

# Quest

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# THE X-15 SPACEPLANE

by Jonathan McDowell

The North American X-15 rocketship was the first true winged spaceship. In this, the first article of our X-15 issue, contributing writer Jonathan McDowell gives an overview of the pioneering missions of the X-15 into the mesosphere and in outer space and concludes by presenting the most complete log of X-15 flights yet published.

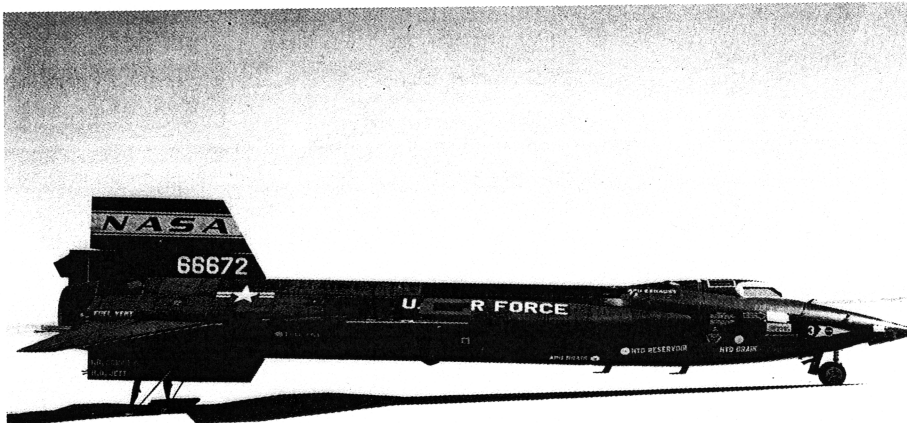
## The Vehicle

The X-15 [1,2,3,4] was a winged rocketplane with a single pilot, carried aloft under the wing of a modified B-52 bomber. Three X-15s were built by North American Aviation as part of a joint NASA/USAF/US Navy program to explore hypersonic flight based at the Flight Test Center at Edwards Air Force Base, California.

In a test program lasting 9 years the X-15 broke all records, reaching a speed of Mach 6.7 and an altitude of over 100 km. The X-15's fuselage was 15 meters long and the wingspan was 6.8 meters. The plane weighed approximately 5000 kg empty and 14,000 kg fully fuelled. It was powered by a single XLR-99 rocket engine, although early flights used a pair of XLR-11 rocket engines since the XLR-99 was not ready. The plane was carried under the starboard wing of one of two NASA NB-52 carrier aircraft.

The NB-52's were modified prototype B-52 bombers (a B-52A, no. 52-003 and a B-52B, no. 52-008) which were obtained to replace the B-50 used to carry earlier rocket planes. 52-003 is now in the Puma Air Museum at Tucson, Arizona; 52-008 continues to be used for test programs at Edwards.

The NB-52, with a crew of two, would take off from Edwards AFB, usually using the concrete runway RW4/22 and climb to an altitude of 13.7 km over the chosen launch site, which would be near a dry lake bed. Then if no problems were encountered



X-15 SN 66672 on Edwards Lakebed. Photo #E63-9704 Courtesy NASA.

the X-15 would be released and the X-15 pilot would ignite the rocket engine. If the engine failed to light, an emergency glide landing would be made on the dry lake. Otherwise, the rocket would burn for a minute and a half, accelerating the X-15 to typical speeds of around Mach 5.

The X-15 would fly a ballistic trajectory into the upper atmosphere and carried out a controlled reentry, glide approach and landing on Rogers dry lake bed at Edwards for a total free flight time of 10 minutes. Just before landing, the ventral fin below the X-15 would be jettisoned and the landing gear would be deployed. The main gear at the rear of the fuselage consisted of skids rather than wheels; there was a single nosewheel, but no steering capability.

The big lake bed at Edwards has several long runways marked out; the prime X-15

runway [1] was RW18/36, with RW05/23 (later the landing site for the first orbital flight of the Space Shuttle) as a backup. RW17/35 was also used. Other landing sites, used in emergencies, were Rosamond Dry Lake, Mud Lake, Cuddeback Lake, Delamar Dry Lake, Smith Ranch Lake and Silver Lake. These were all used as launch sites, as well as Palmdale, Hidden Hills, and Railroad Valley (see Table 1).

The X-15-1 (S/N 56-6670) was carried aloft by the B-52 142 times, making 81 free flights. It is now in the National Air and Space Museum in Washington, D.C.

The X-15-2 (S/N 56-6671) was carried aloft 52 times and made 31 free flights. On its last flight in November 1962, the plane was severely damaged in an emergency landing. It was rebuilt in modified form as the X-15A-2, with a longer fuselage and external jettisonable fuel tanks. The X-15A-2 was used for high speed tests at relatively low altitude, making Mach 6.7 on its last flight. It flew mated to the B-52 45 times, including 22 free flights. It is now on display at Wright-Patterson AFB.

The X-15-3 (S/N 56-6672) was carried aloft 97 times and made 65 free flights. On the last flight, during reentry from space, it entered a spin at Mach 5 at an altitude of 70 km. At an altitude of 18 km the vehicle broke up and the pieces impacted the Mojave Desert. The pilot, Mike Adams, was killed in the accident. A complete summary of all emergency landings made during the program is given in Table 2.

Table 1: X-15 Launch and Landing Sites

Site	Abbrev	Location	No. Launches	No. Landings	Used
Rogers Dry Lake, Edwards, CA	EAFB	117.8W 34.9N	0	188	1959-68
Rosamond Dry Lake, CA	ROS	118.1W 34.8N	18	1	1959-68
Cuddeback Lake, CA	CUD	117.5W 35.3N	1	3	1959-68
Palmdale, CA	PLM	118.1W 34.6N	8	0	1960-61
Silver Lake, CA	SIL	116.1W 35.3N	14	1	1960-67
Hidden Hills, CA	HH	116.0W 36.0N	50	0	1961-68
Mud Lake, NV	MUD	117.1W 37.9N	34	4	1961-67
Delamar Dry Lake, NV	DDL	114.9W 37.4N	62	1	1962-68
Smith Ranch Lake, NV	SRL	117.5W 39.3N	10	1	1963-68
Railroad Valley Lake, NV	RRV	116.0W 38.0N	2	0	1968

Milt Thompson's book [1] talks about flying the X-15 to the edge of space. This raises an interesting question - where does space start? In the late 1950s the USAF decided to award 'astronaut wings' to pilots flying above 50 statute miles. This boundary was chosen as a nice round figure, but it is also the right choice from a physical point of view.

Space is not, of course, a vacuum. The atmosphere of the Earth gets thinner and thinner with distance from Earth's surface until a magnetic shock front is reached, marking the boundary with the solar wind, which can be considered as the Sun's outer atmosphere. This boundary is about the height of geostationary orbit at the closest point, and clearly a lot of the region within it, including almost all spaceflights to date, ought to be counted as space. We can get an intuitive idea of where the boundary should be by comparing the maximum altitude reached by vehicles which use the air for propulsion and the minimum altitude at which satellites can travel without re-entering. The altitude record for non-rocket-powered airplanes is 37 km, set at the Soviet equivalent of Edwards, LII Gromov, by Aleksandr Fedotov in 1977. The record for piloted balloons is the same, although unpiloted scientific balloons have flown at 50 km. In contrast, the lowest perigee at which satellites have flown for more than one orbit is 90 km. Hence, the boundary of space should be chosen at somewhere between 50 and 90 km. However, it's dangerous to use a technological criterion to define the boundary - one would rather use a physical criterion which will remain valid even given advances in technology. There are a couple

Table 2: Emergency Landings

Date	A/C	Flight	Pilot	Site	Cause
1959 Nov 5	X-15-2	2-3-9	Crossfield	Rosamund	XLR-11 exploded
1960 Sep 23	X-15-1	1-13-25	Petersen	Rogers	XLR-11 out early
1962 Jan 10	X-15-1	1-25-44	Petersen	Mud	XLR-99 did not ignite
1962 Apr 20	X-15-3	3-4-8	Armstrong	Rogers	Reentry bounce
1962 Nov 9	X-15-2	2-31-52	McKay	Mud	XLR-99 failed, X-15-2 wrecked
1964 May 21	X-15-3	3-29-48	Thompson	Cuddeback	XLR-99 failed
1964 Aug 14	X-15A-2	2-33-56	Rushworth	Rogers	Nose gear deploy at Mach 4
1964 Sep 29	X-15A-2	2-34-57	Rushworth	Rogers	Nose gear deploy at Mach 4
1965 Feb 17	X-15A-2	2-36-63	Rushworth	Rogers	Main gear deploy at Mach 4
1966 May 6	X-15-1	1-63-104	McKay	Delamar	XLR-99 failed
1966 Jul 1	X-15A-2	2-45-81	Rushworth	Mud	External tank problem
1966 Sep 8	X-15-1	1-68-113	McKay	Smith Ranch	Engine problem
1966 Oct 6	X-15-1	1-69-116	Adams	Cuddeback	Fuel tank rupture
1967 Apr 26	X-15-3	3-58-87	Dana	Silver Lake	Engine problem
1967 Jun 29	X-15-1	1-73-126	Knight	Mud	APU failure, manual reentry
1967 Nov 15	X-15-3	3-65-97	Adams	[Cuddeback]	Hypersonic spin, destroyed

of obvious candidates: natural discontinuities in atmospheric structure called the stratopause (which divides the stratosphere and the mesosphere) and the mesopause (which divides the mesosphere and the outer atmosphere). The mesosphere is a region where the temperature decreases with altitude, the opposite of the behavior in the stratosphere and the upper atmosphere. The stratopause is at around 50 km; but the stratosphere and the mesosphere are often considered together as the 'middle atmosphere' and it seems more natural to choose the outermost boundary, the mesopause, as the physical boundary which marks the edge of space. It turns out that the traditional value for the height of the mesopause, 80 km, is also within 500 meters of the 50 mile 'astronaut wings' boundary historically used by the USAF. I therefore suggest that we adopt as the formal boundary of space an altitude of exactly 80 km, representing the typical location of the

mesopause. The true mesopause varies with time and geographic location by up to 10 km, and more recent values quoted as 'typical' tend to be a bit higher, around 85 km. But the 80 km value is not too much of a fudge for the sake of historical continuity (Note: if we adopted the 85 km value, only Adams would lose astronaut status). With this definition, the X-15 is the only class of piloted vehicle to have flown in space but not in orbit; it was the first reusable spaceship.

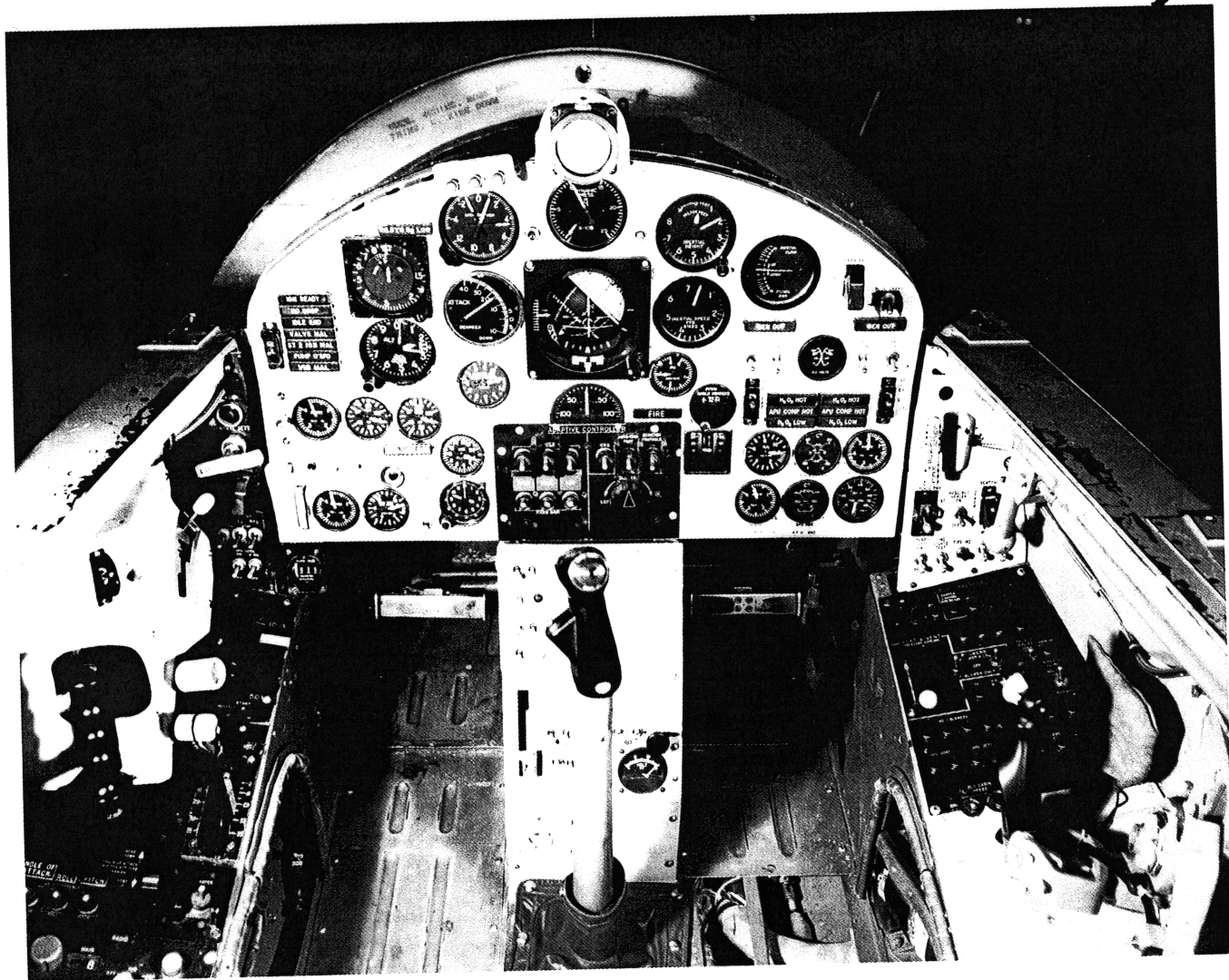
The Pilots

The X-15 was a joint program, and all three sponsor organizations contributed pilots. The first X-15 pilot, however, worked for the manufacturer North American Aviation (NAA) - test pilot Scott Crossfield, veteran of early NACA rocketplane programs. He carried out initial flight tests of each X-15 before it was turned over to NASA and the USAF. His backup, Al White, never actually flew the X-15. Crossfield remained with NAA as a manager until July 1967; White was an NAA test pilot until 1966, when he survived the mid-air collision that killed Joe Walker. Table 3 lists all the X-15 pilots [1, 3], giving the time period for which they were test pilots at Edwards, the dates they joined and left the X-15 program, and the number of X-15 free flights they made, as well as the number of those which qualify as spaceflights. The final column gives the date of death where applicable; six of the fourteen are now dead, four as a result of test-flying accidents. Experimental test flying is a risky business.

Many of the X-15 pilots went on to be successful in other programs. The USN pilot was Forrest Petersen, who left the X-15 program when the Navy stopped participating and was transferred to a fighter squadron. He later commanded the *USS Enterprise* and retired in 1980 with the rank of Vice Admiral.

Table 3: The X-15 Pilots

Name	Edwards Pilot	To X-15 Program	Left X-15 Program	X-15 Free Flights	X-15 Space Flights	Died
NAA Test Pilots						
Scott Crossfield	1950-60	1955 Sep?	1960 Dec 7	14	0	
Alvin White	1954-66	1955 Sep?	1960 Dec 7	0	0	
USN Pilot						
Forrest Petersen	1958-62	1958 Aug	1962 Feb	5	0	1990
USAF Pilots						
Iven Kincheloe	1955-58	1958 Apr 4	1958 Jul 26	0	0	1958
Robert White	1955-63	1958 Apr 4	1962 Dec	16	1	
Robert Rushworth	1957-67	1958 Apr 4	1966 Jul	34	1	1993
Joe Engle	1962-66	1963 Jun	1966 Apr	16	3	
'Pete' Knight	1958-69	1965 Jul	1968 Dec	16	1	
Mike Adams	1963-67	1966 Jul 20	1967 Nov 15	7	1	1967
NASA Pilots						
Joseph Walker	1951-66	1958	1963 Aug	25	3	1966
John McKay	1951-?	1958	1966 Sep	29	1	1975
Neil Armstrong	1955-62	1958	1962 Aug	7	0	
Milton Thompson	1956-67	1963 Jul	1965 Aug	14	0	1993
William Dana	1958-	1965 Jul	1968 Dec	16	2	



*View of the interior X-15 cockpit/instrument panel showing center stick, left-hand side arm controller for manual reaction controls on left-hand console with throttle handle to right and tank pressurization and vent above this. T-handle above tank lever is landing gear release. Photo #E63-9834 Courtesy NASA.*

Most of the X-15 flights were flown by USAF and NASA pilots. The USAF's prime X-15 test pilot was Iven Kincheloe, but his back up Bob White had to take over when Kincheloe was killed on July 26, 1958 in a plane crash at Edwards, before the first X-15 flight. White later became commander of the Flight Test Center at Edwards, and eventually was promoted to Major General, serving in Germany where he remained after his retirement in 1981. Rushworth also became commander of the Flight Test Center and a Major General, retiring in 1981. Joe Engle and Neil Armstrong joined the NASA astronaut corps, Engle flying the Shuttle in the 1980s and Armstrong becoming the first human to walk on the Moon in 1969. Thompson and Dana remained at Edwards, Thompson as NASA-Dryden's Chief Engineer (until his death in 1993), and Dana as chief pilot. William 'Pete' Knight eventually left Edwards, but didn't go far - he is

mayor of the neighboring aerospace-dominated town of Palmdale.

### The Program

Thompson [1] divides the flight program into several overlapping phases. The first phase was NAA's contractor demonstration phase, following which the aircraft were delivered to the government. The second phase was the envelope expansion phase using the XLR-11 engine. Thompson's Phase III consisted of checkout flights for Petersen, McKay, Rushworth and Armstrong. Crossfield's flights for NAA to demonstrate the XLR-99 engine were Phase IV and the corresponding government envelope expansion phase was Phase V. A new flight control system, the Minneapolis-Honeywell MH-96, was installed in late 1961 and Phase VI checked out this equipment. The aircraft was now ready to carry out its main

research tasks.

Thompson distinguishes between test flights of the aircraft per se (Phase VII; expanding the flight envelope, measuring its handling qualities) and flights where the aircraft was simply used to carry experiments to high altitudes or speeds (Phase VIII). Some experiments involved astronomical studies or earth observation; others involved minor modifications to the aircraft such as altering the shape of the tail fin or the nose cone and measuring the aerodynamic effects. Finally, there was the X-15A-2 program to carry a dummy scramjet to speeds around Mach 7 (Phase IX).

### High Altitude Flights by the X-15

The first flight into the mesosphere was 2-14-28 on March 30, 1961. Joe Walker was launched in X-15-2 from Hidden Hills on an envelope expansion flight. The flight

was intended to reach only 45 km but Walker overshot and reached 51 km. He was followed by White on flight 2-20-36 on October 11, 1961, reaching 66 km and Mach 5 after launch from Mud Lake. On this flight the windshield shattered during reentry. Neil Armstrong was the next pilot to be scheduled for a high altitude flight, as part of the MH-96 test program. The first attempt to launch was on March 29, 1962, but this and attempts on the next two days were aborted due to problems with the X-15. Finally Armstrong was launched on flight 3-3-7 on April 5, reaching an altitude of 54.

The final MH-96 test flight, 3-4-8, was launched on April 20, with Armstrong again on the controls. He reached a 63 km apogee, but during reentry 'bounced' off the atmosphere and flew past Edwards 30 km up at Mach 3. Armstrong managed to turn the X-15 around and just made it back, touching down on the southern part of the dry lake, for a record flight time of 12 min 28 seconds.

The final envelope expansion flight was due to occur only 7 days later; 1-A-47 was an abort, but was followed on April 30 by the successful 1-27-48 flight. Joe Walker flew X-15-1 from Mud Lake to the design altitude of 250,000 feet (75 km), the fringe of space.

Now Delamar Dry Lake, Nevada was introduced as a launch site for high altitude flights, and a series of altitude buildup flights were begun. Robert White flew X-15-3 on June 12 and 21 to 56 and 75 km, respectively. The X-15 was ready for space: the next flight was scheduled to reach 86 km. The first attempt to launch the mission, on July 10, 1962, was aborted, as were two more attempts on July 11 and 16. Finally, on July 17, Pilots Allavie and Archer took off in 52-003, carrying White in X-15-3 to the launch point over Delamar/ At 1731 UT the X-15 was dropped and White ignited the engine, shutting it down after 82 seconds. The X-15 continued to rise, peaking at the remarkable altitude of 95.9 km. White had earned astronaut wings, flying higher than anyone except Gagarin, Shepard, Grissom, Titov, Glenn and Carpenter. The reentry was uneventful and White touched down at Edwards at 1741, after a flight lasting 10 min 20 sec.

The next few high altitude flights were made by Joe Walker in the X-15-3. In August he made a research flight (3-9-18) to 59 km; on another flight on December 20 (3-13-23), planned to go to 53 km, he only made it to 49 km. His next flight, 3-14-24, was the X-15's second spaceflight, although it was only intended to reach 76 km. Launched at 1859 on January 17, 1963 from Delamar, Walker flew the X-15-3 to 83 km, carrying an infrared sensor experiment. The flight lasted 10 minutes 59 seconds. In May 1963, flight 3-16-26 carried the infrared experiment and an ultraviolet photometer to 63

km.

Next it was Bob Rushworth's turn to build up high altitude experience. He flew 3-19-30 to 68 km in June, with the UV photometer experiment, and at 1756 on June 27 was launched on the project's third spaceflight, reaching 86.9 km on flight 3-20-31. Payload was the UV and infrared experiments and a horizon scanner. Then Walker started building up for a new altitude record. On July 9 he flew to 69 km, on a testbed flight carrying an optical degradation experiment and a traversing probe. On July 19 he was launched from Smith Ranch Lake carrying a battery of experiments (the UV photometer, the IR experiment, the horizon scanner, an optical photometer and a balloon for atmospheric density research). Flight 3-21-32 reached a record altitude of 106 km, meeting the FAI's international standard for a spaceflight. Flights on August 6, 13 and 15 were aborted because of weather and technical problems. Finally, on August 22 at 1805, Walker was again launched aboard X-15-3 from Smith Ranch Lake, reaching an altitude of 108 km. The experiment complement included a spectrometer and a photometer. The 11 minute 8 second long flight (3-22-36) would mark the all-time height record for the X-15. Even higher flights might have been possible but were vetoed because of concerns that a structural failure might occur during reentry.

The next year it was Joe Engle's turn to practice flight in the mesosphere, while carrying out another optical degradation experiment (1-46-73 and 1-48-75) and a horizon scanner experiment (3-30-50). An altitude buildup flight by Jack McKay on June 30, 1964 planned to go to 55 km but was abandoned when the inertial guidance failed at launch and the mission flew a conservative profile reaching only 30 km. The same thing happened to McKay the following February on flight 1-52-85, although this time he made it to 47 km following a computer malfunction. He finally reached 64 km on July 8, 1965 on flight 2-40-72 in the X-15A-2, carrying out a star tracker experiment and studying the new X-15A's landing dynamics. On May 25, 1965 Milt Thompson made it into the mesosphere on X-15-1, reaching an altitude of almost 55 km. He turned out to be the only X-15 pilot to reach 50 km without ever reaching the 80 km astronaut qualification; we can consider him as having the unique distinction of being the world's only 'mesonaut.' Engle now headed for space, with two more mesospheric flights (3-42-65 and 3-43-66) followed by a flight to 85 km on June 29, 1965 (3-44-67). These flights carried an experiment to measure boundary layer noise, a radiometer, and an experiment called the Langley scanner. Engle's next spaceflight was on August 10, 1965, again in the X-15-3, and his third was on October 14, 1965.

Both flights were to 81 km. Engle then left Edwards for Houston; he would return there from even higher altitudes in November 1981, guiding Space Shuttle Columbia to a landing on its second mission. Meanwhile, McKay flew to 90 km in September 1965. He would later retire on a medical disability as a result of long-term complications from his 1962 X-15-2 crash.

The next X-15 spaceflight was not made until November 1966, when Bill Dana flew to 93 km to collect micrometeorites. In October 1967 Pete Knight flew the X-15A-2 with ablative heat shield and external tank to a record Mach 6.7. This low altitude flight damaged the X-15A-2 and put an end to the high speed attempts. All the remaining X-15 flights were above 50 km with the exception of one test flight following the fatal Adams flight in which X-15-3 was lost. The last spaceflight of the program was made by Dana in August 1968. On December 12, 1968, the B-52 took off for the last time carrying an X-15 on what was intended to be the 200th and last free flight. Problems with the inertial system caused an abort, and the B-52 returned to Edwards. The X-15 program was over.

### The X-15 in Context

Earlier rocket-powered planes had pushed the flight envelope beyond the sound barrier and even up to Mach 3, but the X-15 went far beyond its predecessors, exceeding their speed and altitude records by a factor of two. The X-15 was the last of the high-performance aircraft pioneered at Edwards, at least until an aerospace plane along the lines of the cancelled X-30 project is developed.

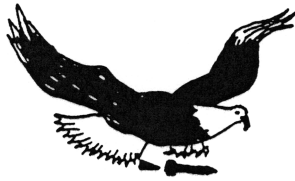
As the X-15 project closed down, the lifting body programs were in full swing. The HL-10, M2-F2/F3, and X-24A/B were launched from the B-52 over Edwards. They explored approach and landing techniques and did not reach the high altitudes and speeds of the X-15 but provided a technological bridge between the X-15 and the Space Shuttle.

I would like to acknowledge the generous help of Jack Kolf and the late Milt Thompson in the preparation of this article. ●

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# X-15 Flight Log



The High and Mighty One...



Beginning on this page, "QUEST" is pleased to present "The X-15 Flight Log" by Jonathan McDowell, the most complete flight log of the X-15 ever published. The first column in this group of tables gives the official flight designation. The designation indicates which X-15 flew the mission, whether the mission was a free flight and how many times that aircraft had been flown mated to the B-52. For instance, 1-11-21 is the 21st time the X-15-1 had been carried into the air, and its 11th free flight. Sometimes flights were cancelled after takeoff but before X-15 drop because of a problem in the countdown. These were known as aborted flights and have designations like 2-A-17. Other flights were intentional captive flights to test out some aspect of the mated NB-52/X-15 system without a free flight. These captive flights have a 'C' designation, such as 2-C-1. There were 12 captive flights. The date of the flight is given in Column 2, with the Universal Time of launch for free flights. Columns 3 and 4 give the B-52 number and site above which the X-15 was dropped. The landing site is always Rogers Dry Lake, except for the emergency landings listed in Table 2 of the preceding article. The following Columns give free flight duration (from being dropped by the B-52 to touchdown) in minutes and seconds, apogee in km, maximum speed in km/h, maximum Mach number, and engine burn duration in seconds. The three crew members are given, with the X-15 pilot first and then the two B-52 crew members. Finally the mission is summarized, indicating which program phase was involved. Note that in most cases the identity of the pilot for aborted flights is a guess based on the following free flight, except where explicit identification has been found in the quoted references.

Flight	Date	B-52	Launch <sup>a</sup>	Landing Site <sup>a</sup>	Duration	Apogee	V <sub>Maz</sub>	M <sub>Maz</sub>	Burn	Crew	Mission <sup>b</sup>	Notes <sup>c</sup>
1-C-1	1959 Mar 10	003	-	-	0				0	Crossfield	NAA LR-11 captive demo	
1-A-2	1959 Apr 1	003	-	-	0				0	Crossfield	NAA LR-11 demo	GA
1-A-3	1959 Apr 10	003	-	-	0				0	Crossfield	NAA LR-11 demo	GA
1-A-4	1959 May 21	003	-	-	0				0	Crossfield	NAA LR-11 demo	GA
1-1-5	1959 Jun 8 1638:40	003	ROS	EAFB RW35	04:56.6	11.4	840	0.79	0	Crossfield/Bock/Allavie	NAA LR-11 glide demo	G
2-C-1	1959 Jul 24	003	-	-	0				0	Crossfield	NAA LR-11 demo	
2-A-2	1959 Sep 4	003	-	-	0				0	Crossfield	NAA LR-11 demo	
2-1-3	1959 Jun 17 1608:48	003	ROS	EAFB	09:11.1	15.9	2242	2.11	224.3	Crossfield/Bock/Allavie	NAA LR-11 demo	
2-A-4	1959 Oct 10	003	-	-	0				0	Crossfield	NAA LR-11 demo	
2-A-5	1959 Oct 14	003	-	-	0				0	Crossfield	NAA LR-11 demo	
2-2-6	1959 Oct 17 1913:07	003	ROS	EAFB	09:37.7	18.8	2283	2.15	254.5	Crossfield/Allavie/Bock	NAA LR-11 demo	
2-A-7	1959 Oct 22	003	-	-	0				0	Crossfield	NAA LR-11 demo	
2-A-8	1959 Oct 31	003	-	-	0				0	Crossfield	NAA LR-11 demo	
2-3-9	1959 Nov 5 1739:28	003	ROS	ROS	05:28.0	13.9	1062	1.00	11.7	Crossfield/Fulton/Allavie	NAA LR-11 demo	
1-A-6	1959 Dec 16	003	-	-	0				0	Crossfield	NAA LR-11 demo	
1-2-7	1960 Jan 24 0017:05	008	ROS	EAFB	09:53.8	20.4	2688	2.53	267.0	Crossfield/Fulton/Kuyk	NAA LR-11 demo	
2-A-10	1960 Feb 4	008	-	-	0				0	Crossfield	NAA LR-11 demo	
2-4-11	1960 Feb 11 1815:04	008	ROS	EAFB	10:15.5	26.9	2359	2.22	258.6	Crossfield/Allavie/Fulton	NAA LR-11 demo	
2-5-12	1960 Feb 17 1741:32	008	ROS	EAFB	10:35.9	16.0	1667	1.57	332.0	Crossfield/Fulton/Allavie	NAA LR-11 demo	
2-6-13	1960 Mar 17 1631:25	008	ROS	EAFB	08:39.5	16.0	2284	2.15	233.5	Crossfield/Allavie/Kuyk	NAA LR-11 demo	
2-A-14	1960 Mar 18	008	-	-	0				0	Crossfield	NAA LR-11 demo	
1-3-8	1960 Mar 25 2343:23	008	ROS	EAFB	09:08.0	14.8	2124	2.00	272.0	Walker/Allavie/Fulton	LR-11 envelope expansion	
2-7-15	1960 Mar 29 1759:28	008	ROS	EAFB	09:10.5	15.2	2080	1.96	244.2	Crossfield/Fulton/Allavie	NAA LR-11 demo	
2-8-16	1960 Mar 31 1642:05	008	ROS	EAFB	08:56.5	15.6	2156	2.03	254.5	Crossfield/Allavie/Fulton	NAA LR-11 demo	
1-4-9	1960 Apr 13 1715:11	003	ROS	EAFB	08:52.7	14.6	2018	1.90	253.7	White/Allavie/Kuyk	LR-11 envelope expansion	
1-5-10	1960 Apr 19 1651:44	003	ROS	EAFB	09:58.6	18.1	2179	2.56	260.6	Walker/Fulton/Allavie	LR-11 envelope expansion	
2-A-17	1960 May 5	008	-	-	0				0	Crossfield	NAA LR-11 demo	
1-6-11	1960 May 6 1753:19	003	ROS	EAFB	09:23.2	18.6	2337	2.20	246.5	White/Fulton/Allavie	LR-11 envelope expansion	
1-7-12	1960 May 12 1647:37	003	SIL	EAFB	10:10.3	23.7	3396	3.19	256.3	Walker/Bock/Allavie	LR-11 envelope expansion	
1-8-13	1960 May 19 1646:47	003	SIL	EAFB	11:24.6	33.2	2559	2.31	274.6	White/Allavie/Bock	LR-11 envelope expansion	
2-9-18	1960 May 26 1708:36	008	ROS	EAFB	09:14.4	15.6	2337	2.20	243.4	Crossfield/Bock/Allavie	NAA LR-11 demo	
1-A-14	1960 May 27	003	-	-	0				0	Walker	LR-11 envelope expansion	
1-A-15	1960 Jun 3	003	-	-	0				0	Walker	LR-11 envelope expansion	
1-A-16	1960 Jun 8	003	-	-	0				0	Walker	LR-11 envelope expansion	
1-9-17	1960 Aug 4 1659:13	003	SIL	EAFB	10:22.6	23.8	3532	3.31	264.2	Walker/Allavie/Fulton	LR-11 envelope expansion	
1-A-18	1960 Aug 11	003	-	-	0				0	White	LR-11 envelope expansion	
1-10-19	1960 Aug 12 1648:43	003	SIL	EAFB	11:39.1	41.6	2853	2.52	256.2	White/Fulton/Allavie	LR-11 envelope expansion	
1-A-20	1960 Aug 18	003	-	-	0				0	Walker	LR-11 envelope expansion	
1-11-21	1960 Aug 19 1634:22	003	SIL	EAFB	09:42.4	23.1	3195	3.13	251.6	Walker/Allavie/Cole	LR-11 envelope expansion	

About the author: Jonathan McDowell has been studying the technical history of the space program since he joined the British Interplanetary Society as a teenager in London. Now resident in Cambridge, Massachusetts, he is currently researching aspects of the former Soviet space program, U.S. sounding rocket programs and other extraterrestrial arcana. Dr. McDowell publishes "Jonathan's Space Report," a weekly electronic newsletter about current space launches available from him at [jcm@urania.harvard.edu](mailto:jcm@urania.harvard.edu), and is the regular space mission columnist for "Sky & Telescope" magazine. In his spare time, Jonathan hunts for black holes and quasars using ROSAT and the Hubble Space Telescope and has published over twenty research papers in the field of astrophysics.

Flight	Date	B-52	Launch <sup>a</sup>	Landing Site <sup>a</sup>	Duration	Apogee	V <sub>Max</sub>	M <sub>Max</sub>	Burn	Crew	Mission <sup>b</sup>	Notes <sup>c</sup>	
1-A-22	1960 Sep 2			-	0				0	White	LR-11 envelope expansion		
1-12-23	1960 Sep 10	1945:10	008	SIL	EAFB	10:00.0	24.3	3512	3.23	284.3	White/Kirk/Allavie	LR-11 envelope expansion	
1-A-24	1960 Sep 20			-	0				0	Petersen	LR-11 pilot checkout		
1-13-25	1960 Sep 23	1752:06	008	PLM	EAFB RW18	07:09.6	16.1	1785	1.68	146.4	Petersen/Allavie/Fulton	LR-11 pilot checkout	
1-A-26	1960 Oct 11			-	0				0	Petersen	LR-11 pilot checkout		
2-A-19	1960 Oct 13			-	0				0	Crossfield	NAA LR-99 demo		
1-14-27	1960 Oct 20	1730:27	008	PLM	EAFB	09:26.1	16.4	2060	1.94	285.4	Petersen/Fulton/Kuyk	LR-11 pilot checkout	
1-15-28	1960 Oct 28	1743:56	008	PLM	EAFB	09:05.3	15.4	2146	2.02	267.5	McKay/Fulton/Cole	LR-11 pilot checkout	
2-A-20	1960 Nov 4			-	0				0	Crossfield	NAA LR-99 demo		
1-16-29	1960 Nov 4	2043:33	008	PLM	EAFB	08:46.3	14.9	2071	1.95	271.0	Rushworth/Fulton/Cole	LR-11 pilot checkout	
2-10-21	1960 Nov 15	1759:00	003	ROS	EAFB	08:28.4	24.7	3154	2.97	137.3	Crossfield/Allavie/Kuyk	NAA LR-99 demo	
1-17-30	1960 Nov 17	2043:07	003	PLM	EAFB	08:58.2	16.7	2018	1.90	260.4	Rushworth/Fulton/Allavie	LR-11 pilot checkout	
2-11-22	1960 Nov 22	2125:55	003	ROS	EAFB	07:31.7	18.8	2666	2.51	125.1	Crossfield/Allavie/Fulton	NAA LR-99 demo	
1-18-31	1960 Nov 30	1842:43	008	PLM	EAFB	09:53.8	14.9	1859	1.75	309.1	Armstrong/Cole/Fulton	LR-11 pilot checkout	
2-12-23	1960 Dec 6	2329:30	003	ROS	EAFB	08:07.2	16.2	3027	2.85	128.9	Crossfield/Allavie/Cole	NAA LR-99 demo	
1-19-32	1960 Dec 9	1952:40	008	PLM	EAFB	10:49.0	15.3	1912	1.80	270.1	Armstrong/Allavie/Cole	LR-11 pilot checkout	
1-A-33	1960 Dec 15			-	0				0	McKay	LR-11 pilot checkout		
1-A-34	1961 Jan 11			-	0				0	McKay	LR-11 pilot checkout		
1-20-35	1961 Feb 1	1847:32	008	PLM	EAFB	10:47.7	15.1	1950	1.88	263.5	McKay/Fulton/Lewis	LR-11 pilot checkout	
1-21-36	1961 Feb 7	2056:10	008	SIL	EAFB	10:27.8	23.8	3661	3.50	276.1	White/Fulton/Mosley	LR-11 envelope expansion	
2-A-24	1961 Feb 21			-	0				0	White?	LR-99 envelope expansion		
2-A-25	1961 Feb 24			-	0				0	White?	LR-99 envelope expansion		
2-13-26	1961 Mar 7	1828:33	008	SIL	EAFB	08:34.1	23.6	4675	4.43	127.0	White/Kuyk/Cole	LR-99 envelope expansion	
2-A-27	1961 Mar 21			-	0				0	Walker	LR-99 envelope expansion		
2-14-28	1961 Mar 30	1805:00	008	HH	EAFB	10:16.5	51.69	4443	3.95	81.9	Walker/Kuyk/Fulton	LR-99 envelope expansion	MU
2-15-29	1961 Apr 21	1805:17	008	HH	EAFB	10:03.4	32.0	4948	4.62	71.6	White/Allavie/Mosley	LR-99 envelope expansion	
2-A-30	1961 May 19			-	0				0	Walker	LR-99 envelope expansion		
2-16-31	1961 May 25	2016:35	003	MUD	EAFB	12:08.1	32.7	5322	4.95	74.3	Walker/Allavie/Fulton	LR-99 envelope expansion	
2-A-32	1961 Jun 20			-	0				0	White	LR-99 envelope expansion		
2-17-33	1961 Jun 23	2200:05	003	MUD	EAFB	10:05.7	32.8	5798	5.27	78.7	White/Allavie/Fulton	LR-99 envelope expansion	
1-22-37	1961 Aug 10	1827:05	003	SIL	EAFB	09:24.4	23.8	4400	4.11	117.7	Petersen/Allavie/Archer	LR-99 test	
2-18-34	1961 Sep 12	2240:17	008	MUD	EAFB	08:43.9	34.8	5826	5.21	115.0	Walker/Archer/Allavie	LR-99 envelope expansion	
2-19-35	1961 Sep 28	1750:25	008	HH	EAFB	08:41.6	31.0	5793	5.30	87.1	Petersen/Allavie/Archer	Research flight	
1-A-38	1961 Sep 29			-	0				0	Rushworth	Research flight		
1-23-39	1961 Oct 3	1840:50	003	SIL	EAFB	08:31.3	23.7	4554	4.30	122.0	Rushworth/Allavie/Archer	Research flight, VO	
2-20-36	1961 Oct 11	2020:00	003	MUD	EAFB	10:14.7	66.14	5864	5.21	82.5	White/Allavie/Fulton	LR-99 envelope expansion	M
1-24-40	1961 Oct 17	1857:33	003	MUD	EAFB	10:11.7	33.1	6276	5.74	84.6	Walker/Allavie/Archer	LR-99 envelope expansion	
1-A-41	1961 Oct 27			-	0				0	Petersen	Research flight		
1-A-42	1961 Nov 2			-	0				0	Petersen	Research flight		
1-A-43	1961 Nov 3			-	0				0	Petersen	Research flight		
2-21-37	1961 Nov 9	1757:17	008	MUD	EAFB	09:31.2	31.0	6589	6.04	86.9	White/Allavie/Archer	LR-99 envelope expansion	
3-A-1	1961 Dec 19			-	0				0	Armstrong	MH-96 test flight		
3-1-2	1961 Dec 20	2245:50	003	SIL	EAFB	10:25.4	24.7	4026	3.76	106.3	Armstrong/Allavie/Bement	MH-96 test flight	
1-25-44	1962 Jan 10	2028:16	003	MUD	MUD	03:45.7	13.6	1038	0.97	3.3	Petersen/Allavie/Bement	Research flight	
3-2-3	1962 Jan 17	2000:34	003	MUD	EAFB	10:27.7	40.7	6059	5.51	97.4	Armstrong/Allavie/Bement	MH-96 test flight	
3-A-4	1962 Mar 29			-	0				0	Armstrong	MH-96 test flight	MA	
3-A-5	1962 Mar 30			-	0				0	Armstrong	MH-96 test flight	MA	
3-A-6	1962 Mar 31			-	0				0	Armstrong	MH-96 test flight	MA	
3-3-7	1962 Apr 5	1904:25	003	HH	EAFB	11:17.0	54.86	4587	4.12	79.2	Armstrong/Allavie/Fulton	MH-96 test flight	M
1-A-45	1962 Apr 18			-	0				0	Walker	Research flight		
1-26-46	1962 Apr 19	1902:20	003	MUD	EAFB	08:58.9	46.9	6221	5.69	84.3	Walker/Allavie/Archer	Research flight	
3-4-8	1962 Apr 20	1926:58	008	MUD	EAFB RW35	12:28.7	63.25	6098	5.31	82.4	Armstrong/Allavie/Bement	MH-96 test flight	M
2-A-38	1962 Apr 25			-	0				0	Rushworth	Research flight		
2-A-39	1962 Apr 26			-	0				0	Rushworth	Research flight		
1-A-47	1962 Apr 27			-	0				0	Walker	Research flight		
1-27-48	1962 Apr 30	1823:20	008	MUD	EAFB	09:46.2	75.19	5615	4.94	81.6	Walker/Allavie/Bement	LR-99 envelope expansion	MA
2-22-40	1962 May 8	1801:28	008	HH	EAFB	08:50.4	21.5	5671	5.34	97.9	Rushworth/Allavie/Bement	Research flight	
1-28-49	1962 May 22	1804:46	003	HH	EAFB	09:16.2	30.6	5552	5.03	75.3	Rushworth/Allavie/Campbell	Research flight	
2-A-41	1962 May 25			-	0				0	White	Research flight		
2-A-42	1962 May 29			-	0				0	White	Research flight		
2-23-43	1962 Jun 1	1851:15	008	DDL	EAFB	10:01.9	40.4	5914	5.42	86.0	White/Fulton/Bement	Research flight	
1-29-50	1962 Jun 7	1829:20	003	HH	EAFB	08:24.2	31.6	5910	5.39	81.5	Walker/Allavie/Bement	Research flight	
3-5-9	1962 Jun 12	2004:00	008	DDL	EAFB	09:33.9	56.26	5660	5.02	81.9	White/Allavie/Fulton	Pilot checkout	M
3-6-10	1962 Jun 21	1747:05	008	DDL	EAFB	09:33.6	75.19	5859	5.08	82.3	White/Allavie/Lewis	MH-96 demo	M
1-30-51	1962 Jun 27	2108:10	003	MUD	EAFB	09:32.4	37.7	6606	5.92	88.6	Walker/Allavie/Townsend	Speed record	
2-24-44	1962 Jun 29	1841:47	008	HH	EAFB	08:53.6	25.3	5278	4.95	112.4	McKay/Allavie/Archer	Research flight	
3-A-11	1962 Jul 10			-	0				0	White	MH-96 demo	SA	
3-A-12	1962 Jul 11			-	0				0	White	MH-96 demo	SA	
3-A-13	1962 Jul 16			-	0				0	White	MH-96 demo	SA	
1-31-52	1962 Jul 16	2209:25	008	MUD	EAFB	09:37.8	32.7	5913	5.37	83.9	Walker/Allavie/Archer	Research flight	
3-7-14	1962 Jul 17	1731:10	003	DDL	EAFB	10:20.7	95.94	6167	5.45	82.0	White/Allavie/Archer	MH-96 demo	S
2-25-45	1962 Jul 19	1753:45	008	HH	EAFB	08:23.8	26.0	5590	5.18	106.2	McKay/Fulton/Bement	Research flight	
1-32-53	1962 Jul 26	1922:30	003	MUD	EAFB	10:21.6	30.1	6420	5.74	82.8	Armstrong/Fulton/Bement	Research flight	
3-A-15	1962 Aug 1			-	0				0	Walker	MH-96 tests		
3-8-16	1962 Aug 2	1756:15	003	MUD	EAFB	09:14.0	44.0	5517	5.07	80.0	Walker/Fulton/Bement	MH-96 tests	
2-26-46	1962 Aug 8	1808:35	008	HH	EAFB	07:42.8	27.7	4736	4.40	95.8	Rushworth/Fulton/Sturmthal	Research flight	
3-A-17	1962 Aug 10			-	0				0	Walker	Research flight	MA	
3-9-18	1962 Aug 14	1841:35	003	DDL	EAFB	09:04.9	59.01	6030	5.25	84.2	Walker/Fulton/Crews	Research flight	M
2-27-47	1962 Aug 20	1808:40	008	HH	EAFB	08:38.2	27.1	5689	5.24	86.5	Rushworth/Fulton/Andonian	Research flight	
2-28-48	1962 Aug 29	1836:03	008	HH	EAFB	08:47.1	29.6	5547	5.12	92.0	Rushworth/Fulton/Bement	Research flight	
2-A-49	1962 Sep 27			-	0				0	McKay	Research flight		

Flight	Date	B-52	Launch*	Landing Site*	Duration	Apogee	V <sub>Max</sub>	M <sub>Max</sub>	Burn	Crew	Mission*	Notes†
2-29-50	1962 Sep 28	1804:55	008	HH	EAFB	09:27.5	20.8	4450	4.22	128.2	McKay/Bement/Sturmthal	Research flight, VO
3-10-19	1962 Oct 4	1810:11	008	DDL	EAFB	09:50.5	34.2	5621	5.17	103.2	Rushworth/Fulton/Lewis	Research flight, VO
2-30-51	1962 Oct 9	1858:32	008	DDL	EAFB	09:40.3	39.7	5980	5.46	79.5	McKay/Fulton/Lewis	Research flight, VO
3-11-20	1962 Oct 23	1930:40	008	MUD	EAFB	09:46.3	41.0	6058	5.47	78.0	Rushworth/Bement/Cross	Research flight, VO
2-31-52	1962 Nov 9	1823:07	008	MUD	MUD	06:31.1	18.4	1640	1.49	70.5	McKay/Bement/Lewis	Research flight, VO
3- A-21	1962 Dec 13		008	-	-	0		0		0	White	Science flight
3-12-22	1962 Dec 14	1844:07	008	MUD	EAFB	09:37.1	43.1	6022	5.65	77.7	White/Bement/Cross	Science flight, VO
3-13-23	1962 Dec 20	1925:04	008	MUD	EAFB	08:54.3	48.9	6104	5.73	81.0	Walker/Bement/Fulton	Research flight, VO
3-14-24	1963 Jan 17	1859:37	008	DDL	EAFB	09:44.0	82.81	5918	5.47	81.2	Walker/Bement/Archer	Science flight, VO
1-33-54	1963 Apr 11	1803:20	008	HH	EAFB	08:56.7	22.6	4609	4.25	120.4	Rushworth/Bement/Archer	Science flight
3-15-25	1963 Apr 18	2016:17	008	HH	EAFB	07:13.2	28.2	6067	5.51	79.0	Walker/Fulton/Archer	Science flight
1-34-55	1963 Apr 25	2204:19	008	DDL	EAFB	10:32.3	32.1	5882	5.32	86.1	McKay/Bement/Fulton	Science flight
3-16-26	1963 May 2	1759:54	008	MUD	EAFB	09:17.2	63.83	5613	4.73	79.2	Walker/Bement/Archer	Science flight
3- A-27	1963 May 10		008	-	-	0		0		0	Rushworth	Science flight
3-17-28	1963 May 14	2011:56	008	HH	EAFB	07:33.1	29.1	5794	5.20	86.9	Rushworth/Bement/Archer	Science flight
1-35-56	1963 May 15	1850:46	003	DDL	EAFB	10:20.5	37.8	6206	5.57	84.1	McKay/Bement/Archer	Science flight
3-18-29	1963 May 29	1843:22	008	DDL	EAFB	11:42.5	28.0	6209	5.52	84.3	Walker/Bement/Fulton	Research flight, VO
3-19-30	1963 Jun 18	1834:21	008	DDL	EAFB	09:40.3	68.18	5695	4.97	79.3	Rushworth/Bement/Archer	Science flight
1-36-57	1963 Jun 25	1753:50	003	DDL	EAFB	09:59.3	34.1	6294	5.51	92.8	Walker/Bement/Archer	Science flight
3-20-31	1963 Jun 27	1756:03	008	DDL	EAFB	10:28.0	86.87	5512	4.89	80.1	Rushworth/Bement/Archer	Science flight
1- A-58	1963 Jul 3		008	-	-	0		0		0	Walker	Science flight
1-37-59	1963 Jul 9	2012:12	008	DDL	EAFB	08:58.0	69.00	5843	5.07	83.6	Walker/Archer/Bement	Science flight
1- A-60	1963 Jul 17		008	-	-	0		0		0	Rushworth	Research flight
1-38-61	1963 Jul 18	1807:20	003	MUD	EAFB	09:24.1	31.9	5843	5.63	84.1	Rushworth/Fulton/Bock	Research flight, VO
3-21-32	1963 Jul 19	1820:05	008	SRL	EAFB	11:24.1	106.00	5977	5.50	84.6	Walker/Fulton/Bement	Science flight, VO
3- A-33	1963 Aug 6		008	-	-	0		0		0	Walker	Science flight
3- A-34	1963 Aug 13		008	-	-	0		0		0	Walker	Science flight
3- A-35	1963 Aug 15		008	-	-	0		0		0	Walker	Science flight
3-22-36	1963 Aug 22	1805:57	008	SRL	EAFB	11:08.6	107.96	6106	5.58	85.8	Walker/Bement/Lewis	Science flight
1- A-62	1963 Oct 4		008	-	-	0		0		0	Engle	Pilot checkout
1-39-63	1963 Oct 7	2022:56	008	HH	EAFB	07:37.0	23.7	4560	4.21	118.6	Engle/Bement/Jones	Pilot checkout
3- A-37	1963 Oct 14		008	-	-	0		0		0	Rushworth	Science flight
1-40-64	1963 Oct 29	2042:34	008	HH	EAFB	08:43.0	22.7	4364	4.10	126.1	Thompson/Fulton/Jones	Pilot checkout
3- A-38	1963 Oct 25		008	-	-	0		0		0	Rushworth	Science flight
3-23-39	1963 Nov 7	1811:14	008	HH	EAFB	08:51.7	25.1	4707	4.40	108.2	Rushworth/Bement/Jones	Science flight, sharp fin
1-41-65	1963 Nov 14	1919:21	008	HH	EAFB	07:46.8	27.6	5288	4.75	83.1	Engle/Bement/Jones	Pilot checkout
3- A-40	1963 Nov 19		008	-	-	0		0		0	Thompson	Pilot checkout
3-24-41	1963 Nov 27	2017:40	008	HH	EAFB	07:04.3	27.3	5326	4.94	87.5	Thompson/Fulton/Lewis	Pilot checkout
1- A-66	1963 Dec 3		008	-	-	0		0		0	Rushworth	Science flight
1-42-67	1963 Dec 5	1904:36	008	DDL	EAFB	09:34.0	30.7	6466	6.06	81.2	Rushworth/Bement/Jones	Science flight
1- A-68	1963 Dec 18		008	-	-	0		0		0	Engle	Research flight
1-43-69	1964 Jan 8	2010:31	008	MUD	EAFB	08:50.7	42.6	5819	5.32	74.4	Engle/Fulton/Lewis	Research flight
3-25-42	1964 Jan 16	1803:30	008	HH	EAFB	08:17.0	21.6	5217	4.92	90.5	Thompson/Fulton/Lewis	Science flight, sharp fin
1-44-70	1964 Jan 28	2011:36	008	DDL	EAFB	10:25.5	32.7	5823	5.34	76.2	Rushworth/Bement/Branch	Research flight
3-26-43	1964 Feb 19	1757:24	003	HH	EAFB	07:03.1	23.9	5663	5.29	83.3	Thompson/Fulton/Jones	Science flight, sharp fin
3-27-44	1964 Mar 13	1746:27	003	HH	EAFB	07:29.0	23.1	5458	5.11	105.0	McKay/Bement/Lewis	Science flight, sharp fin
1- A-71	1964 Mar 17		008	-	-	0		0		0	Rushworth	Science flight
1-45-72	1964 Mar 27	1810:18	003	DDL	EAFB	09:52.4	30.9	6159	5.63	82.7	Rushworth/Bement/Lewis	Science flight
3- A-45	1964 Mar 31		008	-	-	0		0		0	McKay	Science flight
1-46-73	1964 Apr 8	1802:27	003	DDL	EAFB	09:45.7	53.34	5581	5.01	79.6	Engle/Bement/Fulton	Science flight
1-47-74	1964 Apr 29	1800:27	003	DDL	EAFB	09:34.6	31.0	6288	5.72	81.3	Rushworth/Fulton/Bock	Science flight
3- A-46	1964 May 11		008	-	-	0		0		0	McKay	Science flight
3-28-47	1964 May 12	1751:46	003	HH	EAFB	08:11.3	22.1	4963	4.66	108.6	McKay/Bement/Jones	Science flight, sharp fin
1-48-75	1964 May 19	1826:28	003	DDL	EAFB	09:01.2	59.67	5623	5.02	78.0	Engle/Fulton/Jones	Science flight
3-29-48	1964 May 21	1739:34	003	SIL	CUD	07:56.5	19.5	3001	2.90	41.0	Thompson/Fulton/Jones	Science flight, sharp fin
2- C-53	1964 Jun 15		008	-	-	0		0		0	Rushworth	X-15A-2 captive checkout
2- A-54	1964 Jun 23		008	-	-	0		0		0	Rushworth	X-15A-2 test flight
2-32-55	1964 Jun 25	1734:47	003	HH	EAFB	08:54.7	25.3	4995	4.59	77.0	Rushworth/Fulton/Bement	X-15A-2 test flight
1- A-76	1964 Jun 11		008	-	-	0		0		0	McKay	Science flight
1-49-77	1964 Jun 30	1749:40	003	DDL	EAFB	11:27.0	30.4	5365	4.96	83.4	McKay/Fulton/Lewis	Science flight
3- A-49	1964 Jul 2		008	-	-	0		0		0	Engle	Science flight
3-30-50	1964 Jul 8	2102:52	003	DDL	EAFB	10:03.6	51.93	5665	5.05	78.3	Engle/Bement/Lewis	Science flight
3- A-51	1964 Jul 28		008	-	-	0		0		0	Engle	Science flight
3-31-52	1964 Jul 29	1955:19	003	HH	EAFB	07:49.0	23.7	5831	5.38	93.6	Engle/Bement/Fulton	Science flight
3-32-53	1964 Aug 12	1812:33	003	HH	EAFB	06:42.8	24.7	5689	5.24	82.1	Thompson/Bement/Fulton	Science flight
2-33-56	1964 Aug 14	1754:19	003	DDL	EAFB	12:06.3	31.4	5777	5.23	80.3	Rushworth/Fulton/Bement	X-15A-2 test flight
3-33-54	1964 Aug 26	1842:07	003	HH	EAFB	07:19.7	27.7	6216	5.65	94.4	McKay/Fulton/Bement	Science flight
3-34-55	1964 Sep 3	1754:54	003	HH	EAFB	06:20.0	23.9	5817	5.35	91.0	Thompson/Bement/Jones	Science flight
3- A-56	1964 Sep 23		008	-	-	0		0		0	Engle	Science flight
3-35-57	1964 Sep 23	2116:00	003	DDL	EAFB	09:34.3	29.5	6257	5.59	80.3	Engle/Fulton/Lewis	Science flight
2-34-57	1964 Sep 29	2100:13	008	MUD	EAFB	09:51.0	29.8	5700	5.20	79.7	Rushworth/Fulton/Townsend	X-15A-2 test flight
1- A-78	1964 Oct 2		008	-	-	0		0		0	McKay	Science flight
1-50-79	1964 Oct 15	2115:40	008	HH	EAFB	08:40.9	25.8	4905	4.56	72.9	McKay/Fulton/Cotton	Science flight, TP
3- C-58	1964 Oct 29		008	-	-	0		0		0	Thompson	Landing gear mod test
3-36-59	1964 Oct 30	1751:52	008	HH	EAFB	07:10.8	25.7	5009	4.66	74.4	Thompson/Bement/Lewis	Science flight
2- C-58	1964 Nov 6		008	-	-	0		0		0	McKay	Landing gear mod test
2- C-59	1964 Nov 16		008	-	-	0		0		0	McKay	Landing gear mod test
2-35-60	1964 Nov 30	2009:32	008	HH	EAFB	08:34.8	26.5	4971	4.66	75.3	McKay/Bement/Bock	X-15A-2 test flight
1- A-80	1964 Dec 4		008	-	-	0		0		0	Engle	Science flight
3-37-60	1964 Dec 9	1836:17	008	HH	EAFB	06:25.7	28.1	5991	5.42	101.4	Thompson/Fulton/Lewis	Science flight



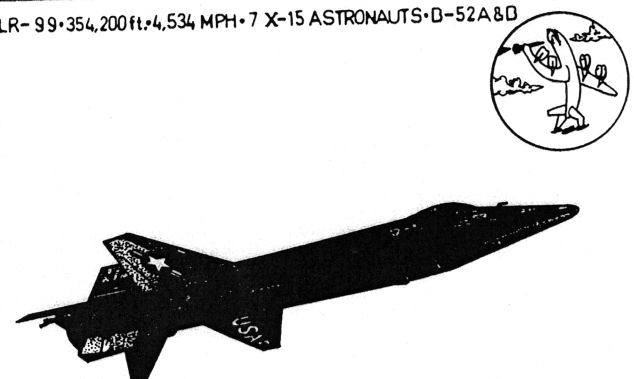
Flight	Date	B-52	Launch <sup>a</sup>	Landing Site <sup>a</sup>	Duration	Apogee	V <sub>Max</sub>	M <sub>Max</sub>	Burn	Crew	Mission <sup>b</sup>	Notes <sup>c</sup>
1-51-81	1964 Dec 10	1910:26	003 DDL	EAFB	09:44.7	34.5	5914	5.35	80.5	Engle/Fulton/Bock	Science flight, TP	
3-38-61	1964 Dec 22	1844:52	003 HH	EAFB	07:51.0	24.7	5782	5.55	88.0	Rushworth/Fulton/Bock	Science flight	
3-39-62	1965 Jan 13	1851:06	003 HH	EAFB	06:47.6	30.3	5975	5.48	98.5	Thompson/Bement/Fulton	Science flight	MA
1-A-82	1965 Jan 26				0				0	McKay	Science flight	
3-40-63	1965 Feb 2	2050:14	008 DDL	EAFB	09:58.4	29.9	6252	5.71	81.4	Engle/Fulton/Bement	Science flight, M25S	
2-C-61	1965 Feb 15				0				0	Rushworth	Landing gear mod test	
2-C-62	1965 Feb 15				0				0	Rushworth	Landing gear mod test	
2-36-63	1965 Feb 17	1844:59	008 MUD	EAFB	09:20.3	29.0	5695	5.27	79.8	Rushworth/Fulton/Bement	X-15A-2 test flight	MA
1-A-83	1965 Feb 19				0				0	McKay	Science flight	MA
1-A-84	1965 Feb 25				0				0	McKay	Science flight	MF
1-52-85	1965 Feb 26	1945:55	008 DDL	EAFB	09:24.7	46.8	5957	5.40	83.2	McKay/Fulton/Bock	Science flight	
1-53-86	1965 Mar 26	1901:59	008 DDL	EAFB	11:24.3	31.0	5761	5.17	79.6	Rushworth/Fulton/Bock	Science flight	
3-41-64	1965 Apr 23	1744:16	008 HH	EAFB	07:42.1	24.2	5885	5.48	91.4	Engle/Fulton/Cotton	Science flight	
2-37-64	1965 Apr 28	2026:20	008 HH	EAFB	08:02.6	28.2	5246	4.80	78.9	McKay/Bock/Townsend	X-15A-2 test flight	
2-A-65	1965 May 13				0				0	McKay	X-15A-2 test flight	
2-38-66	1965 May 18	1756:38	008 MUD	EAFB	09:42.0	31.1	5698	5.17	78.9	McKay/Fulton/Jones	Science flight	MA
1-A-87	1965 May 11				0				0	Thompson	Science flight	M
1-54-88	1965 May 25	1812:07	008 MUD	EAFB	09:02.0	54.80	5501	4.87	81.1	Thompson/Fulton/Jones	Science flight	M
3-42-65	1965 May 28	1743:51	008 DDL	EAFB	09:35.1	63.88	6041	5.17	82.5	Engle/Fulton/Jones	Science flight	
2-A-67	1965 Jun 4				0				0	McKay	X-15A-2 test flight	
2-A-68	1965 Jun 8				0				0	McKay	X-15A-2 test flight	
2-A-69	1965 Jun 11				0				0	McKay	X-15A-2 test flight	
3-43-66	1965 Jun 16	1826:33	003 DDL	EAFB	09:45.0	74.58	5478	4.69	77.8	Engle/Fulton/Cretney	Science flight	M
1-55-89	1965 Jun 17	1740:31	008 DDL	EAFB	08:54.0	33.0	5698	5.14	82.2	Thompson/Fulton/Cotton	Science flight	
2-39-70	1965 Jun 22	1744:43	008 DDL	EAFB	09:47.7	47.5	6337	5.64	85.3	McKay/Fulton/Bock	X-15A-2 test flight	S
3-44-67	1965 Jun 29	1821:17	008 DDL	EAFB	10:32.4	85.52	5523	4.94	81.0	Engle/Fulton/Andonian	Science flight	MA
2-A-71	1965 Jul 2				0				0	McKay	X-15A-2 test flight	M
2-40-72	1965 Jul 8	1716:55	003 DDL	EAFB	09:33.4	64.80	5888	5.19	82.9	McKay/Fulton/Cotton	Science flight	
3-A-68	1965 Jul 13				0				0	Rushworth	Science flight	
3-45-69	1965 Jul 20	1759:28	008 DDL	EAFB	10:34.5	32.1	5964	5.40	79.5	Rushworth/Jones/Andonian	Science flight	
1-A-90	1965 Jul 23				0				0	Thompson	Science flight	
1-A-91	1965 Jul 27				0				0	Thompson	Science flight	
1-A-92	1965 Jul 28				0				0	Thompson	Science flight	
2-41-73	1965 Aug 3	2040:05	008 DDL	EAFB	09:32.0	63.61	5796	5.16	82.4	Rushworth/Bock/Andonian	X-15A-2 test flight	M
1-56-93	1965 Aug 6	1741:46	008 DDL	EAFB	10:13.0	31.4	5687	5.15	83.0	Thompson/Fulton/Andonian	Science flight	S
3-46-70	1965 Aug 10	1924:21	003 DDL	EAFB	09:52.1	82.60	5713	5.20	82.1	Engle/Jones/Andonian	Science flight	MA
1-A-94	1965 Aug 20				0				0	Thompson	Science flight	MA
1-A-95	1965 Aug 24				0				0	Thompson	Science flight	M
1-57-96	1965 Aug 25	1754:46	003 DDL	EAFB	08:51.7	65.25	5800	5.11	84.5	Thompson/Fulton/Cotton	Science flight	M
3-47-71	1965 Aug 26	1752:12	008 DDL	EAFB	10:27.5	73.03	5426	4.79	78.6	Rushworth/Cotton/Bock	Science flight	M
2-42-74	1965 Sep 2	1740:05	008 DDL	EAFB	09:12.8	73.09	5745	5.16	84.0	McKay/Bock/Jones	X-15A-2 test flight	M
1-58-97	1965 Sep 9	1755:50	008 DDL	EAFB	11:10.2	29.6	5687	5.25	82.1	Rushworth/Bock/Fulton	Science flight	
3-48-72	1965 Sep 14	1801:06	008 DDL	EAFB	09:58.0	72.84	5663	5.03	80.9	McKay/Bock/Jones	Science flight	M
1-59-98	1965 Sep 22	1858:39	003 DDL	EAFB	10:54.3	30.5	5713	5.18	82.0	Rushworth/Bock/Jones	Science flight	
3-49-73	1965 Sep 28	1807:37	003 DDL	EAFB	11:56.0	90.09	6006	5.33	80.8	McKay/Bock/Andonian	Science flight	SU
1-60-99	1965 Sep 30	1743:55	003 HH	EAFB	08:22.6	23.3	4374	4.06	127.4	Knight/Bock/Fulton	Pilot checkout	MA
1-A-100	1965 Oct 8				0				0	Engle	Science flight	
3-50-74	1965 Oct 12	1743:13	008 HH	EAFB	07:06.1	28.7	5015	4.62	86.2	Knight/Jones/Fulton	Pilot checkout	SU
1-61-101	1965 Oct 14	2046:32	003 DDL	EAFB	09:27.7	81.22	5719	5.08	84.8	Engle/Bock/Jones	Science flight	M
3-51-75	1965 Oct 27	1849:10	003 DDL	EAFB	11:51.2	72.20	5705	5.06	75.6	McKay/Fulton/Jones	Pilot checkout	
1-A-102	1965 Nov 2				0				0	Dana	ET test flight	
2-43-75	1965 Nov 3	1709:10	003 HH	EAFB	05:01.6	21.5	2436	2.31	84.1	Rushworth/Bock/Doryland	ET test flight	
1-62-103	1965 Nov 4	1711:31	008 HH	EAFB	08:45.2	24.4	4449	4.22	124.2	Dana/Bock/Doryland	Pilot checkout	
2-A-76	1966 Apr 13				0				0	Rushworth	ET test flight	
2-A-77	1966 Apr 20				0				0	Rushworth	ET test flight	
2-A-78	1966 May 5				0				0	Rushworth	ET test flight	
1-63-104	1966 May 6	2130:12	003 DDL	EAFB	06:02.7	20.8	2336	2.21	35.4	McKay/Fulton/Doryland	Science flight	MF
2-44-79	1966 May 18	1824:00	003 MUD	EAFB	08:56.8	30.1	5957	5.43	81.9	Rushworth/Fulton/Doryland	ET test flight	
1-A-105	1966 Jun 2				0				0	Knight	Pilot checkout	
1-A-106	1966 Jun 10				0				0	Knight	Pilot checkout	
3-A-76	1966 Jun 20				0				0	Dana	Pilot checkout	
2-C-80	1966 Jun 27				0				0	Rushworth	ET captive test	
2-45-81	1966 Jul 1	1902:36	008 MUD	EAFB	04:28.6	13.7	1815	1.70	33.2	Rushworth/Fulton/Doryland	ET test flight	
1-64-107	1966 Jul 12	1932:15	003 MUD	EAFB	08:36.0	39.6	5891	5.34	83.2	Knight/Fulton/Bowline	Pilot checkout, science	
3-A-77	1966 Jul 13				0				0	Dana	Pilot checkout	
3-52-78	1966 Jul 18	1938:24	003 HH	EAFB	07:30.0	29.3	5158	4.71	95.5	Dana/Fulton/Doryland	Pilot checkout, science	MA
2-A-82	1966 Jul 20				0				0	Knight	Science flight	M
2-46-83	1966 Jul 21	2002:03	003 DDL	EAFB	08:51.0	58.61	5742	5.12	81.3	Knight/Doryland/Bowline	Science flight	M
1-65-108	1966 Jul 28	1801:12	008 DDL	EAFB	09:43.0	73.70	5957	5.19	85.4	McKay/Fulton/Bowline	Science flight	M
2-47-84	1966 Aug 3	1645:26	008 DDL	EAFB	09:05.5	75.89	5595	5.03	81.8	Knight/Doryland/Bowline	Science flight	
3-53-79	1966 Aug 4	1754:43	008 MUD	EAFB	08:27.6	40.4	5943	5.34	78.9	Dana/Doryland/Bowline	Pilot checkout, science	MA
1-A-109	1966 Aug 9				0				0	McKay	Science flight	MA
1-A-110	1966 Aug 10				0				0	McKay	Science flight	M
1-66-111	1966 Aug 11	1744:13	003 DDL	EAFB	09:22.2	76.50	5777	5.21	84.8	McKay/Doryland/Bowline	Science flight	M
2-48-85	1966 Aug 12	1825:33	003 DDL	EAFB	08:39.4	70.43	5589	5.02	81.7	Knight/Doryland/Bowline	Science flight	M
3-54-80	1966 Aug 19	1804:35	003 DDL	EAFB	09:32.7	54.25	5805	5.20	75.8	Dana/Fulton/Bowline	Science flight	M
1-67-112	1966 Aug 25	1749:11	003 DDL	EAFB	10:16.2	78.48	5701	5.11	83.4	McKay/Doryland/Bowline	Science flight	M
2-49-86	1966 Aug 30	1751:37	008 MUD	EAFB	08:49.9	31.1	5701	5.21	80.5	Knight/Doryland/Cotton	Science flight	
1-68-113	1966 Sep 8	1839:16	008 SRL	SRL	06:24.5	22.3	2584	2.44	45.5	McKay/Doryland/Cotton	Science flight	MF
3-A-81	1966 Sep 13				0				0	Dana	Science flight	MA

Flight	Date	B-52	Launch*	Landing Site*	Duration	Apogee	V <sub>Max</sub>	M <sub>Max</sub>	Burn	Crew	Mission <sup>b</sup>	Notes <sup>c</sup>	
3-55-82	1966 Sep 14	2001:29	003	DDL	EAFB	08:57.5	77.48	5782	5.12	79.3	Dana/Doryland/Cotton	Science flight, TP	M
1-A-114	1966 Sep 28	-	-	-	-	0	-	-	-	0	Adams	Pilot checkout	
1-A-115	1966 Oct 4	-	-	-	-	0	-	-	-	0	Adams	Pilot checkout	
1-69-116	1966 Oct 6	2016:59	003	HH	CUD	08:26.4	23.0	3181	3.00	89.9	Adams/Doryland/Cotton	Pilot checkout	
2-A-87	1966 Oct 7	-	-	-	-	0	-	-	-	0	Knight	ET test flight	
2-A-88	1966 Oct 19	-	-	-	-	0	-	-	-	0	Knight	ET test flight	
3-56-83	1966 Nov 1	2124:12	003	SRL	EAFB	10:43.5	93.54	6089	5.46	82.8	Dana/Doryland/Reschke	Science flight, TP	S
3-A-84	1966 Nov 18	-	-	-	-	0	-	-	-	0	Adams	Pilot checkout	
2-50-89	1966 Nov 18	2124:07	008	MUD	EAFB	08:26.8	30.1	6857	6.33	136.4	Knight/Fulton/Cotton	ET test flight	
3-A-85	1966 Nov 23	-	-	-	-	0	-	-	-	0	Adams	Pilot checkout	
3-57-85	1966 Nov 29	1938:32	003	HH	EAFB	07:55.9	28.1	5021	4.65	97.9	Adams/Fulton/Cotton	Science flight, TP	
2-C-90	1966 Dec 22	-	-	-	-	0	-	-	-	0	Knight?	Thermocouple checkout	
1-A-117	1967 Mar 15	-	-	-	-	0	-	-	-	0	Adams	Science flight	
1-A-118	1967 Mar 21	-	-	-	-	0	-	-	-	0	Adams	Science flight	
1-70-119	1967 Mar 22	1752:04	003	MUD	EAFB	09:27.9	40.5	6150	5.59	79.7	Adams/Cotton/Reschke	Science flight	MA
1-A-120	1967 Apr 20	-	-	-	-	0	-	-	-	0	Adams	Science flight	
3-58-87	1967 Apr 26	1920:17	008	SIL	SIL	05:16.7	16.2	1915	1.80	23.2	Dana/Cotton/Bowline	Science flight, TP	M
1-71-121	1967 Apr 28	1723:32	003	DDL	EAFB	09:16.0	50.96	6007	5.44	82.0	Adams/Cotton/Bowline	Science flight	
2-A-91	1967 May 5	-	-	-	-	0	-	-	-	0	Knight	Ramjet test flight	
2-51-92	1967 May 8	1927:38	008	HH	EAFB	08:31.5	29.7	5157	4.75	76.9	Knight/Cotton/Reschke	Ramjet test flight, TP	
3-A-88	1967 May 12	-	-	-	-	0	-	-	-	0	Dana	Science flight	
3-59-89	1967 May 17	1745:48	003	SIL	EAFB	06:55.6	21.6	5112	4.80	96.1	Dana/Reschke/Cotton	Science flight, TP	
1-A-122	1967 May 25	-	-	-	-	0	-	-	-	0	Adams	Science flight	MA
1-A-123	1967 Jun 1	-	-	-	-	0	-	-	-	0	Adams	Science flight	MA
1-A-124	1967 Jun 14	-	-	-	-	0	-	-	-	0	Adams	Science flight	MA
1-72-125	1967 Jun 15	1809:28	003	DDL	EAFB	09:11.0	69.89	5803	5.14	81.4	Adams/Cotton/Reschke	Science flight	M
3-60-90	1967 Jun 22	2157:17	008	HH	EAFB	07:06.5	25.0	5811	5.34	93.2	Dana/Cotton/Sturmthal	Science flight	
1-73-126	1967 Jun 29	1827:51	008	SRL	MUD	10:07.0	52.73	4618	4.23	67.6	Knight/Reschke/Sturmthal	Science flight	
3-61-91	1967 Jul 20	1711:00	008	HH	EAFB	07:36.5	25.6	5943	5.44	92.1	Dana/Cotton/Fulton	Science flight, TP	
2-C-93	1967 Aug 7	-	-	-	-	0	-	-	-	0	Knight	Systems checkout with ATPS	
2-A-94	1967 Aug 11	-	-	-	-	0	-	-	-	0	Knight	Ramjet, ATPS, TP	
2-A-95	1967 Aug 16	-	-	-	-	0	-	-	-	0	Knight	Ramjet, ATPS, TP	
2-52-96	1967 Aug 21	1759:16	008	HH	EAFB	07:40.0	27.7	5420	4.94	82.2	Knight/Cotton/Reschke	Science flight, TP	
3-62-92	1967 Aug 25	2027:28	003	HH	EAFB	07:37.0	25.7	5013	4.63	71.3	Adams/Bowline/Reschke	Science flight, TP	
3-A-93	1967 Sep 22	-	-	-	-	0	-	-	-	0	Dana	Science flight	MA
2-53-97	1967 Oct 3	2131:50	008	MUD	EAFB RW18	08:17.0	31.1	7274	6.70	140.7	Knight/Cotton/Reschke	ET, Ramjet, ATPS, TP	
3-63-94	1967 Oct 4	1716:54	003	SRL	EAFB	10:46.0	76.53	6292	5.53	84.7	Dana/Cotton/Reschke	Science flight, TP	M
3-64-95	1967 Oct 17	1640:23	008	SRL	EAFB	10:06.3	85.49	6226	5.53	84.2	Knight/Reschke/Miller	Science flight, TP	S
3-A-96	1967 Oct 31	-	-	-	-	0	-	-	-	0	Adams	Science flight	MA
3-65-97	1967 Nov 15	1830:07	008	DDL	[nr CUD]	04:51.4	81.07	5820	5.20	82.3	Adams/Cotton/Miller	Science flight, TP	SU
1-C-127	1968 Feb 6	-	-	-	-	0	-	-	-	0	Dana	Post 1-73-136 electrical test	
1-A-128	1968 Feb 7	-	-	-	-	0	-	-	-	0	Dana	Test flight	
1-A-129	1968 Feb 27	-	-	-	-	0	-	-	-	0	Dana	Test flight	
1-74-130	1968 Mar 1	1928:11	008	HH	EAFB	07:35.1	31.8	4630	4.36	65.6	Dana/Cotton/Stroup	Science flight	MA
1-A-131	1968 Mar 28	-	-	-	-	0	-	-	-	0	Dana	Science flight	MA
1-A-132	1968 Apr 4	-	-	-	-	0	-	-	-	0	Dana	Science flight	M
1-75-133	1968 Apr 4	1802:17	008	DDL	EAFB	09:22.8	57.15	5848	5.27	78.8	Dana/Cotton/Sturmthal	Science flight, TP	M
1-76-134	1968 Apr 26	1951:49	008	DDL	EAFB	09:17.1	63.88	5705	5.05	81.5	Knight/Sturmthal/Reschke	Science flight	MA
1-A-135	1968 May 23	-	-	-	-	0	-	-	-	0	Dana	Science flight	M
1-77-136	1968 Jun 12	1531:01	008	SRL	EAFB	11:28.0	67.08	5738	5.15	83.4	Dana/Cotton/Reschke	Science flight	MA
1-A-137	1968 Jun 15	-	-	-	-	0	-	-	-	0	Knight	Science flight	M
1-78-138	1968 Jul 16	2223:06	003	RRV	EAFB	09:42.3	67.51	5409	4.79	80.5	Knight/Sturmthal/Reschke	Science flight	SU
1-79-139	1968 Aug 21	1604:48	003	RRV	EAFB	09:23.0	81.53	5540	5.01	82.9	Dana/Sturmthal/Fulton	Science flight	M
1-80-140	1968 Sep 13	1819:23	003	SRL	EAFB	10:55.5	77.44	5991	5.37	84.3	Knight/Sturmthal/Miller	Science flight	M
1-81-141	1968 Oct 24	1702:47	003	SRL	EAFB	11:28.3	77.72	5980	5.38	83.8	Dana/Sturmthal/Miller	Science flight	M
1-A-142	1968 Dec 12	-	-	-	-	0	-	-	-	0	Knight	Science flight	MA

\* Launch and landing sites (see also Table 1 of the preceding article): CUD Cuddeback Lake; DDL Delamar Dry Lake; EAFB Edwards Air Force Base; HH Hidden Hills; MUD Mud Lake; PLM Palmdale; ROS Rosemead Dry Lake; RRV Railroad Valley; SIL Silver Lake; SRL Smith Ranch Lake.  
<sup>b</sup> NAA: North American Aviation (X-15 manufacturer); LR-11: early X-15 rocket engine; LR-99: Operational X-15 rocket engine; MH-96: Experimental X-15 guidance system; ATPS: Ablative thermal protection system; TP: Wing tip pod; ET: External tanks; VO: Ventral off.  
<sup>c</sup> S: Spaceflight; M: Mesospheric flight; F: Failed to reach intended altitude; A: Flight aborted before launch; U: Unintentionally high altitude flight; G: Planned glide flight.

THOMPSON, KNIGHT, ADAMS: SN 56-6670; SN 56-6671; SN 56-6672

XLR-99-354, 200 ft., 4,534 MPH • 7 X-15 ASTRONAUTS • D-52A & B



AD INEXPLORATA

The High and Mighty One... X-15

CROSSFIELD WALKER, WHITE PETERSEN, MCKAY, RUSHWORTH, ARMSTRONG, ENGLE, DANA

**Original X-15 Drawings For Sale**

Writer/artist Barry E. DiGregorio has created an original pen and ink drawing commemorating the X-15 program. Shown at left, the drawing includes an information border that lists all X-15 pilots, the 3 serial numbers of the 3 X-15's, the maximum altitude the X-15 achieved, maximum speed and the B-52 launch aircraft. In the upper right hand portion is shown the logo that the B-52A carried as nose art. It shows the B-52 throwing the X-15. On the lower right hand portion is the logo and nose art of the B-52B launch vehicle depicting an American Eagle launching an X-15 with the words "The High and Mighty One!" Finally, on the vertical right hand border are included the words "Ad Inexplorata," which means towards the unknown - the motto of all research pilots. Limited edition (250 copies) 9" x 12" prints of this original drawing are available for \$15 each plus \$2.50 shipping & handling. All prints will be hand signed and numbered by the artist. Send all orders to: Barry E. DiGregorio, 16 North Hartland Street, Middleport, NY 14105.