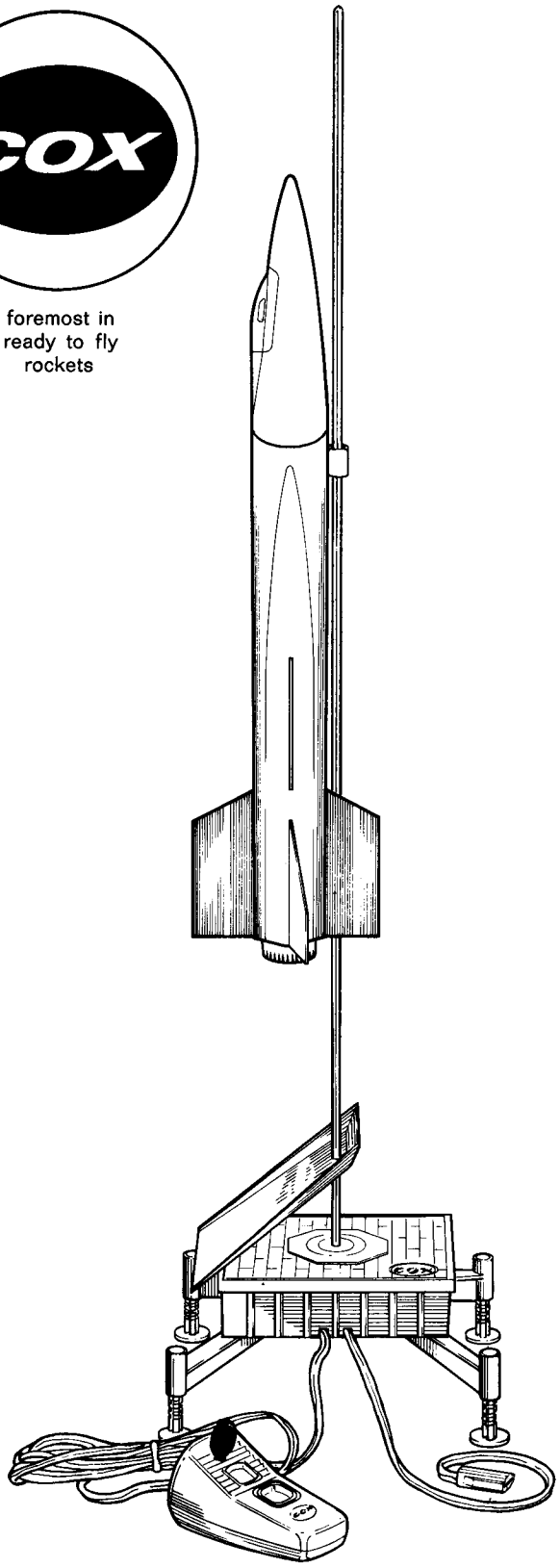
OFFICIAL ROCKET FLIGHT MANUAL

COX

foremost in ready to fly rockets



NASA X-15

1/48 SCALE

IMPORTANT

Cox's model of NASA's X-15 rocket plane cannot and is not intended to glide like the real X-15. It is designed only for parachute recovery! In reality, the actual X-15 rocket plane was not much of a "glider" either. Its landing approach was performed "dead stick" or without any power like a glider, but its final rate of descent was four miles per minute and its touch down speeds were over 200 miles per hour! Not much of a soaring ship to say the least!

For more interesting data on the actual NASA X-15 vehicle refer to the enclosed X-15 HISTORICAL HIGHLIGHTS brochure. The brochure contains actual landing photos and also shows how the real X-15 was air dropped from a 500 mile per hour B-52 jet at an altitude of 45,000 feet. It left the B-52 horizontally and then began climbing rapidly up to the threshhold of outer space as speed built up.

Note that your Cox X-15 is designed only for vertical launches by remote electrical rocket engine ignition. Also a three foot long launch rod must be used to keep your X-15 pointed in the proper direction during the first few moments of high thrust acceleration after ignition. The primary reason for this form of initial guidance is that a sufficiently high speed must be reached BEFORE the aerodynamic fins can be effective in keeping your miniature X-15 stable and pointed straight up.

In order to obtain the full reliability designed into your Cox X-15 you should study the remaining pages of this Rocket Manual along with the separate instructions contained with Cox engines and Cox launching systems. If you follow these instructions and suggestions carefully, your X-15 rocket will easily give you hundreds of enjoyable flights. For those who would like to give their Cox X-15 model the complete authentic appearance of the real X-15 rocket plane we have provided a set of the necessary decals. Refer to the NASA X-15 EXTERIOR MARKINGS SHEET for proper decal locations.

ADULT SUPERVISION IS RECOMMENDED WHEN FLYING MODEL ROCKETS

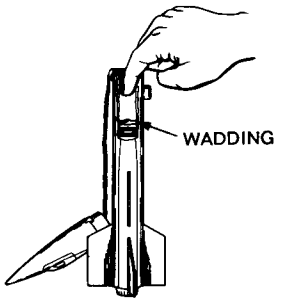
Some states require a minimum area of 5,000 square yards of clear area as a rocket launch site. If in doubt about your State's requirements, contact your local Fire Marshal.

PREPARING THE X-15 FOR FLIGHT

1 INSERT WADDING

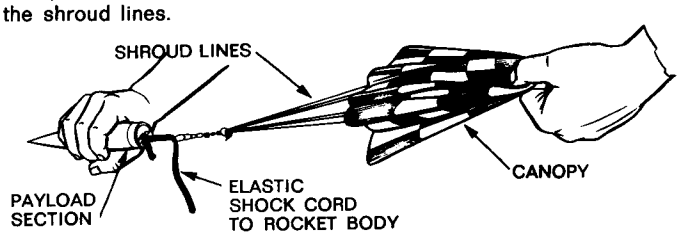
LAY a single layer (1" square) of the flameproof wadding (supplied with Cox Model Rockets) down into the rocket body so it rests on the parachute bulkhead. The wadding is used to provide a gas seal around the edges adjacent to the body.

Thus, instead of leaking past and melting the parachute, the hot ejection charge gases push against the wadding making it work as a piston. This piston-like action separates the nose cone from the rocket body to deploy the recovery system.



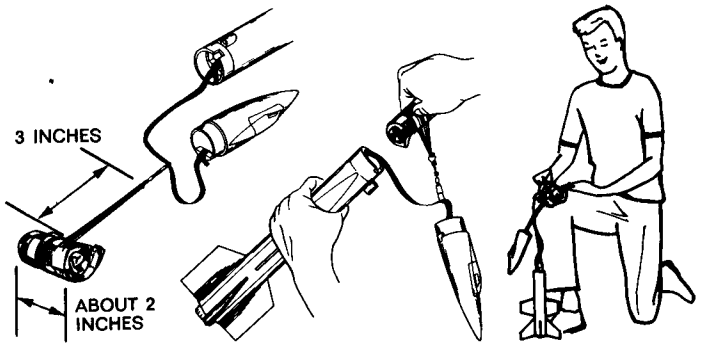
2 PACK PARACHUTE

Grasp the center of the parachute canopy as shown and untangle the shroud lines.



Then, starting from the center of the canopy, tightly roll up the parachute and shroud lines to form a small circular cylinder about 2 inches long. As shown below, your knee can be used as a "handy field bench" when rolling up the parachute.

Leave about three inches of the shroud lines unrolled.



Next insert the parachute into the rocket body. Remember the parachute must fit loosely for easy ejection.

Finally insert the elastic shock cord and remaining shroud lines into the body so that the nose can be mated to the rocket body (using the notch as an alignment guide). Avoid jamming any shroud line, or plastic parachute material between the main body and the nose cone as this extra friction may prevent the nose cone from blowing off.

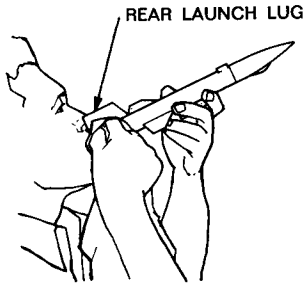
It is recommended that prior to first flight, you lightly rub talcum powder or cornstarch onto both sides of the parachute surface. This prevents the parachute folds from sticking to one another which helps insure positive chute opening.

After a series of flights, carbon residue from the ejection charge builds up on the payload section — body tube mating surfaces. To assure consistent smooth separation, occasionally clean these surfaces by washing them with a wet rag, tissue, or wadding.

In addition to the above, one special parachute packing rule must be observed. Do not prepack the parachute at home before going out to launch. Plastic parachutes tend to retain their folded shape and may not fully deploy if they sit tightly packed for more than half an hour.

3 PREFLIGHT TEST

Prior to first flight, pretest your parachute packing technique by blowing a hard puff of air into the X-15 as shown to simulate the action of the engine's ejection charge. If you can't blow the parachute out, it means everything is too jammed in. Don't expect the engine to be able to blow the recovery system out in flight if you can't!



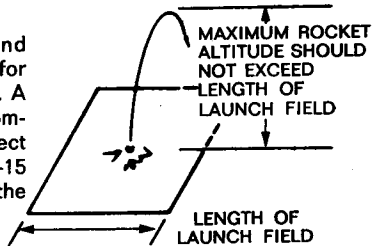
Reread wadding and parachute packing steps 1 and 2 if necessary.

NOTE: To prevent most of the air puff from escaping out the side, use a handkerchief to seal the rear launch lug holes when performing the chute deployment test.

4 SELECT ENGINE

The Performance Chart on the previous page gives the altitude you can expect your X-15 to reach. As you can see, altitude depends on the type of engine used (Bravo or Charlie). The more total energy available in the engine (called Total Impulse) the higher the rocket goes.

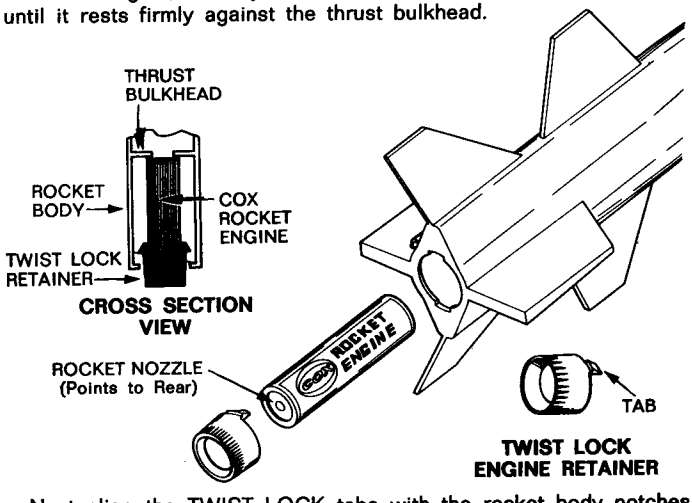
Available **flying site size** and **winds** are two good reasons for reducing the engine power used. A general rule of thumb for newcomers to rocketry to follow is to select an engine which will lift the X-15 to an altitude **no greater** than the **length** of your flying site.



The above rule of thumb for a flying site size is only reasonable when winds are mild or perfectly calm. In windy conditions the rocket will drift a greater distance from any given altitude. For example, inadvertently using Charlie power in a 20 mile per hour wind condition will result in your X-15 drifting a considerable distance from its lift off point.

5 INSTALL ENGINE

Slide the engine, which you have selected, up into the rocket body until it rests firmly against the thrust bulkhead.



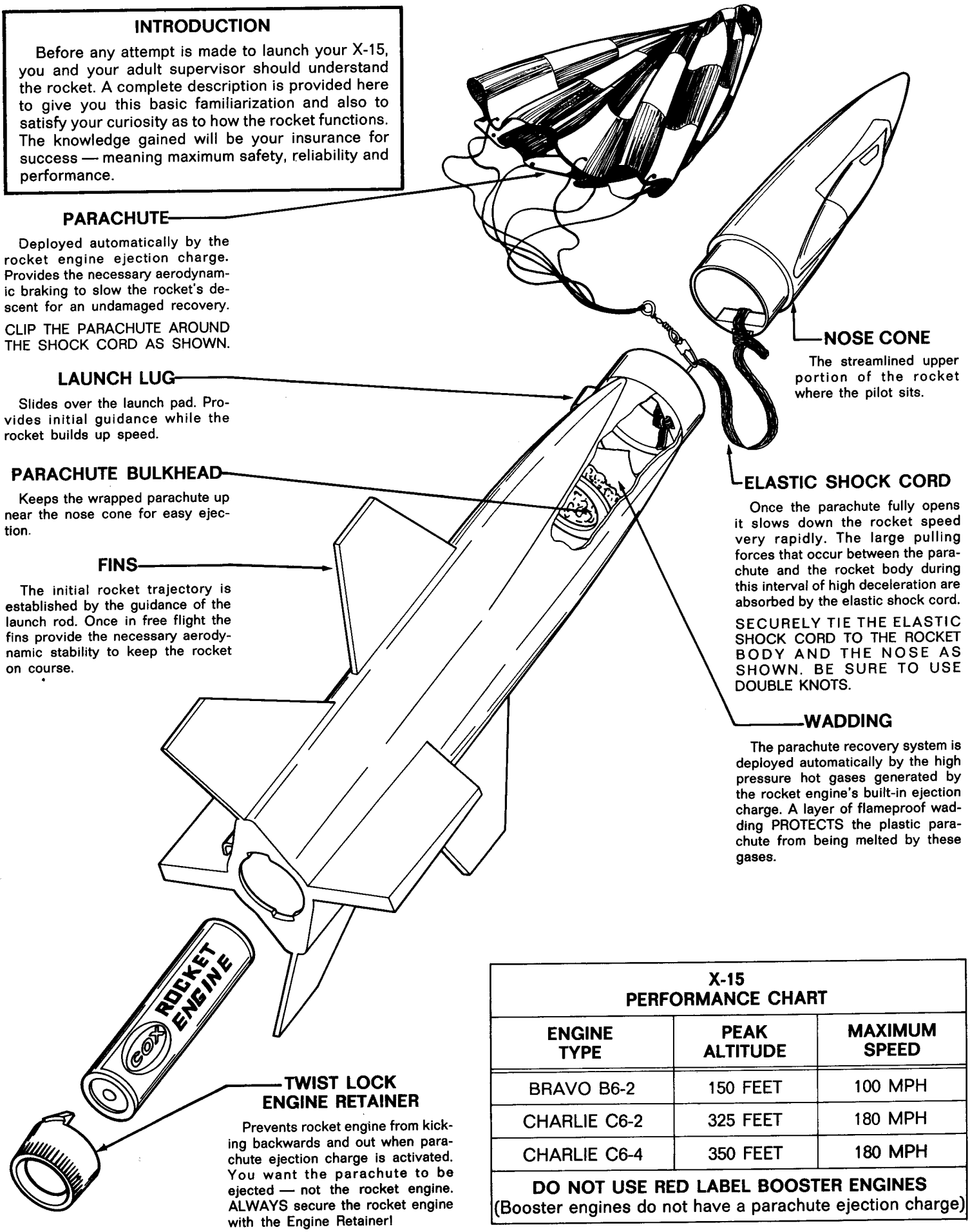
Next align the TWIST LOCK tabs with the rocket body notches and push the retainer up into the body. Then twist clockwise until tight. To remove it after a flight, turn it counterclockwise until tabs on the retainer align with slots in rocket body.

DO NOT INSTALL IGNITER UNTIL LAUNCH TIME!

YOUR NASA X-15 MODEL ROCKET

INTRODUCTION

Before any attempt is made to launch your X-15, you and your adult supervisor should understand the rocket. A complete description is provided here to give you this basic familiarization and also to satisfy your curiosity as to how the rocket functions. The knowledge gained will be your insurance for success — meaning maximum safety, reliability and performance.



PARACHUTE

Deployed automatically by the rocket engine ejection charge. Provides the necessary aerodynamic braking to slow the rocket's descent for an undamaged recovery.

CLIP THE PARACHUTE AROUND THE SHOCK CORD AS SHOWN.

LAUNCH LUG

Slides over the launch pad. Provides initial guidance while the rocket builds up speed.

PARACHUTE BULKHEAD

Keeps the wrapped parachute up near the nose cone for easy ejection.

FINS

The initial rocket trajectory is established by the guidance of the launch rod. Once in free flight the fins provide the necessary aerodynamic stability to keep the rocket on course.

NOSE CONE

The streamlined upper portion of the rocket where the pilot sits.

ELASTIC SHOCK CORD

Once the parachute fully opens it slows down the rocket speed very rapidly. The large pulling forces that occur between the parachute and the rocket body during this interval of high deceleration are absorbed by the elastic shock cord.

SECURELY TIE THE ELASTIC SHOCK CORD TO THE ROCKET BODY AND THE NOSE AS SHOWN. BE SURE TO USE DOUBLE KNOTS.

WADDING

The parachute recovery system is deployed automatically by the high pressure hot gases generated by the rocket engine's built-in ejection charge. A layer of flameproof wadding PROTECTS the plastic parachute from being melted by these gases.

TWIST LOCK ENGINE RETAINER

Prevents rocket engine from kicking backwards and out when parachute ejection charge is activated. You want the parachute to be ejected — not the rocket engine. ALWAYS secure the rocket engine with the Engine Retainer!

X-15 PERFORMANCE CHART

ENGINE TYPE	PEAK ALTITUDE	MAXIMUM SPEED
BRAVO B6-2	150 FEET	100 MPH
CHARLIE C6-2	325 FEET	180 MPH
CHARLIE C6-4	350 FEET	180 MPH

DO NOT USE RED LABEL BOOSTER ENGINES
(Booster engines do not have a parachute ejection charge)

LAUNCHING THE NASA X-15

1 PREPARE LAUNCHER

Read the separate instructions enclosed with both your COX LAUNCHER and COX ROCKET ENGINES prior to flying your X-15.

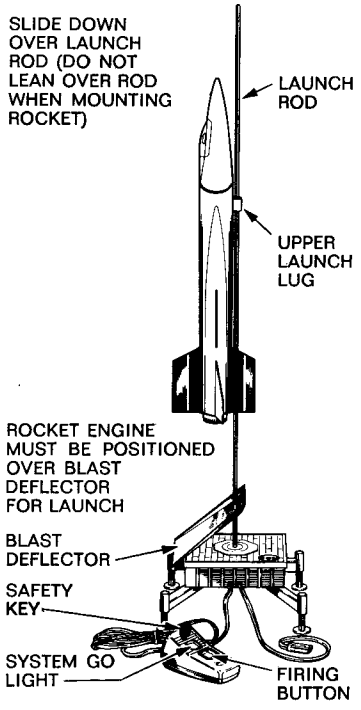
Upon reaching your flying site set up the launcher on level ground if possible, otherwise adjust the legs so the launcher itself will be level.

Unroll the ignition leads so that they will be extended the full 20 feet away from the launcher. Before doing anything else remove the SAFETY KEY from your LAUNCH CONTROL SWITCH and keep it with you until you are actually ready to ignite the rocket engine.

The SAFETY KEY is the system's master switch. When the key is with you it is perfectly safe to approach even an armed rocket and you can be confident that no inadvertent ignition will occur while you're handling the rocket.

With the SAFETY KEY in your hand (or in the hands of your adult supervisor) you can now approach the launcher to mount your X-15. Part of the normal countdown procedure at this time should include a recovery system check. If the parachute has ben sitting packed in the rocket body for over half an hour or if temperatures are near freezing, repack the parachute at this time for maximum recovery reliability.

Mount the rocket by sliding the upper and lower launch lugs over the launch rod. BE SURE to rotate the X-15 around on the launch rod so that the hot rocket engine exhaust gases at liftoff will impinge on the metal blast deflector rather than on the plastic base.

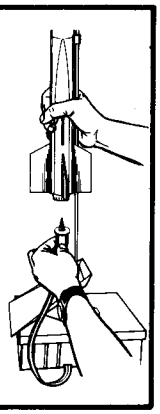


2 INSTALL SAFETY IGNITER

Now you can proceed to arm the rocket for launch. FIRST the SAFETY IGNITER should be inserted firmly into the IGNITER PLUG. THEN the connected safety igniter is pushed gently up and left inside the rocket engine nozzle as shown.

NEVER insert the Safety Igniter into the engine first

This completes the arming of the rocket and you can return to the launch control switch. At this time request any spectators to move back behind you and your adult supervisor.



3 GO FOR LAUNCH

The SAFETY KEY can now be reinserted into the LAUNCH CONTROL SWITCH. The SYSTEM GO light should appear, meaning electrical power is ready and the ignition circuit is armed. Once you have verified that no flying aircraft are overhead start a LOUD countdown from TEN to alert the spectators. Press the firing button just as you reach ZERO in your countdown and hold it firmly until the rocket engine ignites.

Your X-15 will then blast off and streak skyward under tremendous acceleration.

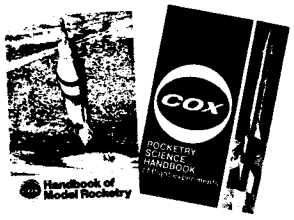
The tense moments are over once you spot the white puff of smoke near the peak altitude. This signifies that nose cone separation has occurred and the recovery system has been deployed. The parachute then blossoms open to bring your X-15 back safely for another flight.

MODEL ROCKETRY SAFETY INSTRUCTIONS

Emphasis on safety has marked the entire American Space Exploration effort. The amazing manned flight success record to date is largely due to being safety minded at all times — a fine example for any young person intending to launch model rockets!

1. ALWAYS fly the model rocket only in open areas, only with adult supervision, and only using a launching rod aimed within 25° of the vertical.
2. ALWAYS use only pre-loaded, factory-made commercial model rocket engines that do not require mixing of chemicals.
3. ALWAYS use only a remotely operated electrical firing system to launch the rocket.
4. ALWAYS inspect the rocket before use for damaged fins or other parts that would cause its flight to be unpredictable.
5. ALWAYS use a recovery device, such as a parachute, that will return the model safely to the ground.
6. NEVER launch the rocket in high winds, conditions of low visibility, near people not aware of the launching, or under any conditions which might endanger property or persons.
7. NEVER use rockets that weigh more than 16 ounces, including engines and payload, or that contain more than 4 ounces of propellant.
8. NEVER use an explosive "warhead" and never use the rocket as a weapon against targets on the ground or in the air.

COX ROCKETRY HANDBOOKS



From the 28 page Cox Handbook of Model Rocketry, the rocketeer will learn the basic theory of rocket propulsion, elementary flight stability, altitude tracking, and the history of space flight. This handbook also describes the various popular rocket contest events and how to form a model rocket club Price 25c Post paid

The Rocketry Science Handbook of Flight Experiments thoroughly discusses model rocket engine internal features; how engines function during a typical flight; and the resulting acceleration, speed, and altitude trajectory time histories. Includes single and two stage Nike Zeus maximum altitude, speed and coast time performance graphs.

Performing the programmed flight experiments enables the rocketeer to measure aerodynamic drag, wind speeds, wind drift, the effect of carrying payloads on peak altitude, and the accuracy of his predicted altitudes. Price 50c Post paid

Replacement parts can usually be purchased directly from your hobby shop dealer. If not available you may order direct from the factory. Order by part number and description. Include check or money order to cover cost. No C.O.D.'s please. California residents, enclose 5% state sales tax.

X-15 REPLACEMENT PARTS

CAT. NO.	DESCRIPTION	PRICE
49 50010	Main Body, Cockpit and Nose Weight Parts	4.50
49 50020	Decal Sheet and Marking Detail Sheet	1.00
49 50700	Pre-assembled 12" Parachute with Shock Cord	.75
49 49600	Twist Lock Engine Retainer	2/.25
	Price subject to change without notice.	

ORDER FROM: CUSTOMER SERVICE
L. M. COX MANUFACTURING CO., INC.
1505 East Warner Avenue, Santa Ana, California 92705
a subsidiary of LEISURE DYNAMICS, INC.

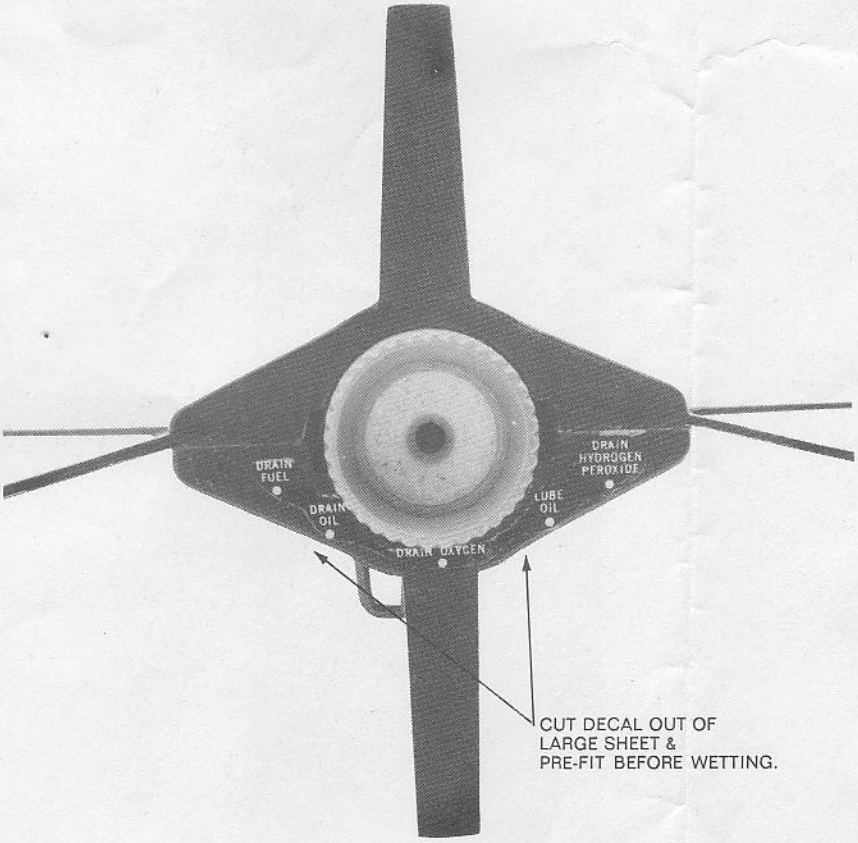
Litho in U.S.A. 50091

X-15 ROCKET DECAL PLACEMENT

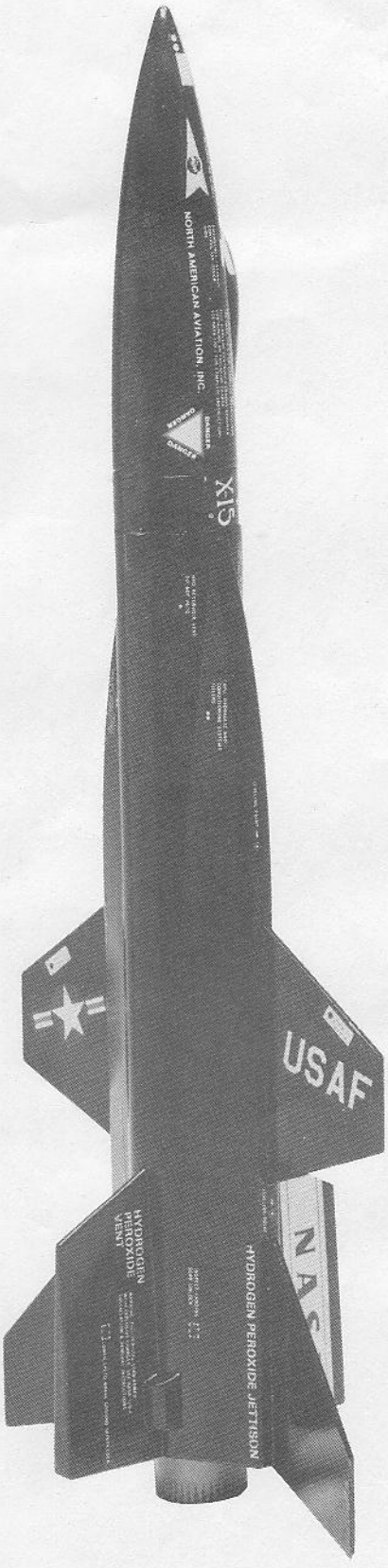
The photos below show where decals should be placed on your model. "No step" decals for the wings and the decal for the end should be pre-fitted and trimmed before wetting and applying.

HOW TO APPLY DECALS

1. Cut the individual decal you are going to apply out of the large sheet.
2. Dip it in water for a few seconds.
3. Remove air bubbles with a soft rubber squeegee. Allow to dry.



END VIEW



BOTTOM VIEW AT 45° ANGLE TO LEFT

BOTT

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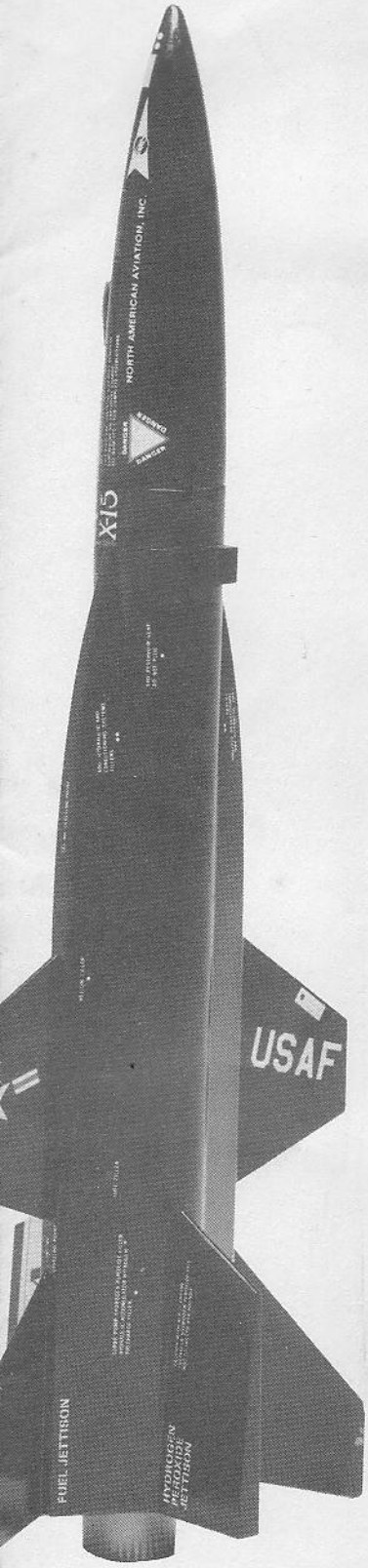
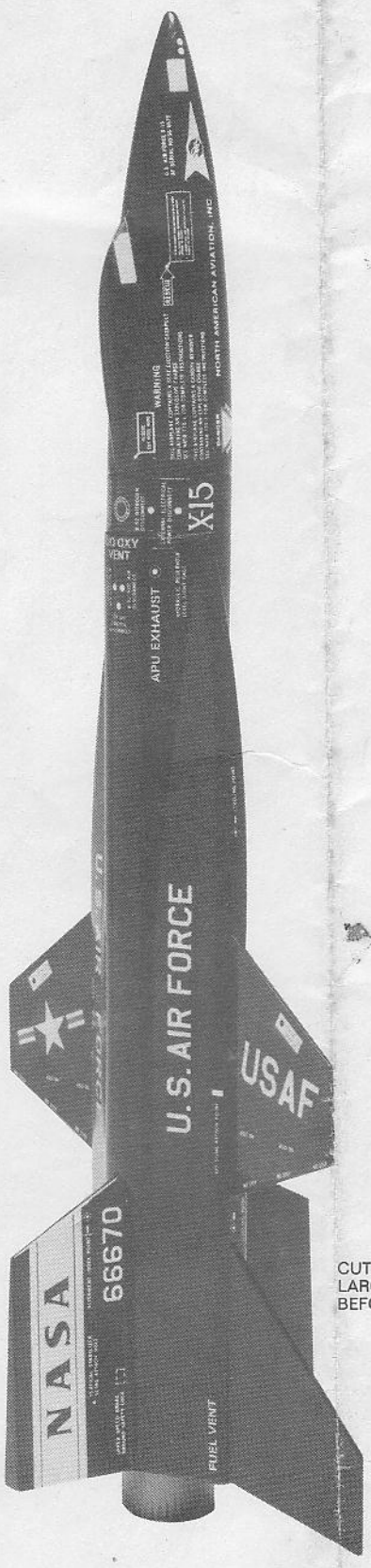
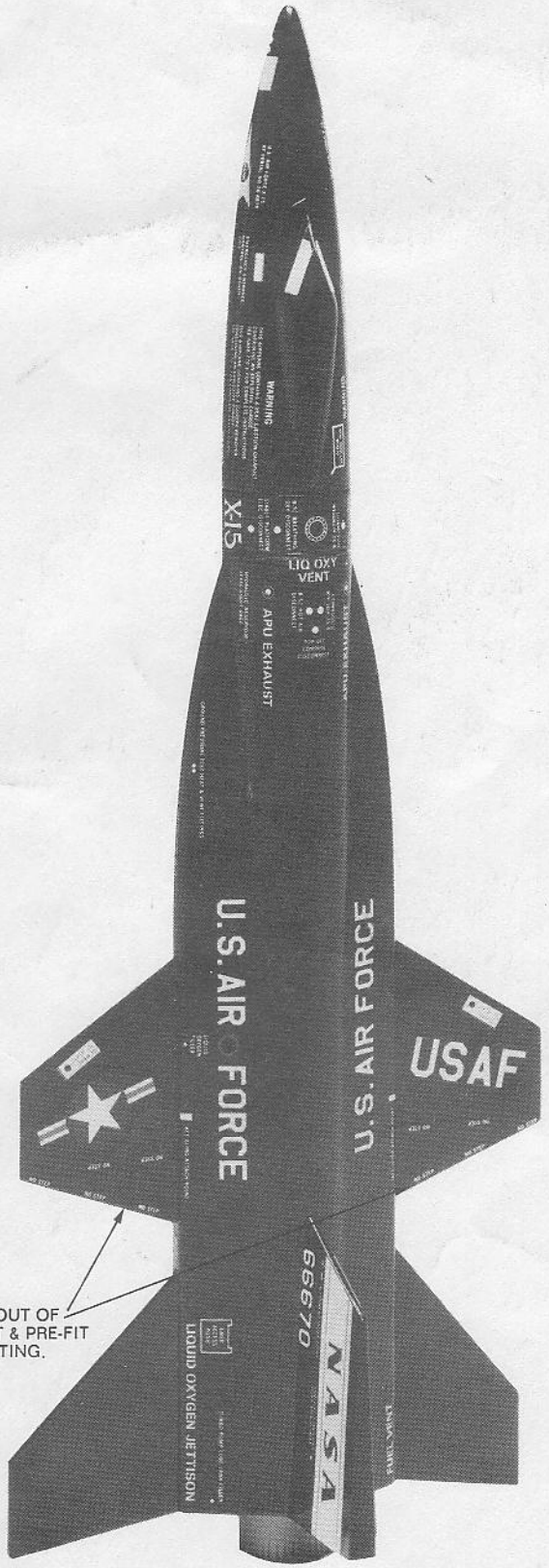


TOM VIEW AT 45° ANGLE TO RIGHT



TOP VIEW AT 45° ANGLE



CUT DECAL OUT OF LARGE SHEET & PRE-FIT BEFORE WETTING.

TOP VIEW

X-15 HISTORICAL HIGHLIGHTS

by Douglas J. Malewicki

BASIC X-15 ROCKET PLANE DATA

The sleek X-15 was a very small rocket propelled aircraft designed solely to extend the frontiers of manned flight to the fringes of outerspace. The 22 foot wingspan of this unique 4500 mile per hour machine is 11 feet less than the popular little Cessna 150 two place flight trainer and just about equivalent to the length of the average home garage.

A distinctive wedge-shaped vertical fin, thin stubby wings, and full length fuselage side fairings were part of the X-15's high heat Inconel-X nickel-chromium-steel structural shell. Underneath this black skin were housed numerous scientific and data acquisition instruments; lots of liquid propellant for the big 58,500 pound thrust Thiokol XLR-99 rocket engine; and one man. When this throttleable rocket was run at maximum power, the X-15 lost 55% of its total weight in a mere 80 seconds! Such thirst dictated use of the air drop technique developed in the early rocket plane days.

RESEARCH ROCKET PLANE ACCOMPLISHMENTS

The first aircraft in the world to reach a supersonic speed of Mach 1 was air dropped from a Boeing B-29 Superfortress at 30,000 feet altitude on October 14, 1947. This was the famous 6,000 pound thrust Bell X-1 rocket plane, piloted by Captain Charles Yaeger. It took five more years of high speed aeronautical research before Mach 2 was attained. On November 21, 1953 Scott Crossfield became the first man to reach Mach 2 (1,237.5 mph) in an air dropped Douglas Skyrocket. Scott eventually became North American Rockwell's chief research test pilot and later was the first person to fly the X-15.

A modified Bell X-1A eventually reached 1,650 mph and a peak altitude of 90,000 feet. On September 27, 1956 Captain Milburn Apt was the first man to exceed 2,000 mph in the Bell X-2 rocket plane. As you can see the X-15 didn't just happen overnight. It was a logical, technical extension based on considerable accumulated knowledge.

X-15 TECHNOLOGICAL ADVANCES

According to the best engineering predictions at the time of its conception, the X-15 design appeared capable of advancing top speeds to 4,000 miles per hour and peak altitudes to 250,000 feet. Three of these super planes were then built by North American Rockwell.

During the preliminary design phase, considerable time went into developing a new system to control the ship near peak altitudes when it would be "flying" in a vacuum. Up there, at the threshold of outer space a wing produces no lift regardless of speed, and the aerodynamic control surfaces normally used for steering purposes are totally useless. Without steering, the X-15 could very easily have reentered the atmosphere backwards, sideways, or even upside down at hypersonic speeds. More than likely, it would burn up before full aerodynamic control was regained.

This potential in-flight hazard was countered by mounting eight small 40 to 100 pound thrust hydrogen peroxide rockets in the X-15's nose and four more in its wing tips. The nose rocket controlled pitch and yaw; wing tip rockets, the roll. A single stick on the pilot's left controlled which rockets would fire and for how long. The various pilots who flew the X-15 proved that man could adapt and feel comfortable using small blips of rocket thrust to steer and orient his craft while in a vacuum. The same type of REACTION CONTROL SYSTEM was later used on the Gemini and Apollo programs for all their precision rendezvous and docking maneuvers.

Another technological advancement from the X-15 program was the special full pressure high-g suits developed for and worn by all X-15 pilots. Today they are called SPACE SUITS.

THE X-15 FLIGHT TEST PROGRAM

After rollout ceremonies, numerous ground tests, and static rocket firings, the first X-15 powered flight was conducted on September 17, 1959. The 4,000 mph design speed was first surpassed on the 45th flight (November 9, 1961) and the design altitude capability of 250,000 feet was considered officially reached on the 52nd flight (May 30, 1962).

It might be interesting to note that the X-15 vehicle was not retired and placed on a pedestal of honor once it reached those dreamed-for design speed and altitudes. NASA flew it continuously prior to finally retiring it 6½ years later. Meeting the speed and altitude goals merely qualified the machine to start its real job as a useful research tool. NASA personnel ceased worrying if the thing would really fly, and overnight the X-15 became a totally reusable platform for carrying a host of exotic scientific experiments up to a true outer space environment. It is most important to note that using the X-15 on certain types of research missions was very inexpensive compared to the throwaway booster methods used at the beginning of the manned Space Program. In the process of performing its job as test bed for scientific experiments (ranging from stellar photography to micrometeorite impact detection), the X-15's speeds advanced up to 4,520 mph (Mach 6.7) and peak altitudes shot up to 354,200 feet (67 miles straight up).

THE X-15 ROCKET PLANE

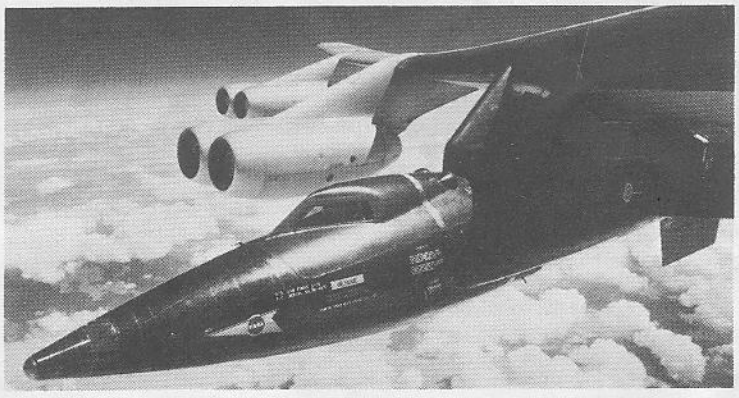
The first completed X-15 is shown here at the North American plant in Los Angeles, California. The first 8 flights covering a period of 9 months were all flown by North American test pilot A. Scott Crossfield prior to official delivery to NASA. At that time NASA identification markings were added.

THE MEN

Six of the twelve pilots involved in the X-15 research program are shown here. From left to right: Captain Joe H. Engle, USAF (presently an astronaut); Lt. Colonel Robert A. Rushworth, USAF; John B. McKay, NASA; Major William J. Knight, USAF; Milton O. Thompson, NASA; William H. Dana, NASA.

Of this group Engle, McKay, Knight, and Dana made flights over 50 miles in altitude which qualified them for astronaut wings. Other X-15 pilots not shown who reached the 50 mile qualifying altitudes were Robert M. White, USAF; Joseph M. Walker, NASA; and Michael J. Adams, USAF.

THEIR TYPICAL MISSION

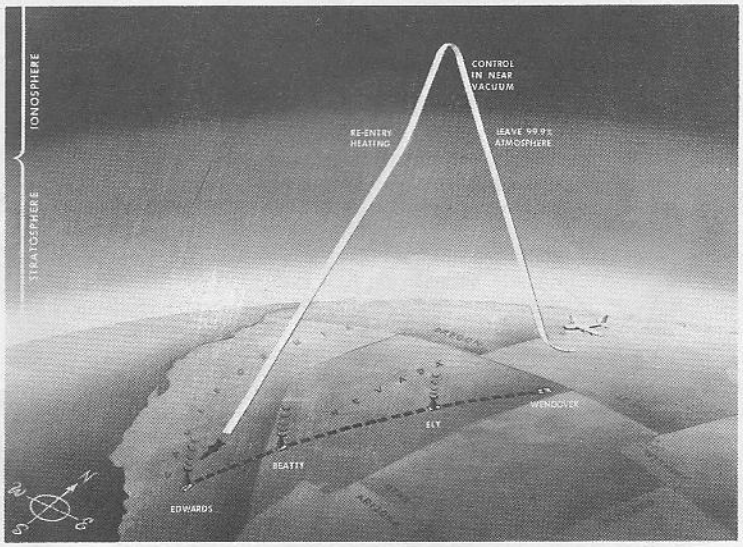


Last minute checks are performed as B-52 mother ship climbs to launch altitude

Because of its large fuel consumption, the X-15 was air launched at an altitude of about 45,000 feet from an 8 engine B-52 jet flying at 500 miles per hour horizontal speed. In essence, the X-15 was like the second stage of a space shuttle and the B-52 was the fully reusable manned booster.

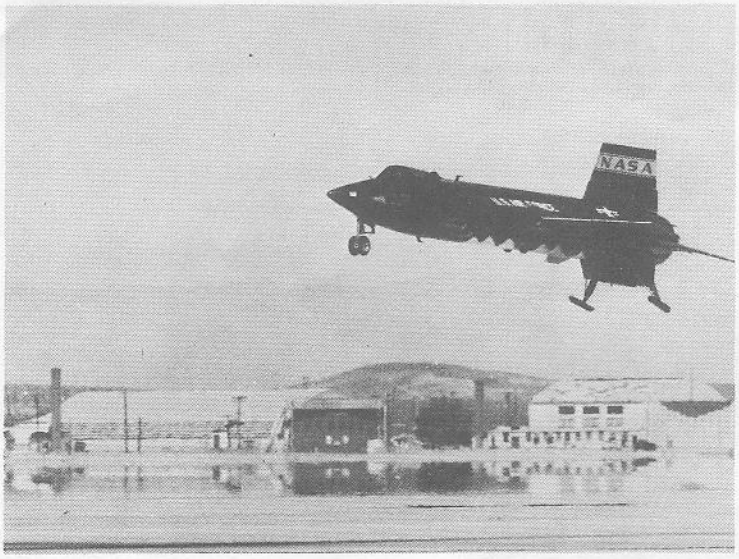
3-2-1 mission is go! Automatic disconnect is followed by YLR-99 rocket engine ignition.

When dropped, the X-15 weighs 33,300 pounds. Eighty seconds later the X-15 only weighs 15,000 pounds. In that short time 18,300 pounds of liquid oxygen and anyhydrous ammonia fuel are consumed. Just prior to "burnout," the engine's full thrust of 58,500 pounds subjects the pilot to approximately 4 g's of acceleration.

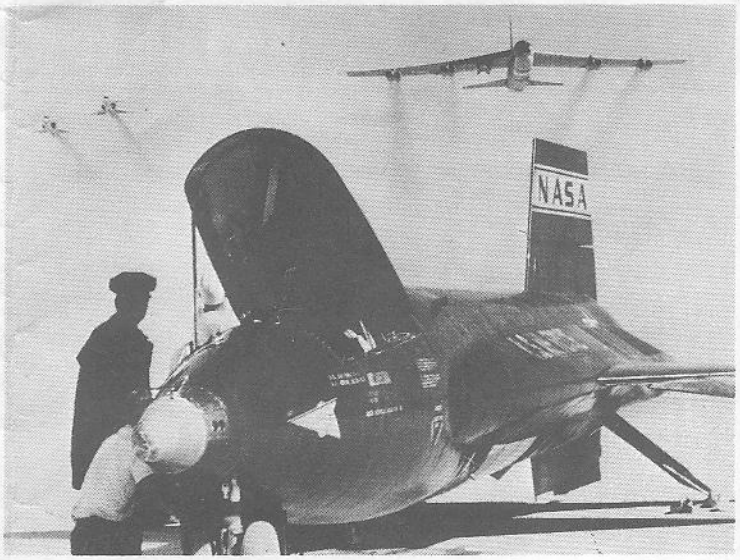


Typical Flight Path

Flights begin with the air drop from the B-52 high above Wendover, Utah. Only ten minutes later the X-15 has completed its space trajectory, its high heating steep reentry maneuvers, and it is ready to touch down at Edwards Air Force Base in California.



Pin point landing approach. Note use of rear landing skids instead of wheels.



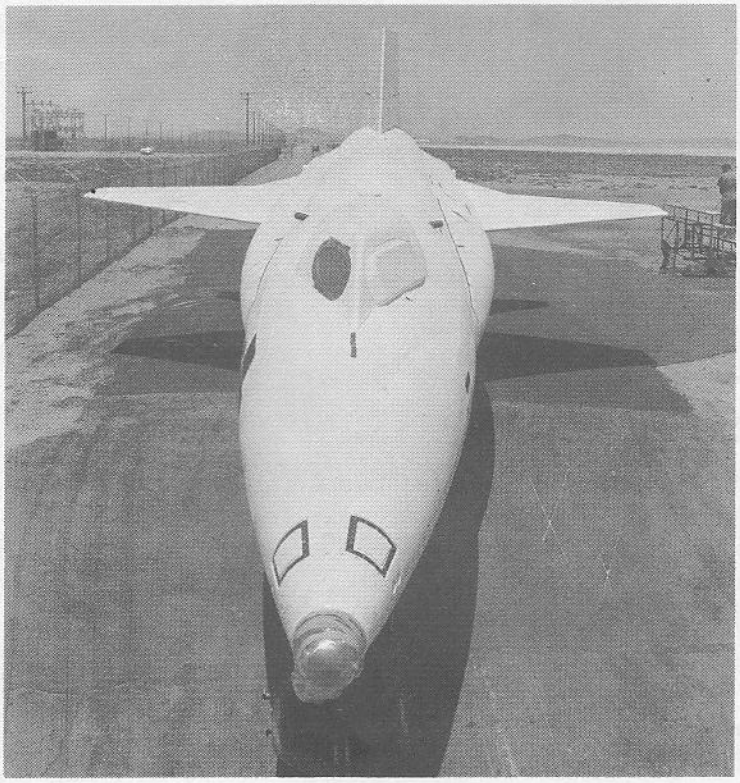
B-52 mother ship and the two F-104 Starfighter chase plane pass overhead after completion of another successful mission.

Landings are accomplished "dead stick." A non-powered very high-speed glide is followed by touchdown speeds of over 200 miles per hour and a mile long skid to a stop.

After the first few flights the pilots surprised all the scientists and engineers with their landing accuracy. After a glide phase extending through most of the state of Nevada and into California, the pilots would still touch down consistently within 1,000 feet of a preselected point. Thus, very valuable information for our country's future Space Shuttle concept was acquired.

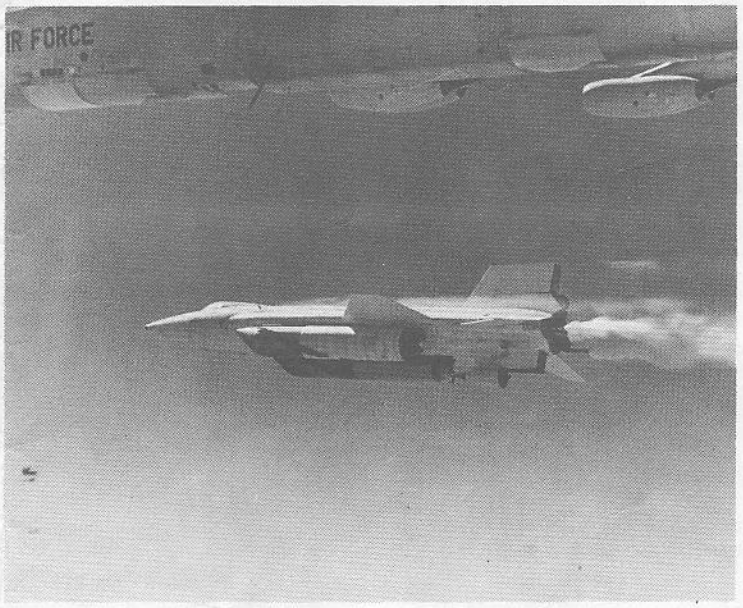
FASTEST X-15 FLIGHT, 4520 MPH, OCTOBER 3, 1967

The third and last X-15 rocket plane built by North American was extended 29 inches in the middle so it could carry more propellant for the really hot flights. First powered flight of ship number 3 was made by Neil Armstrong on December 20, 1961.

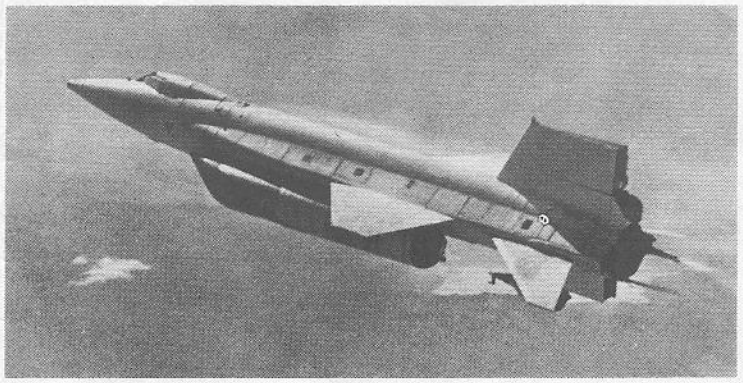


White ablative material protects X-15A2 from extreme heat experienced during mach 6.7 record run. Note ablative covered window hatches. These were jettisoned after reentry for landing visibility.

A coating of white ablative material was added to the number three X-15 ship as the rocket plane's hypersonic speeds were extended further and further. Major William J. (Pete) Knight, USAF, was the pilot during the record speed run. The flight was part of the overall flight research program being conducted with the X-15 as a joint NASA/Air Force operation. This was the 188th X-15 flight conducted from Edwards Air Force Base in California.



X-15A2 drops away from B-52 mother ship to start record flight. Note external drop tanks to increase engine thrust duration and supersonic combustion ram jet (scramjet) attached to ventral rudder.



X-15A2 ignition sequence begins a split second later. Note pilot is flying blind due to window thermal protection requirement.

THE X-15 FLIGHT LOG

FLIGHT NO.	DATE	AIRCRAFT NO.	PILOT	MAXIMUM SPEED MACH NO.	MAXIMUM SPEED MPH	MAXIMUM ALTITUDE IN FEET
1	6-8-59	1	Crossfield	.79	522	37,550
	Planned glide flight					
2	9-17-59	2	Crossfield	2.11	1393	52,341
	First powered flight					
3	10-17-59	2	Crossfield	2.15	1419	61,781
4	11-5-59	2	Crossfield	1.00	660	45,462
	Engine fire; fuselage structural failure on landing					
5	1-23-60	1	Crossfield	2.53	1669	66,844
6	2-11-60	2	Crossfield	2.22	1466	88,116
7	2-17-60	2	Crossfield	1.57	1036	52,640
8	3-17-60	2	Crossfield	2.15	1419	52,640
9	3-25-60	1	Walker	2.00	1320	48,630
	First NASA research flight					
10	3-29-60	2	Crossfield	1.96	1293	49,982
11	3-31-60	2	Crossfield	2.03	1340	51,356
12	4-13-60	1	White	1.94	1254	48,000
13	4-19-60	1	Walker	2.56	1689	59,496
14	5-6-60	1	White	2.20	1452	60,938
15	5-12-60	1	Walker	3.19	2111	77,882
16	5-19-60	1	White	2.31	1590	108,997
17	5-26-60	2	Crossfield	2.20	1452	51,282
18	8-4-60	1	Walker	3.31	2196	78,112
19	8-12-60	1	White	2.52	1772	136,500
20	8-19-60	1	Walker	3.13	1986	75,982
21	9-10-60	1	White	3.23	2182	79,864
22	9-23-60	1	Petersen	1.68	1108	53,043
23	10-20-60	1	Petersen	1.94	1280	53,800
24	10-28-60	1	McKay	2.02	1333	50,700
25	11-4-60	1	Rushworth	1.95	1287	48,900
26	11-15-60	2	Crossfield	2.97	1960	81,200
	First flight with XLR-99 design engine					
27	11-17-60	1	Rushworth	1.90	1254	54,750
28	11-22-60	2	Crossfield	2.51	1656	61,900
	First restart with XLR-99 design engine					
29	11-30-60	1	Armstrong	1.75	1155	48,840
30	12-6-60	2	Crossfield	2.85	1881	53,374
31	12-9-60	1	Armstrong	1.80	1188	50,095
32	2-1-61	1	McKay	1.88	1211	49,780
33	2-7-61	1	White	3.50	2275	78,150
34	3-7-61	2	White	4.43	2905	77,450
35	3-30-61	2	Walker	3.95	2760	169,600
36	4-21-61	2	White	4.62	3074	105,000
37	5-25-61	2	Walker	4.95	3307	107,500
38	6-23-61	2	White	5.27	3603	107,700
39	8-10-61	1	Petersen	4.11	2735	78,200
40	9-12-61	2	Walker	5.21	3618	114,300
41	9-28-61	2	Petersen	5.30	3600	101,800
42	10-4-61	1	Rushworth	4.30	2830	78,000
	Flight made with lower ventral off					
43	10-11-61	2	White	5.21	3647	217,000
	Outer panel of left windshield cracked					
44	10-17-61	1	Walker	5.74	3900	108,600
45	11-9-61	2	White	6.04	4093	101,600
	Design speed achieved					
46	12-20-61	3	Armstrong	3.76	2502	81,000
47	1-10-62	1	Petersen	.97	645	44,750
	Emergency landing on Mud Lake after engine failed to light					
48	1-17-62	3	Armstrong	5.51	3765	133,500
49	4-5-62	3	Armstrong	4.12	2850	180,000
50	4-19-62	1	Walker	5.69	3866	154,000
51	4-20-62	3	Armstrong	5.31	3789	207,500
52	4-30-62	1	Walker	4.94	3489	246,700
	Design altitude flight					
53	5-8-62	2	Rushworth	5.34	3524	70,400
54	5-22-62	1	Rushworth	5.03	3450	100,400
55	6-1-62	2	White	5.42	3675	132,600
56	6-7-62	1	Walker	5.39	3672	103,600
57	6-12-62	3	White	5.02	3517	184,600
58	6-21-62	3	White	5.08	3641	246,700
59	6-27-62	1	Walker	5.92	4104	123,700
	Unofficial world speed record					
60	6-29-62	2	McKay	4.95	3280	83,200
61	7-16-62	1	Walker	5.37	3674	107,200
62	7-17-62	3	White	5.45	3832	314,750
	FAI world altitude record					
63	7-19-62	2	McKay	5.18	3474	85,250
64	7-26-62	1	Armstrong	5.74	3989	98,900
65	8-2-62	3	Walker	5.07	3438	144,500
66	8-8-62	2	Rushworth	4.40	2943	90,877
67	8-14-62	3	Walker	5.25	3747	193,600
68	8-20-62	2	Rushworth	5.24	3534	88,900
69	8-29-62	2	Rushworth	5.12	3447	97,200
70	9-28-62	2	McKay	4.22	2765	68,200
	This and all following flights without lower ventral					
71	10-4-62	3	Rushworth	5.17	3493	112,200
72	10-9-62	2	McKay	5.46	3716	130,200
73	10-23-62	3	Rushworth	5.47	3764	134,500
74	11-9-62	2	McKay	1.49	1019	53,950
	Emergency landing at Mud Lake					
75	12-14-62	3	White	5.65	3742	141,400
76	12-20-62	3	Walker	5.73	3793	160,400
77	1-17-63	3	Walker	5.47	3677	271,700
	First civilian flight above 50 miles					
78	4-11-63	1	Rushworth	4.25	2864	74,400
79	4-18-63	3	Walker	5.51	3770	92,500
80	4-25-63	1	McKay	5.32	3654	105,500
81	5-2-63	3	Walker	4.73	3488	209,400
82	5-14-63	3	Rushworth	5.20	3600	95,600
83	5-15-63	1	McKay	5.57	3856	124,200
84	5-29-63	3	Walker	5.52	3858	92,000
	Inner panel of left windshield cracked					
85	6-18-63	3	Rushworth	4.97	3539	223,700
86	6-25-63	1	Walker	5.51	3911	111,800
87	6-27-63	3	Rushworth	4.89	3425	285,000
88	7-9-63	1	Walker	5.07	3631	226,400
89	7-18-63	1	Rushworth	5.63	3925	104,800
90	7-19-63	3	Walker	5.50	3710	347,800
91	8-22-63	3	Walker	5.58	3794	354,200
	Unofficial world altitude record					
92	10-7-63	1	Engle	4.21	2834	77,800
93	10-29-63	1	Thompson	4.10	2712	74,400
94	11-7-63	3	Rushworth	4.40	2925	82,300
95	11-14-63	1	Engle	4.75	3286	90,800
96	11-27-63	3	Thompson	4.94	3310	89,800
97	12-5-63	1	Rushworth	6.06	4018	101,000
98	1-8-64	1	Engle	5.32	3616	139,900
99	1-16-64	3	Thompson	4.92	3242	71,000
100	1-28-64	1	Rushworth	5.34	3618	107,400
101	2-19-64	3	Thompson	5.29	3519	78,600
102	3-13-64	3	McKay	5.11	3392	76,000
103	3-27-64	1	Rushworth	5.63	3827	101,500
104	4-8-64	1	Engle	5.01	3468	175,000
105	4-29-64	1	Rushworth	5.72	3906	101,600
106	5-12-64	3	McKay	4.66	3084	72,800
107	5-19-64	1	Engle	5.02	3494	195,800
108	5-21-64	3	Thompson	2.90	1865	64,200
	Premature engine shutdown at 41 sec.					
109	6-25-64	2	Rushworth	4.59	3104	83,300
110	6-30-64	1	McKay	4.96	3334	99,600
111	7-8-64	3	Engle	5.05	3520	170,400
112	7-29-64	3	Engle	5.38	3623	78,000
113	8-12-64	3	Thompson	5.24	3535	81,200
114	8-14-64	2	Rushworth	5.23	3590	103,300
115	8-26-64	3	McKay	5.65	3863	91,000
116	9-3-64	3	Thompson	5.35	3615	78,600
117	9-28-64	3	Engle	5.59	3888	97,000
118	9-29-64	2	Rushworth	5.20	3542	97,800
119	10-15-64	1	McKay	4.56	3048	84,900
120	10-30-64	3	Thompson	4.66	3113	84,600
121	11-30-64	2	McKay	4.66	3089	87,200
122	12-9-64	3	Thompson	5.42	3723	92,400
123	12-10-64	1	Engle	5.35	3675	113,200
124	12-22-64	3	Rushworth	5.55	3593	81,200
125	1-13-65	3	Thompson	5.48	3712	99,400
126	2-2-65	3	Engle	5.71	3886	98,200
127	2-17-65	2	Rushworth	5.27	3511	95,100
128	2-26-65	1	McKay	5.40	3750	153,600
129	3-26-65	1	Rushworth	5.17	3580	101,900
130	4-23-65	3	Engle	5.48	3580	79,700
131	4-28-65	2	McKay	4.80	3273	92,600
132	5-18-65	2	McKay	5.17	3541	102,100
133	5-25-65	1	Thompson	4.87	3418	179,800
134	5-28-65	3	Engle	5.17	3754	209,600
135	6-16-65	3	Engle	4.69	3404	244,700
136	6-17-65	1	Thompson	5.14	3541	108,500
137	6-22-65	2	McKay	5.64	3938	155,900
138	6-29-65	3	Engle	4.94	3432	280,600
139	7-8-65	2	McKay	5.19	3659	212,600
140	7-20-65	3	Rushworth	5.40	3760	105,400
141	8-3-65	2	Rushworth	5.16	3602	208,700
142	8-6-65	1	Thompson	5.15	3534	103,200
143	8-10-65	3	Engle	5.20	3550	271,000
144	8-25-65	1	Thompson	5.11	3604	214,100
145	8-26-65	3	Rushworth	4.79	3372	239,600
146	9-2-65	2	McKay	5.16	3570	239,800
147	9-9-65	1	Rushworth	5.25	3534	97,200
148	9-14-65	3	McKay	5.03	3519	239,000
149	9-22-65	1	Rushworth	5.18	3550	100,300
150	9-28-65	3	McKay	5.33	3732	295,600
151	9-30-65	1	Knight	4.06	2718	76,600
152	10-12-65	3	Knight	4.62	3108	94,400
153	10-14-65	1	Engle	5.08	3554	266,500
154	10-27-65	3	McKay	5.06	3519	236,900
155	11-3-65	2	Rushworth	2.31	1500	70,600
	First flight with empty external tanks					
156	11-4-65	1	Dana	4.22	2765	80,200
157	5-6-66	1	McKay	2.21	1434	68,400
	Premature engine shutdown at 32 seconds					
158	5-18-66	2	Rushworth	5.43	3689	99,000
159	7-1-66	2	Rushworth	1.54	1023	45,000
	First heavy tank flight — engine shutdown at 32 seconds					
160	7-12-66	1	Knight	5.34	3652	130,000
161	7-18-66	3	Dana	4.71	3217	96,100
162	7-21-66	2	Knight	5.12	3568	192,300
163	7-28-66	1	McKay	5.19	3702	241,800
164	8-3-66	2	Knight	5.03	3440	249,000
165	8-4-66	3	Dana	5.34	3693	132,700
166	8-11-66	1	McKay	5.21	3590	251,000
167	8-12-66	2	Knight	5.02	3472	231,100
168	8-19-66	3	Dana	5.20	3607	178,000
169	8-25-66	1	McKay	5.11	3543	257,500
170	8-30-66	2	Knight	5.21	3543	100,200
171	9-8-66	1	McKay	2.44	1602	73,200
	Premature engine shutdown at 38 seconds					
172	9-14-66	3	Dana	5.12	3586	254,200
173	10-6-66	1	Adams	3.00	2900	75,400
174	11-1-66	3	Dana	5.46	3750	306,900
175	11-18-66	2	Knight	6.33	4250	98,900
	Unofficial world's speed record					
176	11-29-66	3	Adams	4.65	3120	92,000
177	3-22-67	1	Adams	5.59	3822	133,100
178	4-26-67	3	Dana	1.80	1163	53,400
179	4-28-67	1	Adams	5.44	3720	167,000
180	5-8-67	2	Knight	4.75	3193	97,600
181	5-17-67	3	Dana	4.80	3177	71,100
182	6-15-67	1	Adams	5.12	3606	229,300
183	6-22-67	3	Dana	5.44	3611	82,200
184	6-29-67	1	Knight	4.17	2870	173,200
	Electrical failure climbing through 107,000 —landed at Mud Lake, Nev.					
185	7-20-67	3	Dana	5.44	3693	84,400
186	8-21-67	2	Knight	4.94	3368	91,000
	Full ablative second engine light					
187	8-25-67	3	Adams	4.63	3115	84,400
188	10-3-67	2	Knight	6.70	4520	102,100
	Unofficial world's speed record, (full ablative, tanks, dummy ramjet, mechanical eyelid)					
189	10-4-67	3	Dana	5.53	3897	251,100
190	10-17-67	3	Knight	5.53	3856	280,500
191	11-15-67	3	Adams	5.20	3570	266,000
	Fatal accident, aircraft destroyed					
192	3-1-68	1	Dana	4.36	2878	104,500
193	4-4-68	1	Dana	5.27	3610	187,500
194	4-26-68	1	Knight	5.00	3545	207,000
195	5-11-67	1	Dana	5.15	3563	220,100
196	7-16-68	1	Knight	4.79	3382	221,500
197	8-21-68	1	Dana	5.01	3443	267,500
198	9-13-68	1	Knight	5.37	3723	254,100
199	10-24-68	1	Dana	5.38	3716	255,000
200	5- -69	1	Unmanned	.90	610	30,000
	Carried in jet freighter cargo bay to its permanent display area in the Smithsonian Institution. It now resides next to the original Wright Brother's Kitty Hawk flyer, Lindberg's Spirit of Saint Louis, and the Apollo 11 Command Module					

X-15 PILOTS

First — A. Scott Crossfield, NAR
Total of 14 Flights

Second — Joseph A. Walker, NASA
Total of 25 Flights

Third — Robert M. White, USAF
Total of 16 Flights

Fourth — Forrest S. Petersen, USN
Total of 5 Flights

Fifth — John B. McKay, NASA
Total of 29 Flights

Sixth — Robert A. Rushworth, USAF
Total of 34 Flights

Seventh — Neil A. Armstrong, NASA
Total of 7 Flights

Eighth — Joe H. Engle, USAF
Total of 16 Flights

Ninth — Milton O. Thompson, NASA
Total of 14 Flights

Tenth — William J. Knight, USAF
Total of 16 Flights

Eleventh — William H. Dana, NASA
Total of 16 Flights

Twelfth — Michael J. Adams, USAF
Total of 7 Flights

SUMMARY OF PERFORMANCE

Fastest Speed (basic aircraft)	4104 mph, 6.06 Mach, June 27, 1962
Fastest Speed (with tanks)	4520 mph, 6.70 Mach, October 3, 1967
Highest Altitude	354,200 feet, 67+ miles, August 22, 1963
Total Flight Time	30 hrs, 13 min, 49.4 sec.
Total Distance Flown	41,763 miles
Total Flights	199

Total Time Spent Above	Hours	Min.	Sec.
MACH 6	0	1	18
MACH 5	1	25	33
MACH 4	5	58	52
MACH 3	8	51	33
MACH 2	12	10	44
MACH 1	18	16	28

IMPORTANT X-15 CONTRIBUTIONS

Developmental

Adaptive Control Systems
Inertial Guidance
High Temperature Windows
Reaction Control Systems
Thick Skin Heat Sink Structures
Space Suits

Research

Steep Reentry
Ablative Materials
Saturn Thermal Protection
Supersonic Decelerators
Hypersonic Aerodynamics
Turbulent Heat Transfer
Zero-g (Weightlessness)

Scientific

Ultraviolet Stellar Photography
Simultaneous Photographic Horizon Scanner
Optical Atmospheric Degradation
Infrared Exhaust Signature
Earth Radiance
Ultraviolet Exhaust Plume
Micrometeorite Collection
Rarefied Wake Flow
High Altitude Sky Brightness
Optical Background
Infrared Scanning
Solar Spectrum Measurement