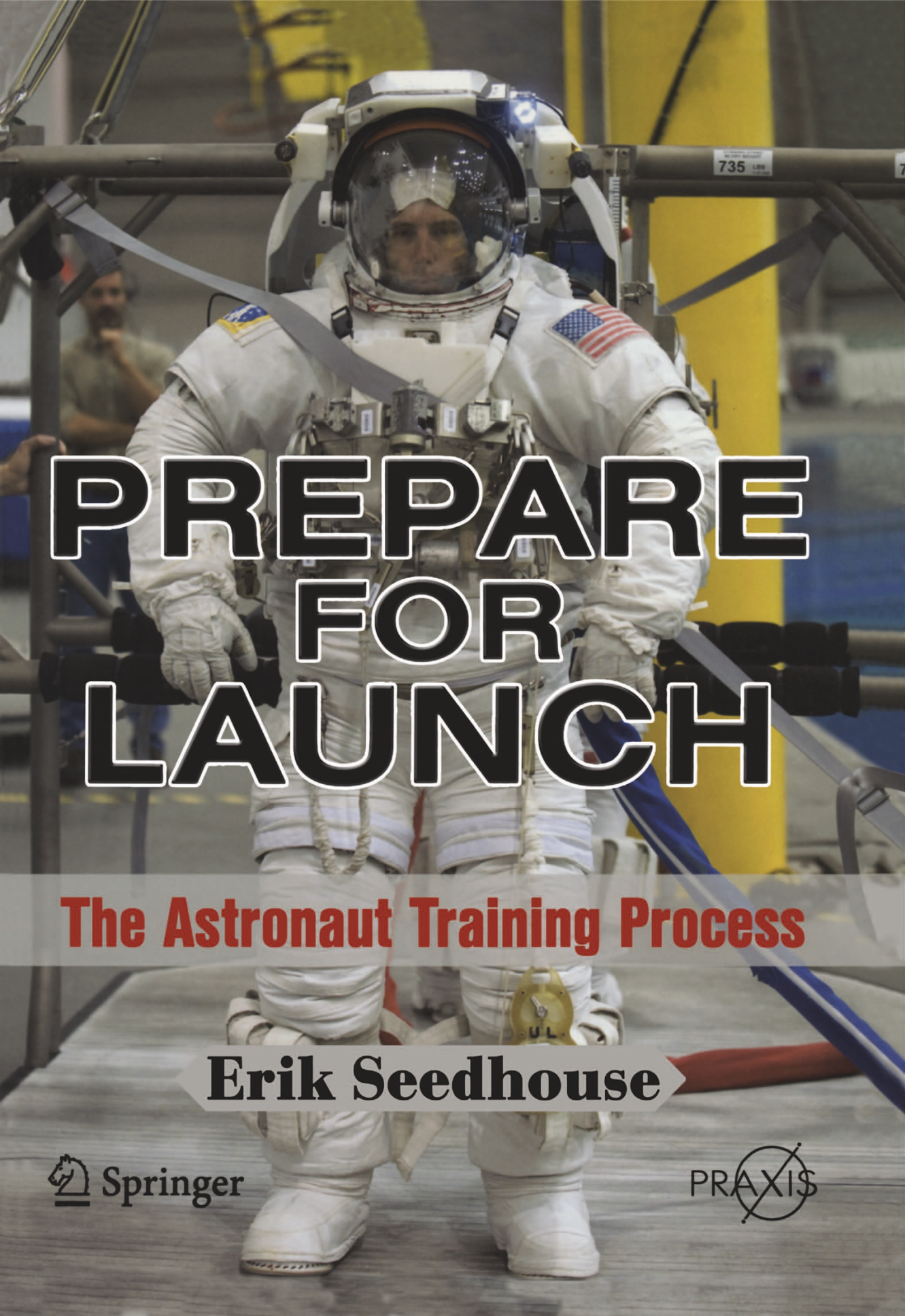

PREPARE FOR LAUNCH

The Astronaut Training Process

Erik Seedhouse

Springer

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Contents

Preface

"I have always wanted to be an astronaut. Every kid growing up during the space race wanted to be an astronaut. Unlike most kids, however, I never vacillated in my career choices. I have a vivid memory of sitting on the lounge floor, watching the first lunar landing on my parents' black and white television set. Watching the images of the *Saturn V* on the launch pad and astronauts bounding across the lunar surface, I resolved to become an astronaut. Only 5 years old at the time, the initial appeal for me of becoming an astronaut was riding a rocket and walking on the Moon.

As I learned more about what was required to be selected as an astronaut, I focused increasingly on achieving my dream. In 1987, knowing many astronauts had a military background, I joined the 2nd Battalion of the Parachute Regiment. Forty-three recruits started the 27-week basic training to become a 'Para'. Just three of us were successful. I was one of the three.

During my time in the Paras, I was trained by the Special Air Service (SAS) in jungle and desert warfare, made night jumps from Chinook helicopters, and jumped out of a Hercules C-130 more times than I can remember. I also endured annual 80-km marches with a 20-kg pack on my back and acquired advanced survival techniques in the jungles of Belize and the desert of northern Cyprus. During operational deployments, I gained extensive experience operating in the cohesive environment of a small team, while under considerable and prolonged stress. I enjoyed the training immensely, especially knowing it provided excellent experience for becoming an astronaut.

My first postgraduate degree was a Master's in Medical Science at Sheffield University. Rather than choose one of the research options offered by the course, I decided to pay Dr. David Grundy a visit. David was Director of the Institute for Space Biomedicine. Together, we formulated a space life-sciences research proposal focusing on head-down-tilt, the outcome of which was an article published in the *Physiologist* in 1991. While at Sheffield, I began to focus more on sports, with the goal of becoming a professional athlete.

On completing my Master's degree, I moved on to work in a Pulmonary Function

Laboratory and learned how to balance budgets and develop test protocols. Shortly after starting work at the laboratory in March, 1992, I applied to the Canadian Astronaut Program. Since I had not yet accumulated the myriad qualifications required for a competitive application, my objective was to indicate to the CSA my interest in becoming an astronaut, with the intention of being able to submit a more competitive application when the next selection was advertised.

Although I realized the next selection might be many years away, my focus never wavered. My next goal was to experience microgravity and, to that end, I volunteered to be a subject in a study conducted by a colleague of Dr. Grundy. In April, 1995, I participated as a subject in the European Space Agency's 22nd Parabolic Flight Campaign, which provided me with valuable experience in performing equipment set-up, calibration, and monitoring in support of physiological testing. The data collection for the study took place over a 5-day period, flying 30 parabolas daily over the Bay of Biscay, providing me with ample opportunity to experience microgravity.

My increasing involvement in competitive sports culminated in my achieving a key ambition: that of becoming a professional athlete. This goal was accomplished after winning the World Endurance Triathlon Championships in 1995. During my triathlon career, I repeatedly demonstrated my commitment to my corporate sponsors, an enduring resolve, and the mental and physical fortitude enabling me to win what many considered impossible races. Winning world championship races was achieved by adhering to a strict and rigorous training regime and with the motivation to achieve distinction, a trait I consider an asset to any aspiring astronaut. Furthermore, due to my success, I was in regular demand by the media for interviews and gained invaluable experience as a representative for my corporate sponsors.

Shortly after becoming a professional triathlete, I moved to Germany, courtesy of a $50,000 ESA grant. While studying for my Ph.D. at the Institute for Space Medicine, I had the opportunity to acquire a working knowledge of ESA's program of operation. My work at the Institute also provided me with experience related to a variety of space program development practices and extended my ability to interact with external and international scientific counterparts. I pursued my Ph.D. studies simultaneously with my sports career – a combination requiring me to work 70 or more hours a week. Apart from being an ideal place to conduct research, the Institute also provided an outstanding opportunity to accumulate expertise in space program procedures and acquire a working knowledge of space medicine.

Upon retiring as a triathlete in 1999, I pursued my post-doctoral qualification at Simon Fraser University's (SFU) Environmental Physiology Unit (EPU). While there, I envisioned the Extreme Physiology Program (EPP) and initiated field research trips to Mount McKinley and Aconcagua. The EPP was envisaged as a multi-science/technology research and development program in which studies of human physiology in stressful environments would be conducted. These studies included lab experiments (simulated space, high altitude, and deep sea) and field studies (using wireless technologies), the first of which was a simulated 5-day stay onboard the International Space Station. Later (field) studies included ascents of Mt.

McKinley and Aconcagua to investigate the differences in physiological responses between athletes and non-athletes. As a Co-Director of the EPP, I directed, implemented, managed, and monitored research programs, and developed the priorities and objectives for research projects within the program.

In 2005, I was recruited by Bigelow Aerospace, Las Vegas, as an Astronaut Training Consultant. During my time at Bigelow Aerospace, I designed, wrote, and edited the *Spaceflight Participants Training Manual*, designed medical algorithms for spaceflight medical emergencies, and developed instructional materials. I also designed, wrote, and edited the *Chief Medical Officer's Manual* for spaceflight participant selection and designed and edited astronaut certification standards for spaceflight participants.

In 2007, I joined the Aerospace Group at the Defence and Research Development Canada (DRDC) in Toronto, to work as a program manager overseeing specialized research development projects.

Curiosity has always gotten the better of me. I enjoy scuba-diving, climbing mountains, writing books, racing Ironman triathlons, flying my Cessna, and writing and directing movies. My quirk is that I prefer technical manuals to television and I hate sitting still. I cannot resist new activities and enjoy squeezing as many projects into my life as possible. I consider the ability to display competence, self-reliance, and the ability to work effectively even under the most challenging conditions as traits required by an astronaut and I believe I possess those qualities. Having varied experiences and adapting well to their demands is a desirable characteristic for an astronaut and I consider my background supports this requirement.

My varied work experience has provided me with the opportunity to develop excellent communication skills, both written and verbal. I have contributed extensively to *Spaceflight* magazine, been interviewed on numerous occasions, published four books, and have worked as a motivational speaker. As an expedition leader, I utilized logistical skills to achieve successful outcomes in dynamic and challenging environments. I consider these and the other aforementioned skills to be key to my effective contribution to the CSA and I am confident in my ability to respond to the challenges of being a Canadian astronaut.

As a potential astronaut, I have demonstrated a willingness to accept physical hazards, a capacity to tolerate rigorous and severe environmental conditions, and the ability to react assertively under conditions of duress. These abilities have been demonstrated during parachute jumps, mountaineering, diving, triathlon, micro-gravity research, and as an instructor during high-altitude indoctrination training.

As an astronaut, I believe I will be an asset to the CSA. My varied scientific experience, combined with my athletic career and military training, have provided me with a unique background that has inculcated a calm, methodical, and cautioned approach to problem solving, whether in a laboratory or under conditions of prolonged physical and mental duress. I am easy to work with and integrate easily within a team and I believe I can provide the same support, encouragement, and honesty to fellow co-workers and astronauts.

Throughout my career, I have maintained an enduring, positive commitment to manned spaceflight, my life's one overriding passion. I have been reading about and

studying spaceflight since that day I watched the Moon landings. I want to join the Canadian Astronaut Team because it is the best occupation to fully utilize my professional skills and experience, and because it is a profession in which I could contribute the most to the CSA in its execution of Canada's space policy. I would be privileged to join the Canadian Astronaut Team, who have raised teamwork to a new level, made excellence a given, and challenged conventional thinking with courage and imagination. I am ready and eager to be a part of that team."

One of the first stages of the CSA's 2008 Astronaut Recruitment Campaign required applicants to write an essay explaining why they wanted to be an astronaut. The essay you have just read was the one I submitted. After a year of selection tests, including sea survival, fighting fires, robotics assessment, and a myriad other trials and evaluations, I made it to the final 30. Unfortunately, I didn't make it any further. For those applicants who had dedicated 20 years or more to the goal of becoming an astronaut, the blow was devastating to put it mildly. Unlike NASA, which routinely recruits astronauts, the CSA's campaign was only the third since 1983. For many of those deselected at the final stage who had waited 16 years since the CSA's 1992 campaign, it was the end of the road. The lucky few who worked in the US indicated they would apply for a Green Card with the intent of applying to NASA at the next campaign. Others returned to their jobs in academia, flying jets, or performing research. A small number found themselves recalibrating their life, trying to find another challenge. For example, one of the most highly qualified candidates confided to me he really didn't like his job (he is one of the world's leading emergency physicians and an Everest summiteer) and was considering climbing K2. Some reflected on the high price they had paid in the personal lives (many had burned through more than one marriage) by following a dream demanding sacrifices few can fathom. Then there were candidates such as myself who set their sights on achieving their goal by gaining employment (and hopefully a flight!) with one of the fledgling private space companies such as Virgin Galactic and SpaceX.

The road to becoming an astronaut is one demanding tremendous sense of direction, perspective, resolve, and extraordinary self-confidence. While many have entertained thoughts of becoming an astronaut, few ever embark upon the journey requiring them to accumulate the myriad qualifications essential for a competitive application. Those ultimately selected are already some of the most highly trained humans on the planet, yet the preparation for their new occupation hasn't even begun! Here, in this book, you will learn how these extraordinarily qualified and uniquely gifted people learn to be astronauts and how their unique training prepares them to do the most exciting, rewarding, and fulfilling job on and off the Earth.

Outline of the Chapters

There have been several books written by astronauts describing the challenges of training and preparing for spaceflight, but most of these have focused on time in orbit. Thanks to first-person accounts such as *Sky Walking* by Tom Jones, and

Riding Rockets by Mike Mullane, armchair spacefarers have the opportunity to gain an insight into the orbital adventures of astronauts. The objective of this book, however, is to describe the nuts and bolts of astronaut training, starting with the application process and finishing with the climactic ride into space.

Section I starts with the application and selection process. As a two-time applicant to become an astronaut with the Canadian Space Agency (CSA), the author reveals what it takes to assemble a competitive application and describes the stringent selection criteria used by space agencies to select future astronauts.

Section II begins with a generic chronology of an astronaut's probationary training at Johnson Space Center (JSC). From spending freezing nights in the Absaroka Mountains learning how to survive on rabbit stew, to pulling Gs in T-38s, the author describes the myriad training elements comprising an astronaut candidate's (ascan) first step towards becoming a fully fledged astronaut. Section II also provides an insight into the world of technical assignments, the seemingly never-ending wait for a flight, and an overview of the types of missions astronauts will be flying over the next two decades. Following a detailed account of the multitude of training elements comprising mission training, the author peers into the future by describing the advantages of hibernation and the challenges of bioethics training.

Before Section III delves into the high-intensity world of pre-launch preparation, the author provides an overview of NASA's new family of launch vehicles and spacecraft that will transport astronauts to the International Space Station (ISS), the Moon and, eventually, Mars. Following a "behind-the-scenes" glimpse of the launch team, the reader is guided through the final 10 weeks of mission training and preparation ultimately leading to launch day.

Acknowledgments

In writing this book, I have been fortunate to have had my wife, Doina, as my proof-reader. Once again, she has applied her considerable skills to make the text as smooth and coherent as possible. Any remaining shortcomings are my responsibility and mine alone.

I am also grateful to the five reviewers who made such positive comments concerning the content of this publication and to Clive Horwood and his team at Praxis for guiding this book through the publication process. The author also gratefully acknowledges Christine Cressy and BookEns, whose attention to detail and patience greatly facilitated the publication of this book. Thanks also to Jim Wilkie for creating the cover of this book.

Once again, no acknowledgment would be complete without special mention of our cats, Jasper and MiniMach, who provided endless welcome distraction and entertainment.

This book is dedicated primarily to my wife, without whom I would never have had the opportunity to pursue my dream.

It is also dedicated to those who helped me along the way, such as Professor David Grundy, Professor Paul Enck, and Parvez Kumar.

Finally, this book is dedicated to Heike, Rolf, Christian, Mark, and dozens of other supremely qualified individuals who, due to myopic political agendas or by not having the right passport, were denied an opportunity to demonstrate their talents as astronauts.

About the author

Erik Seedhouse is an aerospace scientist whose ambition has always been to work as an astronaut. After completing his first degree in Sports Science at Northumbria University, the author joined the legendary 2nd Battalion the Parachute Regiment, the world's most elite airborne regiment. During his time in the "Paras", Erik spent 6 months in Belize, where he was trained in the art of jungle warfare and conducted several border patrols along the Belize–Guatemala border. Later, he spent several months learning the intricacies of desert warfare on the Akamas Range in Cyprus. He made more than 30 jumps from a Hercules C130 aircraft, performed more than 200 abseils from a helicopter, and fired more light anti-tank weapons than he cares to remember!

Upon returning to the comparatively mundane world of academia, the author embarked upon a Master's degree in Medical Science at Sheffield University. He supported his Master's degree studies by winning prize money in 100 km ultradistance running races. Shortly after placing third in the World 100 km Championships in 1992 and setting the North American 100 km record, the author turned to ultradistance triathlon, winning the World Endurance Triathlon Championships in 1995 and 1996. For good measure, he also won the inaugural World Double Ironman Championships in 1995 and the infamous Decatriathlon, the world's longest triathlon, an event requiring competitors to swim 38 km, cycle 1,800 km, and run 422 km. Non-stop!

Returning to academia once again in 1996, Erik pursued his Ph.D. at the German Space Agency's Institute for Space Medicine. While conducting his Ph.D. studies, he still found time to win Ultraman Hawaii and the European Ultraman Championships as well as completing the Race Across America bike race. Due to his success as the world's leading ultradistance triathlete, Erik was featured in dozens of magazines and television interviews. In 1997, *GQ* magazine nominated him as the "Fittest Man in the World".

In 1999, Erik decided it was time to get a real job. He retired from being a professional triathlete and started his post-doctoral studies at Vancouver's Simon Fraser University's School of Kinesiology. While living in Vancouver, Erik gained his pilot's license, started climbing mountains, and took up sky-diving to relax in his

spare time. In 2005, the author worked as an astronaut training consultant for Bigelow Aerospace in Las Vegas and wrote *Tourists in Space*, a training manual for spaceflight participants. He is a Fellow of the British Interplanetary Society and a member of the Aerospace Medical Association. Recently, he was one of the final 30 candidates of the Canadian Space Agency's Astronaut Recruitment Campaign. Erik currently works as manned spaceflight consultant and author. He plans to travel into space with one of the private spaceflight companies. As well as being a triathlete, skydiver, pilot, and author, Erik is an avid scuba-diver and has logged more than 200 dives in more than 20 countries. His favorite movie is the director's cut of *Blade Runner*, his favorite science fiction authors are Allen Steele and Stanislav Lem, and his favorite science fiction series is *Red Dwarf*. *Prepare for Launch* is his fifth book. When not writing, he spends as much time as possible in Kona on the Big Island of Hawaii and at his real home in Sandefjord, Norway. Erik lives with his wife and two cats on the Niagara Escarpment in Canada.

Figures

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Tables

Panels

Abbreviations

ACES	Advanced Crew Escape Suit
ACT	Advanced Concepts Team
AGSM	Anti-G Straining Manoeuvre
AI	Artificial Intelligence
ALTEA	Anomalous Long Term Effects in Astronauts
AMP	Acoustics Measurement Program
APC	Armored Personnel Carrier
AQF	Astronaut Quarantine Facility
ARC	Ames Research Center
AR&D	Automated Rendezvous and Docking
ATV	Automated Transfer Vehicle
BEES	Bioinspired Engineering of Exploration Systems
BLS	Basic Life Support
CapCom	Capsule Communicator
CBT	Computer Based Training
CEEG	Crew Escape Equipment Group
CEV	Crew Exploration Vehicle
CEVIS	Cycle Ergometer with Vibration Isolation System
CF	Canadian Forces
CHeCS	Crew Health Care Systems
CLL	Central Light Loss
CMO	Crew Medical Officer
CNM	Computer Network Modeling
CNS	Central Nervous System
COL	Crew Options List
CQRM	Crew Qualifications and Responsibility Matrix
CRM	Crew Resource Management
CSA	Canadian Space Agency
CSVS	Canadian Space Vision System
CT	Computer Tomography
CTN	Crew Training Notebook

DAM	Debris Avoidance Manoeuvre
DARPA	Defense Advanced Research Project
DCP	Display and Control Panel
DCS	Decompression Sickness
DMS	Data Management System
DoF	Degrees of Freedom
D-RATS	Desert Research and Technology Study
EAC	European Astronaut Center
ECG	Electrocardiograph
ECLSS	Environmental Control Life Support System
EDL	Entry, Descent and Landing
EDR	European Drawer Rack
EDS	Earth Departure Stage
EEG	Electroencephalograph
EES	Emergency Escape System
EET	Emergency Egress Training
EMU	Extravehicular Mobility Unit
ENT	Ear, Nose, Throat
EPDS	Electrical Power Distribution System
EPM	European Physiology Module
ESA	European Space Agency
EST	Ejection Seat Training
ETC	European Transport Carrier
EVA	Extravehicular Activity
EVCPDS	Extravehicular Charged Particle Directional Spectrometer
FCB	Functional Cargo Block
FCER	Flight Crew Equipment Representative
FCL	Flight Crew Licensing
FCOD	Flight Crew Operations Directorate
FCR	Flight Control Room
FD	Flight Director
FEPA	Flight Equipment Processing Associate
FIT	Final Inspection Team
FOR	Frame of Resolution
FSL	Fluid Science Laboratory
FTS	Flight Termination System
GCR	Galactic Cosmic Radiation
GCTC	Gagarin Cosmonaut Training Center
G-LOC	Gravity-Induced Loss of Consciousness
GLS	Ground Launch Sequencer
GNC	Guidance Navigation and Control
GOR	Gradual Onset Rate
GRC	Glenn Research Center
HAI	High Altitude Indoctrination
HEAT	High-fidelity Environment Training

HMD	Head-Mounted Display
HMP	Haughton Mars Project
HOSC	Huntsville Operations Support Center
HPS	Human Patient Simulator
HRF	Human Research Facility
IBMP	Institute for Biomedical Problems
IGF	Insulin Growth Factor
ILOB	Icarus Lunar Observatory Base
IMS	Inventory Management System
INS	Inertial Navigation System
IOP	Intraocular Pressure
IR	Infrared
ISPR	International Standard Payload Rack
ISRU	In Situ Resource Utilization
ISS	International Space Station
IST	Increment-Specific Training
IVA	Intravehicular Activity
IVCPDS	Intravehicular Charged Particle Directional Spectrometer
JAA	Joint Aviation Authority
JAR	Joint Aviation Requirements
JGTF	Jake Garn Training Facility
JSC	Johnson Space Center
KSC	Kennedy Space Center
LAS	Launch Abort System
LCC	Launch Control Center
LD	Launch Director
LEE	Latching End Effector
LEO	Low Earth Orbit
LH2	Liquid Hydrogen
LLOX	Lunar Liquid Oxygen
LMA	Laryngeal Mask Airway
LMESSC	Lightweight Multi-Purpose Experiment Support Structure Carrier
LOV	Loss of Vision
LOX	Liquid Oxygen
LPS	Launch Processing System
LRC	Langley Research Center
LSAH	Longitudinal Study of Astronaut's Health
MAG	Maximum Absorbency Garment
MBS	Mobile Base System
MCAT	Medical College Admission Test
MCC	Mission Control Center
MCP	Mechanical Counter-Pressure
MDD	Multispatial Disorientation Device
MER	Mission Evaluation Room
MIT	Massachusetts Institute of Technology

MLC	Multimedia Learning Center
MMPI	Minnesota Multiphasic Personality Inventory
MMT	Mission Management Team
MOI	Mars Orbit Insertion
MOL	Manned Orbiting Laboratory
MRI	Magnetic Resonance Imaging
MRO	Mission Robotics Operator
MSFC	Marshall Space Flight Center
MSFT	Multi-Stage Fitness Test
MSS	Mobile Servicing System
MSSOTS	Mobile Servicing System Operations Training Simulator
NBL	Neutral Buoyancy Laboratory
NEEMO	NASA Extreme Environment Mission Operations Project
NSBRI	National Space Biomedical Research Institute
NTD	NASA Test Director
OBS	Operational Bioinstrumentation System
OETF	Operations Engineering Training Facility
OFK	Official Flight Kit
OID	Operational Intercommunications System
PBAN	Polybutadiene Acrylonitrite
PDGF	Power Data Grapple Fixture
PLL	Peripheral Light Loss
PLSS	Portable Life Support System
PPC	Private Psychological Conference
PPK	Personal Preference Kit
RDS	Russian Docking System
RHC	Rotational Hand Controller
ROR	Rapid Onset Rate
ROV	Remotely Operated Vehicle
RRT	Rapid Response Team
RSO	Range Safety Officer
RSS	Rotating Service Structure
RWS	Robotic Work Station
SAR	Synthetic Aperture Radar
SARJ	Solar Alpha Rotary Joint
SCA	Simulation Control Area
SCTF	Sonny Carter Training Facility
SETI	Search for Extraterrestrial Intelligence
SFU	Simon Fraser University
SM	Service Module
SOLO	Sodium Loading in Microgravity
SOMD	Space Operations Mission Directorate
SPE	Solar Particle Event
SRB	Solid Rocket Booster
SRC	Short-Radius Centrifuge