



# Appendix

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## Flight Information

### Orbiter Enterprise Approach and Landing Test Flights



**Captive-Active Flights**—High-speed taxi tests that proved the Shuttle Carrier Aircraft, mated to Enterprise, could steer and brake with the Orbiter perched on top of the airframe. These flights featured two-man crews.

Captive-Active Flight No.	Crew Members	Test Date	Mission Length
1	Fred Haise (Cdr) Gordon Fullerton (Plt)	6/18/1977	55 min 46 s
2	Joseph Engle (Cdr) Richard Truly (Plt)	6/28/1977	62 min 0 s
3	Fred Haise (Cdr) Gordon Fullerton (Plt)	7/26/1977	59 min 53 s

**Free Flights**—Flights during which Enterprise separated from the Shuttle Carrier Aircraft and landed at the hands of a two-man crew.

Free Flight No.	Crew Members	Test Date	Mission Length
1	Fred Haise (Cdr) Gordon Fullerton (Plt)	8/12/1977	5 min 21 s
2	Joseph Engle (Cdr) Richard Truly (Plt)	9/13/1977	5 min 28 s
3	Fred Haise (Cdr) Gordon Fullerton (Plt)	9/23/1977	5 min 34 s
4	Joseph Engle (Cdr) Richard Truly (Plt)	10/12/1977	2 min 34 s
5	Fred Haise (Cdr) Gordon Fullerton (Plt)	10/26/1977	2 min 1 s

### The Space Shuttle Numbering System

The first nine Space Shuttle flights were numbered in sequence from STS-1 to STS-9. Following STS-9, NASA changed the flight numbering system. The next flight became STS-41B instead of being designated STS-10. This new numbering system was designed to be more specific. The first numeral stood for the fiscal year in which the launch was to take place (i.e., “4” stood for “1984” in the STS-41B example). The second numeral represented the launch site—“1” for Kennedy Space Center, Florida, and “2” for Vandenberg Air Force Base, California. The letter represented the order of launch assignments. Following STS-51L, NASA reestablished the original numerical numbering system, therefore the next flight was designated STS-26 as it represented the 26th Space Shuttle mission.

### Abbreviations, Acronyms, and Definitions

**Cdr**— Commander

**Plt**— Pilot

**MS**— Mission Specialist (a career astronaut)

**PS**— Payload Specialist (an individual selected and trained for a specific mission)

**UP**— Crew member was taken up on the shuttle

**DN**— Crew member was brought down on the shuttle

STS Flight No. and Crew Patch	Orbiter Name	Crew Members	Launch Date	Approx. Mission Days
1 	Columbia	John Young (Cdr) Robert Crippen (Plt)	4/12/1981	2
2 	Columbia	Joe Engle (Cdr) Richard Truly (Plt)	11/12/1981	2
3 	Columbia	Jack Lousma (Cdr) Gordon Fullerton (Plt)	3/22/1982	8
4 	Columbia	Thomas Mattingly (Cdr) Henry Hartsfield (Plt)	6/27/1982	7
5 	Columbia	Vance Brand (Cdr) Robert Overmyer (Plt) William Lenoir (MS) Joseph Allen (MS)	11/11/1982	5
6 	Challenger	Paul Weitz (Cdr) Karol Bobko (Plt) Story Musgrave (MS) Donald Peterson (MS)	4/4/1983	5
7 	Challenger	Robert Crippen (Cdr) Frederick Hauck (Plt) John Fabian (MS) Sally Ride (MS) Norman Thagard (MS)	6/18/1983	6
8 	Challenger	Richard Truly (Cdr) Daniel Brandenstein (Plt) Guion Bluford, Jr. (MS) Dale Gardner (MS) William Thornton (MS)	8/30/1983	6
9 	Columbia	John Young (Cdr) Brewster Shaw (Plt) Owen Garriott (MS) Robert Parker (MS) Byron Lichtenberg (PS) Ulf Merbold (PS)	11/28/1983	10

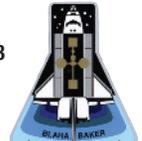


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STS Flight No. and Crew Patch	Orbiter Name	Crew Members	Launch Date	Approx. Mission Days	STS Flight No. and Crew Patch	Orbiter Name	Crew Members	Launch Date	Approx. Mission Days
	Challenger	Vance Brand (Cdr) Robert Gibson (Plt) Bruce McCandless (MS) Ronald McNair (MS) Robert Stewart (MS)	2/3/1984	8		Discovery	Daniel Brandenstein (Cdr) John Creighton (Plt) John Fabian (MS) Steven Nagel (MS) Shannon Lucid (MS) Patrick Baudry (PS) France Sultan Al-Saud (PS) Saudi Arabia	6/17/1985	7
	Challenger	Robert Crippen (Cdr) Francis Scobee (Plt) Terry Hart (MS) James van Hoften (MS) George Nelson (MS)	4/6/1984	7		Challenger	Gordon Fullerton (Cdr) Roy Bridges (Plt) Karl Henize (MS) Anthony England (MS) Story Musgrave (MS) Loren Acton (PS) John-David Bartoe (PS)	7/29/1985	8
	Discovery	Henry Hartsfield (Cdr) Michael Coats (Plt) Judith Resnik (MS) Steven Hawley (MS) Richard Mullane (MS) Charles Walker (PS)	8/30/1984	6		Discovery	Joe Engle (Cdr) Richard Covey (Plt) James van Hoften (MS) John Lounge (MS) William Fisher (MS)	8/27/1985	7
	Challenger	Robert Crippen (Cdr) Jon McBride (Plt) Kathryn Sullivan (MS) Sally Ride (MS) David Leestma (MS) Paul Scully-Power (PS) Marc Garneau (PS) Canada	10/5/1984	8		Atlantis	Karol Bobko (Cdr) Ronald Grabe (Plt) Robert Stewart (MS) David Hilmers (MS) William Pailes (PS)	10/3/1985	4
	Discovery	Frederick Hauck, (Cdr) David Walker (Plt) Joseph Allen (MS) Anna Fisher (MS) Dale Gardner (MS)	11/8/1984	8		Challenger	Henry Hartsfield (Cdr) Steven Nagel (Plt) Bonnie Dunbar (MS) James Buchli (MS) Guion Bluford (MS) Ernst Messerschmid (PS) Germany Reinhard Furrer (PS) Germany Wubbo Ockels (PS) Netherlands	10/30/1985	7
	Discovery	Thomas Mattingly (Cdr) Loren Shriver (Plt) Ellison Onizuka (MS) James Buchli (MS) Gary Payton (PS)	1/24/1985	3		Atlantis	Brewster Shaw (Cdr) Bryan O'Connor (Plt) Sherwood Spring (MS) Mary Cleave (MS) Jerry Ross (MS) Rodolfo Neri Vela (PS) Charles Walker (PS)	11/26/1985	7
	Discovery	Karol Bobko (Cdr) Donald Williams (Plt) Rhea Seddon (MS) David Griggs (MS) Jeffrey Hoffman (MS) Jake Garn (PS) Charles Walker (PS)	4/12/1985	7		Columbia	Robert Gibson (Cdr) Charles Bolden (Plt) George Nelson (MS) Steven Hawley (MS) Franklin Chang-Diaz (MS) Robert Cenker (PS) C. William Nelson (PS)	1/12/1986	6
	Challenger	Robert Overmyer (Cdr) Frederick Gregory (Plt) Don Lind (MS) Norman Thagard (MS) William Thornton (MS) Lodewijk van den Berg (PS) Germany Taylor Wang (PS)	4/29/1985	7		Challenger	Francis Scobee (Cdr) Michael Smith (Plt) Judith Resnik (MS) Ellison Onizuka (MS) Ronald McNair (MS) Gregory Jarvis (PS) Christa McAuliffe (PS)	1/28/1986	0



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STS Flight No. and Crew Patch	Orbiter Name	Crew Members	Launch Date	Approx. Mission Days	STS Flight No. and Crew Patch	Orbiter Name	Crew Members	Launch Date	Approx. Mission Days
	Discovery	Frederick Hauck (Cdr) Richard Covey (Plt) John Lounge (MS) George Nelson (MS) David Hilmers (MS)	9/29/1988	4		Atlantis	John Creighton, (Cdr) John Casper (Plt) David Hilmers (MS) Richard Mullane (MS) Pierre Thuot (MS)	2/28/1990	4
	Atlantis	Robert Gibson (Cdr) Guy Gardner (Plt) Richard Mullane (MS) Jerry Ross (MS) William Shepherd (MS)	12/2/1988	4		Discovery	Loren Shriver (Cdr) Charles Bolden (Plt) Bruce McCandless (MS) Steven Hawley (MS) Kathryn Sullivan (MS)	4/24/1990	5
	Discovery	Michael Coats (Cdr) John Blaha (Plt) James Buchli (MS) Robert Springer (MS) James Bagian (MS)	3/13/1989	5		Discovery	Richard Richards (Cdr) Robert Cabana (Plt) Bruce Melnick (MS) William Shepherd (MS) Thomas Akers (MS)	10/6/1990	4
	Atlantis	David Walker (Cdr) Ronald Grabe (Plt) Norman Thagard (MS) Mary Cleave (MS) Mark Lee (MS)	5/4/1989	4		Atlantis	Richard Covey (Cdr) Frank Culbertson (Plt) Carle Meade (MS) Robert Springer (MS) Charles Gemar (MS)	11/15/1990	5
	Columbia	Brewster Shaw (Cdr) Richard Richards (Plt) James Adamson (MS) David Leestma (MS) Mark Brown (MS)	8/8/1989	5		Columbia	Vance Brand (Cdr) Guy Gardner (Plt) Jeffrey Hoffman (MS) John Lounge (MS) Robert Parker (MS) Samuel Durrance (PS) Ronald Parise (PS)	12/2/1990	9
	Atlantis	Donald Williams (Cdr) Michael McCulley (Plt) Shannon Lucid (MS) Franklin Chang-Diaz (MS) Ellen Baker (MS)	10/18/1989	5		Atlantis	Steven Nagel (Cdr) Kenneth Cameron (Plt) Linda Godwin (MS) Jerry Ross (MS) Jay Apt (MS)	4/5/1991	6
	Discovery	Frederick Gregory (Cdr) John Blaha (Plt) Manley Carter (MS) Story Musgrave (MS) Kathryn Thornton (MS)	11/22/1989	5		Discovery	Michael Coats (Cdr) Blaine Hammond (Plt) Gregory Harbaugh (MS) Donald McMonagle (MS) Guion Bluford (MS) Charles Veach (MS) Richard Hieb (MS)	4/28/1991	8
	Columbia	Daniel Brandenstein (Cdr) James Wetherbee (Plt) Bonnie Dunbar (MS) Marsha Ivins (MS) David Low (MS)	1/9/1990	11		Columbia	Bryan O'Connor (Cdr) Sidney Gutierrez (Plt) James Bagian (MS) Tamara Jernigan (MS) Rhea Seddon (MS) Drew Gaffney (PS) Millie Hughes-Fulford (PS)	6/5/1991	9
						Atlantis	John Blaha (Cdr) Michael Baker (Plt) Shannon Lucid (MS) David Low (MS) James Adamson (MS)	8/2/1991	9



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STS Flight No. and Crew Patch	Orbiter Name	Crew Members	Launch Date	Approx. Mission Days	STS Flight No. and Crew Patch	Orbiter Name	Crew Members	Launch Date	Approx. Mission Days
	Discovery	John Creighton (Cdr) Kenneth Reightler (Plt) Charles Gemar (MS) James Buchli (MS) Mark Brown (MS)	9/12/1991	5		Columbia	James Wetherbee (Cdr) Michael Baker (Plt) Charles Veach (MS) William Shepherd (MS) Tamara Jernigan (MS) Steven MacLean (PS)	10/22/1992	10
	Atlantis	Frederick Gregory (Cdr) Terence Henricks (Plt) James Voss (MS) Story Musgrave (MS) Mario Runco (MS) Thomas Hennen (PS)	11/24/1991	7		Discovery	David Walker (Cdr) Robert Cabana (Plt) Guion Bluford (MS) Michael Clifford (MS) James Voss (MS)	12/2/1992	7
	Discovery	Ronald Grabe (Cdr) Stephen Oswald (Plt) Norman Thagard (MS) William Readdy (MS) David Hilmers (MS) Roberta Bondar (PS) Canada Ulf Merbold (PS) Germany	1/22/1992	8		Endeavour	John Casper (Cdr) Donald McMonagle (Plt) Mario Runco (MS) Gregory Harbaugh (MS) Susan Helms (MS)	1/13/1993	6
	Atlantis	Charles Bolden (Cdr) Brian Duffy (Plt) Kathryn Sullivan (MS) David Leestma (MS) Michael Foale (MS) Dirk Frimout (PS) Belgium Bryon Lichtenberg (PS)	3/24/1992	9		Discovery	Kenneth Cameron (Cdr) Stephen Oswald (Plt) Michael Foale (MS) Kenneth Cockrell (MS) Ellen Ochoa (MS)	4/8/1993	9
	Endeavour	Daniel Brandenstein (Cdr) Kevin Chilton (Plt) Bruce Melnick (MS) Pierre Thuot (MS) Richard Hieb (MS) Kathryn Thornton (MS) Thomas Akers (MS)	5/7/1992	9		Columbia	Steven Nagel (Cdr) Terence Henricks (Plt) Jerry Ross (MS) Charles Precourt (MS) Bernard Harris (MS) Ulrich Walter (PS) Germany Hans Schlegel (PS) Germany	4/26/1993	10
	Columbia	Richard Richards (Cdr) Kenneth Bowersox (Plt) Bonnie Dunbar (MS) Ellen Baker (MS) Carl Meade (MS) Lawrence DeLucas (PS) Eugene Trinh (PS)	6/25/1992	14		Endeavour	Ronald Grabe (Cdr) Brian Duffy (Plt) David Low (MS) Nancy Sherlock (MS) Peter Wisoff (MS) Janice Voss (MS)	6/21/1993	10
	Atlantis	Loren Shriver (Cdr) Andrew Allen (Plt) Claude Nicollier (MS) Switzerland Marsha Ivins (MS) Jeffrey Hoffman (MS) Franklin Chang-Diaz (MS) Franco Malerba (PS) Italy	7/31/1992	8		Discovery	Frank Culbertson (Cdr) William Readdy (Plt) James Newman (MS) Daniel Bursch (MS) Carl Walz (MS)	9/12/1993	10
	Endeavour	Robert Gibson (Cdr) Curtis Brown (Plt) Mark Lee (MS) Jay Apt (MS) Jan Davis (MS) Mae Jemison (MS) Mamoru Mohri (PS) Japan	9/12/1992	8		Columbia	John Blaha (Cdr) Richard Searfoss (Plt) Rhea Seddon (MS) William McArthur (MS) David Wolf (MS) Shannon Lucid (MS) Martin Fettman (PS)	10/18/1993	14

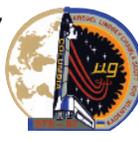


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	Endeavour	Richard Covey (Cdr) Kenneth Bowersox (Plt) Kathryn Thornton (MS) Claude Nicollier (MS) Switzerland Jeffrey Hoffman (MS) Story Musgrave (MS) Thomas Akers (MS)	12/2/1993	11		Discovery	James Wetherbee (Cdr) Eileen Collins (Plt) Bernard Harris (MS) Michael Foale (MS) Janice Voss (MS) Vladimir Titov (MS) Russia	2/3/1995	8
	Discovery	Charles Bolden (Cdr) Kenneth Reightler (Plt) Jan Davis (MS) Ronald Sega (MS) Franklin Chang-Diaz (MS) Sergei Krikalev (MS) Russia	2/3/1994	8		Endeavour	Stephen Oswald (Cdr) William Gregory (Plt) John Grunsfeld (MS) Wendy Lawrence (MS) Tamara Jernigan (MS) Samuel Durrance (PS) Ronald Parise (PS)	3/2/1995	17
	Columbia	John Casper (Cdr) Andrew Allen (Plt) Pierre Thuot (MS) Charles Gemar (MS) Marsha Ivins (MS)	3/4/1994	14		Atlantis	Robert Gibson (Cdr) Charles Precourt (Plt) Ellen Baker (MS) Gregory Harbaugh (MS) Bonnie Dunbar (MS) Anatoly Solovyev (UP) Russia Nikolai Budarin (UP) Russia Vladimir Dezhurov (DN) Russia Gennady Strekalov (DN) Russia Norman Thagard (MS, DN)	6/27/1995	10
	Endeavour	Sidney Gutierrez (Cdr) Kevin Chilton (Plt) Jay Apt (MS) Michael Clifford (MS) Linda Godwin (MS) Thomas Jones (MS)	4/9/1994	11		Discovery	Terence Henricks (Cdr) Kevin Kregel (Plt) Donald Thomas (MS) Nancy Currie (MS) Mary Ellen Weber (MS)	7/13/1995	9
	Columbia	Robert Cabana (Cdr) James Halsell (Plt) Richard Hieb (MS) Carl Walz (MS) Leroy Chiao (MS) Donald Thomas (MS) Chiaki Mukai (PS) Japan	7/8/1994	15		Endeavour	David Walker (Cdr) Kenneth Cockrell (Plt) James Voss (MS) James Newman (MS) Michael Gernhardt (MS)	9/7/1995	11
	Discovery	Richard Richards (Cdr) Blaine Hammond (Plt) Jerry Linenger (MS) Susan Helms (MS) Carl Meade (MS) Mark Lee (MS)	9/9/1994	11		Columbia	Kenneth Bowersox (Cdr) Kent Rominger (Plt) Catherine Coleman (MS) Michael Lopez-Alegria (MS) Kathryn Thornton (MS) Fred Leslie (PS) Albert Sacco (PS)	10/20/1995	16
	Endeavour	Michael Baker (Cdr) Terrence Wilcutt (Plt) Steven Smith (MS) Daniel Bursch (MS) Peter Wisoff (MS) Thomas Jones (MS)	9/30/1994	11		Atlantis	Kenneth Cameron (Cdr) James Halsell (Plt) Chris Hadfield (MS) Canada Jerry Ross (MS) William McArthur (MS)	11/12/1995	8
	Atlantis	Donald McMonagle (Cdr) Curtis Brown (Plt) Ellen Ochoa (MS) Joseph Tanner (MS) Jean-Francois Clervoy (MS) France Scott Parazynski (MS)	11/3/1994	11		Endeavour	Brian Duffy (Cdr) Brent Jett (Plt) Leroy Chiao (MS) Winston Scott (MS) Koichi Wakata (MS) Japan Daniel Barry (MS)	1/11/1996	9



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STS Flight No. and Crew Patch	Orbiter Name	Crew Members	Launch Date	Approx. Mission Days	STS Flight No. and Crew Patch	Orbiter Name	Crew Members	Launch Date	Approx. Mission Days
	Columbia	Andrew Allen (Cdr) Scott Horowitz (Plt) Jeffrey Hoffman (MS) Maurizio Cheli (MS) Italy Claude Nicollier (MS) Switzerland Franklin Chang-Diaz (MS) Umberto Guidoni (PS) Italy	2/22/1996	16		Columbia	James Halsell (Cdr) Susan Still (Plt) Janice Voss (MS) Michael Gernhardt (MS) Donald Thomas (MS) Roger Crouch (PS) Gregory Linteris (PS)	4/4/1997	4
	Atlantis	Kevin Chilton (Cdr) Richard Searfoss (Plt) Ronald Sega (MS) Michael Clifford (MS) Linda Godwin (MS) Shannon Lucid (MS, UP)	3/22/1996	9		Atlantis	Charles Precourt (Cdr) Eileen Collins (Plt) Jean-Francois Clervoy (MS) France Carlos Noriega (MS) Edward Lu (MS) Elena Kondakova (MS) Russia Michael Foale (MS, UP) Jerry Linenger (MS, DN)	5/15/1997	10
	Endeavour	John Casper (Cdr) Curtis Brown (Plt) Andrew Thomas (MS) Daniel Bursch (MS) Mario Runco (MS) Marc Garneau (MS) Canada	5/19/1996	10		Columbia	James Halsell (Cdr) Susan Still (Plt) Janice Voss (MS) Michael Gernhardt (MS) Donald Thomas (MS) Roger Crouch (PS) Gregory Linteris (PS)	7/1/1997	16
	Columbia	Terence Henricks (Cdr) Kevin Kregel (Plt) Richard Linnehan (MS) Susan Helms (MS) Charles Brady (MS) Jean-Jacques Favier (PS) France Robert Thirsk (PS) Canada	6/20/1996	17		Discovery	Curtis Brown (Cdr) Kent Rominger (Plt) Jan Davis (MS) Robert Curbeam (MS) Stephen Robinson (MS) Bjarni Tryggvason (PS) Canada	8/7/1997	12
	Atlantis	William Readdy (Cdr) Terrence Wilcutt (Plt) Jay Apt (MS) Thomas Akers (MS) Carl Walz (MS) John Blaha (MS, UP) Shannon Lucid (MS, DN)	9/16/1996	10		Atlantis	James Wetherbee (Cdr) Michael Bloomfield (Plt) Vladimir Titov (MS) Russia Scott Parazynski (MS) Jean-Loup Chretien (MS) France Wendy Lawrence (MS) David Wolf (MS, UP) Michael Foale (MS, DN)	9/25/1997	11
	Columbia	Kenneth Cockrell (Cdr) Kent Rominger (Plt) Tamara Jernigan (MS) Thomas Jones (MS) Story Musgrave (MS)	11/19/1996	18		Columbia	Kevin Kregel (Cdr) Steven Lindsey (Plt) Kalpana Chawla (MS) Winston Scott (MS) Takao Doi (MS) Japan Leonid Kadenyuk (PS) Ukraine	11/19/1997	16
	Atlantis	Michael Baker (Cdr) Brent Jett (Plt) Peter Wisoff (MS) John Grunsfeld (MS) Marsha Ivins (MS) Jerry Linenger (MS, UP) John Blaha (MS, DN)	1/12/1997	10		Endeavour	Terrence Wilcutt (Cdr) Joe Edwards (Plt) James Reilly (MS) Michael Anderson (MS) Bonnie Dunbar (MS) Salizhan Sharipov (MS) Russia Andrew Thomas (MS, UP) David Wolf (MS, DN)	1/22/1998	9
	Discovery	Kenneth Bowersox (Cdr) Scott Horowitz (Plt) Joseph Tanner (MS) Steven Hawley (MS) Gregory Harbaugh (MS) Mark Lee (MS) Steven Smith (MS)	2/11/1997	10		Columbia	Richard Searfoss (Cdr) Scott Altman (Plt) Richard Linnehan (MS) Kathryn Hire (MS) Dafydd Williams (MS) Canada Jay Buckey (PS) James Pawelczyk (PS)	4/17/1998	16

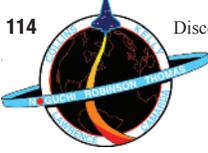


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STS Flight No. and Crew Patch	Orbiter Name	Crew Members	Launch Date	Approx. Mission Days	STS Flight No. and Crew Patch	Orbiter Name	Crew Members	Launch Date	Approx. Mission Days
	Discovery	Charles Precourt (Cdr) Dominic Gorie (Plt) Franklin Chang-Diaz (MS) Wendy Lawrence (MS) Janet Kavandi (MS) Valery Ryumin (MS) Russia Andrew Thomas (MS, DN)	6/2/1998	10		Atlantis	Terrence Wilcutt (Cdr) Scott Altman (Plt) Edward Lu (MS) Richard Mastracchio (MS) Daniel Burbank (MS) Yuri Malenchenko (MS) Russia Boris Morukov (MS) Russia	9/8/2000	12
	Discovery	Curtis Brown (Cdr) Steven Lindsey (Plt) Stephen Robinson (MS) Scott Parazynski (MS) Pedro Duque (MS) Spain Chiaki Mukai (PS) Japan John Glenn (PS)	10/29/1998	10		Discovery	Bryan Duffy (Cdr) Pamela Melroy (Plt) Leroy Chiao (MS) William McArthur (MS) Peter Wisoff (MS) Michael Lopez-Alegria (MS) Koichi Wakata (MS) Japan	10/11/2000	12
	Endeavour	Robert Cabana (Cdr) Frederick Sturckow (Plt) Jerry Ross (MS) Nancy Currie (MS) James Newman (MS) Sergei Krikalev (MS) Russia	12/4/1998	12		Endeavour	Brent Jett (Cdr) Michael Bloomfield (Plt) Joseph Tanner (MS) Marc Garneau (MS) Canada Carlos Noriega (MS)	11/30/2000	11
	Discovery	Kent Rominger (Cdr) Rick Husband (Plt) Tamara Jernigan (MS) Ellen Ochoa (MS) Daniel Berry (MS) Julie Payette (MS) Canada Valery Tokarev (MS) Russia	5/27/1999	10		Atlantis	Kenneth Cockrell (Cdr) Mark Polansky (Plt) Robert Curbeam (MS) Marsha Ivins (MS) Thomas Jones (MS)	2/7/2001	13
	Columbia	Eileen Collins (Cdr) Jeffrey Ashby (Plt) Catherine Coleman (MS) Steven Hawley (MS) Michel Tognini (MS) France	7/23/1999	5		Discovery	James Wetherbee (Cdr) James Kelly (Plt) Andrew Thomas (MS) Paul Richards (MS) James Voss (MS, UP) Susan Helms (MS, UP) Yury Usachev (MS, UP) Russia Sergei Krikalev (MS, DN) Russia William Shepherd (MS, DN) Yuri Gidzenko (MS, DN) Russia	3/8/2001	13
	Discovery	Curtis Brown (Cdr) Scott Kelly (Plt) Steven Smith (MS) Jean-Francois Clervoy (MS) France John Grunsfeld (MS) Michael Foale (MS) Claude Nicollier (MS) Switzerland	12/19/1999	8		Endeavour	Kent Rominger (Cdr) Jeffrey Ashby (Plt) Chris Hadfield (MS) Canada John Phillips (MS) Canada Scott Parazynski (MS) Umberto Guidoni (MS) Italy Yuri Lonchakov (MS) Russia	4/19/2001	12
	Endeavour	Kevin Kregel (Cdr) Dominic Gorie (Plt) Gerhard Thiele (MS) Germany Janet Kavandi (MS) Janice Voss (MS) Mamoru Mohri (MS) Japan	2/11/2000	11		Atlantis	Steven Lindsey (Cdr) Charles Hobbaugh (Plt) Michael Gernhardt (MS) Janet Kavandi (MS) James Reilly (MS)	7/12/2001	13
	Atlantis	James Halsell (Cdr) Scott Horowitz (Plt) Mary Ellen Weber (MS) Jeffrey Williams (MS) James Voss (MS) Susan Helms (MS) Yury Usachev (MS) Russia	5/19/2000	10		Discovery	Scott Horowitz (Cdr) Frederick Sturckow (Plt) Patrick Forrester (MS) Daniel Barry (MS) Frank Culbertson (MS, UP) Vladimir Dezhurov (MS, UP) Russia Mikhail Tyurin (MS, UP) Russia Yuri Usachev (MS, DN) Russia James Voss (MS, DN) Susan Helms (MS, DN)	8/10/2001	12



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STS Flight No. and Crew Patch	Orbiter Name	Crew Members	Launch Date	Approx. Mission Days	STS Flight No. and Crew Patch	Orbiter Name	Crew Members	Launch Date	Approx. Mission Days
	Endeavour	Dominic Gorie (Cdr) Mark Kelly (Plt) Linda Godwin (MS) Daniel Tani (MS) Yuri Onufrienko (MS, UP) Russia Daniel Bursch (MS, UP) Carl Walz (MS, UP) Frank Culbertson (MS, DN) Vladimir Dezhurov (MS, DN) Russia Mikhail Tyurin (MS, DN) Russia	12/5/2001	12		Discovery	Eileen Collins (Cdr) James Kelly (Plt) Soichi Noguchi (MS) Japan Stephen Robinson (MS) Andrew Thomas (MS) Wendy Lawrence (MS) Charles Camarda (MS)	7/26/2005	14
	Columbia	Scott Altman (Cdr) Duane Carey (Plt) John Grunsfeld (MS) Nancy Currie (MS) Richard Linnehan (MS) James Newman (MS) Michael Massimino (MS)	3/1/2002	11		Discovery	Steven Lindsey (Cdr) Mark Kelly (Plt) Michael Fossum (MS) Lisa Nowak (MS) Stephanie Wilson (MS) Piers Sellers (MS) Thomas Reiter (MS, UP) Germany	7/4/2006	13
	Atlantis	Michael Bloomfield (Cdr) Stephen Frick (Plt) Rex Walheim (MS) Ellen Ochoa (MS) Lee Morin (MS) Jerry Ross (MS) Steven Smith (MS)	4/8/2002	11		Atlantis	Brent Jett (Cdr) Christopher Ferguson (Plt) Joseph Tanner (MS) Daniel Burbank (MS) Heidemarie Stefanyshyn-Piper (MS) Steven MacLean (MS) Canada	9/9/2006	12
	Endeavour	Kenneth Cockrell (Cdr) Paul Lockhart (Plt) Franklin Chang-Diaz (MS) Philippe Perrin (MS) France Valery Korzun (MS, UP) Russia Peggy Whitson (MS, UP) Sergei Treschev (MS, UP) Russia Yuri Onufrienko (MS, DN) Russia Daniel Bursch (MS, DN) Carl Walz (MS, DN)	6/5/2002	14		Discovery	Mark Polansky (Cdr) William Oefelein (Plt) Nicholas Patrick (MS) Robert Curbeam (MS) Christer Fuglesang (MS) Sweden Joan Higginbotham (MS) Sunita Williams (MS, UP) Thomas Reiter (MS, DN) Germany	12/9/2006	13
	Atlantis	Jeffrey Ashby (Cdr) Pamela Melroy (Plt) David Wolf (MS) Sandra Magnus (MS) Piers Sellers (MS) Fyodor Yurchikhin (MS) Russia	10/7/2002	11		Atlantis	Frederick Sturkow (Cdr) Lee Archambault (Plt) Patrick Forrester (MS) Steven Swanson (MS) John Olivas (MS) James Reilly (MS) Clayton Anderson (MS, UP) Sunita Williams (MS, DN)	6/8/2007	14
	Endeavour	James Wetherbee (Cdr) Paul Lockhart (Plt) Michael Lopez-Alegria (MS) John Herrington (MS) Kenneth Bowersox (MS, UP) Nikolai Budarin (MS, UP) Russia Donald Pettit (MS, UP) Valery Korzun (MS, DN) Russia Sergei Treschev (MS, DN) Russia Peggy Whitson (MS, DN)	11/23/2002	14		Endeavour	Scott Kelly (Cdr) Charles Hobaugh (Plt) Tracy Caldwell (MS) Richard Mastracchio (MS) Dafydd Williams (MS) Canada Barbara Morgan (MS) Benjamin Drew (MS)	8/8/2007	14
	Columbia	Rick Husband (Cdr) William McCool (Plt) Michael Anderson (MS) David Brown (MS) Kalpana Chawla (MS) Laurel Clark (MS) Ilan Ramon (PS) Israel	1/16/2003	16		Discovery	Pamela Melroy (Cdr) George Zamka (Plt) Scott Parazynski (MS) Stephanie Wilson (MS) Douglas Wheelock (MS) Paolo Nespoli (MS) Italy Daniel Tani (MS, UP) Clayton Anderson (MS, DN)	10/23/2007	15

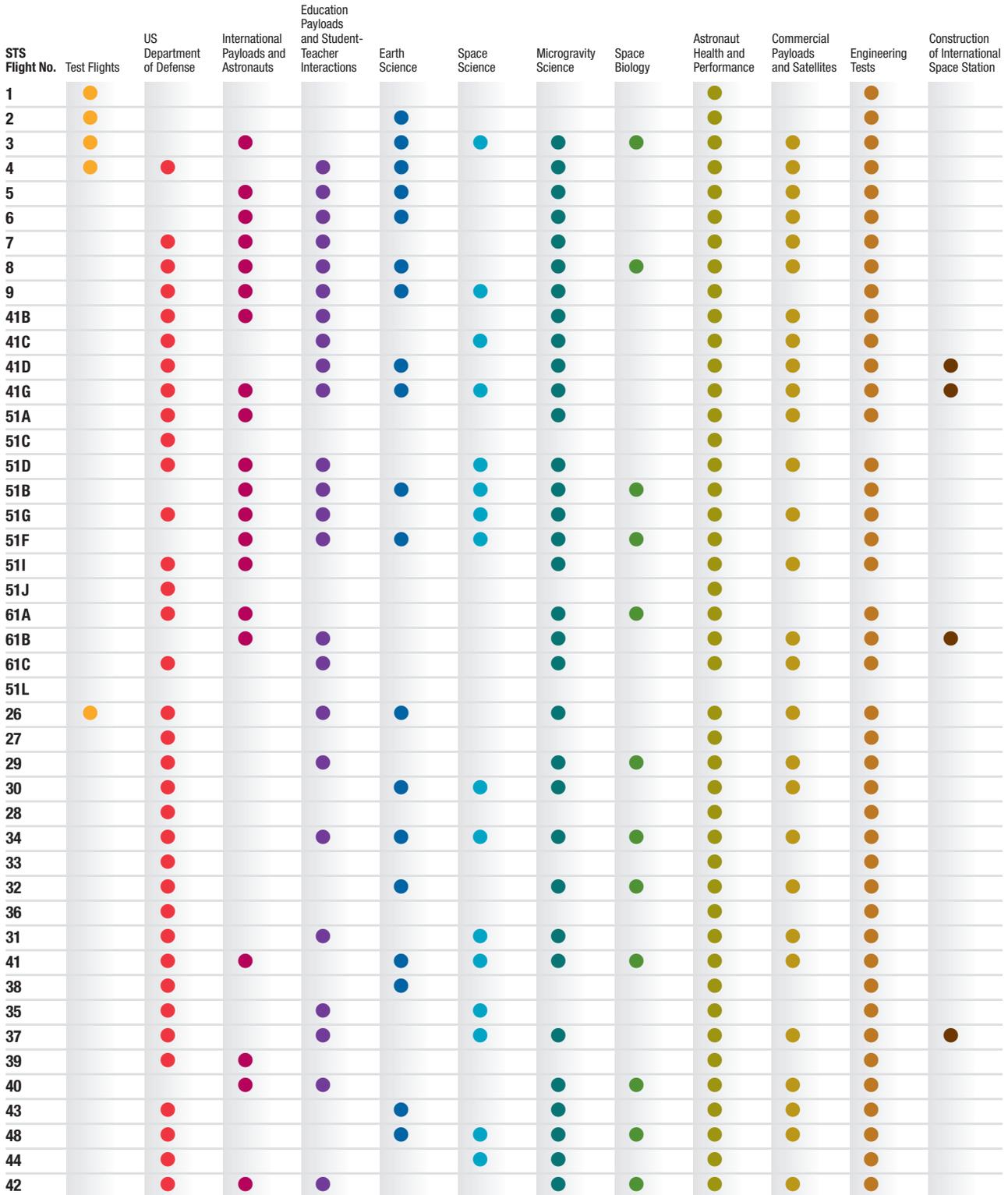


## Flight Information

STS Flight No. and Crew Patch	Orbiter Name	Crew Members	Launch Date	Approx. Mission Days	STS Flight No. and Crew Patch	Orbiter Name	Crew Members	Launch Date	Approx. Mission Days
	Atlantis	Stephen Frick (Cdr) Alan Poindexter (Plt) Leland Melvin (MS) Rex Walheim (MS) Hans Schlegel (MS) Germany Stanley Love (MS) Leopold Eyharts (MS, UP) France Daniel Tani (MS, DN)	2/7/2008	13		Discovery	Frederick Sturckow (Cdr) Kevin Ford (Plt) Patrick Forrester (MS) Jose Hernandez (MS) John Olivas (MS) Christer Fuglesang (MS) Sweden Nicole Stott (MS, UP) Timothy Kopra (MS, DN)	8/28/09	15
	Endeavour	Dominic Gorie (Cdr) Gregory H. Johnson (Plt) Robert Behnken (MS) Michael Foreman (MS) Takao Doi (MS) Japan Richard Linnehan (MS) Garrett Reisman (MS, UP) Leopold Eyharts (MS, DN) France	3/11/2008	16		Atlantis	Charles Hobaugh (Cdr) Barry Wilmore (Plt) Randolph Bresnik (MS) Michael Foreman (MS) Leland Melvin (MS) Robert Satcher (MS) Nicole Stott (MS, DN)	11/16/09	11
	Discovery	Mark Kelly (Cdr) Kenneth Ham (Plt) Karen Nyberg (MS) Ronald Garan (MS) Michael Fossum (MS) Akihiko Hoshide (MS) Japan Gregory Chamitoff (MS, UP) Garrett Reisman (MS, DN)	5/31/2008	14		Endeavour	George Zamka (Cdr) Terry Virts (Plt) Robert Behnken (MS) Nicholas Patrick (MS) Kathryn Hire (MS) Stephen Robinson (MS)	2/8/10	13
	Endeavour	Christopher Ferguson (Cdr) Eric Boe (Plt) Donald Pettit (MS) Stephen Bowen (MS) Heidemarie Stefanyshyn-Piper (MS) Shane Kimbrough (MS) Sandra Magnus (MS, UP) Gregory Chamitoff (MS, DN)	11/14/2008	16		Discovery	Alan Poindexter (Cdr) James Dutton (Plt) Richard Mastracchio (MS) Naoko Yamazaki (MS) Japan Clayton Anderson (MS) Dorothy Metcalf-Lindenburger (MS) Stephanie Wilson (MS)	4/5/10	15
	Discovery	Lee Archambault (Cdr) Dominic Antonelli (Plt) Joseph Acaba (MS) Steven Swanson (MS) Richard Arnold (MS) John Phillips (MS) Koichi Wakata (MS, UP) Japan Sandra Magnus (MS, DN)	3/15/2009	13		Atlantis	Kenneth Ham (Cdr) Dominic Antonelli (Plt) Stephen Bowen (MS) Michael Good (MS) Piers Sellers (MS) Garrett Reisman (MS)	5/14/10	12
	Atlantis	Scott Altman (Cdr) Gregory C. Johnson (Plt) Michael Good (MS) Megan McArthur (MS) John Grunsfeld (MS) Michael Massimino (MS) Andrew Feustel (MS)	5/11/09	13		Discovery	Steven Lindsey (Cdr) Eric Boe (Plt) Benjamin Drew (MS) Michael Barratt (MS) Stephen Bowen (MS) Nicole Stott (MS)	2/24/11	12
	Endeavour	Mark Polansky (Cdr) Douglas Hurley (Plt) Christopher Cassidy (MS) Julie Payette (MS) Canada Thomas Marshburn (MS) David Wolf (MS) Timothy Kopra (MS, UP) Koichi Wakata (MS, DN) Japan	7/15/09	16		Endeavour	Mark Kelly (Cdr) Gregory H. Johnson (Plt) Andrew Feustel (MS) Michael Fincke (MS) Gregory Chamitoff (MS) Roberto Vittori (MS) Italy	5/16/11	16
						Atlantis	Christopher Ferguson (Cdr) Douglas Hurley (Plt) Sandra Magnus (MS) Rex Walheim (MS)	7/8/11	12



## Payloads and Experiments per Space Shuttle Flight



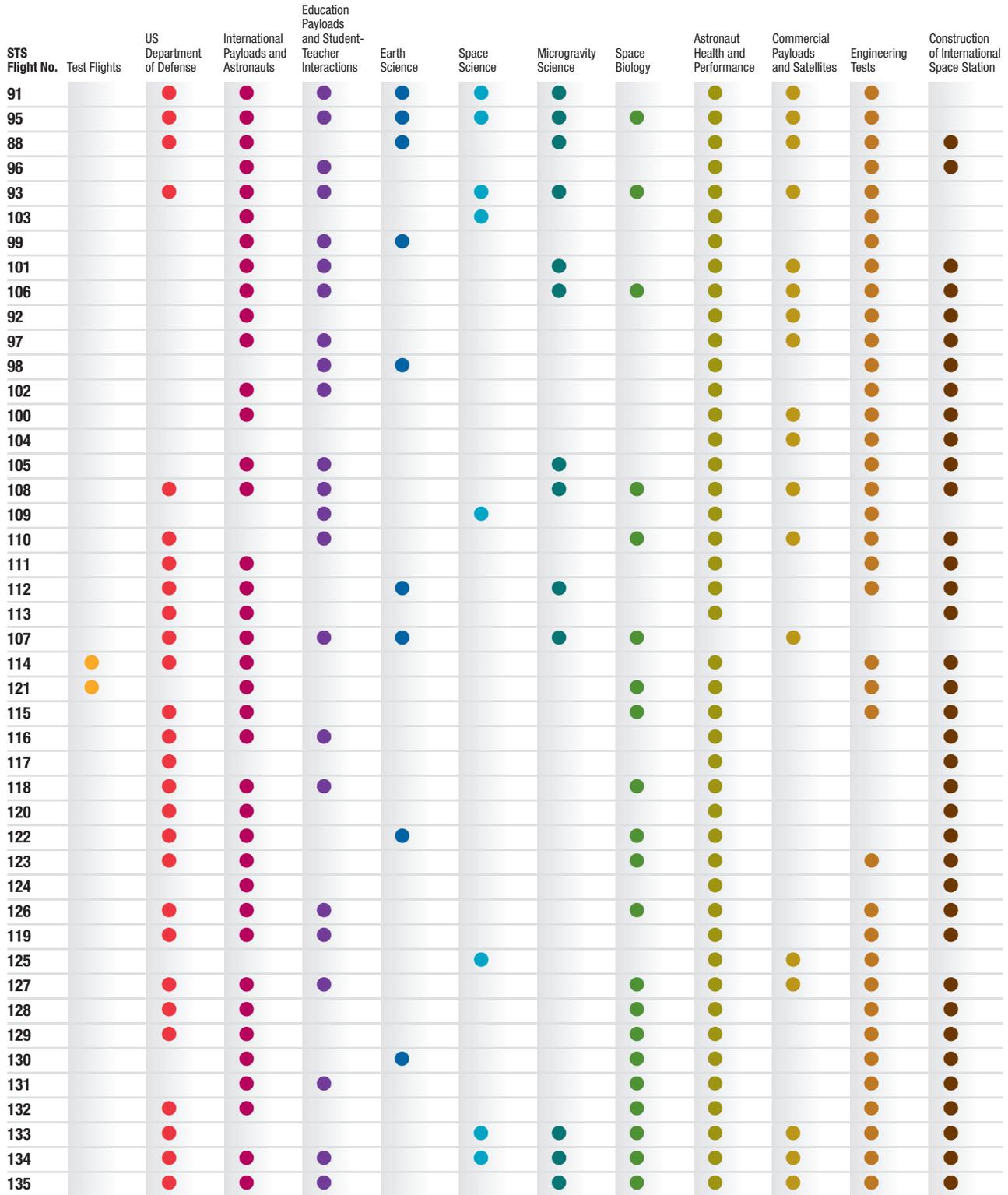


## Payloads and Experiments per Space Shuttle Flight

STS Flight No.	Test Flights	US Department of Defense	International Payloads and Astronauts	Education Payloads and Student-Teacher Interactions	Earth Science	Space Science	Microgravity Science	Space Biology	Astronaut Health and Performance	Commercial Payloads and Satellites	Engineering Tests	Construction of International Space Station
45		●	●	●	●	●	●		●	●	●	
49							●		●	●	●	
50				●			●		●	●	●	
46			●		●	●	●	●	●	●	●	
47			●	●			●	●	●	●	●	
52			●	●	●		●	●	●	●	●	
53		●			●		●		●	●	●	
54				●		●	●	●	●	●	●	
56		●		●	●	●	●	●	●	●	●	
55			●	●	●	●	●	●	●		●	
57		●	●	●	●	●	●	●	●	●	●	
51		●	●			●	●	●	●	●	●	
58				●				●	●		●	
61		●	●			●			●	●	●	
60		●	●	●			●	●	●	●	●	
62		●	●		●		●	●	●	●	●	
59		●	●	●	●		●	●	●	●	●	
65		●	●	●		●	●	●	●	●	●	
64		●	●	●	●	●	●	●	●	●	●	
68		●	●	●	●	●	●	●	●	●	●	
66		●	●		●		●	●	●		●	
63		●	●		●	●	●	●	●	●	●	
67			●	●		●	●		●	●	●	
71			●	●				●	●	●	●	
70		●		●	●		●	●	●	●	●	
69		●	●	●	●	●	●	●	●	●	●	
73			●	●			●		●	●	●	
74		●	●	●	●			●	●	●	●	
72			●		●		●	●	●	●	●	
75			●	●			●		●	●	●	
76		●	●	●	●			●	●		●	
77		●	●	●			●	●	●	●	●	
78		●	●	●			●	●	●	●	●	
79		●	●	●	●	●	●	●	●	●	●	
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82						●			●		●	
83		●	●				●		●	●	●	
84		●	●		●	●	●	●	●	●	●	
94		●	●	●			●		●	●	●	
85		●	●	●	●	●	●	●	●	●	●	
86		●	●	●	●	●	●		●	●	●	
87		●	●	●	●	●	●	●	●	●	●	
89		●	●	●	●		●	●	●		●	
90			●	●	●		●	●	●	●	●	



# Payloads and Experiments per Space Shuttle Flight





## Space Shuttle Program Managers

**John Shannon**

February 2008 – August 2011

**Wayne Hale**

September 2005 – February 2008

**William Parsons**

July 2003 – September 2005

**Ronald Dittmore**

April 1999 – July 2003

**Thomas Holloway**

November 1995 – April 1999

**Brewster Shaw**

March 1993 – November 1995

**Leonard Nicholson**

June 1989 – March 1993

**Richard Kohrs**

November 1986 – June 1989

**Arnold Aldrich**

June 1985 – November 1986

**Glynn Lunney**

June 1981 – June 1985

**Robert Thompson**

February 1970 – June 1981

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### General Information

Astronaut Biographies:  
<http://www.jsc.nasa.gov/Bios/>

Johnson Space Center Oral History Project:  
[http://www.jsc.nasa.gov/history/oral\\_histories/oral\\_histories.htm](http://www.jsc.nasa.gov/history/oral_histories/oral_histories.htm)

NASA History Program Office:  
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<http://www.sti.nasa.gov/STI-public-homepage.html>

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<http://spaceflight.nasa.gov/history/shuttle-mir/>

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Small Business Innovative Research/Small Business Technology Transfer:  
<http://www.sba.gov/aboutsba/sbaprograms/sbir/sbirstir/index.html>

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<http://www.nasa.gov/centers/ames/home/index.html>

Dryden Flight Research Center:  
<http://www.nasa.gov/centers/dryden/home/index.html>

Glenn Research Center:  
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NASA Headquarters:  
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Stennis Space Center:  
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<http://www.nasa.gov/centers/wallops/home/index.html>

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*Leadership in Space. Selected Speeches of NASA Administrator Michael Griffin, May 2005-October 2008.* Griffin, M. NASA/SP-2008-564.  
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*Critical Issues in the History of Spaceflight.* Dick, S and Launius, R, editors. NASA, Washington, DC. NASA/SP-2006-4702.  
[http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20060022843\\_2006166766.pdf](http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20060022843_2006166766.pdf)

*The Story of the Space Shuttle.* Harland, DM. Springer, Praxis Publishing Ltd., 2004.

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LAGEOS: <http://msl.jpl.nasa.gov/QuickLooks/lageosQL.html>

### The Historical Legacy

#### Milestones

#### Publications and Web links:

*Remembering the Space Age. Proceedings of the 50th Anniversary Conference.* Dick, S, editor. NASA, Washington DC. NASA/SP-2008-4703.  
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[http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20060022843\\_2006166766.pdf](http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20060022843_2006166766.pdf)

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Columbia Accident Investigation Board: <http://caib.nasa.gov/>

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#### The Space Shuttle

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##### Additional Web link:

Typical Mission Profile: <http://history.nasa.gov/SP-407/part1.htm>

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#### Web links:

Bill Parsons: <http://www.nasa.gov/centers/kennedy/about/biographies/parsons.html>

Lightning Delays Launch (STS-115):  
[http://www.nasa.gov/mission\\_pages/shuttle/behindscenes/115\\_mission\\_overview.html](http://www.nasa.gov/mission_pages/shuttle/behindscenes/115_mission_overview.html)

US National Lightning Detection Network Database:  
[http://gcmd.nasa.gov/records/GCMD\\_NLDN.html](http://gcmd.nasa.gov/records/GCMD_NLDN.html)

### Flight Operations

#### Web links:

Shuttle Training Aircraft—Test Drive:  
[http://www.nasa.gov/vision/space/preparingtravel/rtf\\_week5\\_sta.html](http://www.nasa.gov/vision/space/preparingtravel/rtf_week5_sta.html)

Payload Communication System:  
<http://spaceflight.nasa.gov/shuttle/reference/shutref/orbiter/comm/orbcomm/plcomm.html>

### Extravehicular Activity Operations and Advancements

#### Web links:

Neutral Buoyancy Laboratory Training:  
<http://spaceflight.nasa.gov/shuttle/support/training/nbl/>

Suit Environment as Compared to Space Environment:  
<http://www.nsbri.org/HumanPhysSpace/introduction/intro-environment-atmosphere.html>

Hubble Servicing Missions:  
[http://hubblesite.org/the\\_telescope/team\\_hubble/servicing\\_missions.php](http://hubblesite.org/the_telescope/team_hubble/servicing_missions.php)

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[http://www.centennialofflight.gov/essay/Evolution\\_of\\_Technology/TPS/Tech41.htm](http://www.centennialofflight.gov/essay/Evolution_of_Technology/TPS/Tech41.htm)

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<http://rtreport.ksc.nasa.gov/techreports/2002report/600%20Fluid%20Systems/604.html>

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[http://www.sti.nasa.gov/tto/Spinoff2008/ch\\_9.html](http://www.sti.nasa.gov/tto/Spinoff2008/ch_9.html)

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<http://pdf.aiaa.org/jaPreview/JSR/2000/PVJAIMP3582.pdf>

Advances in Friction Stir Welding for Aerospace Applications:  
[http://pdf.aiaa.org/preview/CDReady/MATIO06\\_1322/PV2006\\_7730.pdf](http://pdf.aiaa.org/preview/CDReady/MATIO06_1322/PV2006_7730.pdf)

### Aerodynamics and Flight Dynamics

#### Web links:

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[http://www.nas.nasa.gov/SC09/PDF/Datasheets/Tang\\_boundarylayer.pdf](http://www.nas.nasa.gov/SC09/PDF/Datasheets/Tang_boundarylayer.pdf)

Early Conceptual Designs for the Orbiter: <http://history.nasa.gov/SP-432/ch4.htm>

The Space Shuttle’s First Flight: STS-1:  
<http://history.nasa.gov/SP-4219/Chapter12.html>

### Avionics, Navigation, and Instrumentation

#### Web link:

Computers in the Space Shuttle Avionics System:  
<http://history.nasa.gov/computers/Ch4-1.html>



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#### Web links:

Crack Models and Material Properties Required for Fracture Analyses:  
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Orbiter Structure and Thermal Protection System/Review of Design and Development:  
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### Systems Engineering for Life Cycle of Complex Systems

#### Web links:

Calspan-University of Buffalo Research Center: <http://www.cubrc.org/>

Alliant Techsystems, Inc.: <http://www.atk.com/>

United Space Alliance: <http://www.unitedspacealliance.com/>

Pratt & Whitney Rocketdyne:  
<http://www.pw.utc.com/Products/Pratt+%26+Whitney+Rocketdyne>

Boeing: [http://www.boeing.com/defense-space/space\\_exploration/index.html](http://www.boeing.com/defense-space/space_exploration/index.html)

### Major Scientific Studies

#### The Space Shuttle and Great Observatories

##### Publication:

*Hubble: A Journey Through Space and Time.* Weiler, E. Abrams, NY, 2010.

##### Web links:

The Hubble Space Telescope: <http://hubble.nasa.gov/>

Space Telescope Science Institute/Hubble Space Telescope:  
<http://www.stsci.edu/hst/>

#### Atmospheric Observations and Earth Imaging

##### Publication:

*Calibration and Radiometric Stability of the Shuttle Solar Backscatter Ultraviolet (SSBUV) Experiment.* Hilsenrath, E; Williams, DE; Caffrey, RT; Cebula, RP; and Hynes, SJ. *Metrologia*, Issue 4, Vol. 30, 1993.

##### Web links:

Upper Atmosphere Research Satellite Project Science Office:  
[http://umpgal.gsfc.nasa.gov/www\\_root/homepage/uars-science.html](http://umpgal.gsfc.nasa.gov/www_root/homepage/uars-science.html)

Mediterranean Israeli Dust Experiment:  
<http://library01.gsfc.nasa.gov/host/hitchhiker/meidex.html>

### Mapping the Earth: Radars and Topography

#### Publication:

“Shuttle Radar Topography Mission produces a wealth of data.” Farr, TG and Kobrick, M. *American Geophysical Union Eos*, v. 81, p. 583-585, 2000.

#### Web links:

Jet Propulsion Laboratory—Shuttle Radar Topography Mission:  
<http://www2.jpl.nasa.gov/srtm/>

US Geological Survey—Shuttle Radar Topography Mission: <http://srtm.usgs.gov/>

### Astronaut Health and Performance

#### Publications and Web links:

*Neuroscience in Space.* Clement, G and Reschke, MF. Springer Science+Business Media, LLC, 2008.

*The Neurolab Spacelab Mission: Neuroscience Research in Space.* Buckley, JC and Homick JL. NASA, Washington, DC, NASA SP-2003-535, 2003.

“Muscle, Genes and Athletic Performance.” Andersen, J; Schjerling, P; and Saltin, B. *Scientific American*. September 2000.

*Skeletal Muscle Structure, Function, & Plasticity: The Physiologic Basis of Rehabilitation*, 2nd ed. Lieber, RL. Lippincott Williams & Wilkins, 2002.

*Spacefaring: The Human Dimension.* Harrison, A. University of California Press, Berkeley, CA, 2002.

*Habitability in Living Aloft: Human Requirements for Extended Spaceflight.* Connors, M; Harrison, A; and Akins, F. NASA SP-483, NASA Scientific and Technical Information Branch, Washington, DC, 1985.  
<http://history.nasa.gov/SP-483/contents.htm>

*Principles of Clinical Medicine for Space Flight.* Barratt, MR and Pool, SL. Springer, New York, NY, 2008.

*Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants: Volume 4.* National Academy Press, Washington, DC, 2000.  
[http://www.nap.edu/catalog.php?record\\_id=9786#toc](http://www.nap.edu/catalog.php?record_id=9786#toc)

#### Additional Web links:

Effect of Prolonged Space Flight on Cardiac Function and Dimensions:  
<http://sda.jsc.nasa.gov/books/skylab/Ch35.htm>

Life Sciences Data Base—Human Research Program Data: <http://sda.jsc.nasa.gov/>

### The Space Shuttle: A Platform That Expanded the Frontiers of Biology

#### Publications and Web links:

*Animals In Space: From Research Rockets to the Space Shuttle.* Burgess, C and Dubbs, C. Springer Praxis Books, 2007.

“Vertebrate Biology in Microgravity.” Wassersug, R. *American Scientist*: 89:46-53, 2001.

<https://www.americanscientist.org/issues/feature/vertebrate-biology-in-microgravity>

*Life Into Space: Space Life Sciences Experiments, Ames Research Center, 1965-1990.* Souza, K; Hogan, R; and Ballard R, editors. NASA RP-1372, 1995.  
<http://lis.arc.nasa.gov/>

*Life Into Space: Space Life Sciences Experiments, Ames Research Center, Kennedy Space Center, 1991-1998.* Souza, K; Etheridge G; and Callahan, P, editors. NASA SP-2000-534. <http://lis.arc.nasa.gov/>

*Cell Biology and Biotechnology in Space.* Cogoli, A, editor. Elsevier, 2002.

*US and Russian Cooperation in Space Biology and Medicine.* Volume V. Sawin, C; Hanson, S; House, N; and Pestov, I, editors. AIAA, 2009.

*Advances in Space Biology and Medicine.* Volume 1. Bonting, S, editor. Elsevier, 1991.



## Selected Readings

### Microgravity Research in the Space Shuttle Era

#### Publications and Web links:

*Cell Growth in Microgravity.* Sundaresan, A; Risin, D; and Pellis, NR. *Encyclopedia of Molecular Cell Biology and Molecular Medicine, Vol. 2*, pp 303-321, Edited by Meyers, RA; Sendtko, A; and Henheik, P. Wiley-VCH, Weinheim, Germany, 2004.

"Genes in Microgravity," Rayl, AJS. *DISCOVER*, Vol. 22, No. 9, September 2001. <http://discovermagazine.com/2001/sep/featgenes>

*Spacelab Science Results Study.* Naumann, RJ; Lundquist, CA; Tandberg-Hanssen, E; Horwitz, JL; Cruise, JF; Lewis, ML; and Murphy, KL. NASA/CR-2009-215740. [http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20090023425\\_2009021429.pdf](http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20090023425_2009021429.pdf)

*Spacelab 3 Mission Science Review.* NASA Conference Publication 2429. Fichtl, GH; Theon, JS; Hill, KC; and Vaughan, OH, editors. [http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19870012670\\_1987012670.pdf](http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19870012670_1987012670.pdf)

*First International Microgravity Laboratory.* McMahan, T; Shea, C; Wiginton, M; Neal, V; Gately, M; Hunt, L; Graben, J; and Tideman, J; Accardi, D. NASA TM-108007, 1993. [http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19930003925\\_1993003925.pdf](http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19930003925_1993003925.pdf)

*First International Microgravity Laboratory Experiment Descriptions.* Miller, TY. TM-4353, 1992. [http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19920014357\\_1992014357.pdf](http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19920014357_1992014357.pdf)

*Microgravity: A Teacher's Guide With Activities in Science, Mathematics, and Technology.* Rogers, JB; Vogt, GL; and Wargo, MJ. EG-1997-08-1100-HQ. <http://teacherlink.ed.usu.edu/lnasa/units/Microgravity/04.pdf>

*Joint Launch + One Year Science Review of USML-1 and USMP-1 with the Microgravity Measurement Group.* Volume I and II. Ramachandran, N; Frazier, DO; Lehoczy, SL; and Baugher, CR, editors. NASA-CP-3272-VOL-I and NASA-CP-3272-VOL-II.

Volume I: [http://www.ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19950007793\\_1995107793.pdf](http://www.ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19950007793_1995107793.pdf)

Volume II: [http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20030075796\\_2003085850.pdf](http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20030075796_2003085850.pdf)

*The First United States Microgravity Laboratory.* Shea, C; McMahan, T; Accardi, D; and Mikatarian, J. NASA-TM-107980, 1993. [http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19930003763\\_1993003763.pdf](http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19930003763_1993003763.pdf)

*Second United States Microgravity Payload: One Year Report.* Curreri, PA and McCauley, DE. NASA-TM-4737, 1996. [http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19960038726\\_1996063204.pdf](http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19960038726_1996063204.pdf)

*Second International Microgravity Laboratory (IML-2) Final Report.* Snyder, R, compiler. NASA/RP-1405, 1997. [http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19970035095\\_1997064524.pdf](http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19970035095_1997064524.pdf)

*Second United States Microgravity Laboratory (USML-2) One Year Report, Volume I.* Vlasse, M; McCauley, D; and Walker, C. NASA/TM-1998-208697, 1998. [http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19990018868\\_1998415108.pdf](http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19990018868_1998415108.pdf)

*Second United States Microgravity Laboratory (USML-2) One Year Report, Volume 2.* Vlasse, M; McCauley, D; and Walker, C. NASA/TM-1998-208697/VOL2. [http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19990009671\\_1998415144.pdf](http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19990009671_1998415144.pdf)

*Get Away Special... the first ten years.* NASA-TM-102921, 1989. [http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19900007459\\_1990007459.pdf](http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19900007459_1990007459.pdf)

#### Additional Web links:

European Experiments: Erasmus Experiment Archive—Erasmus Centre—ESA: <http://eea.spaceflight.esa.int/?pg=explore&cat=sh>

Get Away Special Web site: <http://library01.gsfc.nasa.gov/host/hitchhiker/gas.html>

### Social, Cultural, and Educational Legacies

#### NASA Reflects America's Changing Opportunities; NASA Impacts US Culture

#### Publication:

*Societal Impact of Spaceflight.* Dick, SJ and Launius, RD. NASA, Washington, DC, NASA SP-2007-4801.

#### Education: Inspiring Students as Only NASA Can

#### Web links:

EarthKAM: <https://earthkam.ucsd.edu>  
[http://geoearthkam.tamu.edu/EarthKAM\\_AM.ppt](http://geoearthkam.tamu.edu/EarthKAM_AM.ppt)  
<http://www.ncsu.edu/earthkam/simulation/>

Toys in Space: <http://quest.nasa.gov/space/teachers/liftoff/toys.html>

Challenger Center: <http://www.challenger.org/>

Resources for Educators: <http://www.nasa.gov/audience/foreducators/>

Project Starshine: <http://spacekids.hq.nasa.gov/starshine/>

Get Away Special Program—Historical Information: <http://library01.gsfc.nasa.gov/host/hitchhiker/history.html>

Shuttle Amateur Radio Experiment: <http://www.qsl.net/w2vtm/shuttle.html>

Instrumentation Technology Associates, Inc. (ITA) Student Outreach Program: <http://www.itaspace.com/students.html>

### Industries and Spin-offs

#### Web links:

MicroMed Cardiovascular, Inc.: [http://www.micromedcv.com/united\\_states/index.html](http://www.micromedcv.com/united_states/index.html)

NASA-developed Tool—LifeShear: <http://ipp.nasa.gov/innovation/Innovation34/Rescue.html>

Microbial Check Valve: <http://www.urc.cc/rmcv.htm>



## Acronyms

AIDS	Acquired Immunodeficiency Syndrome	JATO	jet-assisted takeoff
ANDE	Atmospheric Neutral Density Experiment	JAXA	Japan Aerospace Exploration Agency
ASTM	American Society for Testing and Materials	JSC	Johnson Space Center
ATLAS	Atmospheric Laboratory for Applications and Science	K	potassium
BIRD	Bird Investigation Review and Deterrent	kph	kilometers per hour
Ca	calcium	KSC	Kennedy Space Center
CAT	computerized axial tomography	LAURA	Langley Aerothermodynamic Upwind Relaxation Algorithm
CFC	chlorofluorocarbon	LED	light-emitting diode
CIRRIIS	Cryogenic Infrared Radiance Instrumentation for Shuttle	LiOH	lithium hydroxide
CO <sub>2</sub>	carbon dioxide	MOTEL	Microgravity Opportunity To Enhance Learning
CPR	Chemical Products Research	MRI	magnetic resonance imaging
DAC	digital to analog converter	MSFC	Marshall Space Flight Center
DFRC	Dryden Flight Research Center	NEXRAD	next-generation weather radar
DNA	deoxyribonucleic acid	Na	sodium
DoD	Department of Defense	NASA	National Aeronautics and Space Administration
DOUG	Dynamic Onboard Ubiquitous Graphics	nm	nanometers
DSMC	Direct Simulation Monte Carlo	NOAA	National Oceanic and Atmospheric Administration
EarthKAM	Earth Knowledge Acquired by Middle School Students	NSS	National Security Space
EDGE	Engineering DOUG Graphics for Exploration	O <sub>2</sub>	oxygen
EROS	Earth Resources Observation and Science	PCGOAL	Personal Computer Ground Operations Aerospace Language
ESA	European Space Agency	psi	pounds per square inch
ET	External Tank	psia	pounds per square inch, absolute
EVA	extravehicular activity	REM	Rapid Eye Movement
FAA	Federal Aviation Administration	rem	roentgen-equivalent man
Fe	iron	SAFER	Simplified Aid for EVA Rescue
FGB	Functional Cargo Block	SI	<i>Système International</i>
g	gravitational force (eg, 3g)	SLA	Super-Lightweight Ablator
g-suits	gravity suits	SolarMax	Solar Maximum Satellite
GLS	ground launch sequence	SRB	Solid Rocket Booster
GPS	Global Positioning Satellite	SSME	Space Shuttle Main Engine
GSFC	Goddard Space Flight Center	STS	Space Transportation System
HAL/S	high-order software language	USA	United Space Alliance
HCFC	hydrochlorofluorocarbon	USAF	US Air Force
HEPA	high-efficiency particulate air	USSR	Union of Soviet Socialist Republics
hp	horsepower	UV	ultraviolet
IBM	International Business Machines	VAD	ventricular assist device
Intelsat	International Telecommunications Satellite Organization	Vdc	volts, direct current
ISO	International Standards Organization	WSTF	White Sands Test Facility
ISS	International Space Station		



## Contributors' Biographies

**Alexander, Iwan** – Professor and Chair of Mechanical and Aerospace Engineering at Case Western Reserve University. Investigator for five space experiments, semiconductor crystal growth, liquid diffusion experiment, and an acceleration measurement. Director of the National Center for Space for 5 years.

**Alfrey, Clarence** – Professor at Baylor College of Medicine and former chief of hematology and medical director of the regional blood center. MD from Baylor College of Medicine with residency in internal medicine at State University of Iowa and fellow in hematology at the Mayo Clinic.

**Armor, James** – Major General, US Air Force (retired). Selected as a military spaceflight engineering program astronaut, but never flew as program discontinued.

**Bacon, John** – Systems engineer in the International Space Station (ISS) Program Office. For 20 years, he held assignments in the integration of all US international partner systems in the ISS Program at NASA. PhD, University of Rochester.

**Bains, Elizabeth** – PhD. Leads engineering analysis of Shuttle Robotic Arm operations. Co-chairs a panel overseeing Shuttle Robotic Arm model accuracy. Worked in many areas of Shuttle Robotic Arm software, from testing simulation dynamics models to requirements definition and verification testing for the arm control software.

**Baldwin, Kenneth** – PhD. Professor at University of California, Irvine. Principal investigator for four shuttle missions and numerous ground-based NASA research projects. Muscle team lead for the National Space Biomedical Research Institute for 8 years.

**Barger, Laura** – Instructor in medicine at Harvard Medical School. Associate physiologist at Brigham and Women's Hospital. Co-principal investigator of the sleep study conducted aboard shuttle flights from 2000-2011. Conducted sleep studies on the International Space Station.

**Bauer, Paul** – Thermal analyst at ATK. Led the Reusable Solid Rocket Motor Carbon Fiber Rope implementation team. Worked in design engineering for Electronic Specialty, producer of space-bound relays and switches. BS in Mechanical Engineering, Washington State University.

**Becker, Perry** – NASA, chief of the Engineering Directorate Ground Systems Structures Mechanisms. Twenty-five years of service. Served as crawler systems engineer, transporting over 100 shuttles to the launch pad. Master's degree in Mechanical Engineering, and an MBA.

**Beek, Joachim** – Manages the NASGRO project. Member of the Fracture Control Board at Johnson Space Center. MS in Aerospace Engineering, Texas A&M University.

**Bell, Bradley** – Responsibilities include development and maintenance of the visual simulation systems used in astronaut training, including the rendering software and the helmet-mounted display hardware at Johnson Space Center.

**Blumberg, Baruch** – Professor at Fox Chase Cancer Center, Pennsylvania. Former director NASA Astrobiology Institute. Received the 1976 Nobel Prize in Medicine for identification of hepatitis B virus. MD from Columbia, New York.

**Bordano, Aldo** – Retired from NASA in 2000 after 37 years of engineering service at Johnson Space Center. Chief of the Aeroscience and Flight Mechanics Division (1991-2000). Expertise in vehicle guidance and flight mechanics was critical to the design and development of shuttle spacecraft.

**Brown, Steve** – Started at Johnson Space Center in 1974 with the McDonnell Douglas Corporation. Supported the Space Shuttle Program in aerodynamics throughout career. Worked in the area of wind tunnel testing, and verification of the aerodynamic database for the simulators.

**Brown, Robert** – Lead electrical controls engineer. More than 11 years experience working electrical control upgrades for all mobile launcher platform and pad ground support equipment at Kennedy Space Center. BS in Electrical Engineering, University of Central Florida.

**Bryant, Lee** – Started as a NASA contractor in 1982 in Mission Planning and Analysis Division after graduating from the University of Texas. Flight Mechanics and Trajectory Design. Joined NASA in 1987 as an engineer in the guidance analysis section of Mission Planning and Analysis Division.

**Buning, Pieter** – PhD. Joined NASA in 1979 as a researcher in computational fluid dynamics. Developed computational tools for aerospace vehicles from helicopters and commercial airliners to hypersonic research vehicles and the shuttle, first at NASA Ames Research Center and then at NASA Langley Research Center.

**Burkholder, Jonathan** – Engineer in the Damage Tolerance Assessment Branch at Marshall Space Flight Center (MSFC). Technical secretary of the MSFC Fracture Control Board. BS in Mechanical Engineering, University of Alabama in Huntsville.

**Burns, Bradley** – More than 20 years experience at Kennedy Space Center developing ground support equipment and shop aids for the Space Shuttle Program. BS in Electrical Engineering, University of Central Florida.

**Butler, Jim** – Writer for United Space Alliance at Marshall Space Flight Center. Managed writing assignments for Computer Sciences Corporation, Intergraph, and the US Army prior to joining the NASA team. BA in English and History, University of Alabama in Huntsville.

**Campbell, Charles** – PhD. Began career with Johnson Space Center in 1987 as a cooperative education student, joining the Engineering Directorate in 1990 after graduating from the University of Minnesota with a bachelor's degree. Became the lead for Orbiter aerothermodynamics as the NASA subsystem engineer in 2003.

**Captain, Janine** – Works for NASA at Kennedy Space Center (since 2005), focusing on in-situ resource utilization technologies and sensors for field deployment. PhD in Chemistry, Georgia Institute of Technology.

**Caron, Dan** – Curriculum specialist for Engineering by Design. Teaches aerospace/technology education at Kingswood Regional High School in Wolfeboro, New Hampshire. Led the NASA Educational Workshops at Goddard Space Flight Center and Wallops Flight Facility (1997-1999).

**Carpenter, Bradley** – Works in the Space Operations Mission Directorate at NASA Headquarters. Lead scientist in the Microgravity Research Division of NASA from 1996-2005. PhD in Chemical Engineering, Stanford University.

**Castner, Willard** – Metallurgical engineer who, during his 30+ years at Johnson Space Center, specialized in nondestructive testing, materials testing, and failure analysis. Active member of the American Society for Nondestructive Testing during NASA career.

**Chandler, Michael** – Deputy branch chief of medical operations at Johnson Space Center. Member of the Department of Defense Space Transportation System contingency support office during the Challenger accident. Member of the NASA Mishap Investigation Team following the Columbia Accident.

**Chapline, Gail** – Worked primarily at Johnson Space Center as a materials engineer. Supervised the materials branch. Also worked in the Shuttle Program Office, NASA Headquarters, National Transportation and Safety Board, and NASA White Sands Test Facility. MS in Materials Engineering, Northwestern University.

**Charles, John** – Program scientist for NASA's Human Research Program at Johnson Space Center. Principal investigator for several investigations into the changes in the cardiovascular system. PhD in Physiology and Biophysics, University of Kentucky.

**Christian, Carol** – PhD. Deputy of the Community Missions Office and an astronomer at the Space Telescope Science Institute at Baltimore, Maryland. Served as head of the Office of Public Outreach for Hubble Space Telescope for many years, and has researched stellar populations in nearby galaxies.

**Christiansen, Eric** – PhD. NASA Micro-Meteoroid and Orbital Debris (MMOD) Protection lead at Johnson Space Center. Holds a patent for the Stuffed-Whipple shield used extensively on the International Space Station. Developed a number of design and operational methods to reduce MMOD risk to NASA spacecraft.

**Coglitore, Sebastian** – Brigadier General, retired from US Air Force. Program manager of the first Department of Defense spacecraft to fly on the Space Shuttle.

**Cohen, Aaron** – Worked for NASA from 1962-1993. Served as center director (1986-1993), then returned to Texas A&M University to a distinguished engineering chair. MS in Applied Math, the Stevens Institute of Technology.

**Collins, David** – Deputy associate director of Technology Development and chief of the Instrumentation Section for Development Engineering at Kennedy Space Center. MS in Electrical Engineering, Georgia Tech.

**Connolly, Janis** – Project manager for NASA's Human Research Program and its Space Human Factors Engineering Project at Johnson Space Center. MS in Architecture, University of Wisconsin-Milwaukee.

**Cort, Robert** – Associate manager-technical at NASA White Sands Test Facility. Began working on ground testing of Space Shuttle Orbiter Maneuvering System and reaction control subsystems in 1987, and managed repair and overhaul of flight hardware for those systems/subsystems at White Sands Test Facility.

**Cragnun, Brad** – ATK scientist. Formulated propellants and pyrotechnics for ATK's Castor 120<sup>®</sup> rocket motor and Boeing's Sea Lance missile. Inducted into the Space Technology Hall of Fame for developing a demining flare based on shuttle propellant technology. Graduate of Weber State University.



## Contributors' Biographies

**Cross, Jeffrey** – Aeronautical engineer involved in rotorcraft flight research for 16 years. Public outreach lead and visitor center curator for 10 years. Member of the NASA Ames Research Center's Office of Education for 3 years.

**Crucian, Brian** – Senior scientist with Wyle Laboratories at Johnson Space Center. Expertise in spaceflight-associated immune dysregulation, flow cytometry assay development, and immunology research in extreme environments. PhD, University of South Florida.

**Curtis, Glen** – ATK program manager over Reusable Solid Rocket Motor supply chain, process control, and program transition. Twenty-two-year career has included duties as a proposal manager, supervisor in industrial engineering, and manager of budgets, proposals, and training for operations. Space Shuttle Program Star Award.

**Czeisler, Charles** – PhD, MD, the Baldino Professor of Sleep Medicine, and director of the Division of Sleep Medicine at Harvard Medical School. Chief of the Division of Sleep Medicine at Brigham and Women's Hospital. Principal investigator of multiple sleep studies.

**DeTroye, Jeff** – Works for the CIA (2003-present). Worked for NASA (1985-1998). Commander of the National Reconnaissance Office Aerospace Defense Facility – East. Officer in US Air Force (1977-1985). MS, University of Houston-Clear Lake.

**Ding, Robert** – Welding engineer at NASA Marshall Space Flight Center (MSFC). Currently works in the Material and Processes Laboratory at MSFC in welding process development. Master's degree in Engineering Management.

**Dolman, Everett** – PhD. Professor of Comparative International Studies at the US Air Force's School of Advanced Air and Space Studies. Formerly an intelligence analyst, National Security Agency. Published works include *Astropolitik*, *The Warrior State*, and *Pure Strategy*.

**Dorsey, Geminesse** – Mechanical engineer at Johnson Space Center. Worked as a test director and technical area lead of the Battery Systems Test Facility in the Energy Systems Test Area. Worked on numerous test programs to certify and evaluate batteries used on-orbit.

**Drake, Daniel** – United Space Alliance, lead mechanical engineer. Twenty-six years of service at Kennedy Space Center. Primarily responsible for the hydraulic systems of the crawlers. Holds certifications as driver, jacking console operator, and local test conductor.

**Ecord, Glenn** – Materials Branch, Engineering Directorate at Johnson Space Center. Served as integration technical manager for Fracture Control and for Pressure Vessels and Pressurized Systems, Orbiter, and payloads.

**Faile, Gwyn** – Former chief of the Marshall Space Flight Center Structural Integrity Branch. Served as co-chair of the NASA Fracture Control Analytical Methodology Panel. Currently works for the Qualis Corporation on the Jacobs Engineering team supporting the Marshall Space Flight Center Damage Tolerant Assessment Branch.

**Feagan, Carole-Sue** – Twenty-five years management and human resource experience in private industry. Came to Kennedy Space Center in 2008 to support the director of vehicle operations, planning development with United Space Alliance. Joined a contractor in support of the NASA chief engineer of launch vehicle processing.

**Feedback, Daniel** – Head of the Muscle Research Laboratory, Johnson Space Center, until 2010. Adjunct associate professor, Department of Biochemistry, Institute of Biosciences Bioengineering at Rice University. PhD, University of Oklahoma.

**Fiorucci, Tony** – Aerospace engineer at Marshall Space Flight Center. Responsible for vibration analysis and redline methodology algorithm development and integration for the Space Shuttle Main Engine, Advanced Health Management System. BS in Engineering Science, University of Tennessee.

**Fish, Ozzie** – Works in the NASA Instrumentation Branch. Has served as a Hazardous Warning System engineer since 1988. BS in Electrical Engineering, University of Central Florida.

**Fitts, David** – Chief, Habitability and Human Factors Branch in Johnson Space Center's Space Life Sciences Directorate (2003-present). An architect by formal education, he focused on NASA becoming a product-based and design-solution organization.

**Flores, Rose** – Led the Shuttle Remote Manipulator System analysis, flight hardware and software activities for the Flight Robotic Systems Branch at Johnson Space Center. Co-chaired the Robotics Analysis Working Group and was the shuttle robotics chief engineer. MS in Systems Engineering.

**Fogarty, Jennifer** – Innovation and development lead for Johnson Space Center Space Life Sciences. PhD in Cardiovascular Research, Texas A&M University.

**Folensbee, Al** – Worked at Kennedy Space Center, performing and overseeing the development, automation, and testing of ground application software for the Space Shuttle Program. Master's degree in Computer Science, Florida Institute of Technology.

**Forman, Royce** – Served as the primary NASA technical expert at Johnson Space Center on fracture control and fracture mechanics technology, initiated formation and co-chaired the NASA Fracture Control Methodology Panel, and performed the majority of fracture mechanics experimental efforts at the center.

**Forth, Scott** – Chairs the Johnson Space Center Fracture Control Board and works with the pressure vessel for manned spaceflight. PhD in Mechanical Engineering, Clarkson University.

**Fowler, Michael** – Worked as a materials engineer at Johnson Space Center for 23 years. PhD in Chemical Engineering, University of Texas.

**Fraley, John** – Has worked at Kennedy Space Center for 32 years. Served as an Apollo Structural Systems engineer in spacecraft operations, then as chief, Orbiter Structures, Handling Access Systems Section. BS in Mechanical Engineering, University of Kentucky.

**Frandsen, Jon** – Engineer with Pratt & Whitney Rocketdyne, working with the Space Shuttle Main Engine (SSME). Specialized in fracture mechanics and hydrogen embrittlement materials testing as they relate to the SSME. MS, UCLA.

**Galvez, Roberto** – Started career at NASA as a shuttle flight controller in the Guidance, Navigation & Control Systems. Served as manager of the Space Shuttle Program Flight Management Office. BS in Electrical Engineering, Louisiana State University.

**Gardze, Eric** – Pratt & Whitney Rocketdyne Kennedy Space Center (KSC) senior engineering manager. Supported Space Shuttle Main Engine since 1973. Supported combustion devices development at Canoga Park, California, the first engine hot fire testing at Stennis Space Center, and launch operations at KSC since STS-1.

**Gaylor, Stephen** – Began career with Rockwell Shuttle Operations and joined NASA in 1990. Was responsible for shuttle flight definition and mission performance analysis. Served as a flight manager in the Space Shuttle Program. Degree in Mechanical Engineering, Texas A&M University.

**Gibson, Cecil** – Began career at the Army Ballistic Missile Agency. Transferred to Johnson Space Center Propulsion and Power Division and became Apollo Service Propulsion System manager and, later, Ascent Engine manager. Supervised propulsion development and mission activities for the Space Shuttle and station until he retired.

**Gnoffo, Peter** – Senior research engineer in the Aerothermodynamics Branch at Langley Research Center. Has worked in the area of computational aerothermodynamics since joining NASA in 1974.

**Gomez, Reynaldo** – Member of Johnson Space Center Engineering Directorate since May 1985, after graduating from Rice University. Space Shuttle Ascent Aerosciences Technical Panel chairman since 1993.

**Greene, Ben** – Engineering project manager for the Reinforced Carbon-Carbon Repair Team at Johnson Space Center (JSC). Has been developing extravehicular activity tools and equipment at JSC for spacewalking astronauts for 15 years. BS in Mechanical Engineering, University of Houston.

**Grogan, James** – Colonel, retired, US Air Force.

**Hale, Wayne** – Shuttle flight director for 41 missions at Johnson Space Center. Kennedy Space Center shuttle launch integration manager, shuttle deputy program manager, and Space Shuttle Program manager. MS in Engineering, Purdue University.

**Hall, Jennifer** – More than 20 years of technical and managerial experience at Kennedy Space Center. Deputy director of the Florida Program Office. BS in Industrial Engineering, University of Central Florida. MBA, Florida Tech.

**Hallett, Charles** – Worked for 20 years with manufacturing systems in New York and started at Kennedy Space Center in 1990. Introduced many standard manufacturing concepts to shuttle business processes and has been Collaborative Integrated Processing Solutions project manager since its inception. Graduated from University of Buffalo.

**Hamel, Michael** – Lieutenant General, retired, US Air Force.

**Harris, Yolanda** – Technical representative for the Marshall Space Flight Center Ares First Stage Office. Served as technical assistant to the Space Shuttle Program deputy manager for propulsion. Juris Doctor Degree, University of Alabama.

**Hayes, Judith** – Exercise physiologist at Johnson Space Center. Deputy division chief, Human Adaptation & Countermeasures. Master of Public Health. MS in Exercise Physiology, West Virginia University.

**Helms, Bill** – Retired NASA physicist, 35 years Kennedy Space Center (KSC) designing launch complex instrumentation for the Space Shuttle and the Hazardous Gas Detection System. Managed KSC Instrumentation Development Labs for 20 years.

**Herron, Marissa** – Began career at Johnson Space Center in 2000 as a flight controller in the Flight Design and Dynamics Division. MS in Aerospace Engineering, University of Colorado at Boulder.



## Contributors' Biographies

**Herst, Terri** – More than 26 years of shuttle processing technical and managerial experiences at Kennedy Space Center. Serves as Shuttle Project Engineer and is responsible for leading integrated technical issues to resolution during the launch countdown.

**Hess, David** – Director, Department of Defense (DoD) Human Space Flight Payloads Office, Johnson Space Center. Responsible for all actions related to access to space aboard human-rated spacecraft on DoD's behalf.

**Hill, Arthur** – Member of the Pratt & Whitney Rocketdyne technical staff since 1975. Led the development and implementation of the Space Shuttle Main Engine instrumentation system for over 30 years. BS in Electrical Engineering, UCLA.

**Hill, Paul** – Director of Mission Operations for Space Shuttle and International Space Station at Johnson Space Center. MS in Aerospace Engineering, Texas A&M University.

**Hilsenrath, Ernest** – PhD. Retired from Goddard Space Flight Center (GSFC). Served as principal investigator for several remote sensing satellite and shuttle missions of the Earth's atmosphere and was director of GSFC's Radiometric Calibration and Development Laboratory.

**Hirko, John** – Worked on Kennedy Space Center's Operational Intercommunication System – Digital (OIS-D) development team starting in 1987. Contributed to design, build, integration, testing, installation, operation, and troubleshooting throughout OIS-D's 21-year history at that center. Graduated from University of Pittsburgh's School of Engineering.

**Hoblitt, Jeffrey** – Has served as the contractor task lead of Johnson Space Center's Integrated Extravehicular Activity Radiation Monitoring Virtual Reality Laboratory since the mid 1990s. BS in Aerospace Engineering, University of Cincinnati.

**Holland, Albert** – PhD. Senior operations psychologist at Johnson Space Center. Worked with astronauts and their families for over 25 years, including during the Shuttle-Mir Program, International Space Station, and analog environments such as winter over in Antarctica. Credited with numerous publications.

**Homan, David** – Manager of the Integrated Extravehicular Activity Robotics Virtual Reality Simulation Facility at Johnson Space Center. BS in Mechanical Engineering, Iowa State University.

**Horvath, Thomas** – Senior research engineer in the Research Technology Directorate at Langley Research Center, where he has worked since 1989. Primary area of expertise includes experimental research to determine and optimize the aerodynamic characteristics and heating environments for aerospace vehicles.

**Howell, Patricia** – Aerospace engineer with 20 years of experience in nondestructive evaluation research at NASA Langley Research Center, specializing in thermal modeling and data analysis for defect detection methods. NASA's Silver Snoopy Award. NASA Exceptional Achievement Medal.

**Huss, Terry** – Senior materials and processes engineer for United Space Alliance. Responsibilities include automation and robotic process development for shuttle and Ares Solid Rocket Booster elements. Graduate of the University of Colorado at Boulder's Aerospace Engineering Program.

**James, John** – PhD in Pathology and a Diplomat of the American Board of Toxicology. NASA chief toxicologist at Johnson Space Center. NASA Exceptional Service Medal and Shuttle Star Award. Authored or co-authored more than 100 articles and numerous book chapters.

**Johnson, Dexter** – Began career with Rockwell Shuttle Operations and joined NASA Johnson Space Center in 1989 in the Cargo Integration Office. Served as technical monitor representative for the Shuttle Middeck Integration contract. BS in Physics, Michigan State University.

**Johnson, Steve** – PhD. Professional Engineer. Member of Space Radiation Analysis Group, which is responsible for radiation monitoring and operational support in mission control for shuttle and International Space Station (ISS) missions. Participated in radiation investigations conducted on shuttle, Mir, and ISS during his 20 years at Johnson Space Center.

**Jones, Samuel** – Division chief engineer for the Space Shuttle. Mechanical engineer at Johnson Space Center in the Energy Systems Division. During 35 years experience, has served as test manager in the Energy Systems Test Area for test programs involving pyrotechnic devices, fuel cell components, and cryogenics.

**Jordan, Coy** – ATK design engineer. Responsible for the nozzle flexible bearing and bearing Thermal Protection System for the Reusable Solid Rocket Motor and the Ares rocket motor. Employed with Raytech Corporation, prior to ATK. BS in Mechanical Engineering, Arizona State University.

**Jorgensen, Glenn** – Worked on the Shuttle Robotic Arm with Spar Aerospace as a systems engineer and then a project manager. Participated in design upgrades to the arm and has supported shuttle missions throughout the program. Assigned as subsystem manager for the Shuttle Robotic Arm with NASA in 2007.

**Jue, Fred** – Performs strategic analysis and business development for the Pratt & Whitney Rocketdyne Space Shuttle Main Engine (SSME) program. Began career with Rocketdyne as an SSME turbomachinery engineer. Served as resident manager for development of the alternate turbopumps at the Pratt & Whitney Florida facility.

**Kahl, Bob** – Director of Palmdale Shuttle Operations for Boeing Explorations, and part of the Space Shuttle Program since 1975. Operations director of Orbiter Assembly Test and Logistic Spares (1997-present).

**Kauffman, Larry** – Director of California Operations for Boeing Space Exploration. Part of the Space Shuttle Program since 1979. Associate program director of Orbiter production (1996-2000).

**Kaupp, Henry** – Part of the NASA team that evaluated Canadian ability to build the Shuttle Robotic Arm. Followed the shuttle arm development and supported early missions. Served as shuttle division chief engineer for the Robotics Division, and was prime point of contact for the Shuttle Robotic Arm until his retirement.

**Kaye, Jack** – PhD. Associate director for research, Earth Science Division, NASA Headquarters. Program scientist for Atmospheric Laboratory of Applications and Science missions, Cryogenic Infrared Spectrometers & Telescopes for the Atmosphere-Shuttle Palette Satellite, Mediterranean Israeli Dust Experiment, and Solar Shuttle Backscatter Ultraviolet Experiment.

**Kelly, Mark** – Captain, US Navy. NASA astronaut. Assigned to command crew of STS-134 (2011). Commander on STS-124 (2008). Pilot on STS-121 (2006) and STS-108 (2001). Has received several awards and honors. MS in Aeronautical Engineering, US Naval Postgraduate School.

**Killpack, Michael** – Manages the analytical chemistry department within the ATK Launch Systems research and development laboratory in Promontory, Utah, where he has been employed for more than 10 years. Prior to joining ATK, retired as a Lieutenant Colonel following a 20-year career with the US Air Force.

**Kirazes, John** – Chief of the Communications and Tracking Branch at Kennedy Space Center. Started working on shuttle navigation systems with NASA in 1985. MS in Electrical Engineering, Florida Institute of Technology.

**Kirk, Benjamin** – Joined the Aerosciences & Flight Mechanics Division at Johnson Space Center in 2003. Heavily supported Thermal Protection System repair technique development and implementation for the Orbiter. PhD in Aerospace Engineering.

**Kloeris, Vickie** – Food scientist with a concentration in food microbiology. Manager of the Space Food Systems Laboratory at Johnson Space Center. Manages the International Space Station food system. Additionally, managed the shuttle food system (1989-2005). MS, Texas A&M University.

**Knight, Jack** – Forty years hands-on and management experience in human spaceflight programs at Johnson Space Center. Includes spaceflight operations procedures and planning, real-time vehicle command and control, and facility development project management for simulators and mission control centers.

**Kobrick, Michael** – PhD. Senior scientist at NASA's Jet Propulsion Laboratory, Pasadena, California. Served as the director of the Shuttle Radar Topography Mission.

**Koontz, Steven** – PhD. Works in the Materials and Processes Branch at Johnson Space Center. System manager and expert for spaceflight environment effects on spacecraft performance.

**Kosmo, Joseph** – Senior project engineer in the Extravehicular Activity & Space Suit Systems Branch at Johnson Space Center. Started career at the NASA-Langley Space Task Group in 1961. Involved in design, development, and testing of all major spacesuit assemblies, from Mercury to the International Space Station Program.

**Kuo, Y.M.** – PhD. Modeler of dynamics of on-orbit systems, particularly manipulators, including certification of the Shuttle Robotic Arm model that added capabilities such as constrained motion and end effector dynamics. Leads analyses of manipulator on-orbit performance at Johnson Space Center.

**Lamb, Holly** – Manager of community relations for aerospace and defense manufacturer ATK. Oversees efforts to inspire the next generation of scientists and engineers through education outreach initiatives. Degree in Professional Writing, Carnegie Mellon University.

**Lane, Helen** – Registered Dietician. Served as lead for Johnson Space Center for nutritional biochemistry laboratory, clinical research laboratories, branch chief, engineering interface, and manager of University Research and Affairs. Research focus is nutrition and biochemistry. PhD in Nutrition, University of Florida.



## Contributors' Biographies

**LeBeau, Gerald** – Joined Johnson Space Center as a cooperative education student in 1987. Focus of career was in the area of computational aerosciences, specializing in the development and application of rarefied gas dynamics tools. Served as the chief of the Applied Aeroscience and Computational Fluid Dynamics Branch since 2006.

**Leckrone, David** – Part of the Hubble Space Telescope Project since 1976, first as scientific instruments project scientist, then deputy senior project scientist, and later as chief engineer. Lead project scientist at Johnson Space Center "mission control" during the Hubble servicing missions (1993, 1997, 1999, 2008). PhD in Astronomy, UCLA.

**Leger, Lubert** – Served as chief of the Materials Branch, Engineering Directorate at Johnson Space Center.

**Levin, Zev** – PhD. The J. Goldemberg chair professor in Atmospheric Physics. Principal investigator of the Mediterranean Israeli Dust Experiment on board the Space Shuttle Columbia on its last flight. Served as dean of research and vice president of research at Tel Aviv University, Israel.

**Lewis, Marilyn** – EdD. Education Specialist with WILL Technology, Inc. working in support of the Marshall Space Flight Center Office of Human Capital contract. Coordinates Minority University Research and Education Projects for the Marshall Academic Affairs Office.

**Limer, Thomas** – Johnson Space Center Toxicology Laboratory supervisor (1990-present). Expert in measurement of trace volatile organics in closed environments. Served as lead scientist for development of several spacecraft air quality monitors. PhD in Analytical Chemistry, University of Houston.

**Lingbloom, Mike** – Served as lead ATK engineer for Reusable Solid Rocket Motor optically simulated electron emission technology. Holds Level III certifications in magnetic particle, liquid penetrant, and laser shearography via the American Society for Nondestructive Testing. Associate of Science degree in Electronic Technology.

**Locke, James** – Joined NASA in 1999 as a flight surgeon. Has worked in the NASA Flight Medicine Clinic at Johnson Space Center, and served as a crew surgeon on numerous shuttle and International Space Station missions. MD, University of Wisconsin Medical School. Completed medical residencies in Emergency Medicine and Aerospace Medicine.

**Loveall, James** – Has served as the division chief engineer for shuttle flight software in the Johnson Space Center Engineering Directorate since 2003. Serves as deputy branch chief for the Operational Space Systems Integration Branch in the Avionic Systems Division.

**Lucid, Shannon** – Flew on STS-51G, STS-34, STS-43, STS-57, STS-76, and STS-79, and spent 6 months on Russian space station Mir. Was one of seven women chosen for the first astronaut class that accepted women. PhD in Biochemistry, University of Oklahoma.

**Lulla, Kamlesh** – PhD. Served as chief scientist for Earth Observations and Astronaut Training in Earth Observations for the Space Shuttle and the International Space Station. Conducted experiments in human-directed remote sensing and technology development at Johnson Space Center for the past 23 years.

**Lumpkin, Forrest** – Began career at NASA Ames Research Center in 1990. Joined Johnson Space Center 1994. Career has focused on rarefied gas dynamics emphasizing on plumes. PhD, Stanford University.

**Madura, John** – Over 29 years of weather analysis and research experiences working both for NASA and the Air Force. Serves as manager for the Kennedy Space Center weather office. MS in Meteorology, University of Michigan.

**Manning, Samantha** – Assistant launch vehicle processing chief engineer. Worked at Johnson Space Center for 5 years before going to Kennedy Space Center. Worked Main Propulsion and Max Launch Abort System for 2 years each. Degree in Aeronautical and Astronautical Engineering, University of Illinois at Urbana-Champaign.

**Martin, Fred** – Orbiter NASA subsystem engineer for aerodynamics, and Aeroscience and Flight Mechanics Division chief engineer for aerosciences. Began career at Johnson Space Center in 1980. Led the development of the Space Shuttle Launch Vehicle computational fluid dynamics analysis (1989-1993).

**McArthur, Cynthia** – Lead for Teaching From Space, a NASA K-12 education office located in the Astronaut Office at Johnson Space Center. Teaching From Space facilitates on-orbit education opportunities that use the unique environment of spaceflight, including in-flight education downlinks and education payload operations.

**McClellan, Wayne** – Lead system engineer for ground instrumentation and controls at Kennedy Space Center. BS in Electrical Engineering, Florida Atlantic University.

**McCormick, Patrick** – PhD. Professor and co-director, Center for Atmospheric Sciences, Hampton University. Principal investigator for series of Earth science satellite experiments. Co-principal investigator for Apollo-Soyuz Stratospheric Aerosol Measurement and Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation experiments.

**McGill, Preston** – Structural materials engineer in the Damage Tolerance Assessment Branch at Marshall Space Flight Center (MSFC). Serves on the MSFC Fracture Control Board. Doctorate in Civil Engineering, Auburn University.

**McKelvey, Timothy** – NASA lead computer engineer for the Launch Processing System. Has worked at Kennedy Space Center since 1987. BS in Electrical Engineering, University of South Florida. MS in Engineering Management, Florida Institute of Technology.

**McPeters, Richard** – PhD. Atmospheric physicist at Goddard Space Flight Center. Closely involved in the measurement of ozone from space from a series of Task Order Management System and Solar Backscatter Ultraviolet Instrument since the 1970s.

**Medelius, Pedro** – Has worked at Kennedy Space Center for 18 years—last 7 years with ASRC Aerospace Corporation. Responsible for research and development activities in various aerospace-related areas, applied physics, and real-time signal processing. PhD, University of Florida.

**Mehta, Satish** – Senior scientist at the Microbiology Department of Johnson Space Center. Since 1992, his research focused on reactivation and shedding of Herpes viruses in space and space analogs. PhD, Guru Nanak Dev University.

**Meinhold, Anne** – Principal senior engineer with International Trade Bridge, Inc. MS in Environmental Science, University of North Carolina at Chapel Hill.

**Merceret, Francis** – Director of research for the Kennedy Space Center Weather Office. Specializes in meteorological observation and data analysis with emphasis on winds and lightning. Authored over 100 professional papers (more than 40 peer-reviewed). PhD in Atmospheric Physics, Johns Hopkins University.

**Miller, Glenn** – Senior technical expert working structural design projects. Began career at Johnson Space Center in 1984 as structural engineer in the field of structural analysis and certification. BS in Civil Engineering, Texas A&M University.

**Miralles, Evelyn** – Principal software engineer of the Virtual Reality Laboratory, an astronaut training facility, at Johnson Space Center. BS in Computer Science.

**Mizell, Richard** – Associate director for Management Launch Vehicle Processing Directorate at Kennedy Space Center. Worked at NASA for more than 20 years as a systems engineer on various flight and ground systems, including 10 years on the Hazard Warning Systems beginning during the Main Propulsion System leaks in 1990.

**Modlin, Tom** – Worked at Johnson Space Center in structural analysis. Supported the Mercury, Gemini, Apollo, and Space Shuttle Programs as a structural analysis expert. Served as the chief of the Structural Mechanics Branch.

**Moore, Gilbert** – Retired Thiokol engineer, Utah State physics professor, and US Air Force Academy astronautics professor, where he helped develop the cadet satellite program. Director of Project Starshine. Served as lead for the first canister of Get Away Special experiments and first Space Shuttle student satellite.

**Moore, Dennis** – Chief engineer for Space Shuttle Reusable Solid Rocket Motor at Marshall Space Flight Center. MS, University of Alabama.

**Morgan, Barbara** – Mission specialist and teacher in space on STS-118. Worked as an elementary school teacher in Idaho and educator in residence at Boise State University.

**Moser, Thomas** – Held key positions at Johnson Space Center, including head of structural design, deputy manager Orbiter Project, director of engineering, deputy associate administrator for spaceflight and space station, and director of Space Station Program at Headquarters. MS, University of Pennsylvania.

**Muratore, John** – Teaches at University of Tennessee Space Institute. Supported the Space Shuttle for 28 years, both with the US Air Force and NASA. Worked at Vandenberg Air Force Base, Kennedy Space Center, and Johnson Space Center. Served as manager of Space Shuttle Systems Engineering and Integration following Columbia accident.

**Nickerson, Cheryl** – PhD. Associate professor at The Biodesign Institute, Arizona State University. An expert in mechanisms of microbial pathogenesis. Pioneered discovery of molecular genetic and virulence changes in Salmonella and other pathogens in response to spaceflight.



## Contributors' Biographies

**Nickolenko, Peter** – Has worked at Kennedy Space Center for more than 20 years in shuttle processing operations. Launch director for STS-127 and STS-128. Served in both technical and managerial positions planning launch and landing operations. Degree in Engineering from Military Academy-West Point.

**Norbraten, Lee** – Joined NASA in 1967 as an Apollo mission designer at Johnson Space Center. Led project teams to improve ascent structural safety margins, payload capability, and launch probability for the International Space Station during the shuttle era. MS in Mathematics, University of Houston.

**O'Neill, Patrick** – Has worked in the design and analysis of Guidance, Navigation, & Control Systems at Johnson Space Center. Served as "Radiation Effects scientist," responsible for planning radiation testing, modeling natural space radiation environments, and predicting radiation effects on performance of systems.

**Ott, Mark** – PhD. Microbiologist. Supports spaceflight program operations at Johnson Space Center Microbiology Laboratory. Extensive experience in the assessment of infectious disease risk to the crew during spaceflight missions.

**Paloski, William** – Professor of Health and Human Performance at the University of Houston. Spent 23 years as a neurosciences researcher at Johnson Space Center, studying sensory-motor adaptation to spaceflight. PhD in Biomedical Engineering, Rensselaer Polytechnic Institute.

**Patrick, Nancy** – Started as a NASA shuttle contractor in 1983 in the Mission Operations Directorate after graduating from the University of Notre Dame. Joined NASA in 1990 as an assembly planner for the International Space Station. Worked in the Extravehicular Activity (EVA) office as EVA staff engineer (1996–2008).

**Payne, Stephen** – NASA Payload Operations, Discovery lead for Kennedy Space Center Vehicle Integration Test Team office, NASA test director, ground operations manager for transatlantic abort landing deployments, tanking test director, and shuttle test director for eight launches. MS in Engineering Management, University of Central Florida.

**Payton, Gary** – Lieutenant General, retired, US Air Force. Deputy, Under Secretary of Air Force for Special Program and military payload specialist on STS-51C.

**Pellis, Neal** – Senior scientist at Johnson Space Center. Led the Biotechnology Program and the Biological Systems Office, and was International Space Station Program scientist, following a 21-year career in academics. PhD in Microbiology, Miami University. Postdoctoral fellowship at Stanford University.

**Peralta, Steven** – Technical expert on identifying and controlling fire hazards in oxygen systems. Started career as an engineer and project manager at NASA's White Sands Test Facility in 1999. BS in Mechanical Engineering, New Mexico State University.

**Perkins, Fred** – ATK chief engineer for the Reusable Solid Rocket Motor. Held leadership positions in both design and reliability engineering. MS in Mechanical Engineering, University of Utah.

**Pessin, Myron** – Consultant with Jacobs on the ARES Program. Former NASA External Tank chief engineer. Served as a Space Shuttle Main Engine propulsion engineer. BS in Mechanical Engineering, Tulane University.

**Pham, Chau** – Johnson Space Center Crew and System Division chief engineer for Orbiter Environment Control and Life Support Systems. BS in Aerospace Engineering, University of Texas.

**Pierson, Duane** – NASA's senior microbiologist at Johnson Space Center. Agency's expert on the many microbiological aspects of spaceflight. PhD, Oklahoma State University.

**Pilet, Jeffrey** – Chief Engineer for Lockheed Martin Michoud Assembly Facility on the External Tank Project.

**Platts, Steven** – Head of the Cardiovascular Research Laboratory at Johnson Space Center. PhD in Cardiovascular Physiology, Texas A&M University. Postdoctoral Fellowship, University of Virginia.

**Richmond, Dena** – Employed by United Space Alliance on the Collaborative Integrated Processing Solutions team and is a Solumina subject matter expert.

**Ride, Sally** – PhD. NASA astronaut. First American woman to fly in space. Flew on STS-7 and STS-41G. President of Sally Ride Science – a company that promotes education in science, technology, engineering, and mathematics.

**Ring, Richard** – Employed with United Space Alliance. More than 25 years in the aerospace industry as a design engineer.

**Rivera, Jorge** – Deputy chief engineer for shuttle processing. More than 28 years of technical and managerial experiences at Kennedy Space Center. BS in Industrial Engineering, University of Puerto Rico – Mayaguez.

**Roberson, Luke** – His research at NASA deals with the development, application, and evaluation of conductive polymers, microelectronic devices, and nanocomposite polymeric materials. PhD, Georgia Institute of Technology.

**Roberts, Katherine** – Brigadier General, retired, US Air Force. An original military astronaut for manned spaceflight engineering program, MSE-2, before program was cancelled.

**Rodriguez, Alvaro** – Supported the Space Shuttle Program at Johnson Space Center as the NASA subsystem engineer for the Leading Edge Structural Subsystem using expertise in thermal analysis and testing of Thermal Protection System. Masters of Mechanical Engineering, Rice University.

**Rohan, Richard** – System analyst specialist for Jacobs Technology. Worked supporting NASA for the past 22 years. Provides both 2-D and 3-D graphics and technical drawings for the Johnson Space Center Flight Mechanics Laboratory, in addition to building and maintaining high-performance computer clusters.

**Romere, Paul** – Started career at the Manned Spacecraft Center (now Johnson Space Center). Part of the Shuttle Skunk Works. Served as shuttle aerodynamics subsystem manager for 10 years.

**Ross-Nazzari, Jennifer** – Johnson Space Center historian. Her biography of Emma Smith DeVoe – *Winning the West for Women: The Life of Emma Smith DeVoe* – was published by the University of Washington Press. Her essay, "From Farm to Fork," is included in the *Societal Impact of Spaceflight*. PhD in History, Washington State University.

**Ruiz, Jose** – Guidance, Navigation, & Control engineer at Johnson Space Center. Supported rendezvous operations for four shuttle missions in 2007 and 2008 from Mission Control. MS in Aeronautics and Astronautics, Massachusetts Institute of Technology.

**Russo, Dane** – PhD. Scientist-manager at Johnson Space Center/Space Life Sciences Directorate. For more than 30 years, managed the Space Human Factors and Habitability Element and the Advanced Human Support Technology Program.

**Sams, Clarence** – PhD. Biochemist. Director of Johnson Space Center Immunology Laboratories. Scientific and technical lead (element scientist) for the International Space Station Medical Project.

**Sauer, Richard** – NASA inventor of the year for the microbial check valve that resulted in a patent and license. Major contributor to providing safe water for shuttle crews as the Johnson Space Center lead for the water laboratory and deputy branch chief. He has numerous publications.

**Saunders, Melanie** – Associate director, Johnson Space Center. Served as a member of the NASA negotiation teams for the International Space Station. Main author of the barbers for shuttle launch of the European and Japanese labs, the Balance of Contributions with Russia, and the Code of Conduct for Space Station Crew. Juris Doctor, University of California, Davis.

**Scarpa, Jack** – Manager of the Productivity Enhancement Materials Development at Marshall Space Flight Center. Responsibilities included design, materials development, and testing of Thermal Protection System materials and non-metallic materials for the shuttle Solid Rocket Booster.

**Schneider, William** – Expertise in mathematical engineering mechanics, structural and mechanical design, spacecraft entry Thermal Protection Systems, and large space structures. PhD in Mechanical Engineering, Rice University.

**Schuh, Joseph** – Started career as part of the Orbiter Electrical Engineering group and moved to supporting the design of the Ares I and Ares V/Heavy Launch Vehicle at Kennedy Space Center.

**Scobee Rogers, June** – Founding chairman of Challenger Center for Space Sciences. Taught every grade level from kindergarten through college. Married Dick Scobee, who perished during the Challenger accident (1986). PhD, Texas A&M University.

**Scott, Carl** – Supported thermal protection material testing, aerothermodynamics, and flow diagnostics at Johnson Space Center. Was the first to determine the temperature dependent catalytic atom recombination on shuttle tiles. PhD in Physics, University of Texas.

**Scully, Robert** – Lead engineer of the Johnson Space Center Electromagnetics Compatibility Group. Co-chair of the Shuttle Electromagnetic Environmental Effects (E3) Control Tech Panel, and co-lead of the Constellation Program E3 Working Group.

**Smith, Sarah** – Worked at Johnson Space Center White Sands Test Facility in oxygen hazard analysis as well as in the development of tests and test systems for evaluating ignition and combustion of materials in oxygen-enriched environments. BS in Mechanical Engineering, New Mexico State University.

**Smith, Scott** – Chief of Nutritional Biochemistry Laboratory at Johnson Space Center since 1992 with research in bone metabolism. PhD in Nutrition, Penn State University.



## Contributors' Biographies

**Snapp, Cooper** – Supported the Space Shuttle Program at Kennedy Space Center as a thermal protection engineer prior to becoming the NASA subsystem engineer. Aided the development of tile inspection, analysis, and repair techniques used after the Columbia accident. MS in Engineering, University of Central Florida.

**Sollock, Paul** – Worked in human spaceflight for 42 years at Johnson Space Center. Worked with the hardware and software, which eventually became known as Avionics. Had first hand key roles in the design, development, and verification of critical Avionic Systems on Apollo and the Space Shuttle.

**Souza, Kenneth** – Retired as the deputy director of space research at NASA Ames Research Center. Was responsible for animal and plants payloads. Served as senior scientist for the SETI Institute and Logyx, LLC. PhD, University of California, Berkeley.

**Sparks, J. Scott** – NASA External Tank assistant chief engineer. Served in Marshall Space Flight Center's Materials and Processes Laboratory and specialized in non-metallic materials. MS, Georgia Institute of Technology.

**Spiker, Ivan** – Expert in polymer materials, composites, and bonding. Member of the Materials Branch, Johnson Space Center.

**Steinetz, Bruce** – Expert on seal technology and tribology for aeronautic and space applications. Widely published, and holds 10 patents for seal development work. Twenty-three years experience at NASA Glenn Research Center.

**Stepaniak, Philip** – NASA flight surgeon and lead for the Space Shuttle Program Medical Operations at Johnson Space Center. MD, Northeastern Ohio University, Rootstown. Residency in aerospace and emergency medicine, Wright State University, Dayton.

**Stevenson, Charles** – Worked for NASA for over 43 years. Wide range of experience in management and technical direction for all engineering aspects of integration, test, checkout, documentation, and launch preparation of space vehicles. Served as principal advisor-coordinator and program interface.

**Stone, Randy** – Served in mission operations during the Apollo, Skylab, Apollo Soyuz, Space Shuttle, and International Space Station Programs. Served as flight controller during the early programs, shuttle flight director, director of mission operations, and retired as the deputy center director at Johnson Space Center after 37 years of service.

**Stoltzfus, Joel** – Began his career at NASA's White Sands Test Facility in 1978, developing tests to ignite and burn metals in high-pressure oxygen. Serves as a senior technical expert on identifying and controlling fire hazards in oxygen systems. BS in Mechanical Engineering, New Mexico State University.

**Stull, Edith** – Writer and editor who has worked at Kennedy Space Center since 1973 in technical and public affairs writing. Works for United Space Alliance. Previously worked as a magazine and newspaper writer and editor.

**Sullivan, Steven** – Chief engineer for shuttle processing. More than 25 years of engineering experience in Kennedy Space Center shuttle ground operations preparing the Space Shuttle for flight. MS in Management, Florida Tech.

**Summers, Carolyn** – EdD. Director for Astronomy at the Houston Museum of Natural Science. Served as the principal investigator for "Toys in Space" payload on two Space Shuttle missions in 1985 and 1993.

**Swanson, Gregory** – PhD. Engineer in the Damage Tolerance Assessment Branch at Marshall Space Flight Center (MSFC). More than 25 years experience in spaceflight systems structural and fracture mechanics. Chairs the MSFC Fracture Control Board. Co-chairs the NASA Fracture Control Methodology Panel.

**Tigges, Michael** – Entry guidance subsystem manager for the crew exploration vehicle at Johnson Space Center. Started as a NASA contractor in 1982 in the Mission Planning and Analysis Division (MPAD) after graduating with an MS from Georgia Tech. Joined NASA in 1985 as a guidance engineer for MPAD.

**Trevino, Robert** – Professional Engineer. Worked on Space Shuttle, International Space Station, and Constellation Programs' extravehicular activity programs at Johnson Space Center. MS in Space Studies, University of North Dakota.

**Trevino, Luis** – Thermal lead engineer in the Extravehicular Activity and Space Suit Systems Branch at Johnson Space Center. BS in Mechanical Engineering, University of Texas.

**Ulrich, Richard** – Engineer for Boeing Mission Planning and Analysis Division at Johnson Space Center. Developed ascent guidance software for Solid Rocket Booster dispersions, Day of Launch I-load Update, and First Stage Engine Out.

**Upton, Avis** – Software engineer at Kennedy Space Center since 1985. Oversees the development, testing, and deployment of advisory software for the Space Shuttle Program. Bachelor's degree in Mathematics, Norfolk State University.

**Van Hooser, Katherine** – For 14 years, worked at Marshall Space Flight Center on the Space Shuttle Main Engine (SSME) high-pressure turbopumps. Served as Turbomachinery branch chief and SSME deputy chief engineer before becoming SSME chief engineer in 2008. BS in Aerospace Engineering, University of Tennessee (1991).

**Velez, Ivan** – Worked for more than 31 years in the Mechanical Systems Division at Kennedy Space Center in various roles. Involved in testing, repairs, and flight preparations for Orbiter mechanical systems. Participated in the application of new technologies to improve the flight readiness of these systems.

**Vellinger, John** – Executive vice president and chief operating officer of Techshot, Inc. Principal investigator for the shuttle student involvement project that developed avian housing for shuttle.

**Vicker, Darby** – Started engineering career in the Applied Aerospace and Computational Fluid Dynamics Branch at Johnson Space Center supporting various programs with Computational Fluid Dynamics analysis. Graduated from Iowa State University (2000).

**Walker, Charles** – First commercial payload specialist. Was employed by McDonnell Douglas Astronautics Company and a member of the space manufacturing team. Led the microgravity research on STS-41D, STS-51D, and STS-61D. BS in Engineering, Purdue University.

**Walker, James** – Member of the Nondestructive Evaluation Team at Marshall Space Flight Center since 1999, specializing in the field of nontraditional nondestructive evaluation methods and composite structures. Active member of the American Society for Nondestructive Testing.

**Webb, Dennis** – Served in Mission Operations at Johnson Space Center in the Skylab, Space Shuttle, International Space Station, and Constellation Programs. Electrical engineer from the University of Houston. Received NASA's Outstanding Leadership Medal.

**Welzyn, Kenneth** – Served as NASA External Tank chief engineer beginning with STS-121 through the end of the Space Shuttle Program at Marshall Space Flight Center. MS in Mechanical Engineering, University of Alabama.

**Whipps, Patrick** – Deputy project manager for the External Tank Project and resident manager at Michoud Assembly Facility. Served as senior engineer, design integration lead, and materials and processes engineer.

**White, Harold** – More than a decade of experience with flight hardware at Johnson Space Center. Served as Shuttle Remote Manipulator System subsystem manager during Return to Flight. NASA Exceptional Achievement Medal. PhD in Physics, Rice University.

**White, Susan** – Education director for Johnson Space Center's Office of External Relations. Math educator, having taught at Pearland High School in Pearland, Texas, for 10 years. MS in Math Education, University of Houston.

**Whitten, Mary** – Served as assistant professor of chemistry at University of the Virgin Islands prior to employment at Kennedy Space Center. PhD in Chemistry, Northern Illinois University.

**Williams, Martha** – Lead polymer scientist in the Polymer and Chemical Analysis Branch at Kennedy Space Center. Principal investigator for several wire repair and fault detection systems activities. PhD in Polymer Chemistry.

**Wood, David** – Chief engineer for the shuttle Reusable Solid Rocket Booster since 2003. Auburn University graduate whose 24-year career has been dedicated to supporting NASA programs, including 20 with the Reusable Solid Rocket Booster.

**Young, Charles** – Started career at NASA as a shuttle mission flight controller in the Shuttle Propulsion System. Managed the preliminary mission analysis process responsible for defining the mission parameters for each shuttle mission. Degree in Aerospace Engineering, Texas A&M University.

**Young, Laurence** – Apollo Program Professor of Astronautics and Professor of Health Sciences and Technology. Principal investigator on neurovestibular studies. Founding director of the National Space Biomedical Research Institute. PhD, Massachusetts Institute of Technology.

**Youngquist, Robert** – Lead of the Kennedy Space Center (KSC) Applied Physics Lab. Taught at University College London, then joined KSC in 1988. Multiple publications and patents resulting from his work on the Space Shuttle Program. PhD in Applied Physics, Stanford University.

**Zapp, Neal** – PhD. Manager of the Space Radiation Analysis Group at Johnson Space Center. International Space Station (ISS) Radiation System manager, managing the technical baseline for radiation protection aboard the ISS. Background in particle physics, space radiation dosimetry.