

Legend		
Apollo 1 (AS-204) 1/27/1967 Crew cabin fire (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
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



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: 6/7/7	Soyuz TM-9 2/11/1990 DM insulation torn loose on ascent; contingency EVA repair. Crew: 2
STS-51L 1/28/1986 SRB seal failure. Crew: 7 Loss of Crew	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: 2 Crew Injury Loss of Vehicle/Mission	Apollo 13 4/11/1970 2 nd 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 1 st 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	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
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Soyuz 18-1 (18a) 4/5/1975 After ascent abort, capsule landed on snowy slope above cliff. Parachute snagged and prevented fall. Crew: 2	Altitude Chamber O₂ 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)	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)	SpaceShipOne, Flight 11P 12/17/2003 Left main gear collapsed. Crew: 1	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 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

STS-134 5/6/2011 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
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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 O₂ fire in Soviet Russia occurred prior to the loss of the Apollo 1 crew in an O₂ 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 O₂. 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.



Significant Incidents and Close Calls in Human Spaceflight

S&MA Flight Safety Office

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

Spring 2012

Abbreviations and Acronyms					
AC	Air Conditioner	H₂	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	LH₂	Liquid Hydrogen	RMS	Remote Manipulator System
CO	Carbon Monoxide	LOC	Loss of Crew	RS	Russia or Russian
CO₂	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	N₂O₄	Nitrogen Tetroxide	SSME	Space Shuttle Main Engine
FSO	Flight Safety Office	O₂	Oxygen	SSP	Space Shuttle Program
GIRA	Galley Iodine Removal Assembly	OM	Orbital Module	TPS	Thermal Protection System
GPC	General Purpose Computer	OSMA	Office of Safety & Mission Assurance (NASA HQ)	US	United States
GPS	Global Positioning System				

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:

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