

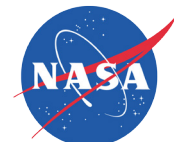
JSC SMA FLIGHT SAFETY OFFICE

Significant Incidents and Close Calls in Human Spaceflight

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WHAT IS IT?

Human spaceflight grew out of the Cold War between the United States and the Soviet Union. Competitive struggles laid the groundwork with advances in high altitude flight, rocketry, and human performance. Human spaceflight reached its first defining success more than half a century ago, when Cosmonaut Yuri Gagarin became the first man to orbit the Earth in April 1961. In November 2000, a multi-national crew moved aboard the International Space Station. By November 2011, the former Cold War rivals had collaborated to surpass 10 years of continuous presence in space. Now a new record of continuous space habitation is established daily.

The Significant Incidents and Close Calls in Human Spaceflight chart presents a visual overview of major losses and close calls spanning the history of human spaceflight. It heightens awareness of the risks that must be managed as human spaceflight continues to advance.

HOW DOES IT WORK?

Events on the chart are organized by flight phase and ordered chronologically within each phase. Each event is represented by a small box which includes the mission name, date, a brief description of the incident and any significant result, such as injury or loss of life. Three types of important events are highlighted: loss of crew, crew injury, and related or recurring events. Events with one or more crew fatalities are considered a loss of crew and highlighted in red. Crew injury or illness and/or loss of vehicle or mission is designated by orange shading. Related or recurring events are grouped together and set apart by yellow shaded boxes. These events have occurred repeatedly, are similar in nature, and may continue to occur today.

WHY DO WE HAVE IT?

The Significant Incidents and Close Calls in Human Spaceflight chart is maintained by NASA Johnson Space Center's Flight Safety Office to raise awareness of lessons that have been learned through the years. It is a visible reminder of the risks inherent in human spaceflight. It is intended to spark an interest in past events, inspire people to delve into lessons learned, and encourage continued vigilance. It can aid in developing "what-if" scenarios and in ensuring the lessons of history are incorporated into new designs. It is being distributed as widely as possible in the hope that future accidents may be prevented.

WHAT IS THE BONDARENKO STORY?

Two fatal events, the Soviet altitude chamber oxygen fire and the Apollo 1 terminal countdown demonstration test, highlight the importance of sharing information. On March 23, 1961 Soviet cosmonaut Valentin Bondarenko lost his life after being severely burned in an altitude chamber fire. The incident occurred during a routine training exercise, when Bondarenko attempted to throw an alcohol swab into a waste basket, but hit the edge of a hot plate instead. The oxygen-rich environment quickly ignited. Rescue efforts were thwarted because internal pressure prevented rescuers from opening the chamber's inwardly swinging hatch for several minutes. By the time the pressure was released and the hatch could be opened, Bondarenko had been hopelessly burned. He died hours later.

Six years later, three U.S. astronaut's lives were lost in a fire during the terminal countdown demonstration test. During the test, the Apollo crew module contained an oxygen-rich atmosphere. An electrical short caused a fire that spread quickly throughout the cabin. Again, rescue efforts were delayed due to the buildup of pressure behind an inwardly opening hatch. Unlike the Soviet altitude chamber oxygen fire, the crew did not die due to burns from the fire, but from cardiac arrest caused by smoke inhalation. However, in both the Bondarenko tragedy and the Apollo 1 incident, high levels of oxygen caused the fires to spread rapidly, and pressure against inward opening hatches slowed rescue efforts. Neither cabin was equipped with effective fire-suppression equipment.

Information about the Bondarenko incident was not known in the U.S. until 1986 – more than 20 years later. Would access to this information have led to design changes that saved lives? Although that question can never be answered, these events underscore the importance of sharing information in the effort to prevent future tragedies.

Abbreviations and Acronyms

AC	Air Conditioner
APU	Auxiliary Power Unit
BMP	Microimpurities Removal System (Russian)
CDRA	Carbon Dioxide Removal System
CMG	Control Management Gyroscope
CO	Carbon Monoxide
CO ₂	Carbon Dioxide
DM	Descent Module
EMU	Extravehicular Mobility Unit
EPS	Electrical Power System
EVA	Extravehicular Activity
FGB	Functional Cargo Block (Russian)
FSO	Flight Safety Office
GIRA	Galley Iodine Removal Assembly
GPC	General Purpose Computer
GPS	Global Positioning System
H ₂	Hydrogen
IMU	Inertial Measurement Unit
ISS	International Space Station
ITCS	Internal Thermal Control System
KOH	Potassium Hydroxide
LH ₂	Liquid Hydrogen
LOC	Loss of Crew
LOV	Loss of Vehicle
LOX	Liquid Oxygen
MDF	Minimum Duration Flight
MetOx	Metal Oxide
MMOD	Micro-Meteoroid Orbital Debris
N ₂ O ₄	Nitrogen Tetroxide
NSI	NASA Standard Initiator
O ₂	Oxygen
OM	Orbital Module
OSMA	Office of Safety & Mission Assurance
PAL	Protuberance Air Load
PASS	Primary Avionics Software System
PCCO ₂	Partial Pressure of Carbon Dioxide
RCS	Reaction Control System/Subsystem
RMS	Remote Manipulator System
RTLS	Return to Launch Site
SFOG	Solid Fuel Oxygen Generator
SMA	Safety & Mission Assurance
SM	Service Module
SRB	Solid Rocket Booster
SSME	Space Shuttle Main Engine
SSP	Space Shuttle Program
STS	Space Transportation System
TPS	Thermal Protection System
U.S.	United States

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Spaceflight chart.

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