

Human Space Milestones, Life Support and Space Suit Development Timeline

1959 – Mercury Space Suits Competition conducted by USAF and USN for NASA. Suits submitted by B. F. Goodrich Corporation, David Clark Company, and International Latex Corporation were evaluated during manned testing at WPAFB, Ohio. Manned testing included a 24 hour chamber test at 5 psia using an in-house developed semi-closed loop life support system, suited cold chamber, heated oven, and centrifuge environmental testing was also conducted. Additional manned thermal testing was performed by the USN. NASA selected a modified USN Mark IV pressure suit for Project Mercury.

May 5, 1961 – Alan Shepard's Sub-orbital MR-3 Mercury flight

July 1961 – Gus Grissom's Sub-orbital MR-4 Mercury flight

Oct 24, 1961 – Manned Spacecraft Center formally established, temporary quarters set up in Houston.

1962 – Gemini Space Suits evaluation conducted by NASA. Suits developed for NASA by Arrowhead Products Company and B.F. Goodrich Corporation, together with a suit submitted by the David Clark Company were evaluated by astronaut Gus Grissom in a Gemini mockup spacecraft at St. Louis, Mo. Based upon Gus Grissom's evaluation and recommendation the suit provided by the David Clark Company was selected by NASA for the Gemini Program.

1962 – NASA selected Hamilton Standard and International Latex Corporation to develop a portable life support system and space suit for the Apollo Program.

Feb 20, 1962 – John Glenn's MA-6 Mercury flight – first orbital mission

1964 – 1965 – Under NASA contract David Clark Company developed the Gemini G-4C EV suit, and NASA developed in-house the Gemini EVA chamber vent system(life support system) to provide astronaut ED White the capability to demonstrate the EVA first conducted by the U.S. during the GT-4 mission on June 3, 1965.

1965 – NASA selected the David Clark Company to provide a modified Gemini space suit for Apollo Block I missions due to unacceptable Apollo prototype space suits evaluation results, development problems, and resulting schedule delay. As part of the recovery effort, NASA conducted a competitive evaluation of space suit prototypes developed for NASA by Hamilton Standard and the David Clark Company, together with a suit submitted by the International Latex Corporation. Upon completion of the competitive evaluation NASA selected the International Latex Corporation to continue development of the space suit for Apollo Block II missions.

1964 – 1972 – Vapor Compression Distillation development by Chemtrix, under contract to the Manned Spacecraft Center. Technology was based on earlier work at Marquardt. (After years of further development, this technology is planned for use on the ISS in the Urine Water Processor, scheduled to be launched on ULF-2, in October 2008.)

March 23, 1965 – First Gemini flight with Gus Grissom and John Young

Nov 11 – 15: Last of 10 manned Gemini flights with James Lovell and Edwin Aldrin

January 27, 1967 – Apollo 1 fire

1967 – NASA cancelled the David Clark Apollo Block I space suit program after the Apollo 1 fire. NASA also directed major redesign of the Apollo Block II space suit being developed by the International Latex Company to incorporate non-flammable materials and related design changes...

Dec 21, 1968 – Apollo 8 circumlunar flight.

May 1968 – 28 Day Closed Door Test was conducted in the Langley Integrated Life Support System (ILSS). Regenerative technologies were tested to close the oxygen loop and partially close the water loop. A four person crew continuously occupied the ILSS over the test duration. The technologies (4bed molecular sieve, Sabatier, and water electrolysis) are either installed on the ISS or planned for installation in the future.

March 9, 1969 – First EVA demonstration of the Apollo suit and life support system was conducted during Apollo 9 by astronaut Rusty Schweickart from the Lunar Module, and by David Scott using an umbilical at the Command Module hatch.

July 16, 1969 – First lunar surface EVA's were conducted by Neil Armstrong and Buzz Aldrin.

April 11, 1970 – Apollo 13 aborted lunar landing mission

1970 – Langley contracted with General Electric to develop Solid Polymer Electrolyte (SPE) water electrolysis technology, based on the fuel cell used on the Gemini Spacecraft. (This technology is included in the Oxygen Generation System on the ISS. It was launched on ULF-1 in July 2006 and is planned to be started on July 11, 2007).

1970 – Langley contracted with McDonnell Douglas to conduct a 90 day closed chamber test including a four person crew. Regenerative technologies were tested that closed both the oxygen and water loops. A radioisotope was used to power the urine flush water processor. CO₂ was controlled with a Solid Amine Water Desorbed (SAWD) unit while Sabatier reactor and water electrolysis technologies completed the O₂ loop closure. 4 bed molecular sieve was a backup for the SAWD and an air evaporation closed cycle unit was a backup for the urine flush water processor.

June 30, 1972 – First use of the increased EVA duration Apollo A-7LB EV and CMP suits, portable life support system, and Buddy Life support System occurred during the Apollo 15 mission. Four lunar surface and one trans-earth EVA's were performed.

September 20, 1972 – The Skylab Medical Experiments Altitude Test (SMEAT) is completed at JSC. This 56-day test in the 20 foot chamber with 3 astronaut test subjects was conducted at 70 percent oxygen, 30 percent nitrogen, and 4.9 psia total pressure.

December 13, 1972. Last of the Apollo Program lunar surface EVA's were performed by Apollo 17 astronauts Harrison Schmidt and Gene Cernan. On December 17, 1972 Command Module pilot Ronald Evans performed a trans-earth EVA which was the last Apollo EVA conducted.

May 14, 1973 – Skylab 1 unmanned launch. The Skylab was a very successful orbital station program manned by subsequent crews of 3 for missions of 28, 59 and 84 days. Water was stored in tanks and carbon dioxide removal was provided by a molecular sieve unit, similar to the Carbon Dioxide Removal Assembly (CDRA) that is currently on ISS.

May 25, 1973 – Skylab 2 manned launch with standup EVA performed by astronaut Paul Weitz using a command module life support umbilical in an unsuccessful attempt to free the orbital workshop solar array wing damaged during Skylab 1 launch. On June 7, 1973 astronauts Pete Conrad and Joe Kerwin successfully deployed the stuck solar wing during an EVA from the Skylab airlock using for the first time the Astronaut Life Support Assembly.

August 6, 1973 – Skylab 3 astronauts Owen Garriott and Jack Lousma installed a thermal shade and serviced experiments. On August 24, 1973, astronauts Lousma and Garriott again conducted an EVA to service experiments and perform minor equipment repairs.

Nov, 1973 – Skylab 4 astronauts Bill Pogue and Gerald Carr serviced experiments and repaired an antenna, and pinned a door to the telescope. On December 24, 1973, astronauts Pogue and Carr performed the longest Skylab EVA (7 hours and 1 minute) to service experiments and to photograph the comet Kohoutek. On December 29, 1973 astronauts Pogue and Carr conducted an EVA to conduct two experiments and two observe the comet Kohoutek. The final Skylab Program EVA was performed on January 17, 1974 by astronauts Pogue and Carr to retrieve film magazines and cameras, deploy experiments, and to retrieve the AM thermal and micrometeoroid shield.

1973 – 1977 – JSC testing of the Space Station Prototype (SSP) subsystems.

July 15, 1975 – Apollo-Soyuz Test Project

January, 1977 - NASA selected Hamilton Standard, ILC Dover, and Airlock Inc. to develop and provide the Shuttle Program Extravehicular Mobility Unit.

1978 – 1983: – *Regenerative Life Support Evaluation (RLSE) Subsystem Testing and RLSE Integrated Testing conducted at JSC.*

April 12, 1981 – Space Shuttle Columbia (STS-1).

April 6, 1983 – Astronauts Story Musgrave and Donald Peterson performed the first Shuttle EVA during the STS-6 mission.

June 18, 1983 – Space Shuttle Challenger (STS-7), with first female astronaut, Sally Ride

November 28 1983 –first flight of Spacelab in orbiter. European jointly with MSFC life support oversight. Successfully flew 15 manned modules thru 97, with no significant life support problems. First flight of dedicated TCCS.

1984 - *MSFC is assigned responsibility for the Space Station ECLS hardware. MSFC starts early ECLS subsystem testing.*

May 1993 Space Station phase C/D CDR completed

Jan 28, 1986 – Loss of Space Shuttle Challenger (STS-51L)

1986-1987- *Full set of competitive ECLSS loop closure hardware received at MSFC with integrated pre-prototype Space Station development hardware. Martin Marietta and Boeing participate in MSFC WP01 LS comparative and system testing during phase B contracts; Boeing selected as phase C/D contractor for WP01-- entering into testing with MSFC in-house Core Module Integrated Facility (CMIF)/comparative test facility.*

May 1990- Space Station phase C/D PDR completed at MSFC

April 24, 1990 – Hubble Space Telescope deployed on STS-31, Space Shuttle Discovery

May/June 1990- *Phase III Water Recovery Test Stages 1A, 2A, and 3A. This test series marked the start of Space Station ECLS hardware integrated testing with Humans-in-the-Loop generating wastewater and using the processed water.*

May 1991- *Space Station ECLS subsystem selections.*

1991/92/93/94- *Continuation of Space Station Water Recovery Test; as the hardware was improved it was integrated and tested at MSFC testing facility with Humans-in-the-Loop.*

1993/94 Russian joined the US and the international partners (Space Station Alpha)

June – July, 1995 – Space Shuttle Atlantis visits the Mir Space Station

March 1996- *Space Station Phase III Integrated Atmosphere Revitalization Test at MSFC closed module testing facility- Test included the SFE, CDRA, TCCS, and MCA.*

July 1996 – *Phase II Regenerative Life Support Systems (RLSS) 30-day test completed at JSC in the 20 foot chamber, with 4 human test subjects, utilizing physicochemical life support system technologies for air revitalization, water recovery, and thermal control.*

March 1997 – *Phase IIA RLSS 60-day test completed at JSC with 4 human test subjects utilizing functionally-similar ISS life support subsystems.*

November 1997- *ISS System-Level Trace Contaminant Injection Test at MSFC- Valuable test for determining the fate of a variety of trace contaminants in a cabin atmosphere.*

December 1997 – *Phase III RLSS 90-day test completed at JSC with 4 human test subjects with a combination of physicochemical and biological life support hardware.*

December 1998 – Initiation of the ISS. Space Shuttle docked the node Unity with the Russian FGB which was launched in November 1998.

July 2000- International Space Station US Lab and Node 1 ECLSS Sustaining Engineering test bed completed and operational at MSFC

October 30, 2000 – Initial crew arrives on the ISS, on a Russian Soyuz.