

## APPENDIX A-1

## U.S. Government Spacecraft Record

(Includes spacecraft from cooperating countries launched by U.S. launch vehicles.)

Calendar Year	Earth Orbit <sup>a</sup>		Earth Escape <sup>a</sup>	
	Success	Failure	Success	Failure
1957	0	1	0	0
1958	5	8	0	4
1959	9	9	1	2
1960	16	12	1	2
1961	35	12	0	2
1962	55	12	4	1
1963	62	11	0	0
1964	69	8	4	0
1965	93	7	4	1
1966	94	12	7	1 <sup>b</sup>
1967	78	4	10	0
1968	61	15	3	0
1969	58	1	8	1
1970	36	1	3	0
1971	45	2	8	1
1972	33	2	8	0
1973	23	2	3	0
1974	27	2	1	0
1975	30	4	4	0
1976	33	0	1	0
1977	27	2	2	0
1978	34	2	7	0
1979	18	0	0	0
1980	16	4	0	0
1981	20	1	0	0
1982	21	0	0	0
1983	31	0	0	0
1984	35	3	0	0
1985	37	1	0	0
1986	11	4	0	0
1987	9	1	0	0
1988	16	1	0	0
1989	24	0	2	0
1990	40	0	1	0
1991	32 <sup>c</sup>	0	0	0
1992	26 <sup>c</sup>	0	1	0
1993	28 <sup>c</sup>	1	1	0
1994	31 <sup>c</sup>	1	1	0
1995	24 <sup>c,d</sup>	2	1	0
1996	30	1	3	0
1997	22 <sup>e</sup>	0	1	0
1998 (through September 30, 1998)	7	0	0	0
<b>TOTAL</b>	<b>1,401</b>	<b>149</b>	<b>90</b>	<b>15</b>

- a. The criterion of success or failure used is attainment of Earth orbit or Earth escape rather than judgment of mission success. "Escape" flights include all that were intended to go to at least an altitude equal to lunar distance from Earth.
- b. This Earth-escape failure did attain Earth orbit and, therefore, is included in the Earth-orbit success totals.
- c. This excludes commercial satellites. It counts separately spacecraft launched by the same launch vehicle.
- d. This counts the five orbital debris radar calibration spheres that were launched from STS-63 as one set of spacecraft.
- e. This includes the SSTI Lewis spacecraft that began spinning out of control shortly after it achieved Earth orbit.

## World Record of Space Launches Successful in Attaining Earth Orbit or Beyond

(Enumerates launches rather than spacecraft; some launches orbited multiple spacecraft.)

Calendar Year	United States	USSR/ CIS	France <sup>a</sup>	Italy <sup>a</sup>	Japan	People's Republic of China	Australia	United Kingdom	European Space Agency	India	Israel
1957		2									
1958	5	1									
1959	10	3									
1960	16	3									
1961	29	6									
1962	52	20									
1963	38	17									
1964	57	30									
1965	63	48	1								
1966	73	44	1								
1967	57	66	2	1			1				
1968	45	74									
1969	40	70									
1970	28	81	2	1 <sup>b</sup>	1	1					
1971	30	83	1	2 <sup>b</sup>	2	1		1			
1972	30	74		1	1						
1973	23	86									
1974	22	81		2 <sup>b</sup>	1						
1975	27	89	3	1	2	3					
1976	26	99			1	2					
1977	24	98			2						
1978	32	88			3	1					
1979	16	87			2				1		
1980	13	89			2						1
1981	18	98			3	1			2		1
1982	18	101			1	1					
1983	22	98			3	1			2		1
1984	22	97			3	3			4		
1985	17	98			2	1			3		
1986	6	91			2	2			2		
1987	8	95			3	2			2		
1988	12	90			2	4			7		
1989	17	74			2				7		1
1990	27	75			3	5			5		1
1991	20 <sup>c</sup>	62			2	1			9	1	
1992	31 <sup>c</sup>	55			2	3			7 <sup>b</sup>	2	
1993	24 <sup>c</sup>	45			1	1			7 <sup>b</sup>		
1994	26 <sup>c</sup>	49			2	5			6 <sup>b</sup>	2	
1995	27 <sup>c</sup>	33 <sup>b</sup>			1	2 <sup>b</sup>			12 <sup>b</sup>		1
1996	32 <sup>c</sup>	25			1	3 <sup>d</sup>			10	1	
1997	37	19			2	6			11	1	
1998	23	19			2	5			6		
<i>(through September 30, 1998)</i>											
TOTAL	1,143	2,563	10	8	54	53	1	1	103	10	3

a. Since 1979, all launches for ESA member countries have been joint and are listed under ESA.

b. Includes foreign launches of U.S. spacecraft.

c. This includes commercial expendable launches and launches of the Space Shuttle, but because this table records launches rather than spacecraft, it does not include separate spacecraft released from the Shuttle.

d. This includes the launch of ChinaSat 7, even though a third stage rocket failure led to a virtually useless orbit for this communications satellite.

## APPENDIX B

## Successful Launches to Orbit on U.S. Launch Vehicles October 1, 1997–September 30, 1998

Launch Date Spacecraft Name COSPAR Designation Launch Vehicle	Mission Objectives	Apogee and Perigee (km), Period (min), Inclination to Equator (°)	Remarks
<b>Oct. 5, 1997</b> EchoStar 3 59A Atlas IIAS*	Communications satellite	Geosynchronous	
<b>Oct. 15, 1997</b> Cassini 61A Titan IVB	Interplanetary spacecraft to orbit Saturn		
<b>Oct. 22, 1997</b> STEP-4 63A Pegasus XL	Military satellite	495 km 429 km 1 hour 34 minutes 44.9°	Space Test Experimental Program 4
<b>Oct. 24, 1997</b> USA 133 64A Atlas IIA	Military satellite	Orbital parameters unavailable	
<b>Oct. 25, 1997</b> DSCS 3 65A Atlas IIA	Military satellite	Orbital parameters unavailable	Defense Satellite Communications System 3
<b>Nov. 6, 1997</b> Navstar 38 (USA 135) 67A Delta II	GPS satellite	20,644 km 19,923 km 12 hours 2 minutes 54.9°	
<b>Nov. 7, 1997</b> USA 136 68A Titan IVA	Military satellite	Orbital parameters unavailable	
<b>Nov. 8, 1997</b> Iridium 38–41, 43 69A–E Delta II*	Communications satellite	650 km 635 km 1 hour 37 minutes 86.6°	
<b>Nov. 19, 1997</b> Space Shuttle <i>Columbia</i> (STS-87) 73A Space Shuttle	Carry out EVA's as training for ISS spacewalks	286 km 280 km 1 hour 30 minutes 28.4°	Payloads included USMP-4, SPARTAN 201-04 free-flyer, CUE in space biology, and several other "hitchhiker" payloads.
<b>Nov. 21, 1997</b> SPARTAN 201-04 73B Space Shuttle	Reusable solar observatory	Orbital parameters similar to those of STS-87	Recaptured manually by spacewalking astronauts

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(Continued)

Successful Launches to Orbit on U.S. Launch Vehicles  
October 1, 1997–September 30, 1998

Launch Date Spacecraft Name COSPAR Designation Launch Vehicle	Mission Objectives	Apogee and Perigee (km), Period (min), Inclination to Equator (°)	Remarks
<b>Dec. 8, 1997</b> Galaxy 8 78A Atlas IIAS*	Communications satellite	Geosynchronous	
<b>Dec. 20, 1997</b> Iridium 45–49 82A–E Delta II*	Communications satellites	642 km 633 km 1 hour 37 minutes 86.6°	
<b>Dec. 23, 1997</b> Orbcomm FM 84A–H Pegasus*	Relay GPS signals	834 km 824 km 1 hour 41 minutes 45°	
<b>Jan. 6, 1998</b> Lunar Prospector 1A Delta II*	Lunar orbiter		
<b>Jan. 9, 1998</b> Skynet-4D 2A Delta II*	British military communications satellite	Geosynchronous	
<b>Jan. 22, 1998</b> Space Shuttle <i>Endeavour</i> (STS-89) 3A Space Shuttle	Eighth Shuttle docking mission to <i>Mir</i>	385 km 379 km 1 hour 32 minutes 51.7°	Andrew Thomas replaced David Wolf on <i>Mir</i> . Shuttle payloads included SPACEHAB double module of science experiments.
<b>Jan. 29, 1998</b> Capricorn (USA 137) 5A Atlas IIA	Military photo/radar imaging satellite	Initial apogee and perigee of 38,400 km and 320 km, respectively	NRO satellite
<b>Feb. 10, 1998</b> Geosat Follow-On 7A Taurus*	Military Earth science satellite	878 km 775 km 1 hour 41 minutes 108°	
<b>Feb. 10, 1998</b> Orbcomm FM-3, FM-4 7B, 7C Taurus*	Communications satellite	878 km 784 km 1 hour 41 minutes 108°	
<b>Feb. 10, 1998</b> Celestis 2 7D Taurus*	Funeral ashes disposal	Disintegrated with launch vehicle upon atmospheric reentry	

## APPENDIX B

(Continued)

## Successful Launches to Orbit on U.S. Launch Vehicles October 1, 1997–September 30, 1998

Launch Date Spacecraft Name COSPAR Designation Launch Vehicle	Mission Objectives	Apogee and Perigee (km), Period (min), Inclination to Equator (°)	Remarks
<b>Feb. 14, 1998</b> Globalstar L-1, L-2, U-1, U-2 8A-D Delta II*	Communications satellite	1,258 km 1,245 km 1 hour 52 minutes 52°	
<b>Feb. 18, 1998</b> Iridium 50, 52–54, 56 10A–E Delta II*	Communications satellites	643 km 625 km 1 hour 37 minutes 86.5°	
<b>Feb. 25, 1998</b> SNOE 12A Pegasus XL*	Student science satellite	580 km 535 km 1 hour 36 minutes 97.7°	Student Nitric Oxide Explorer
<b>Feb. 27, 1998</b> INTELSAT 806 14A Atlas IIAS*	International consortium's communications satellite	Geosynchronous	
<b>Mar. 16, 1997</b> UHF F/O F8 (USA 137) 126A Atlas IIAS*	Military communications satellite	Geosynchronous	
<b>Mar. 29, 1998</b> Iridium 55, 57–60 19A–E Delta II*	Communications satellites	635 km 620 km 1 hour 37 minutes 86°	
<b>Apr. 1, 1998</b> TRACE 20A Pegasus XL	Solar physics science satellite	644 km 597 km 1 hour 37 minutes 97.8°	Transition Region and Coronal Explorer
<b>Apr. 17, 1998</b> Space Shuttle <i>Columbia</i> (STS-90) 22A Space Shuttle	Carry Neurolab module for microgravity research in the human nervous system	286 km 257 km 1 hour 30 minutes 39°	Secondary goals included measurement of Shuttle vibration forces, demonstration of the bioreactor system for cell growth, and three Get Away Special payloads.
<b>Apr. 24, 1998</b> Globalstar 5–8 23A–D Delta II*	International consortium's communications satellites	1,253 km 1,236 km 1 hour 51 minutes 52°	

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(Continued)

## Successful Launches to Orbit on U.S. Launch Vehicles October 1, 1997–September 30, 1998

Launch Date Spacecraft Name COSPAR Designation Launch Vehicle	Mission Objectives	Apogee and Perigee (km), Period (min), Inclination to Equator (°)	Remarks
<b>May 9, 1998</b> USA 139 29A Titan IVB	Military reconnaissance satellite	Orbital parameters unavailable	NRO satellite
<b>May 13, 1998</b> NOAA 15 (NOAA-K) 30A Titan II	Weather satellite	824 km 808 km 1 hour 41 minutes 98.7°	Replacement for decommissioned NOAA 12 satellite
<b>May 17, 1998</b> Iridium 70, 72–75 32A–E Delta II*	Communications satellites	670 km 665 km 1 hour 38 minutes	Completed constellation of 66 operational and 6 reserve satellites
<b>June 2, 1997</b> Space Shuttle <i>Discovery</i> (STS-91) 34A	Last of nine docking missions with <i>Mir</i>	330 km 326 km 1 hour 31 minutes 51.7°	Mission brought home Andrew Thomas. Payloads included DoE's Alpha Magnetic Spectrometer (AME) to study high-energy particles from deep space, four Get Away Specials, and two Space Experiment Modules.
<b>June 10, 1998</b> Thor 3 35A Delta II*	Norwegian communications satellite	Geosynchronous	
<b>June 18, 1998</b> INTELSAT 805 37A Atlas IIAS*	International consortium's communications satellite	Geosynchronous	
<b>Aug. 2, 1998</b> Orbcomm FM-13–20 46A–H Pegasus XL*	Communications satellite	826 km 816 km 1 hour 41 minutes 45°	
<b>Sep. 8, 1998</b> Iridium 77, 79–82 51A–E Delta II*	Communications satellites	540 km 520 km 1 hour 35 minutes 86°	Replacements for dysfunctional members of the fleet
<b>Sep. 23, 1998</b> Orbcomm FM-21–27 53A–H Pegasus XL*	Communications satellites	830 km 820 km 1 hour 41 minutes 45°	

\* Commercial launch licensed as such by the Federal Aviation Administration.

## APPENDIX C

## U.S. and Russian Human Space Flights 1961–September 30, 1998

Spacecraft	Launch Date	Crew	Flight Time (days:hrs:min)	Highlights
Vostok 1	Apr. 12, 1961	Yury A. Gagarin	0:1:48	First human flight.
Mercury-Redstone 3	May 5, 1961	Alan B. Shepard, Jr.	0:0:15	First U.S. flight; suborbital.
Mercury-Redstone 4	July 21, 1961	Virgil I. Grissom	0:0:16	Suborbital; capsule sank after landing; astronaut safe.
Vostok 2	Aug. 6, 1961	German S. Titov	1:1:18	First flight exceeding 24 hrs.
Mercury-Atlas 6	Feb. 20, 1962	John H. Glenn, Jr.	0:4:55	First American to orbit.
Mercury-Atlas 7	May 24, 1962	M. Scott Carpenter	0:4:56	Landed 400 km beyond target.
Vostok 3	Aug. 11, 1962	Andriyan G. Nikolayev	3:22:25	First dual mission (with Vostok 4).
Vostok 4	Aug. 12, 1962	Pavel R. Popovich	2:22:59	Came within 6 km of Vostok 3.
Mercury-Atlas 8	Oct. 3, 1962	Walter M. Schirra, Jr.	0:9:13	Landed 8 km from target.
Mercury-Atlas 9	May 15, 1963	L. Gordon Cooper, Jr.	1:10:20	First U.S. flight exceeding 24 hrs.
Vostok 5	June 14, 1963	Valery F. Bykovskiy	4:23:6	Second dual mission (with Vostok 6).
Vostok 6	June 16, 1963	Valentina V. Tereshkova	2:22:50	First woman in space; within 5 km of Vostok 5.
Voskhod 1	Oct. 12, 1964	Vladimir M. Komarov Konstantin P. Feoktistov Boris G. Yegorov	1:0:17	First three-person crew.
Voskhod 2	Mar. 18, 1965	Pavel I. Belyayev	1:2:2	First extravehicular activity (EVA), by Leonov, 10 min.
Gemini 3	Mar. 23, 1965	Aleksey A. Leonov Virgil I. Grissom John W. Young	0:4:53	First U.S. two-person flight; first manual maneuvers in orbit.
Gemini 4	June 3, 1965	James A. McDivitt Edward H. White, II	4:1:56	21-min. EVA (White).
Gemini 5	Aug. 21, 1965	L. Gordon Cooper, Jr. Charles Conrad, Jr.	7:22:55	Longest duration human flight to date.
Gemini 7	Dec. 4, 1965	Frank Borman James A. Lovell, Jr.	13:18:35	Longest human flight to date.
Gemini 6-A	Dec. 15, 1965	Walter M. Schirra, Jr. Thomas P. Stafford	1:1:51	Rendezvous within 30 cm of Gemini 7.
Gemini 8	Mar. 16, 1966	Neil A. Armstrong David R. Scott	0:10:41	First docking of two orbiting spacecraft (Gemini 8 with Agena target rocket).
Gemini 9-A	June 3, 1966	Thomas P. Stafford Eugene A. Cernan	3:0:21	EVA; rendezvous.
Gemini 10	July 18, 1966	John W. Young Michael Collins	2:22:47	First dual rendezvous (Gemini 10 with Agena 10, then Agena 8).
Gemini 11	Sep. 12, 1966	Charles Conrad, Jr. Richard F. Gordon, Jr.	2:23:17	First initial-orbit docking; first tethered flight; highest Earth-orbit altitude (1,372 km.).
Gemini 12	Nov. 11, 1966	James A. Lovell, Jr. Edwin E. Aldrin, Jr.	3:22:35	Longest EVA to date (Aldrin, 5 hrs.).
Soyuz 1	Apr. 23, 1967	Vladimir M. Komarov	1:2:37	Cosmonaut killed in reentry accident.
Apollo 7	Oct. 11, 1968	Walter M. Schirra, Jr. Donn F. Eisele R. Walter Cunningham	10:20:9	First U.S. three-person mission.
Soyuz 3	Oct. 26, 1968	Georgiy T. Beregovoy	3:22:51	Maneuvered near uncrewed Soyuz 2.
Apollo 8	Dec. 21, 1968	Frank Borman James A. Lovell, Jr. William A. Anders	6:3:1	First human orbit(s) of Moon; first human departure from Earth's sphere of influence; highest speed attained in human flight to date.
Soyuz 4	Jan. 14, 1969	Vladimir A. Shatalov	2:23:23	Soyuz 4 and 5 docked and transferred two cosmonauts from Soyuz 5 to Soyuz 4.
Soyuz 5	Jan. 15, 1969	Boris V. Volynov Aleksey A. Yeliseyev Yevgeniy V. Khrunov	3:0:56	
Apollo 9	Mar. 3, 1969	James A. McDivitt David R. Scott Russell L. Schweickart	10:1:1	Successfully simulated in Earth orbit operation of lunar module to landing and takeoff from lunar surface and rejoining with command

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**U.S. and Russian Human Space Flights**  
1961–September 30, 1998

Spacecraft	Launch Date	Crew	Flight Time (days:hrs:min)	Highlights
Apollo 10	May 18, 1969	Thomas P. Stafford John W. Young Eugene A. Cernan	8:0:3	Successfully demonstrated complete system, including lunar module to 14,300 m from the lunar surface.
Apollo 11	July 16, 1969	Neil A. Armstrong Michael Collins Edwin E. Aldrin, Jr.	8:3:9	First human landing on lunar surface and safe return to Earth. First return of rock and soil samples to Earth and human deployment of experiments on lunar surface.
Soyuz 6	Oct. 11, 1969	Georgiy Shonin Valery N. Kubasovf	4:22:42	Soyuz 6, 7, and 8 operated as a group flight without actually docking. Each conducted certain experiments,
Soyuz 7	Oct. 12, 1969	A. V. Filipchenko Viktor N. Gorbatko Vladislav N. Volkov	4:22:41	including welding and Earth and celestial observation.
Soyuz 8	Oct. 13, 1969	Vladimir A. Shatalov Aleksey S. Yeliseyev	4:22:50	
Apollo 12	Nov. 14, 1969	Charles Conrad, Jr. Richard F. Gordon, Jr. Alan L. Bean	10:4:36	Second human lunar landing explored surface of Moon and retrieved parts of Surveyor 3 spacecraft, which landed in Ocean of Storms on Apr. 19, 1967.
Apollo 13	Apr. 11, 1970	James A. Lovell, Jr. Fred W. Haise, Jr. John L. Swigert, Jr.	5:22:55	Mission aborted; explosion in service module. Ship circled Moon, with crew using Lunar Module as "lifeboat" until just before reentry.
Soyuz 9	June 1, 1970	Andriyan G. Nikolayev Vitaliy I. Sevastyanov	17:16:59	Longest human spaceflight to date.
Apollo 14	Jan. 31, 1971	Alan B. Shepard, Jr. Stuart A. Roosa Edgar D. Mitchell	9:0:2	Third human lunar landing. Mission demonstrated pinpoint landing capability and continued human exploration.
Soyuz 10	Apr. 22, 1971	Vladimir A. Shatalov Aleksey S. Yeliseyev Nikolay N. Rukavishnikov	1:23:46	Docked with Salyut 1, but crew did not board space station launched Apr. 19. Crew recovered Apr. 24, 1971.
Soyuz 11	June 6, 1971	Georgiy T. Dobrovolskiy Vladislav N. Volkov Viktor I. Patsayev	23:18:22	Docked with Salyut 1, and Soyuz 11 crew occupied space station for 22 days. Crew perished in final phase of Soyuz 11 capsule recovery on June 30, 1971.
Apollo 15	July 26, 1971	David R. Scott Alfred M. Worden James B. Irwin	12:7:12	Fourth human lunar landing and first Apollo "J" series mission, which carried Lunar Roving Vehicle. Worden's inflight EVA of 38 min., 12 sec. was performed during return trip.
Apollo 16	Apr. 16, 1972	John W. Young Charles M. Duke, Jr. Thomas K. Mattingly II	11:1:51	Fifth human lunar landing, with roving vehicle.
Apollo 17	Dec. 7, 1972	Eugene A. Cernan Harrison H. Schmitt Ronald E. Evans	12:13:52	Sixth and final Apollo human lunar landing, again with roving vehicle.
Skylab 2	May 25, 1973	Charles Conrad, Jr. Joseph P. Kerwin Paul J. Weitz	28:0:50	Docked with Skylab 1 (launched uncrewed May 14) for 28 days. Repaired damaged station.
Skylab 3	July 28, 1973	Alan L. Bean Jack R. Lousma Owen K. Garriott	59:11:9	Docked with Skylab 1 for more than 59 days.
Soyuz 12	Sep. 27, 1973	Vasilij G. Lazarev Oleg G. Makarov	1:23:16	Checkout of improved Soyuz.



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## U.S. and Russian Human Space Flights 1961–September 30, 1998

Spacecraft	Launch Date	Crew	Flight Time (days:hrs:min)	Highlights
Skylab 4	Nov. 16, 1973	Gerald P. Carr Edward G. Gibson William R. Pogue	84:1:16	Docked with Skylab 1 in long-duration mission; last of Skylab program.
Soyuz 13	Dec. 18, 1973	Petr I. Klimuk Valentin V. Lebedev	7:20:55	Astrophysical, biological, and Earth resources experiments.
Soyuz 14	July 3, 1974	Pavel R. Popovich Yury P. Artyukhin	15:17:30	Docked with Salyut 3 and Soyuz 14 crew occupied space station.
Soyuz 15	Aug. 26, 1974	Gennady V. Sarafanov Lev S. Demin	2:0:12	Rendezvoused but did not dock with Salyut 3.
Soyuz 16	Dec. 2, 1974	Anatoly V. Filipchenko Nikolay N. Rukavishnikov	5:22:24	Test of Apollo-Soyuz Test Project (ASTP) configuration.
Soyuz 17	Jan. 10, 1975	Aleksay A. Gubarev Georgiy M. Grechko	29:13:20	Docked with Salyut 4 and occupied station.
Anomaly (Soyuz 18A)	Apr. 5, 1975	Vasilij G. Lazarev Oleg G. Makarov	0:0:20	Soyuz stages failed to separate; crew recovered after abort.
Soyuz 18	May 24, 1975	Petr I. Klimuk Vitaliy I. Sevastyanov	62:23:20	Docked with Salyut 4 and occupied station.
Soyuz 19	July 15, 1975	Aleksey A. Leonov Valery N. Kubasov	5:22:31	Target for Apollo in docking and joint experiments of ASTP mission.
Apollo	July 15, 1975	Thomas P. Stafford Donald K. Slayton Vance D. Brand	9:1:28	Docked with Soyuz 19 in joint (ASTP) experiments of ASTP mission.
Soyuz 21	July 6, 1976	Boris V. Volynov Vitaliy M. Zholobov	48:1:32	Docked with Salyut 5 and occupied station.
Soyuz 22	Sep. 15, 1976	Valery F. Bykovskiy Vladimir V. Aksenov	7:21:54	Earth resources study with multispectral camera system.
Soyuz 23	Oct. 14, 1976	Vyacheslav D. Zudov Valery I. Rozhdestvenskiy	2:0:6	Failed to dock with Salyut 5.
Soyuz 24	Feb. 7, 1977	Viktor V. Gorbatko Yury N. Glazkov	17:17:23	Docked with Salyut 5 and occupied station.
Soyuz 25	Oct. 9, 1977	Vladimir V. Kovalenok Valery V. Ryumin	2:0:46	Failed to achieve hard dock with Salyut 6 station.
Soyuz 26	Dec. 10, 1977	Yury V. Romanenko Georgiy M. Grechko	37:10:6	Docked with Salyut 6. Crew returned in Soyuz 27; crew duration 96 days, 10 hrs.
Soyuz 27	Jan. 10, 1978	Vladimir A. Dzhaniybekov Oleg G. Makarov	64:22:53	Docked with Salyut 6. Crew returned in Soyuz 26; crew duration 5 days, 22 hrs., 59 min.
Soyuz 28	Mar. 2, 1978	Aleksey A. Gubarev Vladimir Remek	7:22:17	Docked with Salyut 6. Remek was first Czech cosmonaut to orbit.
Soyuz 29	June 15, 1978	Vladimir V. Kovalenok Aleksandr S. Ivanchenkov	9:15:23	Docked with Salyut 6. Crew returned in Soyuz 31; crew duration 139 days, 14 hrs., 48 min.
Soyuz 30	June 27, 1978	Petr I. Klimuk Miroslaw Hermaszewski	7:22:4	Docked with Salyut 6. Hermaszewski was first Polish cosmonaut to orbit.
Soyuz 31	Aug. 26, 1978	Valery F. Bykovskiy Sigmund Jaehn	67:20:14	Docked with Salyut 6. Crew returned in Soyuz 29; crew duration 7 days, 20 hrs., 49 min. Jaehn was first German Democratic Republic cosmonaut to orbit.
Soyuz 32	Feb. 25, 1979	Vladimir A. Lyakhov Valery V. Ryumin Nikolay N. Rukavishnikov	108:4:24	Docked with Salyut 6. Crew returned in Soyuz 34; crew duration 175 days, 36 min.
Soyuz 33	Apr. 10, 1979	Georgi I. Ivanov	1:23:1	Failed to achieve docking with Salyut 6 station. Ivanov was first Bulgarian cosmonaut to orbit.
Soyuz 34	June 6, 1979	(unmanned at launch)	7:18:17	Docked with Salyut 6, later served as ferry for Soyuz 32 crew while Soyuz 32 returned without a crew.

APPENDIX C  
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**U.S. and Russian Human Space Flights**  
1961–September 30, 1998

Spacecraft	Launch Date	Crew	Flight Time (days:hrs:min)	Highlights
Soyuz 35	Apr. 9, 1980	Leonid I. Popov Valery V. Ryumin	55:1:29	Docked with Salyut 6. Crew returned in Soyuz 37. Crew duration 184 days, 20 hrs., 12 min.
Soyuz 36	May 26, 1980	Valery N. Kubasov Bertalan Farkas	65:20:54	Docked with Salyut 6. Crew returned in Soyuz 35. Crew duration 7 days, 20 hrs., 46 min. Farkas was first Hungarian to orbit.
Soyuz T-2	June 5, 1980	Yury V. Malyshev Vladimir V. Aksenov	3:22:21	Docked with Salyut 6. First crewed flight of new-generation ferry.
Soyuz 37	July 23, 1980	Viktor V. Gorbatko Pham Tuan	79:15:17	Docked with Salyut 6. Crew returned in Soyuz 36. Crew duration 7 days, 20 hrs., 42 min. Pham was first Vietnamese to orbit.
Soyuz 38	Sep. 18, 1980	Yury V. Romanenko Arnaldo Tamayo Mendez	7:20:43	Docked with Salyut 6. Tamayo was first Cuban to orbit.
Soyuz T-3	Nov. 27, 1980	Leonid D. Kizim Oleg G. Makarov Gennady M. Strekalov	12:19:8	Docked with Salyut 6. First three-person flight in Soviet program since 1971.
Soyuz T-4	Mar. 12, 1981	Vladimir V. Kovalenok Viktor P. Savinykh	74:18:38	Docked with Salyut 6.
Soyuz 39	Mar. 22, 1981	Vladimir A. Dzhanibekov Jugderdemidiyn Gurragcha	7:20:43	Docked with Salyut 6. Gurragcha first Mongolian cosmonaut to orbit.
Space Shuttle <i>Columbia</i> (STS-1)	Apr. 12, 1981	Robert L. Crippen Leonid I. Popov	2:6:21	First flight of Space Shuttle; tested spacecraft in orbit. First landing of airplane-like craft from orbit for reuse.
Soyuz 40 cosmonaut	May 14, 1981	Dumitru Prunariu Joe H. Engle Richard H. Truly	7:20:41	Docked with Salyut 6. Prunariu first Romanian to orbit.
Space Shuttle <i>Columbia</i> (STS-2)	Nov. 12, 1981	Jack R. Lousma C. Gordon Fullerton	2:6:13	Second flight of Space Shuttle; first scientific payload (OSTA 1). Tested remote manipulator arm. Returned for reuse.
Space Shuttle <i>Columbia</i> (STS-3)	Mar. 22, 1982	Anatoly Berezhovoy Valentin Lebedev	8:4:49	Third flight of Space Shuttle; second scientific payload (OSS 1). Second test of remote manipulator arm. Flight extended 1 day because of flooding at primary landing site; alternate landing site used. Returned for reuse.
Soyuz T-5	May 13, 1982	Vladimir Dzhanibekov Aleksandr Ivanchenkov Jean-Loup Chrétien	211:9:5	Docked with Salyut 7. Crew duration of 211 days. Crew returned in Soyuz T-7.
Soyuz T-6	June 24, 1982	Thomas K. Mattingly II Henry W. Hartsfield, Jr.	7:21:51	Docked with Salyut 7. Chrétien first French cosmonaut to orbit.
Space Shuttle <i>Columbia</i> (STS-4)	June 27, 1982	Leonid Popov Aleksandr Serebrov Svetlana Savitskaya	7:1:9	Fourth flight of Space Shuttle; first DoD payload; additional scientific payloads. Returned July 4. Completed testing program. Returned for reuse.
Soyuz T-7	Aug. 19, 1982	Vance D. Brand Robert F. Overmyer Joseph P. Allen William B. Lenoir	7:21:52	Docked with Salyut 7. Savitskaya second woman to orbit. Crew returned in Soyuz T-5.
Space Shuttle <i>Columbia</i> (STS-5)	Nov. 11, 1982	Paul J. Weitz Karol J. Bobko Donald H. Peterson Story Musgrave	5:2:14	Fifth flight of Space Shuttle; first operational flight; launched two commercial satellites (SBS 3 and Anik C-3); first flight with four crew members. EVA test canceled when spacesuits malfunctioned.
Space Shuttle <i>Challenger</i> (STS-6)	Apr. 4, 1983		5:0:24	Sixth flight of Space Shuttle; launched TDRS-1.

## APPENDIX C

(Continued)

## U.S. and Russian Human Space Flights 1961–September 30, 1998

Spacecraft	Launch Date	Crew	Flight Time (days:hrs:min)	Highlights
Soyuz T-8	Apr. 20, 1983	Vladimir Titov Gennady Strekalov Aleksandr Serebrov	2:0:18	Failed to achieve docking with Salyut 7 station.
Space Shuttle <i>Challenger</i> (STS-7)	June 18, 1983	Robert L. Crippen Frederick H. Hauck John M. Fabian Sally K. Ride Norman T. Thagard	6:2:24	Seventh flight of Space Shuttle; launched two commercial satellites (Anik C-2 and Palapa B-1); also launched and retrieved SPAS 01; first flight with five crew members, including first woman U.S. astronaut.
Soyuz T-9	June 28, 1983	Vladimir Lyakhov Aleksandr Aleksandrov	149:9:46	Docked with Salyut 7 station.
Space Shuttle <i>Challenger</i> (STS-8)	Aug. 30, 1983	Richard H. Truly Daniel C. Brandenstein Dale A. Gardner Guion S. Bluford, Jr. William E. Thornton	6:1:9	Eighth flight of Space Shuttle; launched one commercial satellite (Insat 1-B); first flight of U.S. black astronaut.
Space Shuttle <i>Columbia</i> (STS-9)	Nov. 28, 1983	John W. Young Brewster W. Shaw Owen K. Garriott Robert A. R. Parker Byron K. Lichtenberg Ulf Merbold	10:7:47	Ninth flight of Space Shuttle; first flight of Spacelab 1; first flight of six crew members, one of whom was West German; first non-U.S. astronaut to fly in U.S. space program (Merbold).
Space Shuttle <i>Challenger</i> (STS 41-B)	Feb. 3, 1984	Vance D. Brand Robert L. Gibson Bruce McCandless Ronald E. McNair Roben L. Stewart	7:23:16	Tenth flight of Space Shuttle; two communication satellites failed to achieve orbit; first use of Manned Maneuvering Unit in space.
Soyuz T-10	Feb. 8, 1984	Leonid Kizim Vladimir Solovev Oleg Atkov	62:22:43	Docked with Salyut 7 station. Crew set space duration record of 237 days. Crew returned in Soyuz T-11.
Soyuz T-11	Apr. 3, 1984	Yury Malyshev Gennady Strekalov Rakesh Sharma	181:21:48	Docked with Salyut 7 station. Sharma first Indian in space. Crew returned in Soyuz T-10.
Space Shuttle <i>Challenger</i> (STS 41-C)	Apr. 6, 1984	Robert L. Crippen Frances R. Scobee Terry J. Hart George D. Nelson James D. van Hoften	6:23:41	Eleventh flight of Space Shuttle; deployment of Long-Duration Exposure Facility (LDEF-1) for later retrieval; Solar Maximum Satellite retrieved, repaired, and redeployed.
Soyuz T-12	July 17, 1984	Vladimir Dzhanibekov Svetlana Savitskaya Igor Volk	11:19:14	Docked with Salyut 7 station. First female EVA.
Space Shuttle <i>Discovery</i> (STS 41-D)	Aug. 30, 1984	Henry W. Hartsfield Michael L. Coats Richard M. Mullane Steven A. Hawley Judith A. Resnick Charles D. Walker	6:0:56	Twelfth flight of Space Shuttle. First flight of U.S. nonastronaut.
Space Shuttle <i>Challenger</i> (STS 41-G)	Oct. 5, 1984	Robert L. Crippen Jon A. McBride Kathryn D. Sullivan Sally K. Ride David Leestma Paul D. Scully-Power Marc Garneau	8:5:24	Thirteenth flight of Space Shuttle; first with seven crew members, including first flight of two U.S. women and one Canadian (Garneau).

APPENDIX C  
(Continued)  
**U.S. and Russian Human Space Flights**  
1961–September 30, 1998

Spacecraft	Launch Date	Crew	Flight Time (days:hrs:min)	Highlights
Space Shuttle <i>Discovery</i> (STS 51-A)	Nov. 8, 1984	Frederick H. Hauck David M. Walker Joseph P. Allen Anna L. Fisher Dale A. Gardner	7:23:45	Fourteenth flight of Space Shuttle; first retrieval and return of two disabled communications satellites (Westar 6, Palapa B2) to Earth.
Space Shuttle <i>Discovery</i> (STS 51-C)	Jan. 24, 1985	Thomas K. Mattingly Loren J. Shriver Ellison S. Onizuka James F. Buchli Gary E. Payton	3:1:33	Fifteenth STS flight. Dedicated DoD mission.
Space Shuttle <i>Discovery</i> (STS 51-D)	Apr. 12, 1985	Karol J. Bobko Donald E. Williams M. Rhea Seddon S. David Griggs Jeffrey A. Hoffman Charles D. Walker E. J. Garn	6:23:55	Sixteenth STS flight. Two communications satellites. First U.S. Senator in space (Garn).
Space Shuttle <i>Challenger</i> (STS 51-B)	Apr. 29, 1985	Robert F. Overmyer Frederick D. Gregory Don L. Lind Norman E. Thagard William E. Thornton Lodewijk van den Berg Taylor Wang	7:0:9	Seventeenth STS flight. Spacelab-3 in cargo bay of Shuttle.
Soyuz T-13	June 5, 1985	Vladimir Dzhanibekov Viktor Savinykh	112:3:12	Repair of Salyut-7. Dzhanibekov returned to Earth with Grechko on Soyuz T-13 spacecraft, Sept. 26, 1985.
Space Shuttle <i>Discovery</i> (STS 51-G)	June 17, 1985	Daniel C. Brandenstein John O. Creighton Shannon W. Lucid John M. Fabian Steven R. Nagel Patrick Baudry Prince Sultan Salman Al-Saud	7:1:39	Eighteenth STS flight. Three communications satellites. One reusable payload, Spartan-1. First U.S. flight with French and Saudi Arabian crew members.
Space Shuttle <i>Challenger</i> (STS 51-F)	July 29, 1985	Charles G. Fullerton Roy D. Bridges Karl C. Henize Anthony W. England F. Story Musgrave Loren W. Acton John-David F. Bartoe	7:22:45	Nineteenth STS flight. Spacelab-2 in cargo bay.
Space Shuttle <i>Discovery</i> (STS 51-I)	Aug. 27, 1985	Joe H. Engle Richard O. Covey James D. van Hoften William F. Fisher John M. Lounge	7:2:18	Twentieth STS flight. Launched three communications satellites. Repaired Syncom IV-3.
Soyuz T-14	Sep. 17, 1985	Vladimir Vasyutin Georgiy Grechko Aleksandr Volkov	64:21:52	Docked with Salyut 7 station. Viktor Savinykh, Aleksandr Volkov, and Vladimir Vasyutin returned to Earth Nov. 21, 1985, when Vasyutin became ill.
Space Shuttle <i>Atlantis</i> (STS 51-J)	Oct. 3, 1985	Karol J. Bobko Ronald J. Grabe Robert A. Stewart David C. Hilmers William A. Pailes	4:1:45	Twenty-first STS flight. Dedicated DoD mission.

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(Continued)

## U.S. and Russian Human Space Flights 1961–September 30, 1998

Spacecraft	Launch Date	Crew	Flight Time (days:hrs:min)	Highlights
Space Shuttle <i>Challenger</i> (STS 61-A)	Oct. 30, 1985	Henry W. Hartsfield Steven R. Nagel Bonnie J. Dunbar James F. Buchli Guion S. Bluford, Jr. Ernst Messerschmid Reinhard Furrer (FRG) Wubbo J. Ockels (ESA)	7:0:45	Twenty-second STS flight. Dedicated German Spacelab D-1 in shuttle cargo bay.
Space Shuttle <i>Atlantis</i> (STS 61-B)	Nov. 27, 1985	Brewster H. Shaw Bryan D. O'Connor Mary L. Cleve Sherwood C. Spring Jerry L. Ross Rudolfo Neri Vela Charles D. Walker	6:22:54	Twenty-third STS flight. Launched three communications satellites. First flight of Mexican astronaut (Neri Vela).
Space Shuttle <i>Columbia</i> (STS 61-C)	Jan. 12, 1986	Robert L. Gibson Charles F. Bolden Jr. Franklin Chang-Diaz Steve A. Hawley George D. Nelson Roger Cenker Bill Nelson	6:2:4	Twenty-fourth STS flight. Launched one communications satellite. First member of U.S. House of Representatives in space (Bill Nelson).
Soyuz T-15	Mar. 13, 1986	Leonid Kizim Vladimir Solovyov	125:1:1	Docked with <i>Mir</i> space station on May 5/6 transferred to Salyut 7 complex. On June 25/26 transferred from Salyut 7 back to <i>Mir</i> .
Soyuz TM-2	Feb. 5, 1987	Yury Romanenko Aleksandr Laveykin	174:3:26	Docked with <i>Mir</i> space station. Romanenko established long-distance stay in space record of 326 days.
Soyuz TM-3	July 22, 1987	Aleksandr Viktorenko Aleksandr Aleksandrov Mohammed Faris	160:7:16	Docked with <i>Mir</i> space station. Aleksandr Aleksandrov remained in <i>Mir</i> 160 days, returned with Yury Romanenko. Viktorenko and Faris returned in Soyuz TM-2, July 30, with Aleksandr Laveykin who experienced medical problems. Faris first Syrian in space.
Soyuz TM-4	Dec. 21, 1987	Vladimir Titov Musa Manarov Anatoly Levchenko	180:5	Docked with <i>Mir</i> space station. Crew of Yury Romanenko, Aleksandr Aleksandrov, and Anatoly Levchenko returned Dec. 29 in Soyuz TM-3.
Soyuz TM-5	June 7, 1988	Viktor Savinykh Anatoly Solovyev Aleksandr Aleksandrov	9:20:13	Docked with <i>Mir</i> space station; Aleksandrov first Bulgarian in space. Crew returned Jun. 17 in Soyuz TM-4.
Soyuz TM-6	Aug. 29, 1988	Vladimir Lyakhov Valery Polyakov Abdul Mohmand	8:19:27	Docked with <i>Mir</i> space station; Mohmand first Afghanistani in space. Crew returned Sept. 7, in Soyuz TM-5.
Space Shuttle <i>Discovery</i> (STS-26)	Sep. 29, 1988	Frederick H. Hauck Richard O. Covey John M. Lounge David C. Hilmers George D. Nelson	4:1	Twenty-sixth STS flight. Launched TDRS-3.
Soyuz TM-7	Nov. 26, 1988	Aleksandr Volkov Sergey Krikalev Jean-Loup Chrétien	151:11	Docked with <i>Mir</i> space station. Soyuz TM-6 returned with Chrétien, Vladimir Titov, and Musa Manarov. Titov and Manarov completed 366-day mission Dec. 21. Crew of Krikalev, Volkov, and Valery Polyakov returned Apr. 27, 1989, in Soyuz TM-7.

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(Continued)

## U.S. and Russian Human Space Flights 1961–September 30, 1998

Spacecraft	Launch Date	Crew	Flight Time (days:hrs:min)	Highlights
Space Shuttle <i>Atlantis</i> (STS-27)	Dec. 2, 1988	Robert "Hoot" Gibson Guy S. Gardner Richard M. Mullane Jerry L. Ross William M. Shepherd	4:9:6	Twenty-seventh STS flight. Dedicated DoD mission.
Space Shuttle <i>Discovery</i> (STS-29)	Mar. 13, 1989	Michael L. Coats John E. Blaha James P. Bagjan James F. Buchli Robert C. Springer	4:23:39	Twenty-eighth STS flight. Launched TDRS-4.
Space Shuttle <i>Atlantis</i> (STS-30)	May 4, 1989	David M. Walker Ronald J. Grabe Nomman E. Thagard Mary L. Cleave Mark C. Lee	4:0:57	Twenty-ninth STS flight. Venus orbiter Magellan launched.
Space Shuttle <i>Columbia</i> (STS-28)	Aug. 8, 1989	Brewster H. Shaw Richard N. Richards James C. Adamson David C. Leestma Mark N. Brown	5:1	Thirtieth STS flight. Dedicated DoD mission.
Soyuz TM-8	Sep. 5, 1989	Aleksandr Viktorenko Aleksandr Serebrov	166:6	Docked with <i>Mir</i> space station. Crew of Viktorenko and Serebrov returned in Soyuz TM-8, Feb. 9, 1990.
Space Shuttle <i>Atlantis</i> (STS-34)	Oct. 18, 1989	Donald E. Williams Michael J. McCulley Shannon W. Lucid Franklin R. Chang-Diaz Ellen S. Baker	4:23:39	Thirty-first STS flight. Launched Jupiter probe and orbiter Galileo.
Space Shuttle <i>Discovery</i> (STS-33)	Nov. 23, 1989	Frederick D. Gregory John E. Blaha Kathryn C. Thornton F. Story Musgrave Manley L. "Sonny" Carter	5:0:7	Thirty-second STS flight. Dedicated DoD mission.
Space Shuttle <i>Columbia</i> (STS-32)	Jan. 9, 1990	Daniel C. Brandenstein James D. Wetherbee Bonnie J. Dunbar Marsha S. Ivins G. David Low	10:21	Thirty-third STS flight. Launched Syncom IV-5 and retrieved LDEF.
Soyuz TM-9	Feb. 11, 1990	Anatoly Solovyov Aleksandr Balandin	178:22:19	Docked with <i>Mir</i> space station. Crew returned Aug. 9, 1990, in Soyuz TM-9.
Space Shuttle <i>Atlantis</i> (STS-36)	Feb. 28, 1990	John O. Creighton John H. Casper David C. Hilmers Richard H. Mullane Pierre J. Thuot	4:10:19	Thirty-fourth STS flight. Dedicated DoD mission.
Space Shuttle <i>Discovery</i> (STS-31)	Apr. 24, 1990	Loren J. Shriver Charles F. Bolden, Jr. Steven A. Hawley Bruce McCandless II Kathryn D. Sullivan	5:1:16	Thirty-fifth STS flight. Launched Hubble Space Telescope (HST).
Soyuz TM-10	Aug. 1, 1990	Gennady Manakov Gennady Strekalov	130:20:36	Docked with <i>Mir</i> space station. Crew returned Dec. 10, 1990, with Toyohiro Akiyama, Japanese cosmonaut and journalist in space.

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(Continued)

## U.S. and Russian Human Space Flights 1961–September 30, 1998

Spacecraft	Launch Date	Crew	Flight Time (days:hrs:min)	Highlights
Space Shuttle <i>Discovery</i> (STS-41)	Oct. 6, 1990	Richard N. Richards Robert D. Cabana Bruce E. Melnick William M. Shepherd Thomas D. Akers	4:2:10	Thirty-sixth STS flight. Ulysses spacecraft to investigate interstellar space and the Sun.
Space Shuttle <i>Atlantis</i> (STS-38)	Nov. 15, 1990	Richard O. Covey Frank L. Culbertson, Jr. Charles "Sam" Gemar Robert C. Springer Carl J. Meade	4:21:55	Thirty-seventh STS flight. Dedicated DoD mission.
Space Shuttle <i>Columbia</i> (STS-35)	Dec. 2, 1990	Vance D. Brand Guy S. Gardner Jeffrey A. Hoffman John M. "Mike" Lounge Robert A. R. Parker	8:23:5	Thirty-eighth STS flight. Astro-1 in cargo bay.
Soyuz TM-11	Dec. 2, 1990	Viktor Afanasyev Musa Manarov Toyohiro Akiyama	175:01:52	Docked with <i>Mir</i> space station. Toyohiro Akiyama returned Dec. 10, 1990, with previous <i>Mir</i> crew of Gennady Manakov and Gennady Strekalov.
Space Shuttle <i>Atlantis</i> (STS-37)	Apr. 5, 1991	Steven R. Nagel Kenneth D. Cameron Linda Godwin Jerry L. Ross Jay Apt	6:0:32	Thirty-ninth STS flight. Launched Gamma Ray Observatory to measure celestial gamma-rays.
Space Shuttle <i>Discovery</i> (STS-39)	Apr. 28, 1991	Michael L. Coats Blaine Hammond, Jr. Gregory L. Harbaugh Donald R. McMonagle Guion S. Bluford, Jr. Lacy Veach Richard J. Hieb	8:7:22	Fortieth STS flight. Dedicated DoD mission.
Soyuz TM-12	May 18, 1991	Anatoly Artsebarskiy Sergei Krikalev Helen Sharman	144:15:22	Docked with <i>Mir</i> space station. Helen Sharman first from United Kingdom to fly in space. Crew of Viktor Afanasyev, Musa Manarov, and Helen Sharman returned May 20, 1991. Artsebarskiy and Krikalev remained on board <i>Mir</i> , with Artsebarskiy returning Oct. 10, 1991, and Krikalev doing so Mar. 25, 1992.
Space Shuttle <i>Columbia</i> (STS-40)	June 5, 1991	Bryan D. O'Conner Sidney M. Gutierrez James P. Bagian Tamara E. Jernigan M. Rhea Seddon Francis A. "Drew" Gaffney Millie Hughes-Fulford	9:2:15	Forty-first STS flight. Carried Spacelab Life Sciences (SLS-1) in cargo bay.
Space Shuttle <i>Atlantis</i> (STS-43)	Aug. 2, 1991	John E. Blaha Michael A. Baker Shannon W. Lucid G. David Low James C. Adamson	8:21:21	Forty-second STS flight. Launched fourth Tracking and Data Relay Satellite (TDRS-5).
Space Shuttle <i>Discovery</i> (STS-48)	Sep. 12, 1991	John Creighton Kenneth Reightler, Jr. Charles D. Gemar James F. Buchli Mark N. Brown	5:8:28	Forty-third STS flight. Launched Upper Atmosphere Research Satellite (UARS).

APPENDIX C  
(Continued)  
**U.S. and Russian Human Space Flights**  
1961–September 30, 1998

Spacecraft	Launch Date	Crew	Flight Time (days:hrs:min)	Highlights
Soyuz TM-13	Oct. 2, 1991	Aleksandr Volkov Toktar Aubakirov (Kazakh Republic) Franz Viehboeck (Austria)	90:16:00	Docked with <i>Mir</i> space station. Crew returned Oct. 10, 1991, with Anatoly Artsebarsky in the TM-12 spacecraft.
Space Shuttle <i>Atlantis</i> (STS-44)	Nov. 24, 1991	Frederick D. Gregory Tom Henricks Jim Voss Story Musgrave Mario Runco, Jr. Tom Hennen	6:22:51	Forty-fourth STS flight. Launched Defense Support Program (DSP) satellite.
Space Shuttle <i>Discovery</i> (STS-42)	Jan. 22, 1992	Ronald J. Grabe Stephen S. Oswald Norman E. Thagard David C. Hilmers William F. Readdy Roberta L. Bondar Ulf Merbold (ESA)	8:1:12	Forty-fifth STS flight. Carried International Microgravity Laboratory-1 in cargo bay.
Soyuz TM-14	Mar. 17, 1992	Alexandr Viktorenko Alexandr Kaleri Klaus-Dietrich Flade (Germany)	145:15:11	First manned CIS space mission. Docked with <i>Mir</i> space station Mar. 19. The TM-13 capsule with Flade, Aleksandr Volkov, and Sergei Krikalev returned to Earth Mar. 25. Krikalev had been in space 313 days. Viktorenko and Kaleri remained on the <i>Mir</i> space station.
Space Shuttle <i>Atlantis</i> (STS-45)	Mar. 24, 1992	Charles F. Bolden Brian Duffy Kathryn D. Sullivan David C. Leestma Michael Foale Dirk D. Frimout Byron K. Lichtenberg	9:0:10	Forty-sixth STS flight. Carried Atmospheric Laboratory for Applications and Science (ATLAS-1).
Space Shuttle <i>Endeavour</i> (STS-49)	May 7, 1992	Daniel C. Brandenstein Kevin P. Chilton Richard J. Hieb Bruce E. Melnick Pierre J. Thuot Kathryn C. Thornton Thomas D. Akers	8:16:17	Forty-seventh STS flight. Reboosted a crippled INTELSAT VI communications satellite.
Space Shuttle <i>Columbia</i> (STS-50)	June 25, 1992	Richard N. Richards Kenneth D. Bowersox Bonnie Dunbar Ellen Baker Carl Meade	13:19:30	Forty-eighth STS flight. Carried U.S. Microgravity Laboratory-1.
Soyuz TM-15	July 27, 1992	Anatoly Solovyov Sergei Avdeyev Michel Tognini (France)	189:17:43	Docked with <i>Mir</i> space station Jul. 29. Tognini returned to Earth in TM-14 capsule with Aleksandr Viktorenko and Aleksandr Kaleri. Solovyov and Avdeyev spent over six months in the <i>Mir</i> orbital complex and returned to Earth in the descent vehicle of the TM-15 spacecraft on Feb. 1, 1993.



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## U.S. and Russian Human Space Flights 1961–September 30, 1998

Spacecraft	Launch Date	Crew	Flight Time (days:hrs:min)	Highlights
Space Shuttle <i>Atlantis</i> (STS-46)	Jul. 31, 1992	Loren J. Shriver Andrew M. Allen Claude Nicollier (ESA) Marsha S. Ivins Jeffrey A. Hoffman Franklin R. Chang-Diaz Franco Malerba (Italy)	7:23:16	Forty-ninth STS flight. Deployed Tethered Satellite System-1 and Eureka-1.
Space Shuttle <i>Endeavour</i> (STS-47)	Sep. 12, 1992	Robert L. Gibson Curtis L. Brown, Jr. Mark C. Lee Jerome Apt N. Jan Davis Mae C. Jemison Mamoru Mohri	7:22:30	Fiftieth STS flight. Carried Spacelab J. Jemison first African American woman to fly in space. Mohri first Japanese to fly on NASA spacecraft. Lee and Davis first married couple in space together.
Space Shuttle <i>Columbia</i> (STS-52)	Oct. 22, 1992	James D. Wetherbee Michael A. Baker William M. Shepherd Tamara E. Jernigan Charles L. Veach Steven G. MacLean	9:20:57	Fifty-first STS flight. Studied influence of gravity on basic fluid and solidification processes using U.S. Microgravity Payload-1 in an international mission. Deployed second Laser Geodynamics Satellite and Canadian Target Assembly.
Space Shuttle <i>Discovery</i> (STS-53)	Dec. 2, 1992	David M. Walker Robert D. Cabana Guion S. Bluford, Jr. James S. Voss Michael Richard Clifford	7:7:19	Fifty-second STS flight. Deployed the last major DoD classified payload planned for Shuttle (DoD 1) with ten different secondary payloads.
Space Shuttle <i>Endeavour</i> (STS-54)	Jan. 13, 1993	John H. Casper Donald R. McMonagle Gregory J. Harbaugh Mario Runco, Jr. Susan J. Helms	6:23:39	Fifty-third STS flight. Deployed Tracking and Data Relay Satellite-6. Operated Diffused X-ray Spectrometer Hitchhiker experiment to collect data on stars and galactic gases.
Soyuz TM-16	Jan. 24, 1993	Gennady Manakov Aleksandr Poleshchuk	179:0:44	Docked with <i>Mir</i> space station Jan. 26. On July 22, 1993, the TM-16 descent cabin landed back on Earth with Manakov, Poleschuk, and French cosmonaut Jean-Pierre Haignere from Soyuz TM-17 on board.
Space Shuttle <i>Discovery</i> (STS-56)	Apr. 8, 1993	Kenneth D. Cameron Stephen S. Oswald C. Michael Foale Kenneth D. Cockerell Ellen Ochoa	9:6:9	Fifty-fourth STS flight. Completed second flight of Atmospheric Laboratory for Applications and Science and deployed SPARTAN-201.
Space Shuttle <i>Columbia</i> (STS-55)	Apr. 26, 1993	Steven R. Nagel Terence T. Henricks Jerry L. Ross Charles J. Precourt Bernard A. Harris, Jr. Ulrich Walter (Germany) Hans W. Schlegel (Germany)	9:23:39	Fifty-fifth STS flight. Completed second German microgravity research program in Spacelab D-2.
Space Shuttle <i>Endeavour</i> (STS-57)	June 21, 1993	Ronald J. Grabe Brian J. Duffy G. David Low Nancy J. Sherlock Peter J. K. Wisoff Janice E. Voss	9:23:46	Fifty-sixth STS flight. Carried Spacelab commercial payload module and retrieved European Retrievable Carrier in orbit since August 1992.

APPENDIX C  
(Continued)  
**U.S. and Russian Human Space Flights**  
1961–September 30, 1998

Spacecraft	Launch Date	Crew	Flight Time (days:hrs:min)	Highlights
Soyuz TM-17	July 1, 1993	Vasiliy Tsibliyev Aleksandr Serebrov Jean-Pierre Haignere	196:17:45	Docked with <i>Mir</i> space station July 3. Haignere returned to Earth with Soyuz TM-16. Serebrov and Tsibliyev landed in TM-17 spacecraft on Jan. 14, 1994.
Space Shuttle <i>Discovery</i> (STS-51)	Sep. 12, 1993	Frank L. Culbertson, Jr. William F. Readdy James H. Newman Daniel W. Bursch Carl E. Walz	9:20:11	Fifty-seventh STS flight. Deployed ACTS satellite to serve as testbed for new communications satellite technology and U.S./German ORFEUS-SPAS.
Space Shuttle <i>Columbia</i> (STS-58)	Oct. 18, 1993	John E. Blaha Richard A. Searfoss Shannon W. Lucid David A. Wolf William S. McArthur Martin J. Fettman	14:0:29	Fifty-eighth STS flight. Carried Spacelab Life Sciences-2 payload to determine the effects of microgravity on M. Rhea Seddon human and animal subjects.
Space Shuttle <i>Endeavour</i> (STS-61)	Dec. 2, 1993	Richard O. Covey Kenneth D. Bowersox Tom Akers Jeffrey A. Hoffman Kathryn C. Thornton Claude Nicollier E. Story Musgrave	10:19:58	Fifty-ninth STS flight. Restored planned scientific capabilities and reliability of the Hubble Space Telescope.
Soyuz TM-18	Jan. 8, 1994	Viktor Afanasyev Yuri Usachev Valery Polyakov	182:0:27	Docked with <i>Mir</i> space station Jan. 10. Afanasyev and Usachev landed in the TM-18 spacecraft on July 9, 1994. Polyakov remained aboard <i>Mir</i> in the attempt to establish a new record for endurance in space.
Space Shuttle <i>Discovery</i> (STS-60)	Feb. 3, 1994	Charles F. Bolden, Jr. Kenneth S. Reightler, Jr. N. Jan Davis Ronald M. Sega Franklin R. Chang-Diaz Sergei K. Krikalev (Russia)	8:7:9	Sixtieth STS flight. Carried the Wake Shield Facility to generate new semi-conductor films for advanced electronics. Also carried SPACEHAB. Krikalev's presence signified a new era in cooperation in space between Russia and the United States.
Space Shuttle <i>Columbia</i> (STS-62)	Mar. 4, 1994	John H. Casper Andrew M. Allen Pierre J. Thuot Charles D. Gemar Marsha S. Ivins	13:23:17	Sixty-first STS flight. Carried U.S. Microgravity Payload-2 to conduct experiments in materials processing, biotechnology, and other areas.
Space Shuttle <i>Endeavour</i> (STS-59)	Apr. 9, 1994	Sidney M. Gutierrez Kevin P. Chilton Jerome Apt Michael R. Clifford Linda M. Godwin Thomas D. Jones	11:5:50	Sixty-second STS flight. Carried the Space Radar Laboratory-1 to gather data on the Earth and the effects humans have on its carbon, water, and energy cycles.
Soyuz TM-19	July 1, 1994	Yuri I. Malenchenko Talgat A. Musabayev	125:22:53	Docked with <i>Mir</i> space station July 3. Both Malenchenko and Musabayev returned to Earth with the Soyuz TM-19 spacecraft, landing in Kazakhstan on Nov. 4 together with Ulf Merbold of Germany, who went up aboard Soyuz TM-20 on Oct 3, 1994. Merbold gathered biological samples on the effects of weightlessness on the human body in the first of two ESA missions to <i>Mir</i> to prepare for the International Space Station.

## APPENDIX C

(Continued)

## U.S. and Russian Human Space Flights 1961–September 30, 1998

Spacecraft	Launch Date	Crew	Flight Time (days:hrs:min)	Highlights
Space Shuttle <i>Columbia</i> (STS-65)	July 8, 1994	Robert D. Cabana James D. Halsell, Jr. Richard J. Hieb Carl E. Walz Leroy Chiao Donald A. Thomas Chiaki Naito-Mukai (Japan)	14:17:55	Sixty-third STS flight. Carried International Microgravity Laboratory-2 to conduct research into the behavior of materials and life in near weightlessness.
Space Shuttle <i>Discovery</i> (STS-64)	Sep. 9, 1994	Richard N. Richards L. Blaine Hammond, Jr. J. M. Linenger Susan J. Helms Carl J. Meade Mark C. Lee	10:22:50	Sixty-fourth STS flight. Used LIDAR In-Space Technology Experiment to perform atmospheric research. Included the first untethered spacewalk by astronauts in over 10 years.
Space Shuttle <i>Endeavour</i> (STS-68)	Sep. 30, 1994	Michael A. Baker Terrence W. Wilcutt Thomas D. Jones Steven L. Smith Daniel W. Bursch Peter J. K. Wisoff	11:5:36	Sixty-fifth STS flight. Used Space Radar Laboratory-2 to provide scientists with data to help distinguish human-induced environmental change from other natural forms of change.
Soyuz TM-20	Oct. 3, 1994	Alexsandr Viktorenko Yelena Kondakova Ulf Merbold (ESA)	*	Soyuz TM-19 returned to Earth on Nov. 4, 1994, with Yuri Malenchenko, Talgat Musabayev, and Ulf Merbold. Valeriy Polyakov remained aboard <i>Mir</i> .
Space Shuttle <i>Atlantis</i> (STS-66)	Nov. 3, 1994	Donald R. McMonagle Curtis L. Brown, Jr. Ellen Ochoa Joseph R. Tanner Jean-Francois Clervoy (ESA) Scott E. Parazynski	10:22:34	Sixty-sixth STS flight. Three main payloads: the third Atmospheric Laboratory for Applications and Science (ATLAS-3), the first Cryogenic Infrared Spectrometers and Telescopes for the Atmosphere-Shuttle Pallet Satellite (CRISTA-SPAS-1), and the Shuttle Solar Backscatter Ultraviolet (SSBUV) spectrometer. Astronauts also conducted protein crystal growth experiments.
Space Shuttle <i>Discovery</i> (STS-63)	Feb. 3, 1995	James D. Wetherbee Eileen M. Collins Bernard A. Harris, Jr. C. Michael Foale Janice E. Voss Vladimir G. Titov (Russia)	8:6:28	Sixty-seventh STS flight. Primary objective: first close encounter in nearly 20 years between American and Russian spacecraft as a prelude to establishment of International Space Station. (Shuttle flew close by to <i>Mir</i> .) Main Payloads: Spacehab 3 experiments and Shuttle Pointed Autonomous Research Tool for Astronomy (SPARTAN) 204, Solid Surface Combustion Experiment (SSCE), and Air Force Maui Optical Site (AMOS) Calibration Test. Also launched very small Orbital Debris Radar Calibration Spheres (ODERACS).
Space Shuttle <i>Endeavour</i> (STS-67)	Mar. 2, 1995	Stephen S. Oswald William G. Gregory John M. Grunsfeld Wendy B. Lawrence Tamara E. Jernigan Ronald A. Parise Samuel T. Durrance	16:15:8	Sixty-eighth STS flight. Longest Shuttle mission to date. Primary payload was a trio of ultraviolet telescopes called <i>Astro-2</i> .

APPENDIX C  
(Continued)  
**U.S. and Russian Human Space Flights**  
1961–September 30, 1998

Spacecraft	Launch Date	Crew	Flight Time (days:hrs:min)	Highlights
Soyuz TM-21	Mar. 14, 1995	Vladimir Dezhurov Gennadi Strekalov Norman Thagard (U.S.)	*	Thagard was the first American astronaut to fly on a Russian rocket and to stay on the <i>Mir</i> space station. Soyuz TM-20 returned to Earth on Mar. 22, 1995, with Valeriy Polyakov, Aleksandr Viktorenko, and Yelena Kondakova. Polyakov set world record by remaining in space for 438 days.
Space Shuttle <i>Atlantis</i> (STS-71)	June 27, 1995	Robert L. Gibson Charles J. Precourt Ellen S. Baker Gregory Harbaugh Bonnie J. Dunbar	9:19:22	Sixty-ninth STS flight and one hundredth U.S. human space flight. Docked with <i>Mir</i> space station. Brought up <i>Mir</i> 19 crew (Anatoly Y. Solovyev and Nikolai M. Budarin). Returned to Earth with <i>Mir</i> 18 crew (Vladimir N. Dezhurov, Gennady M. Strekalov, and Norman Thagard). Thagard set an American record by remaining in space for 115 days.
Space Shuttle <i>Discovery</i> (STS-70)	July 13, 1995	Terence Henricks Kevin R. Kregel Nancy J. Currie Donald A. Thomas Mary Ellen Weber	8:22:20	Seventieth STS flight. Deployed Tracking and Data Relay Satellite (TDRS). Also conducted various biomedical experiments.
Soyuz TM-22	Sep. 3, 1995	Yuri Gidzenko Sergei Avdeev Thomas Reiter (ESA)	*	Soyuz TM-21 returned to Earth on Sep. 11, 1995, with <i>Mir</i> 19 crew (Anatoly Solovyev and Nikolay Budarin).
Space Shuttle <i>Endeavour</i> (STS-69)	Sep. 7, 1995	David M. Walker Kenneth D. Cockrell James S. Voss James H. Newman Michael L. Gernhardt	10:20:28	Seventy-first STS flight. Deployed Wake Shield Facility (WSF-2) and SPARTAN 201-03.
Space Shuttle <i>Columbia</i> (STS-73)	Oct. 20, 1995	Kenneth D. Bowersox Kent V. Rominger Catherine G. Coleman Michael Lopez-Alegria Kathryn C. Thornton Fred W. Leslie Albert Sacco, Jr.	15:21:52	Seventy-second STS flight. Carried out micro-gravity experiments with the U.S. Microgravity Laboratory (USML-2) payload.
Space Shuttle <i>Atlantis</i> (STS-74)	Nov. 12, 1995	Kenneth D. Cameron James D. Halsell, Jr. Chris A. Hadfield (CSA) Jerry L. Ross William S. McArthur, Jr.	8:4:31	Seventy-third STS flight. Docked with <i>Mir</i> space station as part of International Space Station (ISS) Phase I efforts.
Space Shuttle <i>Endeavour</i> (STS-72)	Jan. 11, 1996	Brian Duffy Brent W. Jett, Jr. Leroy Chiao Winston E. Scott Koichi Wakata (Japan) Daniel T. Barry	8:22:1	Seventy-fourth STS flight. Deployed OAST Flyer. Retrieved previously launched Japanese Space Flyer Unit satellite. Crew performed spacewalks to build experience for ISS construction.
Soyuz TM-23	Feb. 21, 1996	Yuri Onufrienko Yuri Usachyou	*	Soyuz TM-22 returned to Earth on Feb. 29, 1996, with <i>Mir</i> 20 crew (Yuri Gidzenko, Sergei Avdeev, and Thomas Reiter).

## APPENDIX C

(Continued)

## U.S. and Russian Human Space Flights 1961–September 30, 1998

Spacecraft	Launch Date	Crew	Flight Time (days:hrs:min)	Highlights
Space Shuttle <i>Columbia</i> (STS-75)	Feb. 22, 1996	Andrew M. Allen Scott J. Horowitz Jeffrey A. Hoffman Maurizio Cheli (ESA) Claude Nicollier (ESA) Franklin R. Chang-Diaz Umberto Guidoni (ESA)	13:16:14	Seventy-fifth STS flight. Deployed Tethered Satellite System, U.S. Microgravity Payload (USMP-3), and protein crystal growth experiments.
Space Shuttle <i>Atlantis</i> (STS-76)	Mar. 22, 1996	Kevin P. Chilton Richard A. Searfoss Linda M. Godwin Michael R. Clifford Ronald M. Sega Shannon W. Lucid**	9:5:16	Seventy-sixth STS flight. Docked with <i>Mir</i> space station and left astronaut Shannon Lucid aboard <i>Mir</i> . Also carried SPACEHAB module.
Space Shuttle <i>Endeavour</i> (STS-77)	May 19, 1996	John H. Casper Curtis L. Brown Andrew S. W. Thomas Daniel W. Bursch Mario Runco, Jr. Marc Garneau (CSA)	10:2:30	Seventy-seventh STS flight. Deployed SPARTAN/Inflatable Antenna Experiment, SPACEHAB, and PAMS-STU payloads.
Space Shuttle <i>Columbia</i> (STS-78)	June 20, 1996	Terrence T. Henricks Kevin Kregel Richard M. Linnehan Susan J. Helms Charles E. Brady, Jr. Jean-Jacques Favier (CSA) Robert B. Thirsk (ESA)	16:21:48	Seventy-eighth STS flight. Set Shuttle record for then-longest flight. Carried Life and Microgravity Sciences Spacelab.
Soyuz TM-24	Aug. 17, 1996	Claudie Andre-Deshays (ESA) Valery Korzun Alexander Kaleri	*	Soyuz TM-23 returned to Earth on Sep. 2, 1996, with Claudie Andre-Deshays, Yuri Onufrienko, and Yuri Usachev.
Space Shuttle <i>Atlantis</i> (STS-79)	Sep. 16, 1996	William F. Readdy Terrence W. Wilcutt Jerome Apt Thomas D. Akers Carl E. Walz John E. Blaha** Shannon W. Lucid***	10:3:19	Seventy-ninth STS flight. Docked with <i>Mir</i> space station. Picked up astronaut Shannon Lucid and dropped off astronaut John Blaha.
Space Shuttle <i>Columbia</i> (STS-80)	Nov. 19, 1996	Kenneth D. Cockrell Kent V. Rominger Tamara E. Jernigan Thomas David Jones F. Story Musgrave	17:15:53	Set record for longest Shuttle flight. At age 61, Musgrave became oldest person to fly in space. He also tied record for most space flights (six) by a single person. Crew successfully deployed ORFEUS-SPAS II ultraviolet observatory and Wake Shield Facility payloads.
Space Shuttle <i>Atlantis</i> (STS-81)	Jan. 12, 1997	Michael A. Baker Brent W. Jett Peter J.K. "Jeff" Wisoff John M. Grunsfeld Marsha S.Ivins Jerry M. Linenger** John E. Blaha***	10:4:56	Fifth Shuttle mission to <i>Mir</i> . Jerry Linenger replaced John Blaha as U.S. resident on <i>Mir</i> .

## APPENDIX C

(Continued)

## U.S. and Russian Human Space Flights 1961–September 30, 1998

Spacecraft	Launch Date	Crew	Flight Time (days:hrs:min)	Highlights
Soyuz TM-25	Feb. 10, 1997	Vasily Tsibliyev Aleksandr Lazutkin Reinhold Ewald	*	Soyuz TM-24 returned to Earth on March 2, 1997, with Reinhold Ewald, Valery Korzun, and Aleksandr Kaleri.
Space Shuttle <i>Discovery</i> (STS-82)	Feb. 11, 1997	Kenneth D. Bowersox Scott J. Horowitz Joseph R. Tanner Steven A. Hawley Gregory J. Harbaugh Mark C. Lee Steven L. Smith	9:23:36	Crew successfully performed second servicing mission of the Hubble Space Telescope.
Space Shuttle <i>Columbia</i> (STS-83)	Apr. 4, 1997	James D. Halsell, Jr. Susan L. Still Janice Voss Michael L. Gernhardt Donald A. Thomas Roger K. Crouch Gregory T. Linteris	3:23:34	Crew deployed a Spacelab module configured as the first Microgravity Science Laboratory. Shuttle fuel cell malfunction necessitated an early termination of the mission.
Space Shuttle <i>Atlantis</i> (STS-84)	May 15, 1997	Charles J. Precourt Eileen Marie Collins Jean-François Clervoy Carlos I. Noriega Edward Tsang Lu Elena V. Kondakova Michael Foale** Jerry M. Linenger***	9:5:21	Sixth Shuttle mission to <i>Mir</i> . Michael Foale replaced Jerry Linenger on <i>Mir</i> .
Space Shuttle <i>Columbia</i> (STS-94)	July 1, 1997	James D. Halsell, Jr. Susan L. Still Janice Voss Michael L. Gernhardt Donald A. Thomas Roger K. Crouch Gregory T. Linteris	15:16:45	Reflight of STS-83 and the same payload, the Microgravity Science Laboratory. Mission proceeded successfully.
Soyuz TM-26	Aug. 5, 1997	Anatoly Solovyev Pavel Vinogradov	*	Soyuz TM-25 returned to Earth on August 14, 1997, with Vasily Tsibliyev and Aleksandr Lazutkin.
Space Shuttle <i>Discovery</i> (STS-85)	Aug. 7, 1997	Curtis L. Brown, Jr. Kent V. Rominger N. Jan Davis Robert L. Curbeam, Jr. Stephen K. Robinson Bjarni V. Tryggvason	11:20:27	Crew successfully deployed two payloads: CRISTA-SPAS-2 on infrared radiation and an international Hitchhiker package of four experiments on ultraviolet radiation. The crew also successfully performed the Japanese Manipulator Flight Demonstration of a robotic arm.
Space Shuttle <i>Atlantis</i> (STS-86)	Sep. 25, 1997	James D. Wetherbee Michael J. Bloomfield Scott E. Parazynski Vladimir Titov Jean-Loup Chretien Wendy B. Lawrence David A. Wolf** C. Michael Foale***	10:19:21	Seventh Shuttle docking with <i>Mir</i> . David Wolf replaced Michael Foale on <i>Mir</i> . Parazynski and Titov performed a spacewalk to retrieve four <i>Mir</i> Environmental Effects Payload experiments from the exterior of the docking module and left a solar array cover cap for possible future repair of the damaged <i>Spektr</i> module.

## APPENDIX C

(Continued)

## U.S. and Russian Human Space Flights 1961–September 30, 1998

Spacecraft	Launch Date	Crew	Flight Time (days:hrs:min)	Highlights
Space Shuttle <i>Columbia</i> (STS-87)	Nov. 19, 1997	Kevin R. Kregel Steven W. Lindsey Kalpana Chawla Winston E. Scott Takao Doi Leonid K. Kadenyuk	15:16:34	Payloads included USMP-4, SPARTAN 201-04 free-flyer, Collaborative Ukrainian Experiment (CUE) in space biology, and several other "hitchhiker" payloads.
Space Shuttle <i>Endeavour</i> (STS-89)	Jan. 22, 1998	Terrence W. Wilcutt Joe F. Edwards, Jr. James F. Reilly II Michael P. Anderson Bonnie J. Dunbar Salizhan S. Sharipov Andrew S. Thomas** David A. Wolf***	8:19:47	Eighth Shuttle docking mission to <i>Mir</i> . Andrew Thomas replaced David Wolf on <i>Mir</i> . Shuttle payloads included SPACEHAB double module of science experiments.
Soyuz TM-27	Jan. 29, 1998	Talgat Musabayev Nikolai Budarin Leopold Eyharts	*	Soyuz TM-26 left <i>Mir</i> and returned to Earth on February 19 with Anatoly Solovyev, Pavel Vinogradov, and Leopold Eyharts.
Space Shuttle <i>Columbia</i> (STS-90)	Apr. 17, 1998	Richard A. Searfoss Scott D. Altman Richard M. Linnehan Kathryn P. Hire Dafydd Rhys Williams Jay Clark Buckley, Jr. James A. Pawelczyk	15:21:50	Carried Neurolab module for microgravity research in the human nervous system. Secondary goals included measurement of Shuttle vibration forces, demonstration of the bioreactor system for cell growth, and three Get Away Special payloads.
Space Shuttle <i>Discovery</i> (STS-91)	June 2, 1998	Charles J. Precourt Dominic L. Pudwill Gorie Franklin R. Chang-Diaz Wendy B. Lawrence Janet Lynn Kavandi Valery V. Ryumin Andrew S. Thomas***	9:19:48	Last of nine docking missions with <i>Mir</i> , this one brought home Andrew Thomas. Payloads included DoE's Alpha Magnetic Spectrometer to study high-energy particles from deep space, four Get Away Specials, and two Space Experiment Modules.
Soyuz TM-28	Aug. 13, 1998	Gennady Padalka Segei Avdeev Yuri Baturin	*	Docked to <i>Mir</i> using manual backup system because of prior failure of one of two automatic systems. Soyuz TM-27 left <i>Mir</i> returned to Earth with Talgat Musabayev, Nikolai Budarin, and Yuri Baturin.

\* *Mir* crew members stayed for various and overlapping lengths of time.

\*\* Flew up on Space Shuttle; remained in space aboard Russian *Mir* space station.

\*\*\* Returned to Earth via Space Shuttle from Russian *Mir* space station.

## U.S. Space Launch Vehicles

Vehicle	Stages: Engine/Motor	Propellant <sup>a</sup>	Thrust (kilonewtons) <sup>b, c</sup>	Max. Dia x Height (m)	Max. Payload (kg) <sup>d</sup>			First Launch <sup>f</sup>
					185-km Orbit	Geosynch. Transfer Orbit	Sun- Synch. Orbit <sup>e</sup>	
Pegasus				6.71x15.5 <sup>h</sup>	380 280 <sup>f</sup>	—	210	1990
	1. Orion 50S	Solid	484.9	1.28x8.88				
	2. Orion 50	Solid	118.2	1.28x2.66				
	3. Orion 38	Solid	31.9	0.97x1.34				
Pegasus XL				6.71x16.93	460 350 <sup>f</sup>	—	335	1994 <sup>g</sup>
	1. Orion 50S-XL	Solid	743.3	1.28x10.29				
	2. Orion 50-XL	Solid	201.5	1.28x3.58				
	3. Orion 38	Solid	31.9	0.97x1.34				
Taurus				2.34x28.3	1,400 1,080 <sup>f</sup>	255	1,020	Not scheduled
	0. Castor 120	Solid	1,687.7	2.34x11.86				
	1. Orion 50S	Solid	580.5	1.28x8.88				
	2. Orion 50	Solid	138.6	1.28x2.66				
	3. Orion 38	Solid	31.9	0.97x1.34				
Delta II (7920, 7925)				2.44x29.70	5,089 3,890 <sup>f</sup>	1,842 <sup>i</sup>	3,175	1990, Delta-7925 [1960, Delta]
	1. RS-270/A	LOX/RP-1	1,043.0 (SL)	3.05x38.1				
	Hercules GEM (9)	Solid	487.6 (SL)	1.01x12.95				
	2. AJ10-118K	N204/A-50	42.4	2.44x5.97				
	3. Star 48B <sup>j</sup>	Solid	66.4	1.25x2.04				
Atlas E				3.05x28.1	820 <sup>f</sup> 1,860 <sup>e, k</sup>	—	910 <sup>k</sup>	1968, Atlas F [1958, Atlas LV-3A]
	1. Atlas MA-3	LOX/RP-1	1,739.5 (SL)	3.05x21.3				
Atlas I				4.2x43.9	—	2,255	—	1990, I [1966, Atlas Centaur]
	1. Atlas MA-5	LOX/RP-1	1,952.0 (SL)	3.05x22.16				
	2. Centaur I: RL10A-3-3A (2)	LOX/LH <sub>2</sub>	73.4/ engine	3.05x9.14				
Atlas II				4.2x47.5	6,580 5,510 <sup>f</sup>	2,810	4,300	1991, II [1966, Atlas Centaur]
	1. Atlas MA-5A	LOX/RP-1	2,110.0 (SL)	3.05x24.9				
	2. Centaur II: RL10A-3-3A (2)	LOX/LH <sub>2</sub>	73.4/engine	3.05x10.05				
Atlas IIA				4.2x47.5	6,828 6,170 <sup>f</sup>	3,062	4,750	1992, Atlas IIA [1966, Atlas Centaur]
	1. Atlas MA-5A	LOX/RP-1	2,110.0 (SL)	3.05x24.9				
	2. Centaur II: RL10A-4 (2)	LOX/LH <sub>2</sub>	92.53/engine	3.05x10.05				
Atlas IIAS				4.2x47.5	8,640 7,300 <sup>f</sup>	3,606	5,800	1993, IIAS [1966, Atlas Centaur]
	1. Atlas MA-5A Castor IVA (4) <sup>j</sup>	LOX/RP-1 Solid	2,110.0 (SL) 433.6 (SL)	3.05x24.9 1.01x11.16				
	2. Centaur II: RL10A-4 (2)	LOX/LH <sub>2</sub>	92.53/engine	3.05x10.05				



## APPENDIX D

(Continued)

## U.S. Space Launch Vehicles

Vehicle	Stages: Engine/Motor	Propellant <sup>a</sup>	Thrust (kilonewtons) <sup>b, c</sup>	Max. Dia x Height (m)	Max. Payload (kg) <sup>d</sup>			First Launch <sup>f</sup>
					185-km Orbit	Geosynch. Transfer Orbit	Sun- Synch. Orbit <sup>e</sup>	
Titan II					1,905 <sup>c</sup>	—	—	1988, Titan II SLV [1964, Titan II Gemini]
1.	LR-87-AJ-5 (2)	N204/A-50	1,045.0	3.05x42.9				
2.	LR-91-AJ-5	N204/A-50	440.0	3.05x21.5				
Titan III					14,515	5,000 <sup>l</sup>	—	1989, Titan III [1964, Titan IIIA]
0.	Titan III SRM (2) (5-1/2 segments)	Solid	6,210.0	3.05x47.3 3.11x27.6				
1.	LR87-AJ-11 (2)	N204/A-50	1,214.5	3.05x24.0				
2.	LR91-AJ-11	N204/A-50	462.8	3.05x10.0				
Titan IV					17,700 14,110 <sup>f</sup>	6,350 <sup>m</sup>	—	1989, Titan IV
0.	Titan IV SRM (2) (7 segments)	Solid	7,000.0	3.05x62.2 3.11x34.1				
1.	LR87-AJ-11 (2)	N204/A-50	1,214.5	3.05x26.4				
2.	LR91-AJ-11	N204/A-50	462.8	3.05x10.0				
Titan IV/ Centaur					—	5,760 <sup>a</sup>	—	1994, Titan IV Centaur
0.	Titan IV SRM (2) (7 segments)	Solid	7,000.0	4.3x62.2 3.11x34.1				
1.	LR87-AJ-11 (2)	N204/A-50	1,214.5/engine	3.05x26.4				
2.	LR91-AJ-11(1)	N204/A-50	462.5	3.05x10.0				
3.	Centaur: RL-10A-3-3A	LOX/LH <sub>2</sub>	73.4	4.3x9.0				
4.	SRMU (3 segments)		7690	3.3x34.3				
Space Shuttle <sup>n</sup>					24,900 <sup>o</sup>	5,900 <sup>p</sup>	—	1981, Columbia
1.	SRB: Shuttle SRB (2)	Solid	11,790.0 (SL)	23.79x56.14 <sup>h</sup> 3.70x45.46				
2.	Orbiter/ET: SSME (3)	LOX/LH <sub>2</sub>	1,668.7 (SL)	8.41x47.00 (ET) 23.79x37.24 <sup>h</sup> (orbiter)				
3.	Orbiter/OMS: OMS engines (2)	N <sub>2</sub> O <sub>4</sub> /MMH	26.7	23.79x37.24 <sup>h</sup>				
Delta III					8,292	3,810	6,768	1998 <sup>g</sup>
1.	RS-27A Alliant GEM (9)	LOX/RP-1 Solid	1,043.0 (SL) 608.8	4x39.1 1.16x14.7				
2.	RL-10B-2	LOX/LH <sub>2</sub>	110	4x8.8				
3.	Star 48B	Solid	66.4	1.25x2.04				

APPENDIX D  
(Continued)  
**U.S. Space Launch Vehicles**

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## NOTES:

- a. Propellant abbreviations used are as follows:
  - A-50 = Aerozine 50 (50% Monomethyl Hydrazine, 50% Unsymmetrical Dimethyl Hydrazine)
  - RP-1 = Rocket Propellant 1 (kerosene)
  - Solid = Solid Propellant (any type)
  - LH<sub>2</sub> = Liquid Hydrogen
  - LOX = Liquid Oxygen
  - MMH = Monomethyl Hydrazine
  - N<sub>2</sub>O<sub>4</sub> = Nitrogen Tetroxide
- b. Thrust at vacuum except where indicated at sea level (SL).
- c. Thrust per engine. Multiply by number of engines for thrust per stage.
- d. Inclination of 28.5° except where indicated.
- e. Polar launch from Vandenberg AFB, CA.
- f. First successful orbital launch [ditto of initial version].
- g. First launch was a failure
- h. Diameter dimension represents vehicle wing span.

**NOTE: Data should not be used for detailed NASA mission planning without concurrence of the Director of Space Transportation System Support Programs.**

## APPENDIX E-1A

## Space Activities of the U.S. Government

HISTORICAL BUDGET SUMMARY—BUDGET AUTHORITY  
(in millions of real-year dollars)

FY	NASA Total	NASA Space <sup>b</sup>	DoD	Other <sup>c</sup>	DoE	DoC	DoI	USDA	NSF <sup>a</sup>	DoT	EPA <sup>d</sup>	Total Space
1959	331	261	490	34	34							785
1960	524	462	561	43	43				0.1			1,066
1961	964	926	814	69	68				1			1,809
1962	1,825	1,797	1,298	200	148	51			1			3,295
1963	3,673	3,626	1,550	259	214	43			2			5,435
1964	5,100	5,016	1,599	216	210	3			3			6,831
1965	5,250	5,138	1,574	244	229	12			3			6,956
1966	5,175	5,065	1,689	217	187	27			3			6,971
1967	4,966	4,830	1,664	216	184	29			3			6,710
1968	4,587	4,430	1,922	177	145	28	0.2	1	3			6,529
1969	3,991	3,822	2,013	141	118	20	0.2	1	2			5,976
1970	3,746	3,547	1,678	115	103	8	1	1	2			5,340
1971	3,311	3,101	1,512	127	95	27	2	1	2			4,740
1972	3,307	3,071	1,407	97	55	31	6	2	3			4,575
1973	3,406	3,093	1,623	109	54	40	10	2	3			4,825
1974	3,037	2,759	1,766	116	42	60	9	3	2			4,641
1975	3,229	2,915	1,892	106	30	64	8	2	2			4,913
1976	3,550	3,225	1,983	111	23	72	10	4	2			5,319
TQ*	932	849	460	32	5	22	3	1	1			1,341
1977	3,818	3,440	2,412	131	22	91	10	6	2			5,983
1978	4,060	3,623	2,738	157	34	103	10	8	2			6,518
1979	4,596	4,030	3,036	177	59	98	10	8	2			7,243
1980	5,240	4,680	3,848	233	40	93	12	14	74			8,761
1981	5,518	4,992	4,828	233	41	87	12	16	77			10,053
1982	6,044	5,528	6,679	311	61	145	12	15	78			12,518
1983	6,875	6,328	9,019	325	39	178	5	20	83			15,672
1984	7,458	6,858	10,195	392	34	236	3	19	100			17,445
1985	7,573	6,925	12,768	580	34	423	2	15	106			20,273
1986	7,807	7,165	14,126	473	35	309	2	23	104			21,764
1987	10,923	9,809	16,287	462	48	278	8	19	108	1		26,558
1988	9,062	8,322	17,679	737	241	352	14	18	111	1		26,738
1989	10,969	10,097	17,906	560	97	301	17	21	116	3	5	28,563
1990	12,324	11,460	15,616	512	79	243	31	25	125	4	5	27,588
1991	14,016	13,046	14,181	697	251	251	29	26	131	4	5	27,924
1992	14,317	13,199	15,023	769	223	327	34	29	145	4	7	28,991
1993	14,310	13,064	14,106	698	165	324	33	25	139	4	8	27,868
1994	14,570	13,022	13,166	601	74	312	31	31	140	5	8	26,789
1995	13,854	12,543	10,644	629	60	352	31	32	141	6	7	23,816
1996	13,884	12,569	11,514	750	46	472	36	37	147	6	6	24,833
1997	13,709	12,457	11,727	727	35	448	42	39	152	6	6	24,912
1998	13,648	12,321	12,359	768	63	456	43	42	152	6	6	25,448

\* Transition Quarter

a. NSF has recalculated its space expenditures since 1980, making them significantly higher than reported in previous years.

b. Includes \$2.1 billion for replacement of Space Shuttle *Challenger*.

c. "Other" column is the total of the non-NASA, non-DoD budget authority figures that appear in succeeding columns. The total is sometimes different from the sum of the individual figures because of rounding. The "Total Space" column does not include the "NASA Total" column because it includes budget authority for aeronautics as well as in space.

d. EPA has recalculated its aeronautics and space expenditures since 1989, making them significantly higher than reported in previous years.

SOURCE: Office of Management and Budget

## Space Activities of the U.S. Government

BUDGET AUTHORITY IN MILLIONS OF EQUIVALENT FY 1998 DOLLARS  
(adjusted for inflation)

FY	Inflation Factors	NASA Total	NASA Space	DoD	Other	DoE	DoC	DoI	USDA	NSF	DoT	EPA	Total Space
1959	4.8506	1,606	1,266	2,377	165	165							3,808
1960	4.7579	2,493	2,198	2,669	205	205				0.5			5,072
1961	4.7149	4,545	4,366	3,838	325	321				5			8,529
1962	4.6469	8,481	8,350	6,032	929	688	237			5			15,311
1963	4.5942	16,875	16,659	7,121	1,190	983	198			9			24,970
1964	4.5409	23,159	22,777	7,261	981	954	14			14			31,019
1965	4.4796	23,518	23,016	7,051	1,093	1,026	54			13			31,160
1966	4.4057	22,800	22,315	7,441	956	824	119			13			30,712
1967	4.3070	21,388	20,803	7,167	930	792	125			13			28,900
1968	4.1756	19,154	18,498	8,026	740	605	117	0.8	4	13			27,263
1969	4.0223	16,053	15,373	8,097	568	475	80	0.8	4	8			24,038
1970	3.8525	14,431	13,665	6,464	443	397	31	4	4	8			20,572
1971	3.6594	12,116	11,348	5,533	465	348	99	7	4	7			17,346
1972	3.4803	11,510	10,688	4,897	338	191	108	21	7	10			15,923
1973	3.3220	11,315	10,275	5,392	362	179	133	33	7	10			16,029
1974	3.1821	9,664	8,779	5,620	369	134	91	29	10	6			14,768
1975	2.9674	9,582	8,650	5,614	315	89	190	24	6	6			14,579
1976	2.6904	9,551	8,677	5,335	299	62	194	27	11	5			14,310
TQ	2.5092	2,339	2,130	1,154	80	13	55	8	3	3			3,365
1977	2.4307	9,280	8,362	5,863	318	53	221	24	15	5			14,543
1978	2.3318	9,467	8,448	6,385	366	79	240	23	19	5			15,199
1979	2.1783	10,012	8,779	6,613	386	129	213	22	17	4			15,778
1980	2.0119	10,542	9,416	7,742	469	80	187	24	28	149			17,626
1981	1.8476	10,195	9,223	8,920	430	76	161	22	30	142			18,574
1982	1.6819	10,166	9,298	11,234	523	103	244	20	25	131			21,054
1983	1.5709	10,800	9,941	14,168	511	61	280	8	31	130			24,620
1984	1.5016	11,199	10,298	15,309	589	51	354	5	29	150			26,195
1985	1.4513	10,990	10,050	18,530	842	49	614	3	22	154			29,422
1986	1.4029	10,953	10,052	19,818	664	49	434	3	32	146			30,533
1987	1.3641	14,900	13,381	22,217	630	65	379	11	26	147	1		36,228
1988	1.3258	12,014	11,033	23,439	977	320	467	19	24	147	1		35,449
1989	1.2813	14,055	12,937	22,943	718	124	386	22	27	149	4	6	36,598
1990	1.2293	15,150	14,088	19,197	629	97	299	38	31	154	5	6	33,914
1991	1.1803	16,544	15,399	16,738	823	296	296	34	31	155	5	6	32,960
1992	1.1317	16,203	14,938	17,002	870	252	370	38	33	164	5	8	32,810
1993	1.1026	15,779	14,405	15,554	770	182	357	36	28	153	4	9	30,728
1994	1.0766	15,686	14,020	14,175	647	80	336	33	33	151	5	9	28,841
1995	1.0513	14,565	13,187	11,190	661	63	370	33	34	148	6	7	25,038
1996	1.0311	14,316	12,960	11,872	773	47	487	37	38	152	6	6	25,605
1997	1.0120	13,874	12,607	11,868	737	35	453	43	39	154	6	6	25,211
1998	1.0000	13,648	12,321	12,359	768	63	456	43	42	152	6	6	25,448

SOURCE: Office of Management and Budget

## APPENDIX E-2

## Federal Space Activities Budget

(in millions of dollars by fiscal year)

Federal Agencies	Budget Authority			Budget Outlays		
	1996 actual	1997 actual	1998 est.	1996 actual	1997 actual	1998 est.
NASA .....	12,569	12,457	12,321	12,694	13,055	12,866
Defense .....	11,514	11,727	12,359	11,353	11,959	12,230
Energy .....	46	35	63	46	37	60
Commerce .....	472	448	456	354	336	342
Interior .....	36	42	43	36	42	43
Agriculture .....	37	39	42	37	39	42
Transportation .....	6	6	6	6	6	6
EPA .....	6	6	6	7	6	6
NSF .....	147	151	152	142	146	147
TOTAL .....	24,833	24,911	25,448	24,675	25,626	25,832

SOURCE: Office of Management and Budget.

## Federal Aeronautics Budget

(in millions of dollars by fiscal year)

Federal Agencies	Budget Authority			Budget Outlays		
	1996 actual	1997 actual	1998 est.	1996 actual	1997 actual	1998 est.
NASA <sup>a</sup> .....	1,315	1,252	1,327	1,187	1,302	1,339
Defense <sup>b</sup> .....	6,792	6,323	6,184	6,974	6,600	6,318
Transportation <sup>c</sup> .....	2,052	2,146	2,099	2,676	2,528	2,429
TOTAL .....	10,159	9,721	9,610	10,837	10,430	10,086

a. Research, Development, Construction of Facilities, Research and Program Management

b. Research, Development, Testing, and Evaluation of aircraft and related equipment.

c. Federal Aviation Administration: Research, Engineering, and Development; Facilities, Engineering, and Development

SOURCE: Office of Management and Budget.