

Significant Incidents and Close Calls in Human Spaceflight: EVA Operations

KEY

Loss of Crew	0	0
+ Crew Injury	13	4
Early Termination	13	4

TOP INCIDENT CATEGORIES

System Issues	70
Operations	50
Inadvertent Releases	40

358 total spacewalks through July 12, 2011.
127 (36%) have experienced significant incidents.

EVA Inadvertent Releases:

Mission ID / EVA / # lost / year	Mission ID / EVA / # lost / year
ISS-28 / 1 / 1 / 2011	ISS-12 / US 4 / 1 / 2005
STS-134/ULF6 / 2 / 4 / 2011	ISS-11 / RS 13 / 1 / 2005
STS-133/ULF5 / 1 / 1 / 2011	ISS-4 / RS 6 / 1 / 2002
ISS-26 / RS 27 / 1 / 2011	STS-102/5A.1 / 1 / 2 / 2001
ISS-25 / RS 26 / 1 / 2010	STS-104/7A / 3 / 1 / 2001
ISS-24 / RS 25 / 4 / 2010	STS-100/6A / 2 / 1 / 2001
STS-126/ULF2 / 1 / 24 / 2008	STS-92/3A / 3 / 1 / 2000
STS-124/1J / 2 / 1 / 2008	STS-101/2A.2a / 1 / 1 / 2000
ISS-16 / US 14 / 1 / 2008	STS-103/HST / 3 / 1 / 1999
ISS-16 / US 13 / 4 / 2007	STS-96/2A.1 / 1 / 1 / 1999
ISS-16 / US 11 / 1 / 2007	STS-88/2A / 2 / 3 / 1998
STS-120/10A / 4 / 2 / 2007	STS-88/2A / 1 / 4 / 1998
ISS-15 / RS 18 / 1 / 2007	Mir/PE-13 / 1 / 1 / 1993
ISS-14 / RS 17A / 3 / 2007	STS-51-A / 2 / 2 / 1984
STS-116/12A.1 / 3 / 1 / 2006	STS-51-A / 2 / 2 / 1984
STS-116/12A.1 / 1 / 1 / 2006	STS-41-G / 1 / 1 / 1984
STS-115/12A / 2 / 1 / 2006	STS-41-C / 2 / 1 / 1984
STS-115/12A / 1 / 1 / 2006	Salyut 7 / 1 / 1 / 1983
STS-121/ULF1.1 / 3 / 1 / 2006	Gemini 10 / 1 / 1 / 1966
ISS-13 / RS 16 / 1 / 2006	Gemini 4 / 1 / 1 / 1965

- Voskhod 2, 3/18/1965**
 - Suit ballooning impeded operations and made airlock ingress difficult.
 - Workload exceeded cooling capacity.
- Gemini 4, 6/3/1965**
 - Difficulty closing hatch after EVA.
 - Workload exceeded cooling capacity.
- Gemini 9, 6/5/1966**
 - Difficulty maneuvering.
 - Multiple areas of suit damage.
 - Workload exceeded cooling capacity.
- + Gemini 10, 7/19/1966**
 - EVA terminated due to eye irritations from LiOH being blown into helmets when suit fans were run simultaneously.
- Gemini 10, 7/20/1966**
 - Difficulty maneuvering.
 - Umbilical blocked view of instruments and caused inadvertent shutdown of Gemini radio.
- Gemini 11, EVA 1, 9/13/1966**
 - EVA terminated due to fatigue.
 - Workload exceeded cooling capacity.
- Apollo 11, EVA 1, 7/20/1969**
 - Some difficulty passing through LEM hatch.
- Apollo 12, EVA 2, 11/20/1969**
 - Lunar dust abraded EMU.
 - Lunar dust caused breathing difficulties post-EVA.

- Apollo 14, EVA 2, 2/6/1971**
 - EMU wrist cable broke on one of the gloves.
- Apollo 15, EVA 2, 7/31/1971**
 - Drink bag would not dispense water.
 - Rover front wheel steering failed.
 - Dust made EMU fittings difficult to operate.
 - Hand pain from gloves pressing against fingernails.
- Apollo 15, EVA 3, 8/1/1971**
 - Radio antenna broke - taped back in place.
 - Difficulty navigating back to LEM.
- Apollo 16, EVA 1, 4/21/1972**
 - Suit ingress problems due to spinal elongation during spaceflight.
 - Lunar dust problems (jammed connectors, accelerated wear, scratches).
 - Tripped over cable to heat-flow sensors.
- Apollo 16, EVA 2, 4/22/1972**
 - Broke EMU radio antenna.
- Apollo 16, EVA 3, 4/23/1972**
 - Temporary LRV navigation failure.
- + Apollo 17, EVA 1, 12/11/1972**
 - Minor contusions from extracting stuck core sample.
 - Broke off one LRV fender which resulted in crew getting showered by dust while driving.
- Skylab 3, EVA 3, 9/22/1973**
 - Water cooling system failed.
- Skylab 4, EVA 1, 11/22/1973**
 - Difficulty keeping umbilicals separated.
- Skylab 4, EVA 2, 12/25/1973**
 - Cooling water leak resulted in ice forming on pressure control unit. EVA continued.
- Skylab 4, EVA 3, 12/29/1973**
 - Cooling water leak resulted in ice forming on pressure control unit. EVA continued.
- Skylab 4, EVA 4, 2/3/1974**
 - Cooling water leak resulted in ice forming on pressure control unit. Cooling flow turned off.
- Salyut 6 PE-1, EVA 1, 12/20/1977**
 - Safety tether not secured, but umbilical in place.
- Salyut 6 PE-3, EVA 1, 8/15/1979**
 - Primary pressure bladder punctured.

- + Salyut 7 PE-1, EVA 1, 7/30/1982**
 - Tool use resulted in wrist ring pressing on wrist and numbing hand.
- STS-5, EVA 1, 11/1982**
 - EVA no-go due to failed fan.
- STS-6, EVA 1, 4/7/1983**
 - Difficulty retracting payload bay winch.
- STS-41-B, EVA 1, 2/7/1984**
 - Slidewire bracket pip-pin pulled free.
- STS-41-B, EVA 2, 2/9/1984**
 - Crew had to retrieve a foot restraint that came loose.
- STS-41-C, EVA 1, 4/8/1984**
 - Hardware configuration difference prevented EVA crew member from capturing satellite. Efforts resulted in satellite losing sun-lock and tumbling.
 - Low temperature of MMU led to false low-nitrogen reading.
- STS-41-C, EVA 2, 4/11/1984**
 - EMU urine containment failure.
 - EMU helmet fogging.
 - Small trash bag lost due to inadvertent release of MWS lock.
- + Salyut 7 VE-3, EVA 6, 8/8/1984**
 - One spacesuit experienced a failure of the cooling water pump.
 - Physician reported the hands of the EVA crew were injured.
- STS-51-A, EVA 1, 11/12/1984**
 - Gloves abraded by knurled tool handle.
 - Capture tool failed to work due to satellite configuration differing from drawings.
- STS-51-D, EVA 1, 4/16/1985**
 - EVA crew became cold, especially the hands, during night pass.
- STS-51-I, EVA 2, 9/1/1985**
 - EVA crew complained of being cold, especially the hands. Shutting off cooling water flow to warm up resulted in the visor fogging up.
 - Difficulty in handling satellite due to lack of sight/visual cues between EVA astronauts.
 - Accidentally reused LiOH canisters from first EVA.
- STS-61-B, EVA 1, 11/29/1985**
 - Glove-induced fatigue severe enough to force redesign.
 - Crew-induced loads contributed to redesign of Hard Upper Torso.
- STS-61-B, EVA 2, 12/1/1985**
 - Glove-induced fatigue severe enough to force redesign.
 - Crew-induced loads contributed to redesign of Hard Upper Torso.
- Mir, PE-2, EVA 1, 4/11/1987**
 - Incorrect switch setting resulted in temporary suit pressure decrease.
- Mir, PE-3, EVA 2, 6/30/1988**
 - High in-suit humidity resulted in false "ventilation low."
- Mir, PE-3/PE-4, EVA 4, 12/9/1988**
 - Cosmonaut kicked stubborn hardware to get it to deploy.

- Mir, PE-6, EVA 1, 7/17/1990**
 - Airlock hatch damaged, prevented closure. Backup airlock used.
- Mir, PE-8, EVA 3, 1/26/1991**
 - Inadvertent kick knocked Kurs antenna off. Not noticed until subsequent EVA.
- STS-37, 4/1991**
 - Glove damage discovered postflight. It is unknown on which EVA it occurred.
- STS-37, EVA 1, 4/7/1991**
 - Palm bar punctured glove and caused minor contusion.
 - Eye irritation in one crew member.
- STS-37, EVA 2, 4/8/1991**
 - Recommended against EVAs on consecutive days due to fatigue and time constraints.
- Mir, PE-8, EVA 4, 4/25/1991**
 - Cosmonaut separates from EVA partner when inspecting the Kurs antenna.
- Mir, PE-9, EVA 3, 7/15/1991**
 - Heavy air leakage through abrasions on glove.
- + Mir, PE-9, EVA 6, 7/27/1991**
 - Heat exchanger of one Orlan ran out of water, resulting in helmet fogging. Other cosmonaut guided crew member back.
 - Crew member had bruises on hands, elbows, and shoulders.
- Mir, PE-10, EVA 1, 2/20/1992**
 - Heat exchanger of one Orlan failed to work, requiring use of umbilical for cooling - limited translation range.
 - Crew member conducted portions of EVA alone.
- STS-49, EVA 1, 5/10/1992**
 - Failed attempt to capture Intelsat VI.
- STS-49, EVA 2, 5/11/1992**
 - Failed attempt to capture Intelsat VI.
- Mir, PE-13, EVA 1, 4/19/1993**
 - Orlan ventilation problems.
- STS-57, EVA 1, 6/25/1993**
 - Cold to point of experiencing hand pain.
 - Almost lost untethered piece of IUS tilt table equipment.
- Mir, PE-14, EVA 3, 9/28/1993**
 - EVA terminated due to Orlan cooling system fault.
- Mir, PE-14, EVA 4, 10/22/1993**
 - EVA terminated due to Orlan oxygen flow system fault.
- STS-61, EVA 2, 12/5/1993**
 - One EV experienced radio problems.
- STS-63, EVA 1, 2/9/1995**
 - EVA terminated when EV became "unacceptably cold."
 - One EV experienced eye irritation, likely from antifogging agent.
- STS-72, EVA 2, 1/17/1996**
 - Hand fatigue from testing of hose clamps.
- STS-80, EVA 1, 11/29/1996**
 - EVA terminated - loose screw jammed airlock hatch, preventing operation.
- Mir, PE-22, EVA 1, 12/2/1996**
 - Knocked antenna cable loose.
- STS-86, EVA 1, 10/1/1997**
 - SAFER pyro failed to fire during DTO. (Crew member in foot restraint.) Anomaly not discovered until post-flight (ground) checkout.
- STS-87, EVA 1 or 2, 11/25 or 12/3/1998**
 - First EVA cut glove. Discovered post-flight. Start of EVA sharp-edged effort.
- STS-88/2A, EVA 3, 12/12/1998**
 - SAFER flight DTO terminated due to erratic GN2 indication. EV1 flew safely to handrail.
- STS-96/2A.1, EVA, 5/27 - 6/6/1999**
 - SAFER NSI (pyro) inadvertently fired on orbit, resulting in pyrotechnic isolation valve opening and loss of GN2. Condition identified post-landing.

- STS-97/4A, EVA 1, 12/3/2000**
 - Crew member experienced eye irritation. Suspect anti-fog agent used in helmet.
- STS-98/5A, EVA 1, 2/10/2001**
 - EV2 sprayed with ammonia requiring decontamination procedure (aka "bakeout").
- STS-100/6A, EVAs 1&2, 4/22 & 4/24/2001**
 - EV1 experienced eye irritation in both eyes. Attributed to leaking in-suit drink bag and anti-fog agent used in helmet.
- ISS-9, EVA 1 (1st attempt), 5/19/2004**
 - EVA canceled due to EMU cooling loop contamination, resulting in temporary loss of ISS US EVA capability.
- ISS-9, EVA 1, 6/24/2004**
 - EVA terminated due to mis-configured valve depleting Orlan O2 supply at start of EVA.
- ISS-9, EVA 3, 8/3/2004**
 - CMGs saturated while crew was EVA. ISS went into free drift. No IVA crew.
- STS-121/ULF1.1, EVA 2, 7/10/2006**
 - EV1's SAFER left tower latch was bumped into the unlatched position, resulting in the left tower disengaging from the EMU. EVA was suspended until latch could be re-engaged by EV2.
- STS-121/ULF1.1, EVA 3, 7/12/2006**
 - EMU "boot bubble" noticed post-EVA. Likely a manufacturing defect. Backup boot was available.
- ISS-13, EVA 2, 8/3/2006**
 - SAFER hand controller inadvertently deployed in airlock. Re-latched successfully.
- STS-116/12A.1, EVA 1, 12/12/2006**
 - EV1's SAFER HCM inadvertently deployed during airlock egress. EV2 re-stowed HCM on second attempt. SAFER NSI (pyro) accidentally fired.
 - Glove damage discovered postflight (EVA unknown).
- STS-118/13A.1, EVA 3, 8/15/2007**
 - EVA terminated due to cut glove.
- STS-118/13A.1, EVA 4, 8/18/2007**
 - EV2's SAFER HCM inadvertently deployed during airlock egress. EV3 re-stowed HCM.
- STS-120/10A, EVA 1, 10/28/2007**
 - One glove damaged, unusable after EVA.
- STS-120/10A, EVA 3, 10/30/2007**
 - One EMU unusable after EVA due to degraded sublimator.
 - One glove unusable after EVA due to thermal garment damage.
- STS-122/1E, 2/2008**
 - Glove damage discovered postflight. It is unknown on which EVA it occurred.
- STS-123/1JA, EVA 2, 3/15/2008**
 - RTV debonded from thumb on both of EV3's gloves. Switched to backup gloves.
- ISS-17, EVA 1, 7/10/2008**
 - Jettisoned Soyuz thruster cover collided with US radiator.
- STS-126/ULF2, EVA 2, 11/20/2008**
 - One EV experienced high CO2 levels. EVA terminated early.
- STS-126/ULF2, EVA 4, 11/24/2008**
 - One EV experienced high CO2 levels. EVA terminated early.
- ISS-18, EVA 2, 3/10/2009**
 - EVs working close to rotating port Service Module solar array. Solar arrays should have been parked for EVA.
- STS-119/15A, EVA 3, 3/23/2009**
 - Suit CO2 sensor failed.
 - Two occurrences of SAFER HCM deployment slider bumped partially up, resulting in HCM door partially opening, with no HCM deployment.
- STS-125/HST, EVA 4, 5/17/2009**
 - Tear in palm of EMU glove noticed when EVA was near completion. EVA terminated.
- STS-127/2JA, EVA 3, 7/22/2009**
 - One EV experienced high CO2 levels. EVA terminated early.
- STS-128/17A, EVA 3, 9/5/2009**
 - EMU camera and light detached from helmet, but held captive by electrical cable.
- STS-129/ULF3, EVA 3, 11/23/2009**
 - SAFER HCM deployment slider bumped partially up, resulting in HCM door partially opening, with no HCM deployment.
- STS-130/20A, EVA 1, 2/11/2010**
 - EV2 observed large water droplets in helmet and water at feet.
- STS-130/20A, EVA 2, 2/14/2010**
 - EV2 exposed to ammonia from leaking quick-disconnect.
- STS-130/20A, EVA 3, 2/17/2010**
 - EV1 observed large water droplets in helmet.
- ISS-24, EVA 2, 8/7/2010**
 - EV1 exposed to ammonia from leaking quick-disconnect, and experienced difficulty actuating quick-disconnect.
- ISS-24, EVA 3, 8/11/2010**
 - EV1 exposed to ammonia from leaking quick-disconnect, and experienced difficulty actuating quick-disconnect.
- STS-134/ULF6, EVA 1, 5/20/2011**
 - CO2 sensor failure resulted in reduced EVA timeline.
- + STS-134/ULF6, EVA 3, 5/25/2011**
 - One EV experienced eye irritation, likely from anti-fogging agent.

1960s: 25 hrs

# of EVAs	Hours
US 16	24
Russia -2	-1
Total 18	25

1970s: 121 hrs

# of EVAs	Hours
US 29	116
Russia -3	-5
Total 32	121

1980s: 145 hrs

# of EVAs	Hours
US 14	69
Russia -20	-77
Total 34	145

1990s: 557 hrs

# of EVAs	Hours
US 36	231
Russia 70	326
Total 106	557

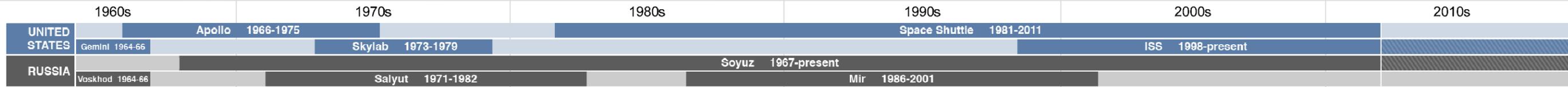
2000s: 900 hrs

# of EVAs	Hours
US 113	756
Russia 30	144
China -1	-25
Total 144	900

Cumulative Russian Hours: 581 (through July, 12 2011)

2010s: 161 hrs

# of EVAs	Hours
US 19	131
Russia -5	-30
Total 24	161



The JSC Flight Safety Office maintains the *Significant Incidents and Close Calls in Human Spaceflight: EVA Operations* graphic to provide continuing visibility of the risks inherent with space exploration and to provide engineers with a summary of past experience. It is hoped this information will be used to learn from the past to make present and future missions safer.

The chart focuses solely on incidents during EVA operations on orbit and on the lunar surface. Incidents on the chart resulted in or had a high likelihood for injury or death, loss of mission, or had significant relevance to future events. The information is presented using a timeline format, by decade. The number of EVA hours per decade and the cumulative hours for US and Russian programs are included to provide context and as a broad indication of the failure rate.

The metrics in the legend show the frequency of early termination and crew injury. Also shown are the most frequent types of incidents which have occurred and the percentage of EVAs which have experienced these incidents. Of a total of 358 EVAs, 127 (36%) have experienced some type of significant incident.

Note: This document is a work in progress. It is continually under review and frequently updated. Please direct comments and questions to the JSC Flight Safety Office contacts listed below.

Significant Incidents and Close Calls in Human Spaceflight: EVA Operations

S&MA Flight Safety Office

Safety & Mission Assurance Support Services Contract
 Flight Safety Office Support Team
 Rapid Information Page

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Abbreviations and Acronyms					
CMG	Control Moment Gyroscope	JSC	Johnson Space Center	PFR	Portable Foot Restraint
CO₂	Carbon Dioxide	LEM	Lunar Excursion Module	PLSS	Primary Life Support System
DTO	Developmental Test Objective	LiOH	Lithium Hydroxide	RCC	Reinforced Carbon-Carbon
EMU	Extravehicular Mobility Unit	LRV	Lunar Roving Vehicle	RIP	Rapid Information Page
EV	EVA Crew Member	MMOD	Micro-Meteoroid Orbital Debris	RTV	Room Temperature Vulcanizing
EVA	Extravehicular Activity	MMU	Manned Maneuvering Unit	S&MA	Safety & Mission Assurance
GN₂	Gaseous Nitrogen	MWS	Mini-Workstation	SAFER	Simplified Aid for EVA Rescue
HCM	Hand Control Module	NSI	NASA Standard Initiator	STS	Space Transportation System (aka Space Shuttle)
HST	Hubble Space Telescope	O₂	Oxygen	UF	Utilization Flight
IUS	Inertial Upper Stage	OSMA	Office of Safety & Mission Assurance (NASA HQ)	ULF	Utilization Logistics Flight
ISS	International Space Station	PAD	PFR Attachment Device	US	United States
IVA	Intravehicular Activity				

Rapid Information Pages (RIPs) are a product of the JSC S&MA Flight Safety Office (FSO) and the FSO Support Team. RIPs assemble and clarify best available data from multiple sources to help S&MA decision makers quickly develop a fully informed and holistic perspective of key factors involved in the risk-based decision process. For further information, please contact:

<p>Nigel Packham, Ph.D., NASA Manager, S&MA Flight Safety Office JSC Safety & Mission Assurance Directorate Email: nigel.packham-1@nasa.gov</p>	<p>Bill Wood, SAIC Manager, FSO Support Team Science Applications International Corp. Email: bill.m.wood@nasa.gov</p>	<p>Dennis Pate, SAIC Assessments Specialist, FSO Support Team Science Applications International Corp. Email: dennis.w.pate@nasa.gov</p>
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Graphic Design by Joanna Opaskar; Artwork by Faisal Ali; Additional review by Bill Stockton, David Salvador, David Bradt, Bob Bobola, Chrystal Hoelscher, Ashley Patterson

