Lander Capabilities for Soft Touchdown | Entry Descent and Landing |
| 87 | 5.5833 | 1436: Efficient and Safe Higher Power Systems for Small Spacecraft | Small Spacecraft |
| 88 | 5.5806 | 1615: Common tools for on-surface maintenance and repair for reduced crew interaction | Surface Systems |
| 89 | 5.5781 | 1604: Find, Study Habitable Zone Earth-like Exoplanets and Search for Biosignatures | Sensors and Instruments |
| 90 | 5.5758 | 1613: Surface-based fluid management for sustained lunar evolution | Surface Systems |
| 91 | 5.5714 | 1431: Access Beyond LEO for Small Spacecraft | Small Spacecraft |

| Academia Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 92 | 5.5588 | 1542: Metrics and Processes for Establishing Trust and Certifying the Trustworthiness of Autonomous Systems | Autonomous Systems and Robotics |
| 93 | 5.5313 | 1506: In-Space & Surface Transfer of High-Pressure Gases | ISAM and RPOC |
| 94 | 5.5294 | 1437: Dynamic and Capable Thermal Control for Small Spacecraft | Small Spacecraft |
| 95 | 5.5152 | 384: Excavation of hard/compacted/icy material | Excavation Construction and Outfitting |
| 95 | 5.5152 | 369: Excavation of granular (surface) regolith for ISRU commodities production | Excavation Construction and Outfitting |
| 97 | 5.4778 | 1602: 3D/3D+ Imaging and Tomography of Complex Features and Dynamical Processes | Sensors and Instruments |
| 98 | 5.4772 | 544: Solar Electric Propulsion to Support Orbital Platforms | Propulsion: Non Nuclear |
| 99 | 5.4688 | 385: Regolith and resource delivery system | Excavation Construction and Outfitting |
| 100 | 5.4474 | 1408: Advanced deployable load-bearing structures | Advanced Materials and Structures |
| 101 | 5.4333 | 1568: Entry Modeling and Simulation for EDL Missions | Entry Descent and Landing |
| 102 | 5.4242 | 1611: Surface-based end-of-life equipment management | Surface Systems |
| 103 | 5.4220 | 1221: Mars Ascent Vehicle Propulsion | Propulsion: Non Nuclear |
| 104 | 5.4000 | 1530: Aerial Robotic Mobility and Onboard Intelligence for Expanded Capabilities on Mars, Venus, and Titan | Autonomous Systems and Robotics |
| 105 | 5.3984 | 1540: Intelligent Robots for the Servicing, Assembly, and Outfitting of In-Space Assets and Industrial-Scale Surface Infrastructure | Autonomous Systems and Robotics |

| Academia Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 106 | 5.3981 | 705: Low Power Nuclear Electric Propulsion | Propulsion: Nuclear |
| 107 | 5.3939 | 1612: Surface-based fluid management for near/mid-term missions | Surface Systems |
| 108 | 5.3843 | 696: Enable Storable Propulsion Systems in Low Temperature Environments | Propulsion: Non Nuclear |
| 109 | 5.3784 | 1521: Crew Exercise and Sensorimotor Countermeasures | Advanced Habitation Systems |
| 110 | 5.3684 | 1496: In-Space and On-Surface Manufacturing, Assembly, and Repair of Composite Structures | Advanced Manufacturing |
| 110 | 5.3684 | 1522: Crew Health Countermeasures – Non-Exercise | Advanced Habitation Systems |
| 112 | 5.3333 | 1390: Power and Data Transfer in Dusty Environments | Power |
| 113 | 5.3125 | 666: On-Surface In-situ Construction of Horizontal Structures | Excavation Construction and Outfitting |
| 114 | 5.3000 | 581: ISRU System Modeling | ISRU |
| 115 | 5.2874 | 1483: Enable commercially-provided Rendezvous, Proximity Operations, and Capture (RPOC) products and services | ISAM and RPOC |
| 116 | 5.2813 | 1620: Conditioned stowage to maintain science and/or nutritional integrity | Thermal Management Systems |
| 117 | 5.2639 | 361: Surface Mating Mechanisms | ISAM and RPOC |
| 118 | 5.2333 | 1617: Autonomous on-surface maintenance and repair for sustained lunar evolution | Surface Systems |
| 119 | 5.2309 | 1486: In-Space and On-Surface NDE and Qualification of Components for Manufacturing, Assembly, and Construction | Advanced Manufacturing |
| 120 | 5.2121 | 425: On-Surface In-situ Construction of Vertical Structures | Excavation Construction and Outfitting |

| Academia Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 121 | 5.2051 | 1537: Free-Flying Systems for Robotic Inspection, Data Collection, and Servicing of In-Space Assets | Autonomous Systems and Robotics |
| 122 | 5.1897 | 1572: Performance-Optimized Low-Cost Aeroshells for EDL Missions | Entry Descent and Landing |
| 123 | 5.1795 | 1534: Autonomous Robotics for Sustained In-Space Manufacturing Operations | Autonomous Systems and Robotics |
| 124 | 5.1765 | 1592: High Power, Long Distance Energy Transmission Across Distributed Surface Assets | Power |
| 125 | 5.1750 | 680: Robust Robotic Intelligence for High-Tempo Autonomous Operations in Dynamic Mission Conditions | Autonomous Systems and Robotics |
| 126 | 5.1667 | 1532: Autonomous Planning, Scheduling, and Decision-Support to Enable Sustained Earth-Independent Missions | Autonomous Systems and Robotics |
| 127 | 5.1515 | 662: Robotic regolith manipulation and site preparation | Excavation Construction and Outfitting |
| 128 | 5.1490 | 703: Rotating Detonation Rocket Engine (RDRE) | Propulsion: Non Nuclear |
| 129 | 5.1429 | 1138: In-Space Transfer of Electric Propulsion Propellant | ISAM and RPOC |
| 130 | 5.1414 | 1566: Characterization of Plume Surface Interaction | Entry Descent and Landing |
| 131 | 5.1212 | 1480: On-surface Outfitting of Lunar Structures | Excavation Construction and Outfitting |
| 132 | 5.1176 | 1609: Surface-based lunar logistics management for sustained lunar evolution | Surface Systems |
| 133 | 5.1053 | 1541: Intuitive and Efficient Human-Robot Interaction for Safe Teaming and Remote Supervisory Control | Autonomous Systems and Robotics |
| 134 | 5.1042 | 1492: Materials and Process Modeling for In-Space and On-Surface Manufacturing | Advanced Manufacturing |

| Academia Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 135 | 5.0882 | 1262: Remediation of Small Debris | Orbital Debris |
| 136 | 5.0538 | 755: Cross-Discipline Cryogenic Fluid Management Technologies | Cryogenic Fluid Management |
| 137 | 5.0333 | 1614: Surface-based planning and scheduling technologies for sustained lunar evolution | Surface Systems |
| 138 | 5.0323 | 1438: Autonomy, Edge Computation, and Interoperable Networking for Small Spacecraft | Small Spacecraft |
| 138 | 5.0323 | 1627: Advanced Sensor Components for Heliophysics and Lunar-Based Astronomy | Sensors and Instruments |
| 140 | 5.0303 | 617: On-surface robotic assembly of vertical structures | Excavation Construction and Outfitting |
| 140 | 5.0303 | 1400: On-surface robotic assembly of horizontal structures | Excavation Construction and Outfitting |
| 142 | 5.0270 | 1529: EVA and IVA Suit System Capabilities for Mars Missions | Advanced Habitation Systems |
| 143 | 5.0238 | 1574: Validated Performance Models for Planetary Parachutes | Entry Descent and Landing |
| 144 | 5.0200 | 611: Sub-kW and kW Class Electric Propulsion Systems | Propulsion: Non Nuclear |
| 145 | 5.0128 | 1518: Logistics Tracking, Clothing, and Trash Management for Habitation | Advanced Habitation Systems |
| 146 | 5.0000 | 1563: Aerocapture for Spacecraft Deceleration and Orbit Insertion | Entry Descent and Landing |
| 147 | 4.9643 | 1605: Peer Back Farther in Time to the Early Universe | Sensors and Instruments |
| 148 | 4.9635 | 1487: In-Space and On-Surface Welding Technologies for Manufacturing, Assembly, and Construction | Advanced Manufacturing |
| 149 | 4.9412 | 707: Transformational Advanced Energetic Propulsion (AEP) | Propulsion: Non Nuclear |
| 150 | 4.9323 | 1513: Advanced Solid Propulsion Systems | Propulsion: Non Nuclear |

| Academia Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 151 | 4.9189 | 767: Advanced designs for lightweight inflatable surface elements | Advanced Materials and Structures |
| 152 | 4.8889 | 1569: High-Mass Mars Entry and Descent Systems | Entry Descent and Landing |
| 153 | 4.8667 | 1598: Quantum Sensors That Use Photons | Sensors and Instruments |
| 154 | 4.8571 | 1606: Observe Some of the Most Energetic Phenomena in the Universe | Sensors and Instruments |
| 155 | 4.8444 | 1495: Advanced Manufacturing for Improved Dimensional Control of Large-Scale Space Structures | Advanced Manufacturing |
| 156 | 4.8426 | 1576: Micrometeoroid-Robust Protection of In-space Observatories | Advanced Materials and Structures |
| 157 | 4.8283 | 1567: Entry Capabilities for Small-Scale and Commercial Spacecraft | Entry Descent and Landing |
| 158 | 4.8276 | 1607: Detect New Astronomical Messenger - Gravitational Waves | Sensors and Instruments |
| 159 | 4.8182 | 1511: Advanced Computational Fluid Dynamics Tools / Capabilities | Propulsion: Non Nuclear |
| 159 | 4.8182 | 1608: Surface-based lunar logistics management for near/mid-term missions | Surface Systems |
| 161 | 4.8056 | 1625: Intelligent Multi-Agent Constellations for Cooperative Operations | Autonomous Systems and Robotics |
| 162 | 4.8000 | 1550: Crew Audio/Visual Interfaces for Long Duration Missions Beyond LEO | Avionics |
| 163 | 4.7949 | 1547: Robotic Systems for Sub-Surface Access | Autonomous Systems and Robotics |
| 164 | 4.7813 | 1594: Martian Surface Power Generation from ISRU Derived Resources | Power |
| 165 | 4.7778 | 1539: Intelligent Robotic Systems for Crew Health and Performance During Long-Duration Missions | Autonomous Systems and Robotics |

| Academia Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 166 | 4.7692 | 1600: Enable Paradigm for System Science to Include Interactions Between Subsystems | Sensors and Instruments |
| 167 | 4.7396 | 1052: EVA/IVA Support Propulsion Development | Propulsion: Non Nuclear |
| 168 | 4.7222 | 1536: Free-Flying Mobility Aids for Crew EVA | Autonomous Systems and Robotics |
| 169 | 4.7143 | 1599: Quantum Sensors That Use Atoms, Ions, and Spins | Sensors and Instruments |
| 170 | 4.7000 | 1533: Autonomous Robotic Sample Identification, Classification, Collection, Manipulation, Verification, and Transport | Autonomous Systems and Robotics |
| 171 | 4.6667 | 1555: Next Generation Avionics Architectures | Avionics |
| 171 | 4.6667 | 1543: Multi-Agent Robotic Coordination and Interoperability for Cooperative Task Planning and Performance | Autonomous Systems and Robotics |
| 173 | 4.6458 | 1194: Prediction Modeling of Cryogenic Fluid Dynamics and Operations | Cryogenic Fluid Management |
| 174 | 4.6071 | 1226: Cryogenic Liquefaction | Cryogenic Fluid Management |
| 175 | 4.5676 | 1544: Resilient Agency: Adaptable Intelligence and Robust Online Learning for Long-Duration and Dynamic Missions | Autonomous Systems and Robotics |
| 176 | 4.5556 | 1552: Extreme Environment Avionics | Avionics |
| 177 | 4.5217 | 1553: Foundational Technologies for Future Avionics Devices and Systems | Avionics |
| 178 | 4.4444 | 1494: Digital Transformation Technologies for Terrestrial, In-Space, On-Surface Manufacturing, and Operations | Advanced Manufacturing |
| 179 | 4.4234 | 1575: Thermal and Vibrational Isolation for Ultra-stable Science Payloads | Advanced Materials and Structures |
| 180 | 4.4074 | 1549: Advanced Data Acquisition Systems for Diverse Applications | Avionics |

| Academia Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 181 | 4.3689 | 1512: Modern Solid Motor Design and Analysis Tools / Capabilities | Propulsion: Non Nuclear |
| 182 | 4.2865 | 700: Solar Sails for Propellant-less Propulsion | Propulsion: Non Nuclear |
| 183 | 4.2171 | 1493: Computational Materials-Informed Qualification and Certification for In-Space and On-Surface Manufacturing | Advanced Manufacturing |
| 184 | 4.1724 | 379: Upgrade or Install Instruments on Large Space Observatories | ISAM and RPOC |
| 185 | 4.0952 | 1551: Distributed Avionics to Enable Improved Performance and SWaP Efficiency | Avionics |
| 186 | 3.9200 | 1601: Enable Observation of Whole Top-to-Bottom Dynamic Ecosystems | Sensors and Instruments |
| 187 | 3.5357 | 1587: Wildfire Integrated Effect Chain | Miscellaneous |

# Stakeholder Group Ranked List: Other

The Other ranked shortfall list used the average shortfall scores from responses affiliated with non-profit organizations, professional societies, think tanks, and the public. This stakeholder group also included responses from individuals who did not disclose an affiliated organization. Several shortfalls ranked equally.

| Other Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 1 | 8.3556 | 1526: Radiation Monitoring and Modeling (Crew and Habitat) | Advanced Habitation Systems |
| 2 | 8.3111 | 1527: Radiation Countermeasures (Crew and Habitat) | Advanced Habitation Systems |
| 3 | 8.0667 | 1562: Advanced Algorithms and Computing for Precision Landing | Entry Descent and Landing |
| 4 | 8.0222 | 1571: Navigation Sensors for Precision Landing | Entry Descent and Landing |
| 5 | 7.7941 | 1569: High-Mass Mars Entry and Descent Systems | Entry Descent and Landing |
| 6 | 7.6667 | 1565: Assessment and Validation Capabilities for Integrated Precision Landing Systems | Entry Descent and Landing |
| 7 | 7.6471 | 1542: Metrics and Processes for Establishing Trust and Certifying the Trustworthiness of Autonomous Systems | Autonomous Systems and Robotics |
| 8 | 7.6458 | 1573: Terrain Mapping Capabilities for Precision Landing and Hazard Avoidance | Entry Descent and Landing |
| 9 | 7.5648 | 1618: Survive and operate through the lunar night | Thermal Management Systems |
| 10 | 7.5370 | 1545: Robotic Actuation, Subsystem Components, and System Architectures for Long-Duration and Extreme Environment Operation | Autonomous Systems and Robotics |
| 11 | 7.5278 | 1524: Crew Medical Care for Mars and Sustained Lunar | Advanced Habitation Systems |
| 12 | 7.5238 | 1520: Fire Safety for Habitation | Advanced Habitation Systems |
| 13 | 7.5128 | 1554: High Performance Onboard Computing to Enable Increasingly Complex Operations | Avionics |

| Other Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 14 | 7.4615 | 1549: Advanced Data Acquisition Systems for Diverse Applications | Avionics |
| 15 | 7.4510 | 1568: Entry Modeling and Simulation for EDL Missions | Entry Descent and Landing |
| 16 | 7.4314 | 1548: Sensing for Autonomous Robotic Operations in Challenging Environmental Conditions | Autonomous Systems and Robotics |
| 17 | 7.4167 | 1578: Extraction and separation of water from extraterrestrial surface material | ISRU |
| 18 | 7.4111 | 1570: Lander Capabilities for Soft Touchdown | Entry Descent and Landing |
| 19 | 7.3333 | 1541: Intuitive and Efficient Human-Robot Interaction for Safe Teaming and Remote Supervisory Control | Autonomous Systems and Robotics |
| 20 | 7.3148 | 1596: High Power Energy Generation on Moon and Mars Surfaces | Power |
| 21 | 7.2368 | 1580: Extraction and separation of oxygen from extraterrestrial minerals | ISRU |
| 22 | 7.2105 | 879: In-space and On-surface, Long-duration Storage of Cryogenic Propellant | Cryogenic Fluid Management |
| 23 | 7.2083 | 1552: Extreme Environment Avionics | Avionics |
| 24 | 7.1979 | 1591: Power Management Systems for Long Duration Lunar and Martian Missions | Power |
| 25 | 7.1667 | 1224: In-Space & Surface Transfer of Earth Storable Propellants | Propulsion: Non Nuclear |
| 26 | 7.1579 | 792: In-space and On-surface Transfer of Cryogenic Fluids | Cryogenic Fluid Management |
| 27 | 7.1316 | 1619: High temperature heat rejection for nuclear applications | Thermal Management Systems |
| 28 | 7.0926 | 1485: In-Space and On-Surface Manufacturing of Parts/Products from Surface and Terrestrial Feedstocks | Advanced Manufacturing |
| 29 | 7.0833 | 1583: Produce propellants and mission consumables from extracted in-situ resources | ISRU |

| Other Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 30 | 7.0667 | 1612: Surface-based fluid management for near/mid-term missions | Surface Systems |
| 31 | 7.0588 | 1538: General-Purpose Robotic Manipulation to Perform Human-Scale Logistics, Maintenance, Outfitting, and Utilization | Autonomous Systems and Robotics |
| 32 | 7.0444 | 755: Cross-Discipline Cryogenic Fluid Management Technologies | Cryogenic Fluid Management |
| 33 | 7.0370 | 1492: Materials and Process Modeling for In-Space and On-Surface Manufacturing | Advanced Manufacturing |
| 34 | 7.0000 | 1563: Aerocapture for Spacecraft Deceleration and Orbit Insertion | Entry Descent and Landing |
| 35 | 6.9778 | 1574: Validated Performance Models for Planetary Parachutes | Entry Descent and Landing |
| 36 | 6.9744 | 1553: Foundational Technologies for Future Avionics Devices and Systems | Avionics |
| 37 | 6.9667 | 1603: Situational Awareness Sensors and Tools for Astronauts | Sensors and Instruments |
| 38 | 6.9630 | 1540: Intelligent Robots for the Servicing, Assembly, and Outfitting of In-Space Assets and Industrial-Scale Surface Infrastructure | Autonomous Systems and Robotics |
| 39 | 6.9286 | 666: On-Surface In-situ Construction of Horizontal Structures | Excavation Construction and Outfitting |
| 39 | 6.9286 | 1550: Crew Audio/Visual Interfaces for Long Duration Missions Beyond LEO | Avionics |
| 41 | 6.9231 | 1555: Next Generation Avionics Architectures | Avionics |
| 42 | 6.9216 | 1477: Mitigation of New Orbital Debris Generation | Orbital Debris |
| 43 | 6.9118 | 1577: Perform resource reconnaissance to locate and characterize resources and estimate reserves | ISRU |
| 44 | 6.9074 | 1489: In-Space and On-Surface Manufacturing from Recycled and Reused Materials and Components | Advanced Manufacturing |
| 45 | 6.9048 | 1525: Food and Nutrition for Mars and Sustained Lunar | Advanced Habitation Systems |

| Other Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 46 | 6.9000 | 1434: Communication Technology and Capabilities for Small Spacecraft | Small Spacecraft |
| 47 | 6.8778 | 672: Long-life thermal control for surface suits capable of extreme access | Thermal Management Systems |
| 48 | 6.8462 | 612: In-Space Diagnostics for Electric Propulsion | Propulsion: Non Nuclear |
| 49 | 6.8431 | 1496: In-Space and On-Surface Manufacturing, Assembly, and Repair of Composite Structures | Advanced Manufacturing |
| 50 | 6.8333 | 680: Robust Robotic Intelligence for High-Tempo Autonomous Operations in Dynamic Mission Conditions | Autonomous Systems and Robotics |
| 51 | 6.8222 | 1567: Entry Capabilities for Small-Scale and Commercial Spacecraft | Entry Descent and Landing |
| 52 | 6.8137 | 709: Nuclear Electric Propulsion for Human Exploration | Propulsion: Nuclear |
| 53 | 6.8095 | 1516: Water and Dormancy Management for Habitation | Advanced Habitation Systems |
| 54 | 6.7895 | 1595: Energy Storage to Enable Robust and Long Duration Operations on Moon and Mars | Power |
| 55 | 6.7500 | 1564: Aeroshell In-Situ Flight Performance Data During EDL | Entry Descent and Landing |
| 56 | 6.7396 | 1546: Robotic Mobile Manipulation for Autonomous Large-Scale Logistics, Payload Handling, and Surface Transport | Autonomous Systems and Robotics |
| 57 | 6.7368 | 1194: Prediction Modeling of Cryogenic Fluid Dynamics and Operations | Cryogenic Fluid Management |
| 58 | 6.7292 | 384: Excavation of hard/compacted/icy material | Excavation Construction and Outfitting |
| 58 | 6.7292 | 1543: Multi-Agent Robotic Coordination and Interoperability for Cooperative Task Planning and Performance | Autonomous Systems and Robotics |
| 60 | 6.7222 | 1490: Additive Manufacturing for New and High-Performance Materials | Advanced Manufacturing |

| Other Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 61 | 6.7179 | 1519: Environmental Monitoring for Habitation | Advanced Habitation Systems |
| 62 | 6.7111 | 617: On-surface robotic assembly of vertical structures | Excavation Construction and Outfitting |
| 62 | 6.7111 | 1400: On-surface robotic assembly of horizontal structures | Excavation Construction and Outfitting |
| 64 | 6.7037 | 1476: Remediation of Large Debris | Orbital Debris |
| 65 | 6.6944 | 1584: Produce manufacturing and construction feedstock from extracted in-situ resources | ISRU |
| 66 | 6.6875 | 1495: Advanced Manufacturing for Improved Dimensional Control of Large-Scale Space Structures | Advanced Manufacturing |
| 67 | 6.6667 | 1557: Position, Navigation, and Timing (PNT) for In-Orbit and Surface Applications | Communication and Navigation |
| 67 | 6.6667 | 1535: Autonomous Vehicle, System, Habitat, and Infrastructure Health Monitoring and Management | Autonomous Systems and Robotics |
| 69 | 6.6579 | 1581: Extraction and separation of extraterrestrial atmospheric resources and gaseous products/reactants | ISRU |
| 70 | 6.6444 | 1560: High-Rate Deep Space Communications | Communication and Navigation |
| 71 | 6.6333 | 1608: Surface-based lunar logistics management for near/mid-term missions | Surface Systems |
| 72 | 6.6275 | 1593: Lunar Surface Power Generation from ISRU Derived Resources | Power |
| 73 | 6.6111 | 1433: Position, Navigation, and Timing for Small Spacecraft | Small Spacecraft |
| 73 | 6.6111 | 1534: Autonomous Robotics for Sustained In-Space Manufacturing Operations | Autonomous Systems and Robotics |
| 73 | 6.6111 | 1226: Cryogenic Liquefaction | Cryogenic Fluid Management |

| Other Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 76 | 6.6042 | 1336: Robotic Mobility for Robust, Repeatable Access To and Through Extreme Terrain, Surface Topography, and Harsh Environmental Conditions | Autonomous Systems and Robotics |
| 77 | 6.5938 | 1221: Mars Ascent Vehicle Propulsion | Propulsion: Non Nuclear |
| 78 | 6.5392 | 702: Nuclear Thermal Propulsion for Human Exploration | Propulsion: Nuclear |
| 79 | 6.5385 | 1528: Spacesuit Physiology | Advanced Habitation Systems |
| 79 | 6.5385 | 696: Enable Storable Propulsion Systems in Low Temperature Environments | Propulsion: Non Nuclear |
| 81 | 6.5357 | 1480: On-surface Outfitting of Lunar Structures | Excavation Construction and Outfitting |
| 82 | 6.5185 | 1047: Active Dust Mitigation Technologies for Diverse Applications | Dust Mitigation |
| 82 | 6.5185 | 1561: Advanced Modeling and Test Capabilities to Characterize Dust Effects on Hardware | Dust Mitigation |
| 84 | 6.4889 | 1610: Surface-based food management for sustained lunar evolution | Surface Systems |
| 84 | 6.4889 | 1613: Surface-based fluid management for sustained lunar evolution | Surface Systems |
| 84 | 6.4889 | 425: On-Surface In-situ Construction of Vertical Structures | Excavation Construction and Outfitting |
| 87 | 6.4583 | 1572: Performance-Optimized Low-Cost Aeroshells for EDL Missions | Entry Descent and Landing |
| 88 | 6.4524 | 1438: Autonomy, Edge Computation, and Interoperable Networking for Small Spacecraft | Small Spacecraft |
| 89 | 6.4444 | 1531: Autonomous Guidance and Navigation for Deep Space Missions | Autonomous Systems and Robotics |
| 90 | 6.4412 | 581: ISRU System Modeling | ISRU |
| 91 | 6.4375 | 1304: Robust, High-Progress-Rate, and Long-Distance Autonomous Surface Mobility | Autonomous Systems and Robotics |

| Other Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 91 | 6.4375 | 369: Excavation of granular (surface) regolith for ISRU commodities production | Excavation Construction and Outfitting |
| 93 | 6.4286 | 1511: Advanced Computational Fluid Dynamics Tools / Capabilities | Propulsion: Non Nuclear |
| 94 | 6.4118 | 1491: Additive Manufacturing of Large-Scale Components | Advanced Manufacturing |
| 95 | 6.4074 | 1493: Computational Materials-Informed Qualification and Certification for In-Space and On-Surface Manufacturing | Advanced Manufacturing |
| 96 | 6.4048 | 1517: Metabolic Waste Management for Habitation | Advanced Habitation Systems |
| 97 | 6.3929 | 498: Broad and dependable supply chain for space-qualified robotic hardware, electronics, and associated software | ISAM and RPOC |
| 97 | 6.3929 | 1529: EVA and IVA Suit System Capabilities for Mars Missions | Advanced Habitation Systems |
| 99 | 6.3922 | 1488: Additive Manufacturing for Propulsion | Advanced Manufacturing |
| 100 | 6.3846 | 1523: Earth Independent Human Operations within Habitat Elements | Advanced Habitation Systems |
| 101 | 6.3824 | 1582: Extraction and separation of metals/metalloids from extraterrestrial minerals | ISRU |
| 102 | 6.3778 | 1622: Novel thermal technologies to improve environmental control of habitats | Thermal Management Systems |
| 103 | 6.3750 | 1532: Autonomous Planning, Scheduling, and Decision-Support to Enable Sustained Earth-Independent Missions | Autonomous Systems and Robotics |
| 104 | 6.3636 | 1551: Distributed Avionics to Enable Improved Performance and SWaP Efficiency | Avionics |
| 105 | 6.3627 | 1586: Enhanced Access to Orbital and Suborbital Space for Flight Demonstration and Test | Miscellaneous |
| 106 | 6.3571 | 707: Transformational Advanced Energetic Propulsion (AEP) | Propulsion: Non Nuclear |

| Other Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 107 | 6.3556 | 1624: Advanced thermal management technologies for diverse applications | Thermal Management Systems |
| 108 | 6.3438 | 385: Regolith and resource delivery system | Excavation Construction and Outfitting |
| 109 | 6.3333 | 844: Passive Dust Mitigation Technologies for Diverse Applications | Dust Mitigation |
| 109 | 6.3333 | 1602: 3D/3D+ Imaging and Tomography of Complex Features and Dynamical Processes | Sensors and Instruments |
| 109 | 6.3333 | 1566: Characterization of Plume Surface Interaction | Entry Descent and Landing |
| 112 | 6.3125 | 610: Solar Electric Propulsion - High Specific Impulse | Propulsion: Non Nuclear |
| 112 | 6.3125 | 1539: Intelligent Robotic Systems for Crew Health and Performance During Long-Duration Missions | Autonomous Systems and Robotics |
| 114 | 6.3056 | 1590: Planetary Protection | Miscellaneous |
| 115 | 6.2889 | 1138: In-Space Transfer of Electric Propulsion Propellant | ISAM and RPOC |
| 116 | 6.2870 | 1616: Dissipation of electrical charge on surface assets | Surface Systems |
| 117 | 6.2778 | 1483: Enable commercially-provided Rendezvous, Proximity Operations, and Capture (RPOC) products and services | ISAM and RPOC |
| 118 | 6.2708 | 662: Robotic regolith manipulation and site preparation | Excavation Construction and Outfitting |
| 119 | 6.2556 | 1620: Conditioned stowage to maintain science and/or nutritional integrity | Thermal Management Systems |
| 120 | 6.2444 | 1559: Deep Space Autonomous Navigation | Communication and Navigation |
| 121 | 6.2396 | 1589: Space Situational Awareness | Miscellaneous |
| 122 | 6.2333 | 1436: Efficient and Safe Higher Power Systems for Small Spacecraft | Small Spacecraft |

| Other Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 123 | 6.2059 | 1579: Extraction and separation of non-water volatile resources from Lunar regolith | ISRU |
| 124 | 6.2037 | 1487: In-Space and On-Surface Welding Technologies for Manufacturing, Assembly, and Construction | Advanced Manufacturing |
| 125 | 6.1961 | 1597: Power for Non-Solar-Illuminated Small Systems | Power |
| 126 | 6.1863 | 1594: Martian Surface Power Generation from ISRU Derived Resources | Power |
| 127 | 6.1667 | 1623: Advanced thermal modeling capabilities | Thermal Management Systems |
| 127 | 6.1667 | 1408: Advanced deployable load-bearing structures | Advanced Materials and Structures |
| 127 | 6.1667 | 1486: In-Space and On-Surface NDE and Qualification of Components for Manufacturing, Assembly, and Construction | Advanced Manufacturing |
| 127 | 6.1667 | 1576: Micrometeoroid-Robust Protection of In-space Observatories | Advanced Materials and Structures |
| 131 | 6.1333 | 703: Rotating Detonation Rocket Engine (RDRE) | Propulsion: Non Nuclear |
| 132 | 6.1250 | 1533: Autonomous Robotic Sample Identification, Classification, Collection, Manipulation, Verification, and Transport | Autonomous Systems and Robotics |
| 133 | 6.1176 | 544: Solar Electric Propulsion to Support Orbital Platforms | Propulsion: Non Nuclear |
| 133 | 6.1176 | 1547: Robotic Systems for Sub-Surface Access | Autonomous Systems and Robotics |
| 135 | 6.0882 | 1585: Extraterrestrial surface environmental simulators, test facilities, and test sites | ISRU |
| 136 | 6.0741 | 1390: Power and Data Transfer in Dusty Environments | Power |
| 137 | 6.0729 | 1588: Protect Earth from Destructive Natural Impacts (Planetary Defense) | Miscellaneous |
| 138 | 6.0333 | 1437: Dynamic and Capable Thermal Control for Small Spacecraft | Small Spacecraft |

| Other Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 139 | 6.0313 | 1432: Rendezvous, Proximity Operations, and Debris Remediation using Small Spacecraft | Small Spacecraft |
| 140 | 6.0222 | 705: Low Power Nuclear Electric Propulsion | Propulsion: Nuclear |
| 141 | 5.9872 | 512: Cooperative interfaces, aids, and standards | ISAM and RPOC |
| 142 | 5.9405 | 1615: Common tools for on-surface maintenance and repair for reduced crew interaction | Surface Systems |
| 143 | 5.9286 | 1599: Quantum Sensors That Use Atoms, Ions, and Spins | Sensors and Instruments |
| 144 | 5.9222 | 1617: Autonomous on-surface maintenance and repair for sustained lunar evolution | Surface Systems |
| 145 | 5.9063 | 1431: Access Beyond LEO for Small Spacecraft | Small Spacecraft |
| 146 | 5.8778 | 513: Robotic Assembly and Construction of Modular Systems for Sustained In-Space Infrastructure | ISAM and RPOC |
| 147 | 5.8690 | 1506: In-Space & Surface Transfer of High-Pressure Gases | ISAM and RPOC |
| 148 | 5.8571 | 1522: Crew Health Countermeasures – Non-Exercise | Advanced Habitation Systems |
| 149 | 5.8111 | 376: Modular design for in-space installation | ISAM and RPOC |
| 150 | 5.7870 | 767: Advanced designs for lightweight inflatable surface elements | Advanced Materials and Structures |
| 151 | 5.7857 | 611: Sub-kW and kW Class Electric Propulsion Systems | Propulsion: Non Nuclear |
| 152 | 5.7738 | 1604: Find, Study Habitable Zone Earth-like Exoplanets and Search for Biosignatures | Sensors and Instruments |
| 152 | 5.7738 | 1609: Surface-based lunar logistics management for sustained lunar evolution | Surface Systems |
| 154 | 5.7451 | 1592: High Power, Long Distance Energy Transmission Across Distributed Surface Assets | Power |
| 155 | 5.7143 | 1544: Resilient Agency: Adaptable Intelligence and Robust Online Learning for Long-Duration and Dynamic Missions | Autonomous Systems and Robotics |

| Other Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 156 | 5.7083 | 1601: Enable Observation of Whole Top-to-Bottom Dynamic Ecosystems | Sensors and Instruments |
| 157 | 5.6667 | 1530: Aerial Robotic Mobility and Onboard Intelligence for Expanded Capabilities on Mars, Venus, and Titan | Autonomous Systems and Robotics |
| 158 | 5.6458 | 1494: Digital Transformation Technologies for Terrestrial, In-Space, On-Surface Manufacturing, and Operations | Advanced Manufacturing |
| 159 | 5.6429 | 1598: Quantum Sensors That Use Photons | Sensors and Instruments |
| 160 | 5.6250 | 1626: Advanced Sensor Components: Imaging | Sensors and Instruments |
| 161 | 5.6078 | 1430: Small Spacecraft Propulsion | Small Spacecraft |
| 162 | 5.5833 | 1558: High-Rate Communications Across The Lunar Surface | Communication and Navigation |
| 163 | 5.5769 | 1606: Observe Some of the Most Energetic Phenomena in the Universe | Sensors and Instruments |
| 164 | 5.5476 | 1514: Atmospheric Metabolic Constituent Management for Habitation | Advanced Habitation Systems |
| 165 | 5.5208 | 1611: Surface-based end-of-life equipment management | Surface Systems |
| 166 | 5.5000 | 1607: Detect New Astronomical Messenger - Gravitational Waves | Sensors and Instruments |
| 167 | 5.4744 | 1605: Peer Back Farther in Time to the Early Universe | Sensors and Instruments |
| 168 | 5.4630 | 1262: Remediation of Small Debris | Orbital Debris |
| 169 | 5.4615 | 1625: Intelligent Multi-Agent Constellations for Cooperative Operations | Autonomous Systems and Robotics |
| 170 | 5.4556 | 1614: Surface-based planning and scheduling technologies for sustained lunar evolution | Surface Systems |
| 171 | 5.4444 | 1575: Thermal and Vibrational Isolation for Ultra-stable Science Payloads | Advanced Materials and Structures |
| 172 | 5.3718 | 1512: Modern Solid Motor Design and Analysis Tools / Capabilities | Propulsion: Non Nuclear |

| Other Rank | Average Score | Shortfall ID | Capability Category |
|---|---|---|---|
| 173 | 5.3333 | 701: Green Propellant Propulsion Systems | Propulsion: Non Nuclear |
| 174 | 5.3000 | 361: Surface Mating Mechanisms | ISAM and RPOC |
| 175 | 5.2667 | 1627: Advanced Sensor Components for Heliophysics and Lunar-Based Astronomy | Sensors and Instruments |
| 176 | 5.2381 | 1521: Crew Exercise and Sensorimotor Countermeasures | Advanced Habitation Systems |
| 176 | 5.2381 | 1513: Advanced Solid Propulsion Systems | Propulsion: Non Nuclear |
| 178 | 5.2353 | 1537: Free-Flying Systems for Robotic Inspection, Data Collection, and Servicing of In-Space Assets | Autonomous Systems and Robotics |
| 179 | 5.2273 | 1600: Enable Paradigm for System Science to Include Interactions Between Subsystems | Sensors and Instruments |
| 180 | 5.2000 | 700: Solar Sails for Propellant-less Propulsion | Propulsion: Non Nuclear |
| 181 | 5.1667 | 379: Upgrade or Install Instruments on Large Space Observatories | ISAM and RPOC |
| 182 | 5.1250 | 1052: EVA/IVA Support Propulsion Development | Propulsion: Non Nuclear |
| 183 | 5.0256 | 1621: Cryogenic cooling for science instrumentation | Thermal Management Systems |
| 184 | 5.0000 | 1536: Free-Flying Mobility Aids for Crew EVA | Autonomous Systems and Robotics |
| 185 | 4.9744 | 1518: Logistics Tracking, Clothing, and Trash Management for Habitation | Advanced Habitation Systems |
| 186 | 4.9286 | 1515: Atmospheric Non-Metabolic Constituent Management for Habitation | Advanced Habitation Systems |
| 187 | 4.7051 | 1587: Wildfire Integrated Effect Chain | Miscellaneous |

National Aeronautics and Space Administration

**Headquarters**
300 E. Street, SW
Washington, DC 20546

**www.nasa.gov**

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