

## Preface

“We’re really on the cusp of an exciting new capability for our country and for our economy.”

Lori Garver, NASA’s deputy administrator, explaining why NASA is seeking \$75 million for NASA’s Commercial Reusable Suborbital Research program

As the main engine ignites, the crew feels a deep rumble far below them and a sudden sensation of motion as the launch vehicle lifts off, trailing a 150-m-long fountain of sun-bright exhaust in an inferno of smoke, searing light, and earth-shaking noise. The three crewmembers feel the thunder of the launch, the numbing noise, and the incredible acceleration, as they are pushed forcefully back into their seats. The gut-wrenching journey to orbit – an event planned for many months and anticipated by the crew for several years – takes less than nine minutes. Once in orbit, the thrill of the ascent is replaced by a moment of fulfillment as the spacefarers get their first glimpse of Earth from space – a moment worth a lifetime of anticipation and the hundreds of hours spent training. But this is no ordinary spaceflight. Seated either side of the pilot are two commercial astronauts – astronauts for hire – employed by a research company to conduct experiments in low-Earth orbit.

Until recently, spaceflight had been the providence of a select corps of professional astronauts whose missions, in common with all remarkable exploits, were experienced vicariously by the rest of the world via television reports and internet feeds. These spacefarers risked their lives in the name of science, exploration, and adventure, thanks to government-funded manned spaceflight programs.

All that is about to change.

Section I describes how Astronauts for Hire (A4H) was created in 2010 by Veronica Ann Zabala-Aliberto, Ryan Kobrick, Amnon Govrin, Brian Shiro, and Joe Palaia. Here, the reader is introduced to A4H’s vision for opening the space frontier to commercial astronauts and describes the tantalizing science opportunities offered when suborbital and orbital trips become routine. Section I goes on to describe the training and qualification necessary to become a member of the future astronaut corps. The process of acquiring the necessary qualifications to become a government-sponsored astronaut can take 20 years or more. To submit a competitive application, it is generally accepted a candidate must possess a myriad of

qualifications, ranging from the requisite Ph.D. and a pilot's license to skydiving credentials and scuba-diving experience. For the budding commercial astronaut, the standards are still challenging, but not as demanding as government selection. Section I concludes by introducing the reader to A4H's suborbital and orbital qualification process, such as the demands of high-altitude indoctrination and the punishing ride in NASTAR's centrifuge.

Section II describes the vehicles that will fly the new crop of commercial astronauts. Anticipation is on the rise for the new fleets of commercial suborbital and orbital spaceships that will serve the scientific and educational market. These reusable rocket-propelled vehicles are expected to offer quick, routine, and affordable access to the edge of space, along with the capability to carry research and educational crew members such as A4H'ers. Yet to be demonstrated is the hoped-for flight rates of suborbital vehicles. Quick turnaround of these craft is central to realizing the profit-making potential of repeated sojourns by commercial astronauts to suborbital and orbital heights. As Section II outlines, vehicle builders still face rigorous shake-out schedules, flight-safety hurdles, as well as extensive trial runs of their respective craft before suborbital space jaunts become commonplace. Section II examines some of these "cash and carry" suborbital craft under development by such companies as Blue Origin, Masten Space Systems, Virgin Galactic, and XCOR Aerospace, and describes the hurdles the space industry must overcome before the hiring of commercial astronauts can develop into a profitable economic entity. It also provides positive suggestions for how the commercial spaceflight industry can plan and prepare for the challenges of marketing and financing the hiring of astronauts. Section II continues by examining the role of commercial operators as enablers of the future of astronauts for hire. It concludes with a vision of a partnership with governments and the private sector and how this collaboration will eventually integrate the free market's innovation of commercial space activities.

Section III describes the various missions this new corps of astronauts will fly and the customers who will employ them. It begins with an assessment of suborbital flights, which may be used to carry out a variety of high-altitude science studies, including access to three to four minutes of microgravity for experimentation in disciplines such as astronomy, life sciences, and microgravity physics. Section III continues by examining the types of missions that will accelerate human expansion outward, beginning with orbital science missions to commercial trips to low-Earth orbit and continuing with Exploration Class missions through cislunar space, the establishment of interplanetary spaceports, lunar bases, and outposts on the surface of Mars. Along the way, it describes the tasks commercial astronauts will perform, ranging from mining asteroids to harvesting helium.

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