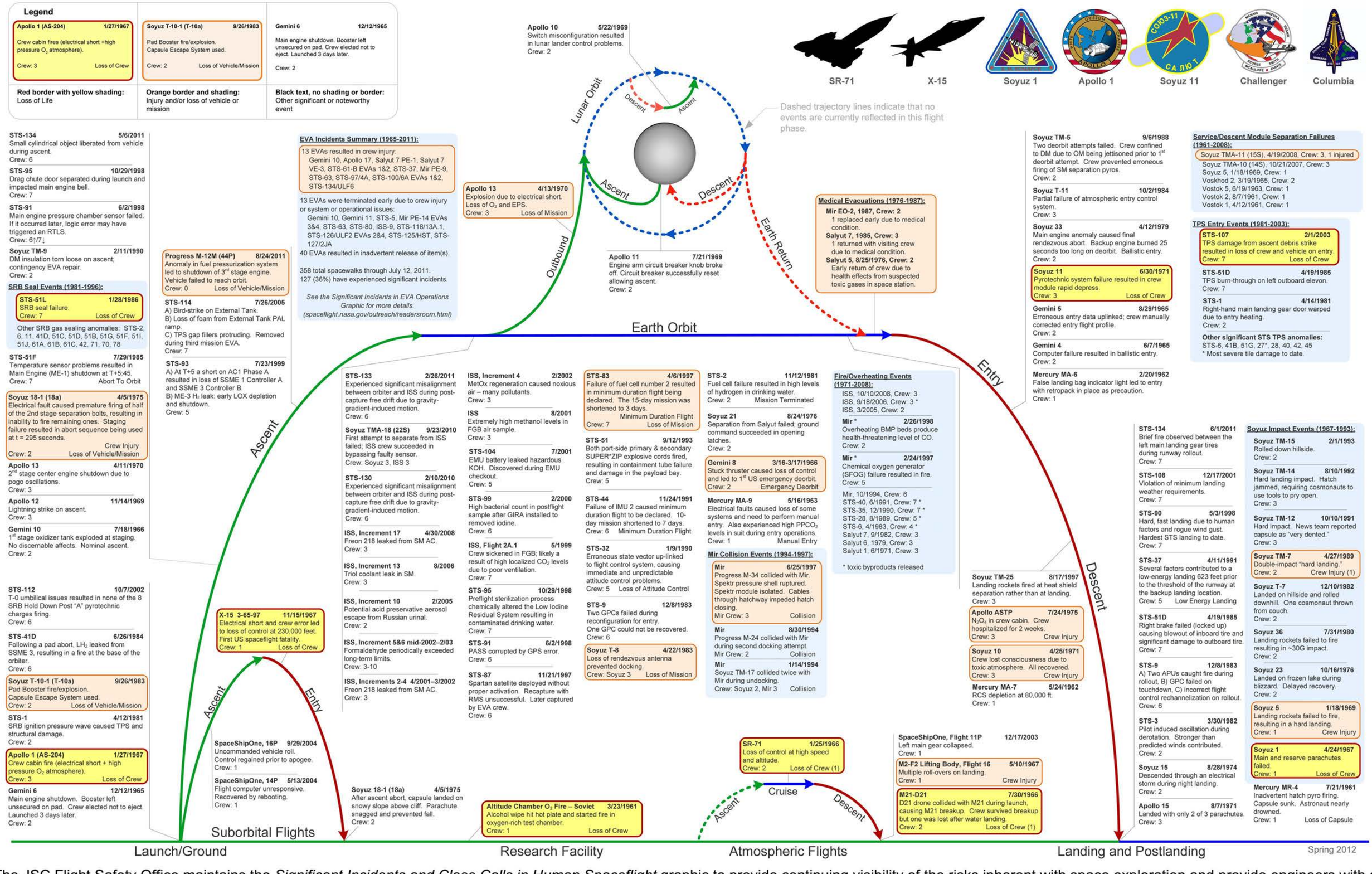
Legend

Red border with yellow shading: Loss of Life	Orange border and shading: Injury and/or loss of vehicle or mission	Black text, no shading or border: Other significant or noteworthy event
Apollo 1 (AS-204) 1/27/1967 Crew cabin fires (electrical short +high pressure O_2 atmosphere). Crew: 3 Loss of Crew	**Soyuz T-10-1 (T-10a) 9/26/1983** Pad Booster fire/explosion. Capsule Escape System used. Crew: 2 Loss of Vehicle/Mission	**Gemini 6 12/12/1965** Main engine shutdown. Booster left unsecured on pad. Crew elected not to eject. Launched 3 days later. Crew: 2



STS-134 5/6/2011
Small cylindrical object liberated from vehicle during ascent.
Crew: 6

STS-95 10/29/1998
Drag chute door separated during launch and impacted main engine bell.
Crew: 7

STS-91 6/2/1998
Main engine pressure chamber sensor failed. If it occurred later, logic error may have triggered an RTLS.
Crew: 6↑/7↓

Soyuz TM-9 2/11/1990
DM insulation torn loose on ascent; contingency EVA repair.
Crew: 2

SRB Seal Events (1981-1996):

STS-51L 1/28/1986
SRB seal failure.
Crew: 7 Loss of Crew

Other SRB gas sealing anomalies: STS-2, 6, 11, 41D, 51C, 51D, 51B, 51G, 51F, 51I, 51J, 61A, 61B, 61C, 42, 71, 70, 78

STS-51F 7/29/1985
Temperature sensor problems resulted in Main Engine (ME-1) shutdown at T+5:45.
Crew: 7 Abort To Orbit

Soyuz 18-1 (18a) 4/5/1975
Electrical fault caused premature firing of half of the 2nd stage separation bolts, resulting in inability to fire remaining ones. Staging failure resulted in abort sequence being used at t = 295 seconds.
Crew Injury
Crew: 2 Loss of Vehicle/Mission

Apollo 13 4/11/1970
2nd stage center engine shutdown due to pogo oscillations.
Crew: 3

Apollo 12 11/14/1969
Lightning strike on ascent.
Crew: 3

Gemini 10 7/18/1966
1st stage oxidizer tank exploded at staging. No discernable affects. Nominal ascent.
Crew: 2

STS-112 10/7/2002
T-0 umbilical issues resulted in none of the 8 SRB Hold Down Post "A" pyrotechnic charges firing.
Crew: 6

STS-41D 6/26/1984
Following a pad abort, LH_2 leaked from SSME 3, resulting in a fire at the base of the orbiter.
Crew: 6

Soyuz T-10-1 (T-10a) 9/26/1983
Pad Booster fire/explosion. Capsule Escape System used.
Crew: 2 Loss of Vehicle/Mission

STS-1 4/12/1981
SRB ignition pressure wave caused TPS and structural damage.
Crew: 2

Apollo 1 (AS-204) 1/27/1967
Crew cabin fire (electrical short + high pressure O_2 atmosphere).
Crew: 3 Loss of Crew

Gemini 6 12/12/1965
Main engine shutdown. Booster left unsecured on pad. Crew elected not to eject. Launched 3 days later.
Crew: 2

EVA Incidents Summary (1965-2011):

13 EVAs resulted in crew injury:
Gemini 10, Apollo 17, Salyut 7 PE-1, Salyut 7 VE-3, STS-61-B EVAs 1&2, STS-37, Mir PE-9, STS-63, STS-97/4A, STS-100/6A EVAs 1&2, STS-134/ULF6

13 EVAs were terminated early due to crew injury or system or operational issues:
Gemini 10, Gemini 11, STS-5, Mir PE-14 EVAs 3&4, STS-63, STS-80, ISS-9, STS-118/13A.1, STS-126/ULF2 EVAs 2&4, STS-125/HST, STS-127/2JA

40 EVAs resulted in inadvertent release of item(s).

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

See the Significant Incidents in EVA Operations Graphic for more details. (spaceflight.nasa.gov/outreach/readersroom.html)

Progress M-12M (44P) 8/24/2011
Anomaly in fuel pressurization system led to shutdown of 3rd stage engine. Vehicle failed to reach orbit.
Crew: 0 Loss of Vehicle/Mission

STS-114 7/26/2005
A) Bird-strike on External Tank.
B) Loss of foam from External Tank PAL ramp.
C) TPS gap fillers protruding. Removed during third mission EVA.
Crew: 7

STS-93 7/23/1999
A) At T+5 a short on AC1 Phase A resulted in loss of SSME 1 Controller A and SSME 3 Controller B.
B) ME-3 H_2 leak: early LOX depletion and shutdown.
Crew: 5

X-15 3-65-97 11/15/1967
Electrical short and crew error led to loss of control at 230,000 feet. First US spaceflight fatality.
Crew: 1 Loss of Crew

SpaceShipOne, 16P 9/29/2004
Uncommanded vehicle roll. Control regained prior to apogee.
Crew: 1

SpaceShipOne, 14P 5/13/2004
Flight computer unresponsive. Recovered by rebooting.
Crew: 1

Soyuz 18-1 (18a) 4/5/1975
After ascent abort, capsule landed on snowy slope above cliff. Parachute snagged and prevented fall.
Crew: 2

STS-133 2/26/2011
Experienced significant misalignment between orbiter and ISS during post-capture free drift due to gravity-gradient-induced motion.
Crew: 6

Soyuz TMA-18 (22S) 9/23/2010
First attempt to separate from ISS failed; ISS crew succeeded in bypassing faulty sensor.
Crew: Soyuz 3, ISS 3

STS-130 2/10/2010
Experienced significant misalignment between orbiter and ISS during post-capture free drift due to gravity-gradient-induced motion.
Crew: 6

ISS, Increment 17 4/30/2008
Freon 218 leaked from SM AC.
Crew: 3

ISS, Increment 13 8/2006
Triol coolant leak in SM.
Crew: 3

ISS, Increment 10 2/2005
Potential acid preservative aerosol escape from Russian urinal.
Crew: 2

ISS, Increment 5&6 mid-2002–2/03
Formaldehyde periodically exceeded long-term limits.
Crew: 3-10

ISS, Increments 2-4 4/2001–3/2002
Freon 218 leaked from SM AC.
Crew: 3

ISS, Increment 4 2/2002
MetOx regeneration caused noxious air – many pollutants.
Crew: 3

ISS 8/2001
Extremely high methanol levels in FGB air sample.
Crew: 3

STS-104 7/2001
EMU battery leaked hazardous KOH. Discovered during EMU checkout.
Crew: 5

STS-99 2/2000
High bacterial count in postflight sample after GIRA installed to removed iodine.
Crew: 6

ISS, Flight 2A.1 5/1999
Crew sickened in FGB; likely a result of high localized CO_2 levels due to poor ventilation.
Crew: 7

STS-95 10/29/1998
Preflight sterilization process chemically altered the Low Iodine Residual System resulting in contaminated drinking water.
Crew: 7

STS-91 6/2/1998
PASS corrupted by GPS error.
Crew: 6

STS-87 11/21/1997
Spartan satellite deployed without proper activation. Recapture with RMS unsuccessful. Later captured by EVA crew.
Crew: 6

STS-83 4/6/1997
Failure of fuel cell number 2 resulted in minimum duration flight being declared. The 15-day mission was shortened to 3 days.
Minimum Duration Flight
Crew: 7 Loss of Mission

STS-51 9/12/1993
Both port-side primary & secondary SUPER*ZIP explosive cords fired, resulting in containment tube failure and damage in the payload bay.
Crew: 5

STS-44 11/24/1991
Failure of IMU 2 caused minimum duration flight to be declared. 10-day mission shortened to 7 days.
Crew: 6 Minimum Duration Flight

STS-32 1/9/1990
Erroneous state vector up-linked to flight control system, causing immediate and unpredictable attitude control problems.
Crew: 5 Loss of Attitude Control

STS-9 12/8/1983
Two GPCs failed during reconfiguration for entry. One GPC could not be recovered.
Crew: 6

Soyuz T-8 4/22/1983
Loss of rendezvous antenna prevented docking.
Crew: Soyuz 3 Loss of Mission

Altitude Chamber O_2 Fire – Soviet 3/23/1961
Alcohol wipe hit hot plate and started fire in oxygen-rich test chamber.
Crew: 1 Loss of Crew

SR-71 1/25/1966
Loss of control at high speed and altitude.
Crew: 2 Loss of Crew (1)

STS-2 11/12/1981
Fuel cell failure resulted in high levels of hydrogen in drinking water.
Crew: 2 Mission Terminated

Soyuz 21 8/24/1976
Separation from Salyut failed; ground command succeeded in opening latches.
Crew: 2

Gemini 8 3/16-3/17/1966
Stuck thruster caused loss of control and led to 1st US emergency deorbit.
Crew: 2 Emergency Deorbit

Mercury MA-9 5/16/1963
Electrical faults caused loss of some systems and need to perform manual entry. Also experienced high $PPCO_2$ levels in suit during entry operations.
Crew: 1 Manual Entry

Mir Collision Events (1994-1997):

Mir 6/25/1997
Progress M-34 collided with Mir. Spektr pressure shell ruptured. Spektr module isolated. Cables through hatchway impeded hatch closing.
Mir Crew: 3 Collision

Mir 8/30/1994
Progress M-24 collided with Mir during second docking attempt.
Mir Crew: 2 Collision

Mir 1/14/1994
Soyuz TM-17 collided twice with Mir during undocking.
Crew: Soyuz 2, Mir 3 Collision

Medical Evacuations (1976-1987):

Mir EO-2, 1987, Crew: 2
1 replaced early due to medical condition.

Salyut 7, 1985, Crew: 3
1 returned with visiting crew due to medical condition.

Salyut 5, 8/25/1976, Crew: 2
Early return of crew due to health effects from suspected toxic gases in space station.

Fire/Overheating Events (1971-2008):

ISS, 10/10/2008, Crew: 3
ISS, 9/18/2006, Crew: 3 *
ISS, 3/2005, Crew: 2

Mir * 2/26/1998
Overheating BMP beds produce health-threatening level of CO.
Crew: 2

Mir * 2/24/1997
Chemical oxygen generator (SFOG) failure resulted in fire.
Crew: 5

Mir, 10/1994, Crew: 6
STS-40, 6/1991, Crew: 7 *
STS-35, 12/1990, Crew: 7 *
STS-28, 8/1989, Crew: 5 *
STS-6, 4/1983, Crew: 4 *
Salyut 7, 9/1982, Crew: 3
Salyut 6, 1979, Crew: 3
Salyut 1, 6/1971, Crew: 3

* toxic byproducts released

Soyuz TM-25 8/17/1997
Landing rockets fired at heat shield separation rather than at landing.
Crew: 3

Apollo ASTP 7/24/1975
N_2O_4 in crew cabin. Crew hospitalized for 2 weeks.
Crew: 3 Crew Injury

Soyuz 10 4/25/1971
Crew lost consciousness due to toxic atmosphere. All recovered.
Crew: 3 Crew Injury

Mercury MA-7 5/24/1962
RCS depletion at 80,000 ft.
Crew: 1

SpaceShipOne, Flight 11P 12/17/2003
Left main gear collapsed.
Crew: 1

M2-F2 Lifting Body, Flight 16 5/10/1967
Multiple roll-overs on landing.
Crew: 1 Crew Injury

M21-D21 7/30/1966
D21 drone collided with M21 during launch, causing M21 breakup. Crew survived breakup but one was lost after water landing.
Crew: 2 Loss of Crew (1)

Soyuz TM-5 9/6/1988
Two deorbit attempts failed. Crew confined to DM due to OM being jettisoned prior to 1st deorbit attempt. Crew prevented erroneous firing of SM separation pyros.
Crew: 2

Soyuz T-11 10/2/1984
Partial failure of atmospheric entry control system.
Crew: 3

Soyuz 33 4/12/1979
Main engine anomaly caused final rendezvous abort. Backup engine burned 25 seconds too long on deorbit. Ballistic entry.
Crew: 2

Soyuz 11 6/30/1971
Pyrotechnic system failure resulted in crew module rapid depress.
Crew: 3 Loss of Crew

Gemini 5 8/29/1965
Erroneous entry data uplinked; crew manually corrected entry flight profile.
Crew: 2

Gemini 4 6/7/1965
Computer failure resulted in ballistic entry.
Crew: 2

Mercury MA-6 2/20/1962
False landing bag indicator light led to entry with retropack in place as precaution.
Crew: 1

Service/Descent Module Separation Failures (1961-2008):

Soyuz TMA-11 (15S), 4/19/2008, Crew: 3, 1 injured
Soyuz TMA-10 (14S), 10/21/2007, Crew: 3
Soyuz 5, 1/18/1969, Crew: 1
Voskhod 2, 3/19/1965, Crew: 2
Vostok 5, 6/19/1963, Crew: 1
Vostok 2, 8/7/1961, Crew: 1
Vostok 1, 4/12/1961, Crew: 1

TPS Entry Events (1981-2003):

STS-107 2/1/2003
TPS damage from ascent debris strike resulted in loss of crew and vehicle on entry.
Crew: 7 Loss of Crew

STS-51D 4/19/1985
TPS burn-through on left outboard elevon.
Crew: 7

STS-1 4/14/1981
Right-hand main landing gear door warped due to entry heating.
Crew: 2

Other significant STS TPS anomalies:
STS-6, 41B, 51G, 27*, 28, 40, 42, 45
* Most severe tile damage to date.

STS-134 6/1/2011
Brief fire observed between the left main landing gear tires during runway rollout.
Crew: 7

STS-108 12/17/2001
Violation of minimum landing weather requirements.
Crew: 7

STS-90 5/3/1998
Hard, fast landing due to human factors and rogue wind gust. Hardest STS landing to date.
Crew: 7

STS-37 4/11/1991
Several factors contributed to a low-energy landing 623 feet prior to the threshold of the runway at the backup landing location.
Crew: 5 Low Energy Landing

STS-51D 4/19/1985
Right brake failed (locked up) causing blowout of inboard tire and significant damage to outboard tire.
Crew: 7

STS-9 12/8/1983
A) Two APUs caught fire during rollout, B) GPC failed on touchdown, C) incorrect flight control rechannelization on rollout.
Crew: 6

STS-3 3/30/1982
Pilot induced oscillation during derotation. Stronger than predicted winds contributed.
Crew: 2

Soyuz 15 8/28/1974
Descended through an electrical storm during night landing.
Crew: 2

Apollo 15 8/7/1971
Landed with only 2 of 3 parachutes.
Crew: 3

Soyuz Impact Events (1967-1993):

Soyuz TM-15 2/1/1993
Rolled down hillside.
Crew: 2

Soyuz TM-14 8/10/1992
Hard landing impact. Hatch jammed, requiring cosmonauts to use tools to pry open.
Crew: 3

Soyuz TM-12 10/10/1991
Hard impact. News team reported capsule as "very dented."
Crew: 3

Soyuz TM-7 4/27/1989
Double-impact "hard landing."
Crew: 2 Crew Injury (1)

Soyuz T-7 12/10/1982
Landed on hillside and rolled downhill. One cosmonaut thrown from couch.
Crew: 2

Soyuz 36 7/31/1980
Landing rockets failed to fire resulting in ~30G impact.
Crew: 2

Soyuz 23 10/16/1976
Landed on frozen lake during blizzard. Delayed recovery.
Crew: 2

Soyuz 5 1/18/1969
Landing rockets failed to fire, resulting in a hard landing.
Crew: 1 Crew Injury

Soyuz 1 4/24/1967
Main and reserve parachutes failed.
Crew: 1 Loss of Crew

Mercury MR-4 7/21/1961
Inadvertent hatch pyro firing. Capsule sunk. Astronaut nearly drowned.
Crew: 1 Loss of Capsule

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

The *Significant Incidents and Close Calls in Human Spaceflight* graphic is primarily focused on human spaceflight incidents that have occurred while a crew was onboard a space vehicle. It includes suborbital, orbital, and lunar missions. The two ground facility events and two atmospheric flight events are included due to the significance of the events to spaceflight. The altitude chamber O_2 fire in Soviet Russia occurred prior to the loss of the Apollo 1 crew in an O_2 fire and could have served as a lesson learned had it been known in the US. The EMU fire resulted in the redesign of the EMU and heightened awareness of design and materials selection for human-rated systems using high-pressure O_2. The M2-F2 lifting body accident occurred during the development of the space shuttle and yielded human engineering lessons learned. The SR-71 accident is the highest and fastest vehicle breakup on record that was survivable, and it represents the demonstrated limit of crew survival with currently fielded technologies.

New in this edition: 26 events have been added since the Fall 2010 release, and the formatting has been updated. EVA incidents were removed and placed on the Significant Incidents in EVA Operations Graphic.

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.

Visit the NASA Human Spaceflight Readers' Room (http://spaceflight.nasa.gov/outreach/readersroom.html) to view the latest version electronically.

Abbreviations and Acronyms

AC	Air Conditioner	**H_2**	Hydrogen	**PAL**	Protuberance Air Load
APU	Auxiliary Power Unit	**IMU**	Inertial Measurement Unit	**PASS**	Primary Avionics Software System
BMP	Microimpurities Removal System	**ISS**	International Space Station	**RCS**	Reaction Control System/Subsystem
CDRA	Carbon Dioxide Removal System	**KOH**	Potassium Hydroxide	**RIP**	Rapid Information Page
CMG	Control Moment Gyroscope	**LH_2**	Liquid Hydrogen	**RMS**	Remote Manipulator System
CO	Carbon Monoxide	**LOC**	Loss of Crew	**RS**	Russia or Russian
CO_2	Carbon Dioxide	**LOV**	Loss of Vehicle	**RTLS**	Return to Launch Site
DM	Descent Module	**MDF**	Minimum Duration Flight	**SFOG**	Solid Fuel Oxygen Generator
EMU	Extravehicular Mobility Unit	**ME**	Main Engine	**S&MA**	Safety & Mission Assurance
EPS	Electrical Power System	**MetOx**	Metal Oxide	**SM**	Service Module
EV	Extravehicular	**MMOD**	Micro-Meteoroid Orbital Debris	**SRB**	Solid Rocket Booster
EVA	Extravehicular Activity	**N_2O_4**	Nitrogen Tetroxide	**SSME**	Space Shuttle Main Engine
FSO	Flight Safety Office	**O_2**	Oxygen	**SSP**	Space Shuttle Program
GIRA	Galley Iodine Removal Assembly	**OM**	Orbital Module	**TPS**	Thermal Protection System
GPC	General Purpose Computer	**OSMA**	Office of Saftey & Mission Assurance (NASA HQ)	**US**	United States
GPS	Global Positioning System				

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Significant Incidents and Close Calls in Human Spaceflight

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