# Commercial Spaceflight Federation Presentation to the Committee on Planetary Protection Meeting No. 4 on Mars Mission Bioburden Requirements

Thursday, May 6, 2021

# Introduction to CSF

# CSF Overview

- CSF is the leading national trade association for the commercial space industry, with more than 85 member companies and organizations across the United States.
- Founded in 2006, CSF is focused on laying the foundation for a sustainable space economy and democratizing access to space for scientists, students, civilians, and businesses.
- Through the promotion of technology innovation, CSF members are guiding the expansion of Earth's economic sphere, bolstering U.S. leadership in aerospace, and inspiring America's next generation of engineers, scientists, and explorers.

# Executive Members (25)

- ABL Space Systems
- Arizona State University
- Axiom Space
- Blue Origin
- BPRH
- Jacksonville Aviation Authority- Cecil Field Spaceport
- Deloitte
- ISS National Laboratory
- Masten
- Maxar Technologies
- Midland International Air & Space Port
- Mojave Air & Space Port
- Planet
- Qwaltec
- Relativity
- Sierra Nevada Corporation
- Southwest Research Institute
- Space Florida
- Space Perspective Inc.
- Spaceport America
- Spaceport Camden
- SpaceX
- Virgin Galactic
- Virginia Commercial Space Flight Authority
- World View Enterprises

# Associate Members (41)

- Advanced Space
- AECOM
- AGI
- Alaska Aerospace Corporation
- Analytical Space
- AST
- Astranis
- Atomos Space
- Barrios Technology
- Cognitive Space
- Colorado Air & Space Port
- David Clark Company
- EnerSys
- Ground Based Space Matters
- Heinlein Prize Trust
- Houston Airport System
- HelicitySpace Corp
- ISPCS
- Jacobs Technology
- John Hopkins Advanced Physics Laboratory
- Kearney
- Kimley-Horn
- Launch on Demand
- Made in Space
- Marotta
- MLA Space
- Momentus Space
- NanoRacks
- Parabilis
- Relativity Space
- Rob Baker & Associates
- Rocket Lab
- RS&H
- Space Adventures
- Space Angels
- Spaceflight Services
- SpinLaunch
- Spaceport Sweden
- Space Tango
- Spire
- TechShot
- Tesseract
- TIP Technologies, Inc.
- University of Colorado Boulder
- Voyager
- Xplore

# Research and Education (REA) Affiliates (20)

- American Society for Gravitational and Space Research
- Association of Spaceflight Professionals
- Battelle Center for Science, Engineering, and Public Policy at Ohio State University
- Department of Aeronautics & Astronautics, Stanford University
- Florida Institute of Technology
- Florida State University
- The Museum of Flight
- National Institute for Aviation Research
- New Mexico Institute of Mining and Technology
- New Mexico State University
- Purdue University
- Silicon Valley Space Center
- Sovaris Aerospace
- Space Medicine Association
- STARS at Carnegie Mellon
- Nancy Vermeulen Space Training Academy
- University of Arizona
- University of Florida
- University of North Dakota
- University of Texas Medical Branch

# CSF Members' Economic Impact & Presence

CSF Members Economic Impact:

- CSF members are responsible for the creation of tens of thousands of high-tech U.S. jobs driven by billions of dollars in investment.

CSF Members Presence:

- CSF members and their subcontractors have a presence in almost all 50 states;
- CSF members and subcontractors have heavy jobs and infrastructure investments in Washington, California, Arizona, New Mexico, Texas, Mississippi, Alabama, and Florida

# How commercial space is enabling more Science & Exploration — & backed by strong bipartisan White House & Congressional support

# Commercial is enabling more Science & Exploration

SPACENEWS

**Op-ed | Advancing science through human-tended suborbital experiments on commercial vehicles**

by Steven Collicott — March 9, 2021

THE HILL

December 24, 2020 · 03:30 PM EST

**Why I'm flying to space to do research aboard Virgin Galactic**

BY ALAN STERN, OPINION CONTRIBUTOR 702 SHARES

NASA TV

May 22, 2020

**NASA's Commercial Crew Program Brings Extra Hands to Science on the Space Station**

SPACE Subscribe

**SpaceX's Crew-2 astronauts will conduct more than 200 science experiments in space**

By Amy Thompson 15 days ago

NASA Researchers Use Planet Data To Study The Effects Of Climate Change On Our Cryosphere

Tanya Harrison | April 22, 2021

NASA TV

Feb 3, 2021

**Lunar Traffic to Pick Up as NASA Readies for Robotic Commercial Moon Deliveries**

SPACENEWS

**NASA selects three companies for human landing system awards**

by Jeff Foust — April 30, 2020

# Commercial is enabling more Science & Exploration

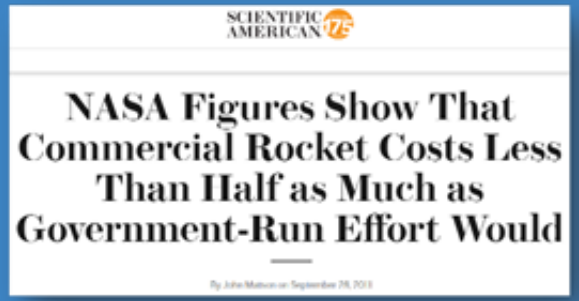
NASA Office of Inspector General
Office of Audits

## RESULTS IN BRIEF

**Audit of Commercial Resupply Services to the International Space Station**

April 26, 2018 IG-18-016 (A-17-013-00)

Cargo missions are key to the successful utilization of the ISS and continued reliance on commercial operators to provide this vital service could play a major role in NASA's future plans as it searches for cheaper and more efficient methods to explore space. Costing more than 30 percent of the ISS Program's annual budget, NASA officials view the commercial resupply contracts as successful and cost effective. In this audit, we examined the CRS contracts for resupplying the


SCIENTIFIC AMERICAN 175

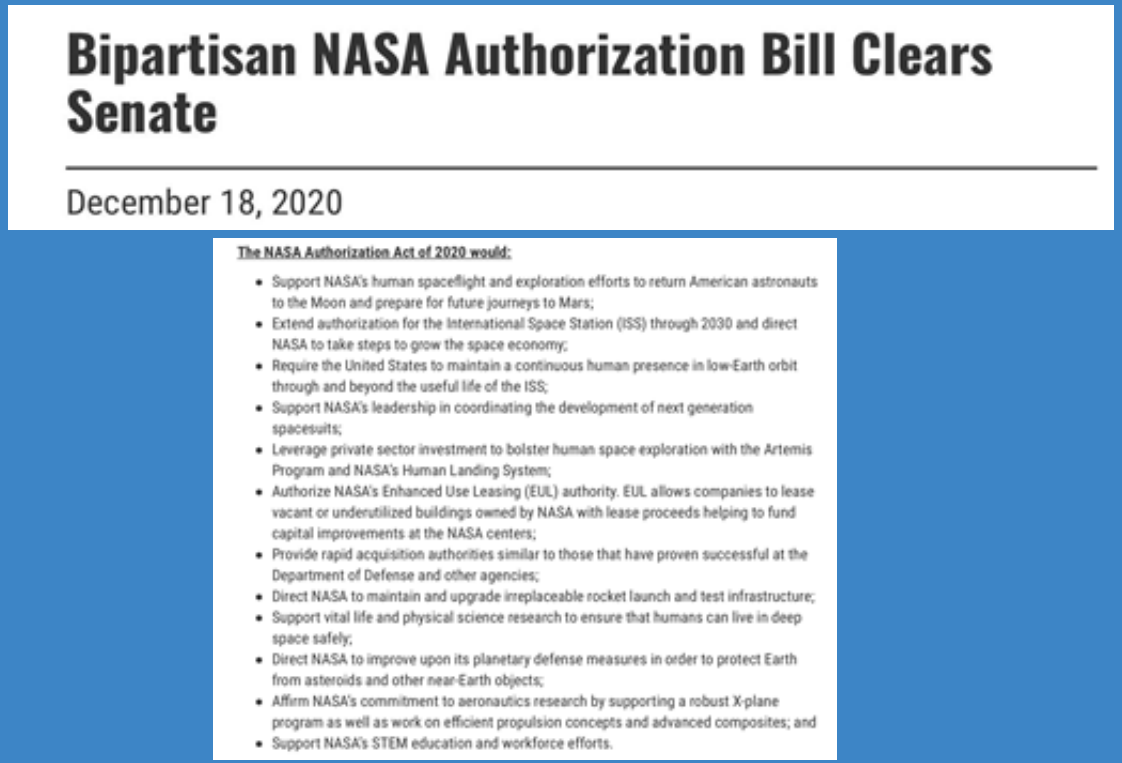
NASA Figures Show That Commercial Rocket Costs Less Than Half as Much as Government-Run Effort Would


MARKETS BUSINESS INVESTING TECH POLITICS CNBC TV WATCHLIST PRO

INVESTING IN SPACE

NASA estimates having SpaceX and Boeing build spacecraft for astronauts saved $20 billion to $30 billion

# Strong Bipartisan Congressional support for Commercial's increasing role in Science & Exploration



**Bipartisan NASA Authorization Bill Clears Senate**

December 18, 2020

**The NASA Authorization Act of 2020 would:**

- Support NASA's human spaceflight and exploration efforts to return American astronauts to the Moon and prepare for future journeys to Mars;
- Extend authorization for the International Space Station (ISS) through 2030 and direct NASA to take steps to grow the space economy;
- Require the United States to maintain a continuous human presence in low-Earth orbit through and beyond the useful life of the ISS;
- Support NASA's leadership in coordinating the development of next generation spacesuits;
- Leverage private sector investment to bolster human space exploration with the Artemis Program and NASA's Human Landing System;
- Authorize NASA's Enhanced Use Leasing (EUL) authority. EUL allows companies to lease vacant or underutilized buildings owned by NASA with lease proceeds helping to fund capital improvements at the NASA centers;
- Provide rapid acquisition authorities similar to those that have proven successful at the Department of Defense and other agencies;
- Direct NASA to maintain and upgrade irreplaceable rocket launch and test infrastructure;
- Support vital life and physical science research to ensure that humans can live in deep space safely;
- Direct NASA to improve upon its planetary defense measures in order to protect Earth from asteroids and other near-Earth objects;
- Affirm NASA's commitment to aeronautics research by supporting a robust X-plane program as well as work on efficient propulsion concepts and advanced composites; and
- Support NASA's STEM education and workforce efforts.

# Strong Bipartisan Executive Branch support for Commercial's increasing role in Science & Exploration

## White House endorses Artemis program

by **Jeff Foust** — February 4, 2021

"Through the Artemis program, the United States government will work with industry and international partners to send astronauts to the surface of the moon — another man and a woman to the moon, which is very exciting — conduct new and exciting science, prepare for future missions to Mars and demonstrate America's values," she said.

In the early months of this administration, President Biden committed his support to the Artemis program. The first of the Artemis mission launches within the next year, and subsequent missions will land the first woman and the first person of color on the Moon. When NASA returns to the Moon this time, we will go in a way that reflects the world today – with government, industry, and international partners in a global effort to build and test the sustainable systems needed for challenging missions to Mars and beyond.

# CSF supports NASA’s efforts to modernize and streamline planetary protection policies

# CSF applauded PPIRB Report

## CSF Applauds NASA's Planetary Protection Independent Review Board Report

by Tommy Sanford **on OCTOBER 18, 2019**

Washington, DC — The Commercial Spaceflight Federation (CSF) applauds NASA's Planetary Protection Independent Review Board (PPIRB) report and its recommendations to modernize and streamline NASA's planetary protection policies. Key among the PPIRB's recommendations is to ease the pursuit of new planetary mission opportunities and the participation of new players, particularly in the private sector. The early adoption and full implementation of these recommendations will increase the number and variety of missions flown and enable greater science and exploration of the Solar System. CSF recognizes the important principles behind planetary protection and supports the modernization of frameworks to enable the responsible exploration of areas of high astrobiological potential by both government and private sector missions.

# CSF feedback to Committee on Planetary Protection Meeting No. 4 on Mars Mission Bioburden Requirements

CSF surveyed our members on commercial perspectives and plans with respect to Mars missions and planetary protection, and in particular, questions related to less restrictive bioburdens for Mars missions. The feedback below is a snapshot of their feedback.

1. As a step towards modernizing NASA's planetary protection requirements, in general do you agree with the concept idea that we should be identifying criteria for determining locations or regions on Mars that are potentially suitable for missions of less restrictive bioburden than the current requirements?

# Responses:

- Yes. The current planetary protection guidelines were based on a much older understanding of Mars and the potential for Earth-based life to confound potential scientific investigations on Mars. They were also developed in the context of government-led robotic science missions. With improved understanding regarding different areas on Mars, including large areas where Earth-based life forms would not replicate, and a broadening of activities that may be conducted on Mars, developing less restrictive guidelines for conducting missions to Mars provides significant opportunities to increase scientific and other activities on Mars in a cost effective fashion.
- Yes to any steps toward facilitating exploration.
- Yes, because this is a more responsible way to treat Mars than as if every locale is equally scientifically valuable.
- Yes. The growing capabilities of the commercial space industry (both in the U.S. and abroad) as well as more international governments participating in Mars exploration suggest that Mars can no longer be “protected” from all but one narrow scientific activity.

2. To help the Committee understand the number of missions, types of missions, and timelines for missions that commercial companies plan to undertake, if you can, please share any general plans your company has for Mars missions and the general timeline for those missions.

# Responses:

- American companies are developing vehicles that will enable the delivery of large quantities of cargo and eventually people to the surface of Mars. These vehicle are in active development, and they will fly initial test missions to Mars within this decade. These flights will support of the build-out of surface infrastructure on Mars and the use of in-situ resources to enable the development of a large and growing outpost leading to the eventual establishment of a city on Mars – all critical steps towards making humanity multiplanetary. In the process of these activities, significant opportunities for Mars science and astrobiological investigations will become available.
- American companies also participate in Mars missions by building payloads, leading or participating in science teams, and sometimes building spacecraft avionics. American companies are also developing capabilities to provide services in orbit at Mars, and offer observational data and communication relay services for the infrastructure and missions being considered on the surface.

# Responses:

- Continued…
- It is clear that there are entrepreneurial firms that wish to participate in the exploration, development, and eventual long-term human habitation on Mars, and that this participation is motivated by intellectual and ideological considerations beyond normal economic motivations. This would suggest that missions to Mars, including human missions, could potentially take place in the next two decades. Astrobiologists should therefore accelerate their efforts to search for life if that search requires or substantially benefits from a lack of other human-instigated activities on Mars, because that situation is unlikely to continue past 2050, if not sooner.

3. The Committee has identified the following criteria for determining if a location on Mars is appropriate for missions with lower bioburden requirements than the current Category IV: 1) Temperatures at the landing site and locations of mission activities are below -25°C, or water activity is less than 0.5 (Note: water activity = water vapor pressure of a solution/vapor pressure of pure water); 2) Mission activities will go no deeper than a certain distance below the surface; 3) Landed spacecraft are not capable of melting the regolith; and 4) Proposed landing and/or mission activity sites do not contain geomorphological characteristics of flowing water, such as recurring slope lineae, etc. Is this appropriate criteria for determining if a location on Mars is appropriate for missions with lower bioburden requirements than the current Category IV?

# Responses:

- Agree that sites that meet these criteria can have less restrictive bioburden standards than are currently employed for NASA robotic Mars missions without unduly impacting on their scientific potential. Additionally, in several cases these constraints could be opened further, such as accessing the deeper sub-surface or melting a small amount of surface material, provided that the extent to which any terrestrial organisms can replicate and be transported beyond the area of that particular mission activity is limited, even in cases where the initial bioburden is greater than current levels. Further, as the scale of missions increase, it is important to evaluate any bioburden guidelines in the context of specific activities, rather than the mission as a whole – for example, if a lander carries a payload that will eventually be used to access into a more restrictive area, the entire lander mission need not apply the more restrictive bioburden guidelines, only the payload in question with appropriate controls in place to maintain the scientific integrity of that payload's activities.
- Yes, seems entirely reasonable.

4. The Committee has identified the following methods to show that the above criteria are met: 1) Observational data from orbiters, landers, rovers, and Earth-based observation; and 2) Modeling based on the most up-to-date knowledge of the Martian environment and its processes. Are these methods appropriate for illustrating the above criteria are met?

# Responses:

- Yes, these seem to be appropriate methods.
- Yes, because these are the only available tools for making such determinations before landings are conducted.

5. In determining criteria for locations on Mars, do you have any thoughts on whether mission activities need to be constrained to an area of a specific diameter, including off-nominal operation margin?

# Responses:

- Given the scale of Mars, the multitude of potential locations for useful scientific investigation, and the relative scarcity of areas that could potential harbor terrestrial organisms near the surface, we do not see a need to constrain operations to a specific diameter at this time. Using the planned mission operations as a basis for assessing the potential for an area to use less stringent bioburden protocols is sufficient.
- Yes, one should map out the surface as a function of Category and then sets a radius of operations around a landing site. Then the mission category would be set by the highest category within that radius, including off nominal ops like an EDL gone bad.

6. Finally, please briefly comment on whether these locations may be suitable for an eventual human exploration mission. NASA is interested in the CoPP's views on whether these criteria may be useful when considering how human missions can be carried out without large-scale biological contamination of Mars.

# Responses:

- While operations in the areas / conditions described above would be acceptable within the context of a human mission, many other activities could also be conducted without creating large-scale biological contamination of Mars. Human missions to Mars will want access to significant quantities of water, most likely in the form of ice. While some ice resources may be available and may be able to be extracted while meeting the above criteria, other resources may be at yet-to-be-determined greater depth or may involve creating transient or persistent liquid water, with the potential for replication of terrestrial organisms. Provided these activities are properly managed (such as by limited replication or transport), they do not present an undue risk of large-scale contamination of Mars.
- Human missions mean contamination, as the NASA PPIRB reported as a finding. That's simply a fact of reality. What the PPIRB also found was that the benefits of human exploration outweighed the contamination concerns at least for non-habitable sites.

# Final Thought/Conclusion

Enabling more organizations to conduct activities on Mars by revising current guidelines will have significant benefits, including to the scientific community and humanity more broadly. These benefits will more than outweigh any increased bioburden impact in terms of investigations in the areas being considered as part of the current study.

# Thank you!

# Discussion