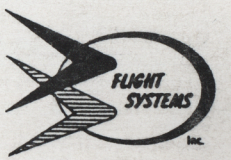
FLIGHT SYSTEMS, INC.

Model Rocketry

1996



FLIGHT SYSTEMS, INC.

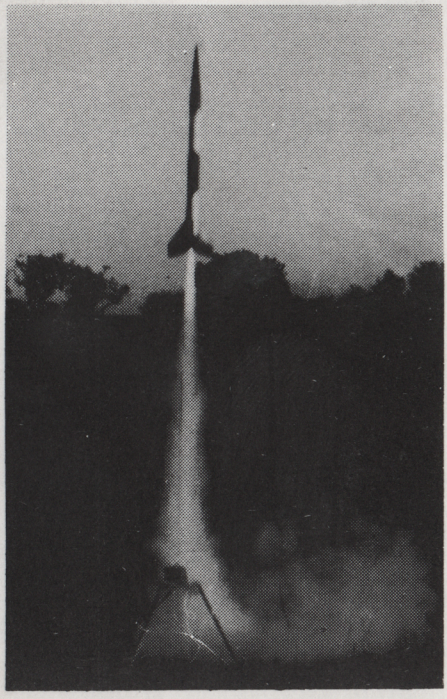
Rockets:

Introduction

Flight Systems, Inc. model rocketry offers a way to become a part of the technological space age. Flight Systems model rockets are high performance solid fuel rockets capable of flights to extreme altitudes. By using the reliable commercially produced FSI thrusters, unlimited scientific experiments can be performed. FSI thrusters are excellent research tools and aid in gaining a thorough understanding of aerodynamics and jet propulsion principles as well as basic physics and meteorology. Many schools incorporate the use of model rockets into their science departments to create interest and demonstrate the principles of rocket flight. They are an excellent teaching aid. When operated in compliance with the Model Rocket Safety Code, they offer a very safe way to enjoy the thrilling sensation of launching a real solid fuel rocket.

Flight Systems, Inc. model rockets can reach altitudes of many thousands of feet. They should be launched in a relatively open area that is free from overhead obstructions. Model rockets should be launched and operated under adult supervision in such a manner that does not create a hazard to persons, property or aircraft.

Model rocketry using premanufactured items has an excellent safety record. LET'S ALL KEEP THAT RECORD IN TACT! REMEMBER – Model Rockets are not toys. They are scientific research vehicles and should be handled and treated as such. Follow the safety rules as you would with any other activity or sport.



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• IMPORTANT •

Model Rocket Safety Code

Presentation of the National Association of Rocketry and Hobby Industries of America

1. **Construction** – My model rockets will be made of lightweight materials such as paper, wood, rubber, and plastic without any metal or other hazardous material as structural parts.

2. **Engines** – I will use only pre-loaded factory-made NAR certified rocket engines in the manner recommended by the manufacturer. I will not alter or dismantle model rocket engines or their ingredients in any way, or attempt to reload these engines.

3. **Recovery** – I will always use a recovery system in my model rockets that will return them safely to the ground so that they may be flown again. I will use only flame resistant recovery wadding in my rockets.

4. **Weight Limits** – My model rockets will weigh no more than 1500 grams (53 ounces) at liftoff and the engines will contain a total of no more than 125 grams (4.4 ounces) of propellant. My model rockets will weigh less than the engine manufacturer's recommended maximum liftoff weight for the engines used, or I will use engines recommended by the manufacturer for my rockets.

5. **Stability** – I will check the stability of my model rockets before their first flight, except when launching models of already proven stability.

6. **Payloads** – My model rockets will never carry live animals, or payloads that are intended to be flammable or explosive.

7. **Launch Area** – I will launch model rockets outdoors in a cleared area, free of tall trees, power lines, and buildings. I will ensure that people in the launch area are aware of the pending rocket launch and are in a position to see the rocket's liftoff before I begin my audible five-second count down.

8. **Launcher** – I will launch my model rockets from a launch rod or other device which provides rigid guidance until the rocket has reached a speed adequate to ensure a safe flight path. To prevent accidental eye injury, I will always place the launcher so that the end of the rod is above eye level or will cap the end of the rod when approaching it. I will cap or disassemble my launch rod when not in use and will never store it in an upright position. My launcher will have a jet deflector device to prevent the engine exhaust from hitting the ground directly. I will always clear the area around my launch device of brown grass, dry weeds, and other easy-to-burn materials.

9. **Ignition System** – The system I use to launch my model rockets will be remotely controlled and electrically operated, and will contain a launching switch that will return to "off" when released. The system will contain a removeable safety interlock in series with the launching switch. All persons will remain at least 15 feet from the model rocket when I am igniting engines totalling 30 Newton-seconds or less of total impulse and at least 30 feet from the model rocket when I am igniting engines totalling more than 30 Newton-seconds total impulse. I will use only electrical igniters that will ignite my rocket engine(s) within one second of actuation of the launching switch.

10. **Launch Safety** – I will not let anyone approach a model rocket on a launcher until I have made sure that the safety interlock has been removed or the battery has been disconnected from the ignition system. In the event of a misfire I will wait one minute before allowing anyone to approach the launcher.

11. **Flying Conditions** – I will launch my model rocket only when the wind is less than 20 miles per hour and under conditions where the model will not fly into clouds, fly near aircraft in flight, or be hazardous to people or property.

12. **Pre-Launch Test** – When conducting research activities with unproven designs or methods I will, when possible, determine their reliability through pre-launch tests. I will conduct launchings of unproven designs in complete isolation from persons not participating in the actual launching.

13. **Launch Angle** – I will not launch model rockets so that their flight path will carry them against targets. My launch device will be pointed within 30 degrees of vertical. I will never use model rocket engines to propel any device horizontally.

14. **Recovery Hazards** – If a model rocket becomes entangled in a power line or other dangerous place, I will not attempt to retrieve it.

(Revised January 1, 1987)

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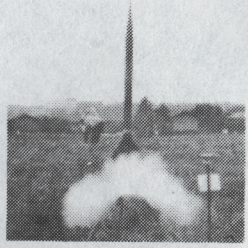
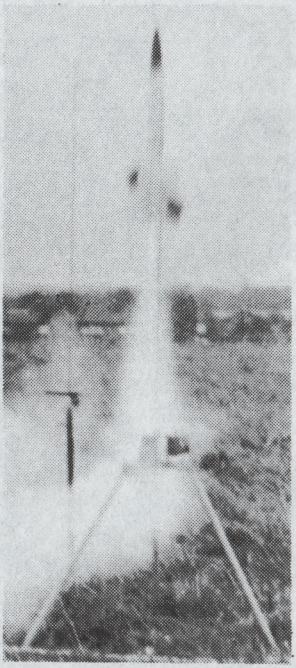
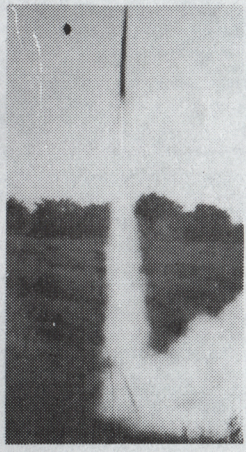
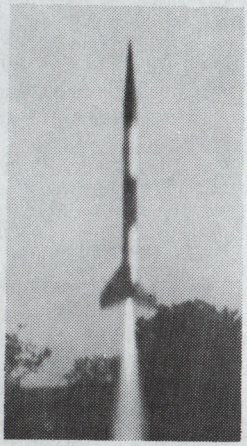
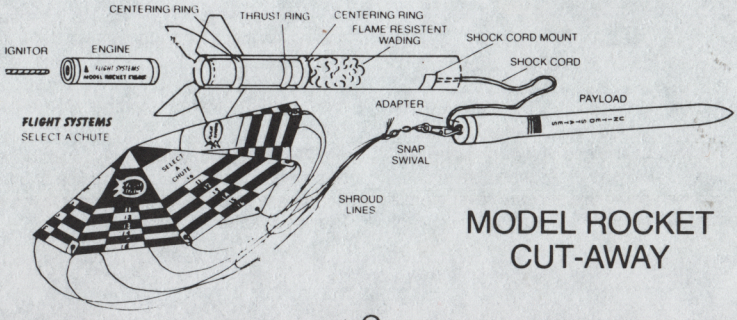








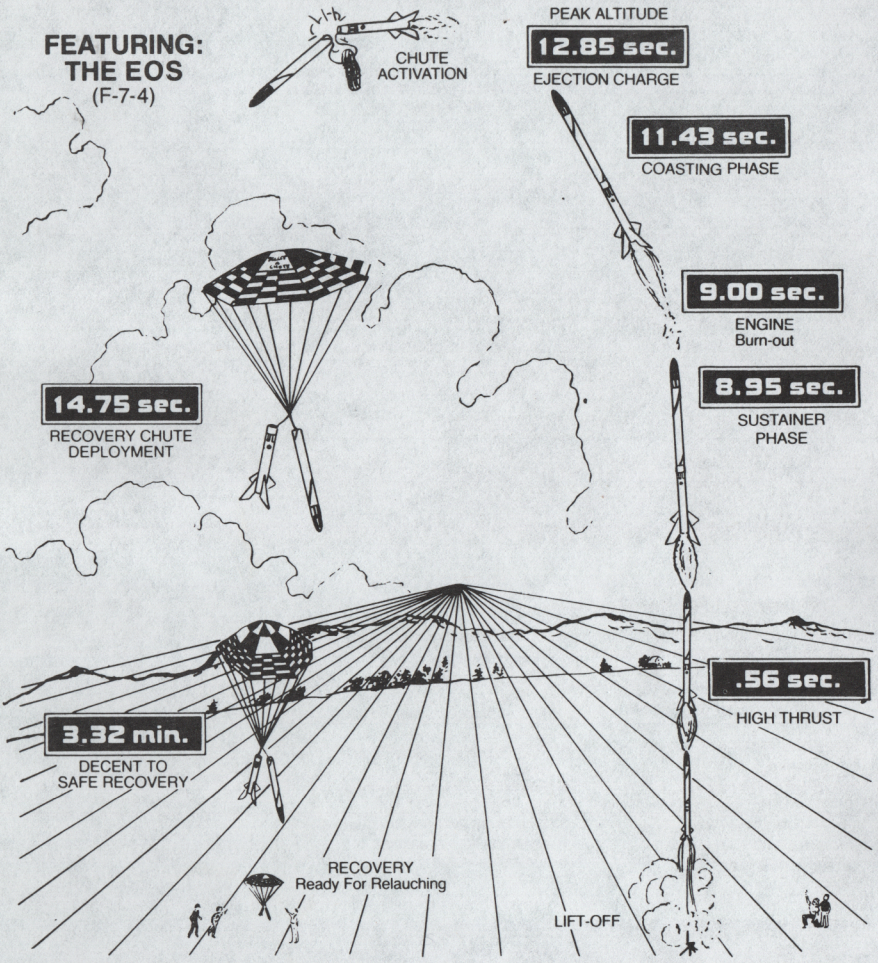


MODEL ROCKET
CUT-AWAY

FLIGHT SYSTEMS, INC.

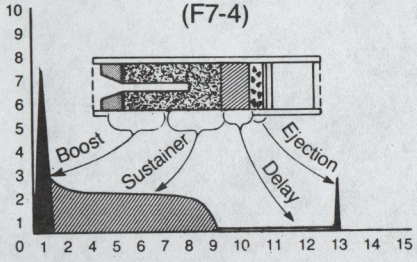
Flight Sequence – Lift-Off, High Thrust and Recovery

FEATURING:
THE EOS
(F-7-4)



MODEL ROCKET ENGINE TIME VERSUS THRUST CURVE

(F7-4)



MODEL ROCKET KIT SKILL LEVEL

The skill level numbers given with each kit description recommend the skills and experience necessary to successfully build the rocket kit.

SKILL LEVEL NO.	DESCRIPTION
1	Very Simple
2	Fairly Easy
3	Average
4	Challenging
5	Extremely Challenging

FLIGHT SYSTEMS, INC.

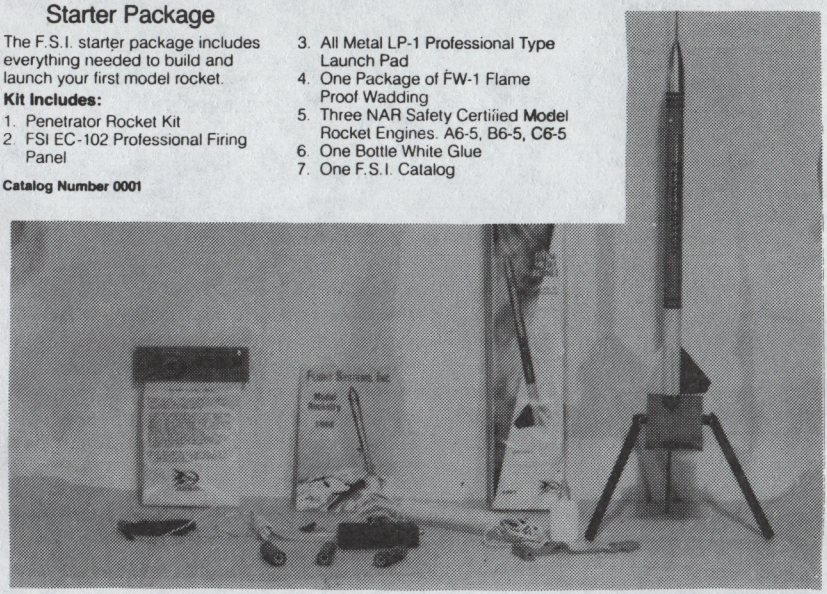
Starter Package

The F.S.I. starter package includes everything needed to build and launch your first model rocket.

Kit Includes:

1. Penetrator Rocket Kit
2. FSI EC-102 Professional Firing Panel
3. All Metal LP-1 Professional Type Launch Pad
4. One Package of FW-1 Flame Proof Wadding
5. Three NAR Safety Certified Model Rocket Engines. A6-5, B6-5, C6-5
6. One Bottle White Glue
7. One F.S.I. Catalog

Catalog Number 0001



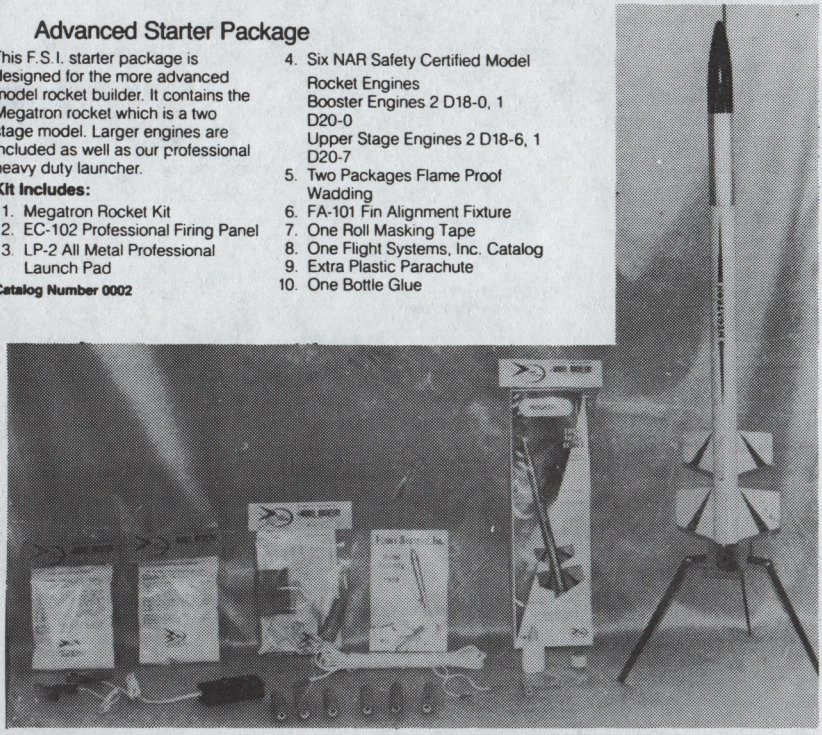
Advanced Starter Package

This F.S.I. starter package is designed for the more advanced model rocket builder. It contains the Megatron rocket which is a two stage model. Larger engines are included as well as our professional heavy duty launcher.

Kit Includes:

1. Megatron Rocket Kit
2. EC-102 Professional Firing Panel
3. LP-2 All Metal Professional Launch Pad
4. Six NAR Safety Certified Model Rocket Engines
   Booster Engines 2 D18-0, 1 D20-0
   Upper Stage Engines 2 D18-6, 1 D20-7
5. Two Packages Flame Proof Wadding
6. FA-101 Fin Alignment Fixture
7. One Roll Masking Tape
8. One Flight Systems, Inc. Catalog
9. Extra Plastic Parachute
10. One Bottle Glue

Catalog Number 0002



FLIGHT SYSTEMS, INC.

Competitor

Skill Level 2

The Competitor features eliptical fins for reduced drag. A unique rear ejection is also used.

Specifications:
Length — 13"
Body Dia. — .903"
Takeoff weight without engine 1.2 oz. (32 g.)*
Recommended F.S.I. Engines:
A6-5, B6-5, C6-5
Catalog Number 1026
Ship Wt. 8 oz.

*All takeoff weights approximate.

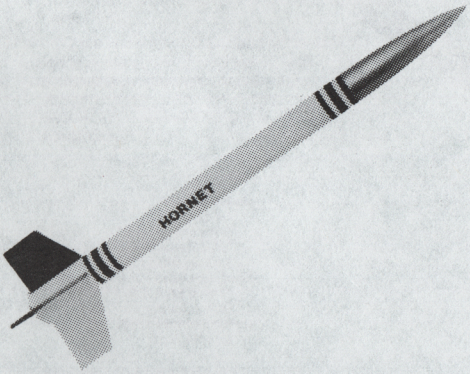
The Hornet

Skill Level 1

The Hornet is the first in a series of high performance model rockets designed exclusively for 18 mm engines. Altitudes up to 1,000' can be achieved using the C6 rocket engine.

Specifications:
Length – 12.5"
Body Dia. – .718"
Takeoff weight without engine: 7 oz. (20 g.)*
Recommended F.S.I. Engines:
**A6-5, B6-5, C6-5
Catalog Number 1021
Ship Wt. 8 oz.

* All takeoff weights approximate.
** Suggested for lower altitude flights to facilitate recovery.



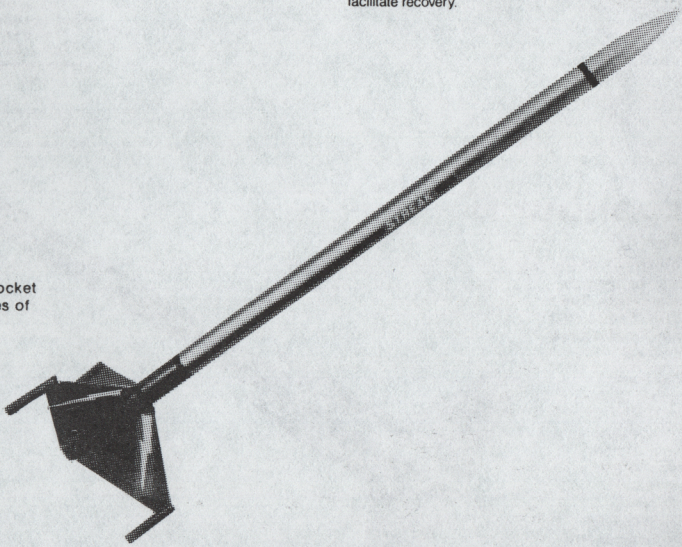
Streak

Skill Level 1

A high performance rocket that will reach altitudes of several hundred feet.

Specifications:
Length — 21"
Body Dia. — .718"
Takeoff weight without engine 79 oz. (22 g.)*
Recommended F.S.I. Engines:
A6-5, B6-5, C6-5
Catalog Number 1028
Ship Wt. 8 oz.

*All takeoff weights approximate.



FLIGHT SYSTEMS, INC.

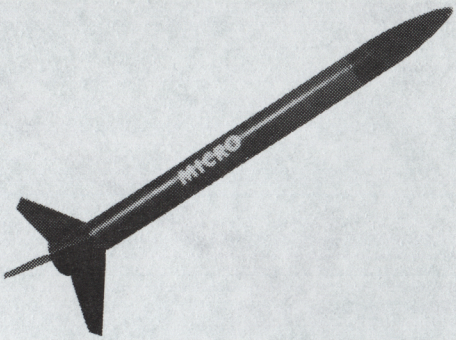
Micro

Skill Level 1

A high performance kit designed by rocket engineers to introduce the newcomer to the thrills and excitement of model rocketry. Easy to follow instructions. This bird performs with the best. Altitudes to 2,500'.

Specifications:
Length – 11.5"
Body Dia. – 0.903"
Takeoff weight without engine: 1.6 oz. (30 g.)*
Recommended F.S.I. Engines:
**A6-5, B6-5, C6-7, D18-6
Catalog Number 1008
Ship Wt. 8 oz.

* All takeoff weights approximate.
** Suggested for lower altitude flights to facilitate recovery.



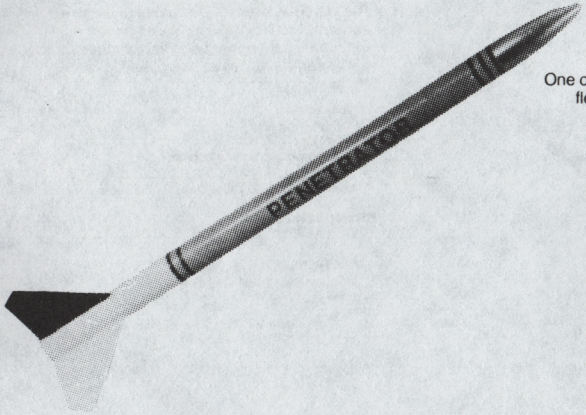
Penetrator

Skill Level 1

One of the finest flying rockets in the F.S.I fleet. Streamlined aerodynamic shape cuts drag to a minimum. Altitudes in excess of 3,000' can be reached using the powerful F.S.I. Rocket Engines.

Specifications:
Length – 19.0"
Body Dia. – 0.903"
Takeoff weight without engine: 1.45 oz. (41 g.)*
Recommended F.S.I. Engines:
**A6-5, B6-5, C6-7, D18-6, D20-7, E5-6
Catalog Number 1001
Ship Wt. 8 oz.

* All takeoff weights approximate.
** Suggested for lower altitude flights to facilitate recovery.



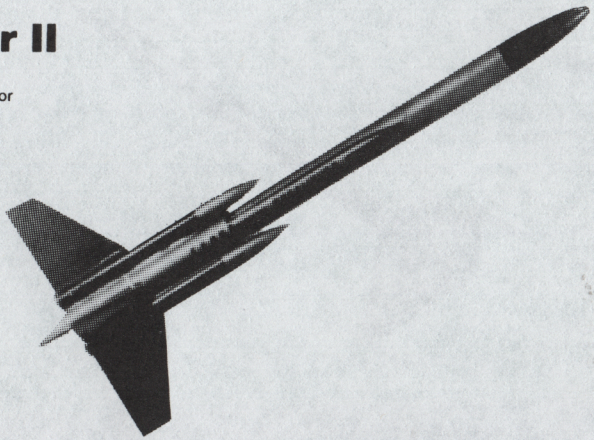
Excalibur II

Skill Level 3

This exotic new interceptor features rear ejection recovery system. The Excalibur is a beautiful flying rocket and a real crowd pleaser.

Specifications:
Length — 21.5"
Body Dia. — 1.13"
Takeoff weight without engine 2.5 oz. (60 g.)*
Recommended F.S.I. Engines:
A6-3, B6-3, C6-6
Catalog Number 1027
Ship Wt. 8 oz.

*All takeoff weights approximate.



FLIGHT SYSTEMS, INC.

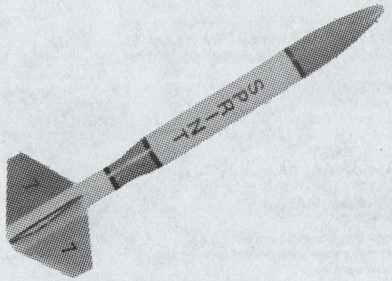
Sprint

Skill Level 2

A competition model, the Sprint features a large upper body tube with a reverse transition to a smaller lower body tube. A large streamer or parachute can be packed in the upper body for long duration flights. The effect of base drag can be compared with that of a model like the Nova Kit.

Specifications:
Length – 15"
Body Dia. –
above transition – 1.130"
below transition – 0.903"
Takeoff weight without engine: 1.94 oz. (55 g.)*
Recommended F.S.I. Engines:
C6-5, D18-6, D20-7,
Catalog Number 1007
Ship Wt. 9 oz.

* All takeoff weights approximate.



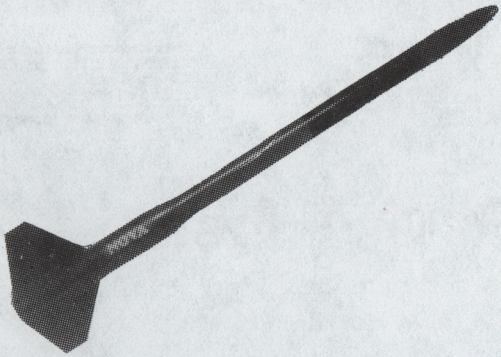
Nova

Skill Level 2

Nova is a kit designed to test your building skill and give you experience with aerodynamic flow across a transition section. Altitudes above 3,500' with larger F.S.I. Engines.

Specifications:
Length – 18"
Body Dia. above transition – 0.903"
below transition – 1.130"
Takeoff weight without engine:
1.45 oz. (57 g.)*
Recommended F.S.I. Engines:
D18-6, D20-5, E5-6, E60-8, F7-6, F100-10
Catalog Number 1003
Ship Wt. 9 oz.

* All takeoff weights approximate.



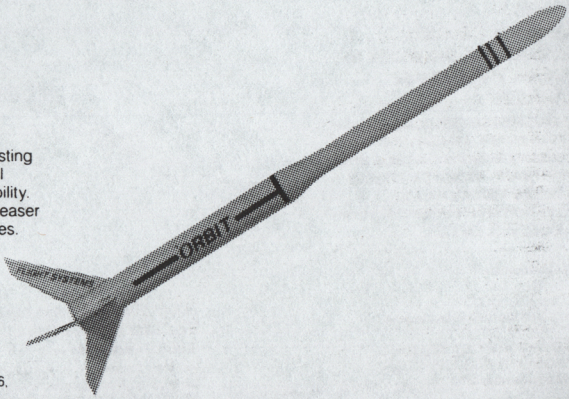
Orbit

Skill Level 2

This rocket is designed to make maximum use of the F.S.I. long thrusting (9 sec.) F7-6 Rocket Engine and will reach altitudes beyond ground visibility. A highly stable bird; a real crowd pleaser even when flown with smaller engines.

Specifications:
Length – 22"
Body Dia. –
above transition – 0.903"
below transition – 1.130"
Takeoff weight without engine:
1.91 oz. (54 g.)*
Recommended F.S.I. Engines:
D18-4, D18-6, D20-5, E5-6, E60-8, F7-6, F100-8
Catalog Number 1006
Ship Wt. 8 oz.

* All takeoff weights approximate.

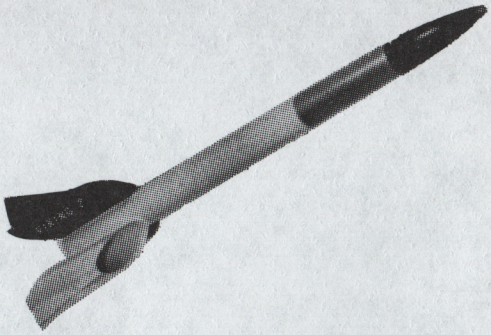


FLIGHT SYSTEMS, INC.

Viking II

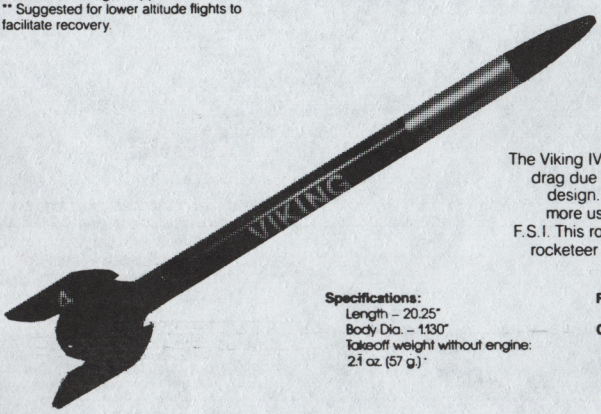
Skill Level 3

Another of the Viking Series rockets, this model makes a fine display rocket as well as a highly stable flying model.



Specifications:
Length – 23"
Body Dia. – 0.903"
Takeoff weight without engine:
1.5 oz. (30 g.)*
Recommended F.S.I. Engines:
**B6-5, C6-7, D18-4, D18-6, E5-6
Catalog Number 1010
Ship Wt. 8 oz.

* All takeoff weights approximate.
** Suggested for lower altitude flights to facilitate recovery.



Viking IV

Skill Level 3

The Viking IV features extreme stability and low drag due to the latest innovation in stabilizer design. Results are altitudes to 4,000' and more using the F Series rocket engines by F.S.I. This rocket is designed for the advanced rocketeer who wants the finest in stable high flying birds.

Specifications:
Length – 20.25"
Body Dia. – 1.130"
Takeoff weight without engine:
2.1 oz. (57 g.)*

Recommended F.S.I. Engines:
D18-4, D18-6, D20-5, E60-6, F7-6, F100-8
Catalog Number 1012
Ship Wt. 10 oz.

* All takeoff weights approximate.

the Mach 1 System

Dart

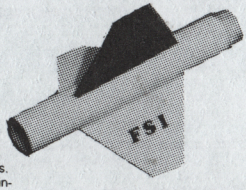
Skill Level 5

The Mach 1 System
A model with the ability to BREAK THE SOUND BARRIER

An excellent contest or sport rocket in its own right. Includes everything necessary to fly the Dart as a single stage model, except the engines. Complete instructions and information on supersonic flight are included with the Dart.

Specifications:
Length – 19"
Body Dia. 0.903
Takeoff weight without engine
1.15 oz. (33 g.)*
Recommended F.S.I. Engines:
A6-5, B6-5, C6-5, D18-6, D20-7
Catalog Number 1017
Ship Wt. 8 oz.

All takeoff weights approximate.



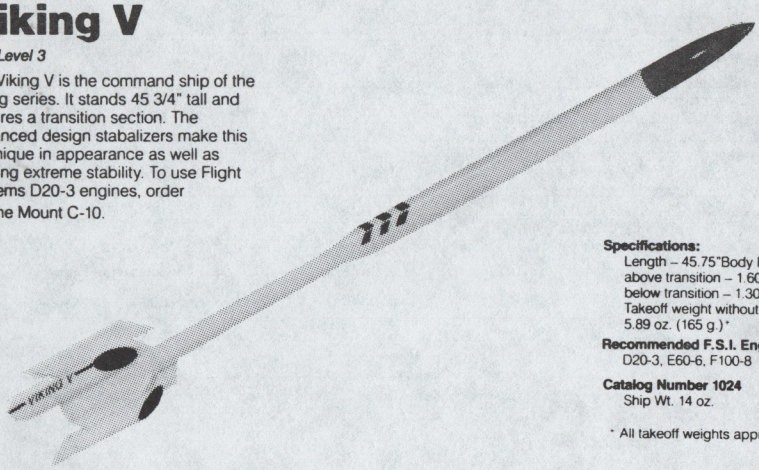
RX-1 Thruster System For The Mach I Dart Sold Separately—
Includes: Booster stage, special engines for both upper and lower stages, Electric Match Ignitor, and complete instructions.
Catalog Number 2217

FLIGHT SYSTEMS, INC.

Viking V

Skill Level 3

The Viking V is the command ship of the Viking series. It stands 45 3/4" tall and features a transition section. The advanced design stabalizers make this kit unique in appearance as well as offering extreme stability. To use Flight Systems D20-3 engines, order Engine Mount C-10.



Specifications:
Length – 45.75"Body Dia.
above transition – 1.60"
below transition – 1.30"
Takeoff weight without engine:
5.89 oz. (165 g.)*

Recommended F.S.I. Engines:
D20-3, E60-6, F100-8

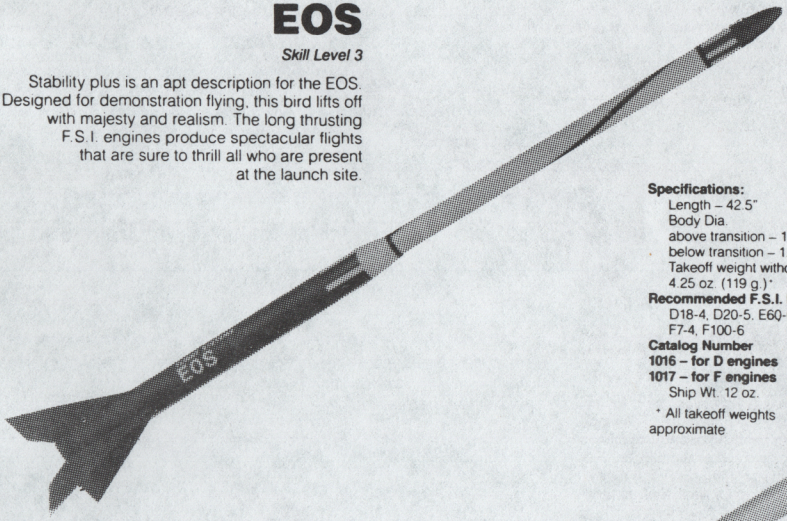
Catalog Number 1024
Ship Wt. 14 oz.

* All takeoff weights approximate.

EOS

Skill Level 3

Stability plus is an apt description for the EOS. Designed for demonstration flying, this bird lifts off with majesty and realism. The long thrusting F.S.I. engines produce spectacular flights that are sure to thrill all who are present at the launch site.



Specifications:
Length – 42.5"
Body Dia.
above transition – 1.34"
below transition – 1.64"
Takeoff weight without engine:
4.25 oz. (119 g.)*

Recommended F.S.I. Engines:
D18-4, D20-5, E60-6,
F7-4, F100-6

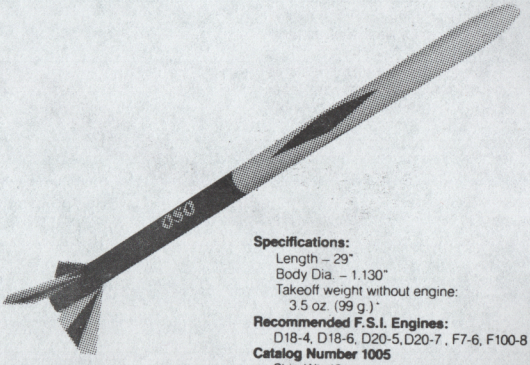
Catalog Number
1016 – for D engines
1017 – for F engines
Ship Wt. 12 oz.

* All takeoff weights approximate

OSO

Skill Level 2

Propel heavy experimental payloads to extreme altitudes with this highly stable and majestic bird. Payload section and rocket body are recovered as one unit. Oso was designed to make use of an engine which was a break-through in model rocket engine design, the F100. Other recommended engines will also assure spectacular flights. Order Engine Mount C-10 for using D engines.



Specifications:
Length – 29"
Body Dia. – 1.130"
Takeoff weight without engine:
3.5 oz. (99 g.)*

Recommended F.S.I. Engines:
D18-4, D18-6, D20-5, D20-7 , F7-6, F100-8

Catalog Number 1005
Ship Wt. 10 oz.

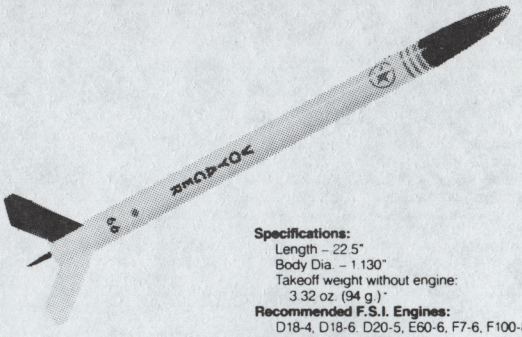
* All takeoff weights approximate.

FLIGHT SYSTEMS, INC.

Voyager

Skill Level 2

The Voyager with its separate recoverable payload capsule is the high altitude scientific experimental vehicle of the F.S.I. Fleet. Experiments placed in the capsule are returned safely to earth with the capsule which is ejected and recovered separately from the main body of the rocket. To use Flight Systems D or E engines, order Engine Mount C-10.



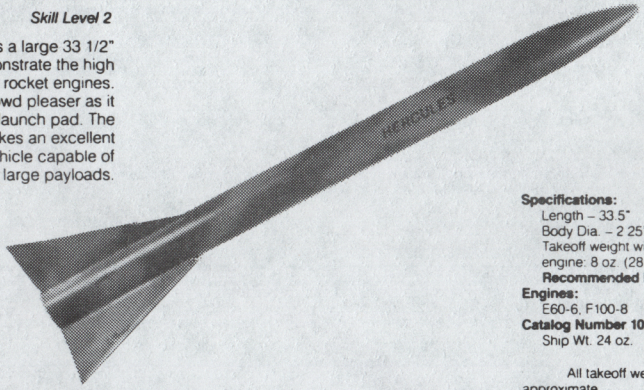
Specifications:
Length – 22.5"
Body Dia. – 1.130"
Takeoff weight without engine:
3.32 oz. (94 g.)*
Recommended F.S.I. Engines:
D18-4, D18-6, D20-5, E60-6, F7-6, F100-8
Catalog Number 1004
Ship Wt. 10 oz.

All takeoff weights approximate.

Hercules

Skill Level 2

The Hercules is a large 33 1/2" rocket used to demonstrate the high performance of F100 rocket engines. It is always a real crowd pleaser as it roars off the launch pad. The Hercules makes an excellent research vehicle capable of carrying large payloads.



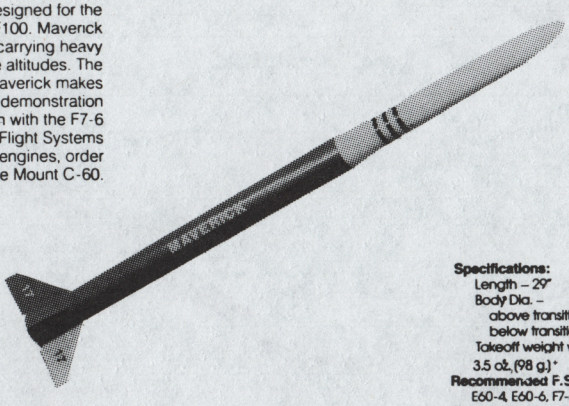
Specifications:
Length – 33.5"
Body Dia. – 2.25"
Takeoff weight without engine: 8 oz. (28 g.)*
Recommended F.S.I. Engines:
E60-6, F100-8
Catalog Number 1020
Ship Wt. 24 oz.

All takeoff weights approximate

Maverick

Skill Level 3

A payload rocket designed for the Loadlifter E60 and F100. Maverick is capable of carrying heavy payloads to extreme altitudes. The high stability of the Maverick makes it a very spectacular demonstration model when flown with the F7-6 thruster. To use Flight Systems D18-4 or D20-5 engines, order Engine Mount C-60.



Specifications:
Length – 29"
Body Dia. –
above transition – 1.34"
below transition – 1.64"
Takeoff weight without engine:
3.5 oz. (98 g.)*
Recommended F.S.I. Engines:
E60-4, E60-6, F7-6, F100-8, F100-10
Catalog Number 1018
Ship Wt. 12 oz.

* All takeoff weights approximate.

FLIGHT SYSTEMS, INC.

Megatron

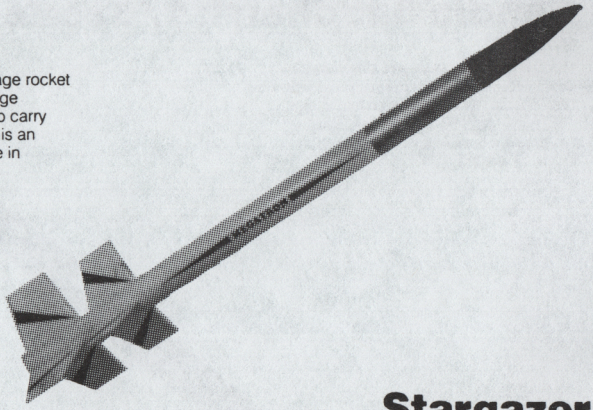
Skill Level 4

The Megatron is a beautiful two stage rocket that will give the ultimate in two stage performance. This rocket is used to carry bulky payloads to high altitudes. It is an excellent model to gain experience in launching staged model rockets.

Specifications:
Length – 34.5"
Body Dia. – 1.60"
Takeoff weight without engine: 5 oz. (140 g.)*

Recommended F.S.I. Engines:
1st stage
D18-0, D20-0
2nd stage
B6-7, , C6-7, D18-6, D20-7, E5-6
Catalog Number 1022
Ship Wt. 12 oz.

* All takeoff weights approximate.



Stargazer

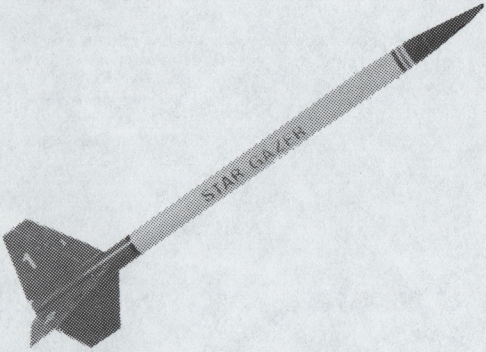
Skill Level 4

High performance two stage rocket. Unique fin design blends upper and lower fins into one smooth aerodynamic shape. 1st stage has tumble recovery. 2nd stage can be flown without booster stage. This bird streaks to altitudes of well over 4,000' with the proven superior performance of Flight Systems' D and E series engines.

Specifications:
Length – 23"
Body Dia. – 0 903"
Takeoff weight without engine: 1.94 oz. (55 g.)*

Recommended F.S.I. Engines:
1st stage
C6-0, D18-0, D20-0, E5-0
2nd stage
A6-5, D18-6, D20-7, E5-6
Catalog Number 1002
Ship Wt. 9 oz.

* All takeoff weights approximate.



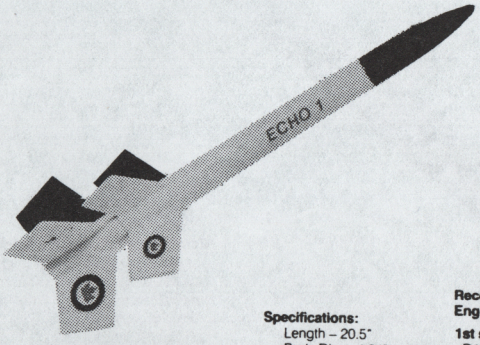
Echo 1

Skill Level 4

An advanced two stage bird capable of flights to extreme altitudes. Utilizing the superior F.S.I. D18-0 booster engine, the Echo I opens a new dimension in two stage rocket performance. A payload section may be added for high altitude experiments. Echo I may also be flown as a high performance single stage rocket.

Catalog Number 1015
Ship Wt. 14 oz.

* All takeoff weights approximate.



Specifications:
Length – 20.5"
Body Dia. – 1.34"
Takeoff weight without engine: 3.5 oz. (28 g.)*

Recommended F.S.I. Engines:

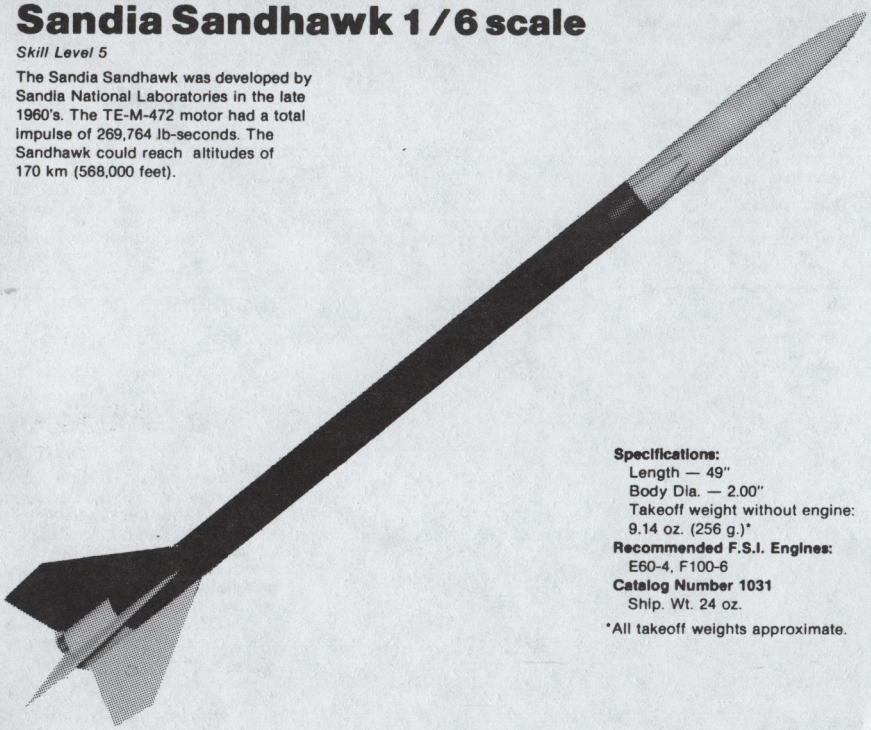
1st stage:	2nd stage:
D18-0	B6-7, , C6-7
D20-0	D18-6, D20-7
	E5-6

FLIGHT SYSTEMS, INC.

Sandia Sandhawk 1/6 scale

Skill Level 5

The Sandia Sandhawk was developed by Sandia National Laboratories in the late 1960's. The TE-M-472 motor had a total impulse of 269,764 lb-seconds. The Sandhawk could reach altitudes of 170 km (568,000 feet).



Specifications:
Length — 49"
Body Dia. — 2.00"
Takeoff weight without engine: 9.14 oz. (256 g.)*
Recommended F.S.I. Engines:
E60-4, F100-6
Catalog Number 1031
Ship. Wt. 24 oz.

*All takeoff weights approximate.

Nike Smoke 1/8 scale

Skill Level 4

The Nike Smoke is a 1/8 scale model of the solid propellant sounding rocket used by NASA to measure wind velocities up to 75,000 ft. Chemicals released from the nose cone formed a dense white smoke that was photographically recorded to show wind movements.

Specifications:
Length — 28.6"
Body Dia. — 2.00"
Recommended F.S.I. Engines:
Takeoff weight without engine: 4.75 oz. (133 g.)*
Recommended F.S.I. Engines:
E60-6, F100-8
Catalog Number 1030
Ship Wt. 12 oz.

*All takeoff weights approximate.

FLIGHT SYSTEMS, INC.

Intrepid

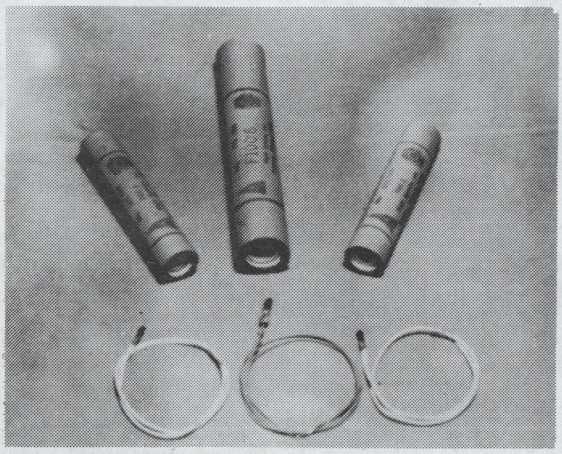
Skill Level 4

An excellent flying model that can be flown with a single engine or with the cluster pack of engines shown on this page. Either way it is sure to be a crowd pleaser.

Specifications:
Length — 49.5"
Body Dia. —
above transition — 2.25"
below transition — 1.7"
Takeoff weight without engine:
9.18 oz. (257 g.)*
Recommended F.S.I. Engines:
F100-6, E60-4
Cluster Pack (3 engines)
F100, (2) D20
Catalog Number 1032
Ship Wt. 14 oz.

*All takeoff weights approximate.

Intrepid Engine Cluster Pack



Intrepid Engine Cluster Pack

This engine cluster is specifically designed for the Intrepid and includes engines and electric squibs necessary for clustering the rocket engines.

Intrepid Engine Cluster Pack

(1) F100-6, (2) D20-0S
(1) M100, (2) M20 ELECTRIC MATCHES

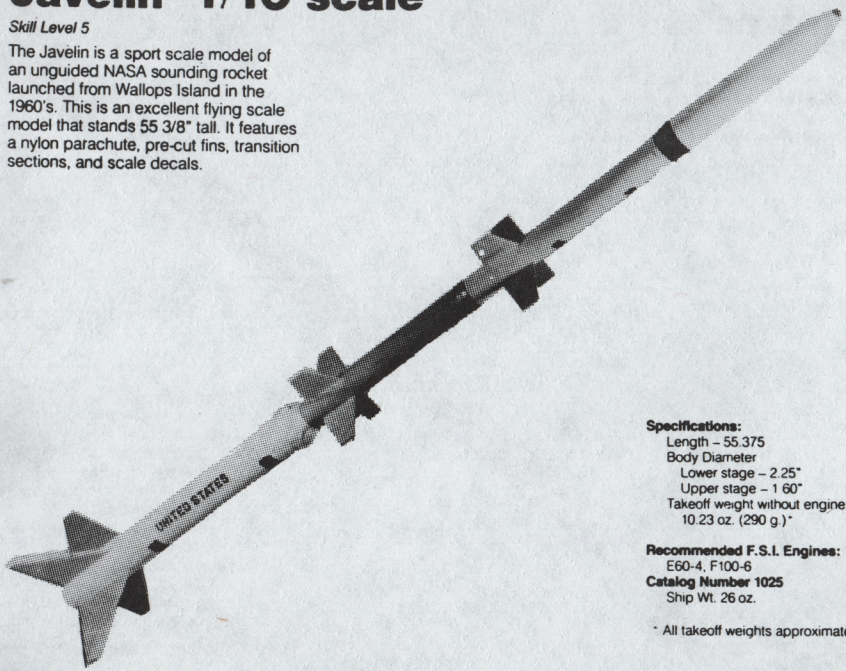
Catalog Number 2217

FLIGHT SYSTEMS, INC.

Javelin 1/10 scale

Skill Level 5

The Javelin is a sport scale model of an unguided NASA sounding rocket launched from Wallops Island in the 1960's. This is an excellent flying scale model that stands 55 3/8" tall. It features a nylon parachute, pre-cut fins, transition sections, and scale decals.



Specifications:
Length – 55.375
Body Diameter
Lower stage – 2.25"
Upper stage – 1.60"
Takeoff weight without engine:
10.23 oz. (290 g.)*

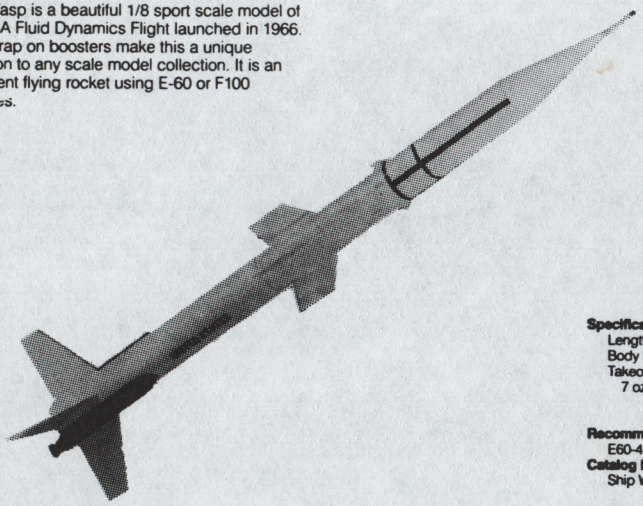
Recommended F.S.I. Engines:
E60-4, F100-6
Catalog Number 1025
Ship Wt. 26 oz.

* All takeoff weights approximate.

Wasp 1/8 scale

Skill Level 5

The Wasp is a beautiful 1/8 sport scale model of a NASA Fluid Dynamics Flight launched in 1966. The strap on boosters make this a unique addition to any scale model collection. It is an excellent flying rocket using E-60 or F100 Engines.



Specifications:
Length – 34.75"
Body Dia. – 2.00"
Takeoff weight without engine:
7 oz. (20 g.)*

Recommended F.S.I. Engines:
E60-4, F100-6
Catalog Number 1024
Ship Wt. 14 oz.

* All takeoff weights approximate.

FLIGHT SYSTEMS, INC.

Black Brant II 1/8 scale

Skill Level 5

This F.S.I. 1/8 scale model of a Canadian sounding rocket is a sophisticated bird unequalled for beauty and performance. Kit features include a 22" nylon parachute, pre-cut fins, pre-cut balsa boattail as well as scale decals.

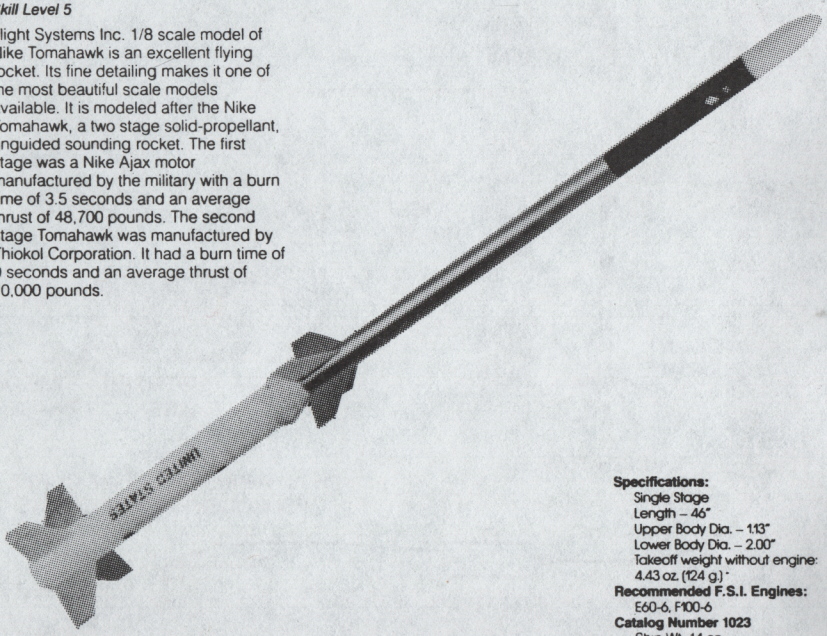
Specifications:
Length – 41.5"
Body Dia. – 2.1"
Takeoff weight without engine: 9.5 oz. (269 g.)*
Recommended F.S.I. Engines:
E60-6, F100-6, F100-8
Catalog Number 1014
Ship Wt. 24 oz.

* All takeoff weights approximate.

Nike Tomahawk 1/8 scale

Skill Level 5

Flight Systems Inc. 1/8 scale model of Nike Tomahawk is an excellent flying rocket. Its fine detailing makes it one of the most beautiful scale models available. It is modeled after the Nike Tomahawk, a two stage solid-propellant, unguided sounding rocket. The first stage was a Nike Ajax motor manufactured by the military with a burn time of 3.5 seconds and an average thrust of 48,700 pounds. The second stage Tomahawk was manufactured by Thiokol Corporation. It had a burn time of 9 seconds and an average thrust of 10,000 pounds.



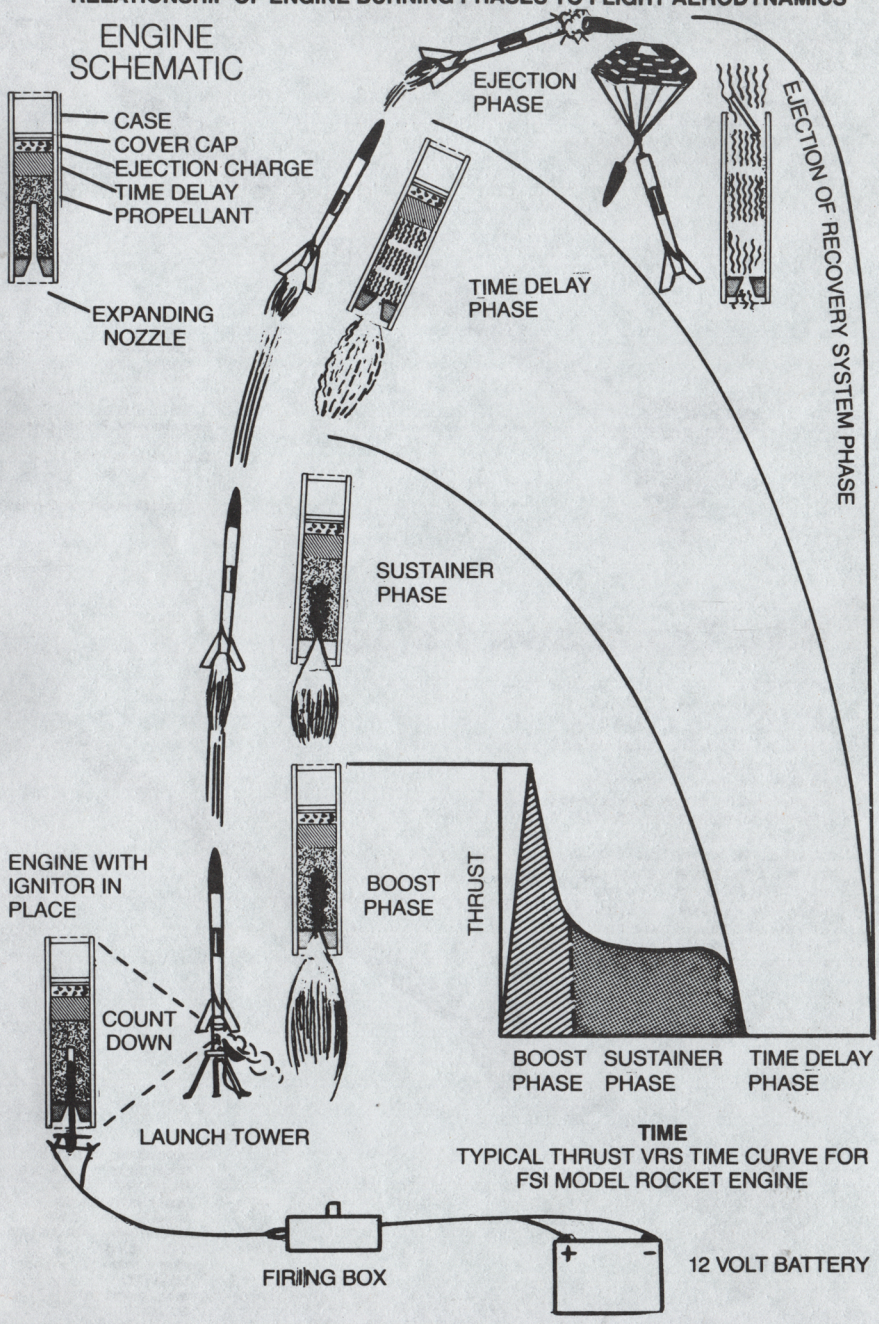
Specifications:
Single Stage
Length – 46"
Upper Body Dia. – 1.13"
Lower Body Dia. – 2.00"
Takeoff weight without engine: 4.43 oz. (124 g.)*
Recommended F.S.I. Engines:
E60-6, F100-6
Catalog Number 1023
Ship Wt. 14 oz.

* All takeoff weights approximate.

FLIGHT SYSTEMS, INC.

Internal – External Ballistics

RELATIONSHIP OF ENGINE BURNING PHASES TO FLIGHT AERODYNAMICS



TYPICAL THRUST VRS TIME CURVE FOR FSI MODEL ROCKET ENGINE

FLIGHT SYSTEMS, INC.

Internal – External Ballistics

Ballistics

Internal Ballistics – is the science dealing with the thermochemistry of combustion of the propellant in the engine and the accompanying physical phenomena of gas production and expulsion to produce thrust. Simply stated, it is the combustion of the propellant to produce a gas which then undergoes a change in enthalpy through the rocket nozzle to produce thrust.

External Ballistics – is the science dealing with the flight of the rocket after it leaves the launcher. As the engine is usually still thrusting at this time, we have the forces of engine thrust and the aerodynamic forces on the rocket body to consider.

Model Rocket Flights

Count Down - The Model Rocket has been preflight checked and placed on the launch tower. The rocket engine ignitor has been placed in the core of the rocket engine. Wires from the firing box are connected to the engine ignitor and the battery. All systems are now go. The countdown is begun and the firing button is pressed when countdown reaches zero. The rocket engine ignites. Action on the thrust-time curve starts at the lower left hand corner.

Boost Phase - The propellant is now burning away from the engine core where it was ignited by the electric ignitor. In a well designed rocket engine, burning takes place only on the surface of the propellant. As the propellant burns out and away from the core, the burning area increases producing an increase in the volume of gas produced. This gas is ejected through the engine nozzle to produce thrust. Burning area continues to increase until all the propellant around the initial core is burned to the engine wall. This produces the high peaked thrust shown on the thrust-time curve.

Initial high thrust is necessary for stable rocket flights. The rocket must leave the launcher with sufficient velocity for aerodynamic control. This is achieved by the fins on the Model Rocket passing through the air at high speed. This keeps the model pointed in an upward direction.

Sustainer Phase - By now the propellant around the core has burned out to the core wall. The area of burning is now across the inside diameter of the engine case. Less gas for thrust is being produced. This is shown on the thrust-time curve by the lower thrust plateau.

During this portion of the flight, sufficient thrust must be produced by the rocket engine to keep the model rocket accelerating upward. Otherwise the model will lose aerodynamic control and pitch over and head back to earth.

Time Delay Phase – All the propellant in the engine is now consumed and the time delay material is ignited. No thrust is produced by the time delay material as shown on the thrust-time curve.

The Model Rocket is now coasting on the momentum which was stored in the system during the boost and sustainer phase of engine thrust. A well designed Model Rocket system should continue to coast to an altitude which is equal to twice engine burn out altitude. Gravity and aerodynamic friction on the Model Rocket begin to slow it down until the apogee of flight is reached.

Ejection Phase – When the Model Rocket is in the apogee of its flight, the time delay material burns through into the ejection charge. The ejection charge produces a large quantity of gas. This gas pushes the cover cap out of the engine, and everything in the tube ahead is ejected. The ejected parachute unfolds and lowers the model rocket gently and safely to the ground. Many more flights can be made with the same model.

FLY with F.S.I.

"Professionalism In Rocketry"

FLIGHT SYSTEMS, INC.

Model Rocket Engines

All FSI model rocket engines are certified by the National Association of Rocketry.

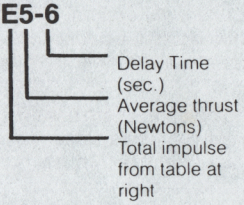
All FSI Model Rocket engines comply with the National Fire Protection Association code for Model Rocketry, No. 41L-1968.

NFPA

Electric Ignitors – Electric ignitors are included with all FSI rocket engines.

Engine Classification – Total impulse limits set by the National Association of Rocketry (NAR) and the Federation Aeronautique Internationale (FAI).

Engine Marking Code



Engine Classification Code

ENGINE TYPE	TOTAL IMPULSE Newton Seconds	TOTAL IMPULSE Pound-Seconds
A	1.26 to 2.50	0.29 to 0.56
B	2.51 to 5.00	0.57 to 1.12
C	5.01 to 10.00	1.13 to 2.24
D	10.01 to 20.00	2.25 to 4.48
E	20.01 to 40.00	4.49 to 8.96
F	40.01 to 80.00	8.97 to 17.92
G	80.00 to 160.00	17.92 to 35.96

Engine Selection

Which Engine Should I Use?

Flight Systems, Inc. – Produces a variety of engines for model rocketeers to choose from. These fall in several broad categories of uses. FSI has NAR Safety Approved & Contest Certified Model Rocket Engines in all sizes A through F.

Initial Thrust – All FSI engines have a high initial thrust so that aerodynamic stability of Model Rocket is obtained when model leaves the launch rod.
Note: Initial thrust is the high peak on the thrust-time curve.

Sustainer Thrust – Thrust necessary to keep Model Rocket accelerating after initial thrust of engine. Note: Sustainer thrust is the lower plateau on the thrust-time curve. Recommended maximum weight of rocket system is based on amount sustainer phase of engine can accelerate after initial boost phase.

Long Thrusting – Engine with normal initial thrust but with a long sustaining thrust for very high altitudes and much realism in Model Rocket flights. Use D-18, E5-x, F7-6. Specify delay time in place of x. See table of delay times manufactured for each engine designation.

Load Lofting – Engine with large total impulse but very short burn-time for lofting heavy models to altitude. Use F100-x. Specify "O" time for booster engine or "8" for delay time engine.

Zero Delay Time – Engine with no delay time or ejection charge. Used for lower stage engines and ignition of upper stage engines. Specify "O" after dash in code number, example: D20-O.

Delay Time – Use 6 and 8 second delay time for upper stage on staged models or for models which are to descend from apogee before recovery. Use other delay times for recovery at apogee. **NOTE:** All engines with delay time have ejection charges.

"Precision with Purpose"

FLIGHT SYSTEMS, INC.

Metric and English Measurement

Much technical information concerning model rockets is expressed using metric measurements. Therefore it is desirable that the rocketeer understand the relationship between the metric and English system of measurements. The following table expresses that relationship.

Millimeter	= .03937 inches	Newton = 0.225 pounds of force
Centimeter	= .3937 inches	Newton second = 0.225 pound of force sec.
Meter	= 39.37 inches	Ounce = 28.35 grams
Meter	= 3.281 feet	1 pound of force = 4.45 newtons
Gram	= 0.0353 ounces	1 pound second = 4.45 newton sec.
Kilogram	= 35.3 ounces	
Kilogram	= 2.207 pounds	

Newton

The energy required to move an object is expressed in newtons. A newton is the amount of energy needed to move one kilogram with a change in velocity of one meter per second each second it is being acted on by the force.

$$\text{change in velocity (meters per sec.)} = \frac{\text{Force in newtons}(20)^*}{\text{Mass in kilograms }(0.4)^*} = (50^* \text{ meters per sec.})$$

Example: 0.4* kilogram rocket acted upon by a force of 20* newtons will have a change in velocity of 50* meters per second each second it is being acted upon, as per the formula given 0.4* kilograms divided into 20* newtons of force equals 50* meters per second change in velocity for each second time force is acting upon the rocket.

```
                    50   CHANGE IN VELOCITY
                         METERS PER SECOND
MASS IN
KILOGRAMS  .4.)20.0.   (FORCE IN NEWTONS)
                20
                ---
                 0.0
```

FLIGHT SYSTEMS, INC.

F.S.I. MODEL ROCKET ENGINES

APPROVED by

THE NATIONAL ASSOCIATION OF ROCKETRY

REGISTERED with

THE CALIFORNIA STATE FIRE MARSHALL

FLIGHT SYSTEMS Inc.

RAYTOWN, MISSOURI 64133

FLIGHT SYSTEMS, INC.

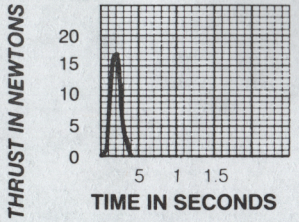
Rocket Engines – Typical Thrust VRS Time Curves

Motor Designation:.....A6
Total Impulse: 2.5nt/sec., .56 lb. sec.
Maximum Thrust:....1.36 Kg/48 oz
Thrust Duration: :..... .46 sec.
Time Delays Available:..... 0, 3, 5

Initial Weight: ..... 16.2 grams
Propellant Weight: ..... 3.12 grams
Engine Casing Size: ...69 x 18 mm
Recommended Maximum
Lift Off Weight: ..... 113.4 grams

CATALOG NO.	ENGINE TYPE	DELAY
2001	A6	0
2002	A6	3
2003	A6	5

(Engines come 3 per package)

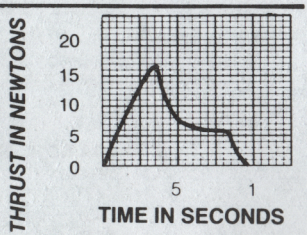


Motor Designation:.....B6
Total Impulse: . 5 nt/sec., 1.2 lb sec.
Maximum Thrust:....1.36 Kg/48 oz
Thrust Duration:..... .83 sec.
Time Delays Available: . 0, 4, 6 sec.

Initial Weight: ..... 20.1 grams
Propellant Weight: ..... 6.24 grams
Engine Casing Size: ...69 x 18 mm
Recommended Maximum
Lift Off Weight: ..... 113.4 grams

CATALOG NO.	ENGINE TYPE	DELAY
2011	B6	0
2012	B6	3
2013	B6	5

(Engines come 3 per package)

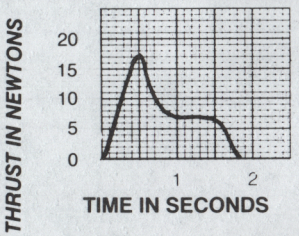


Motor Designation:..... C6
Total Impulse:10 nt/sec., 2.25 lb sec.
Maximum Thrust:... 1.36 Kg/48 oz.
Thrust Duration:..... 1.7 sec.
Time Delays Available:..... 0, 3, 5

Initial Weight: .....25 grams
Propellant Weight: .... 12.48 grams
Engine Casing Size: ...69 x 18 mm
Recommended Maximum
Lift Off Weight: ..... 113.4 grams

CATALOG NO.	ENGINE TYPE	DELAY
2014	C6	0
2015	C6	3
2016	C6	5

(Engines come 3 per package)

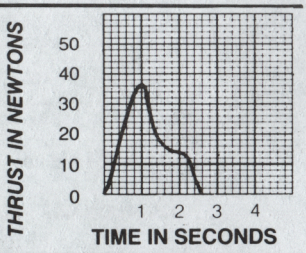


Motor Designation:..... D18
Total Impulse: 20 nt/sec., 4.5 lb/sec.
Maximum Thrust:... 3.6 Kg/127 oz.
Thrust Duration:..... 2.3 sec.
Time Delays Available:..... 0, 4, 6

Initial Weight: .....43 grams
Propellant Weight:.....19 grams
Engine Casing Size: ...95 x 21 mm
Recommended Maximum
Lift Off Weight 175 grams

CATALOG NO.	ENGINE TYPE	DELAY
2021	D18	0
2022	D18	4
2023	D18	6

(Engines come 3 per package)

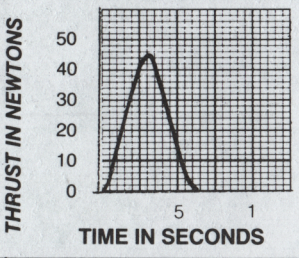


Motor Designation:..... D20
Total Impulse:..... 15 nt/sec.
Maximum Thrust:....44.5 Kg/10 lb.
Thrust Duration:.....6 sec.
Time Delays Available:... 0, 3, 5, 7

Initial Weight: .....43 grams
Propellant Weight:.....19 grams
Engine Casing Size: ...21 x 95 mm
Recommended Maximum
Lift Off Weight 175 grams

CATALOG NO.	ENGINE TYPE	DELAY
2025	D20	0
2026	D20	3
2027	D20	5
2028	D20	7

(Engines come 3 per package)



FLIGHT SYSTEMS, INC.

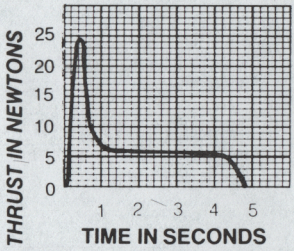
Rocket Engines – Typical Thrust VRS Time Curves

Motor Designation: E5
Total Impulse: . .22 nt/sec., 5 lb/sec.
Maximum Thrust: .... 2.5 Kg/88 oz.
Thrust Duration: ..... 4.5 sec.
Time Delays Available: 0, 4, 6

Initial Weight: .....45 oz.
Propellant Weight: .....21 grams
Engine Casing Size: . . .21 x 95 mm
Recommended Maximum
Lift Off Weight 150 grams

CATALOG NO.	ENGINE TYPE	DELAY
2031	E5	0
2032	E5	4
2033	E5	6

(Engines come 3 per package)

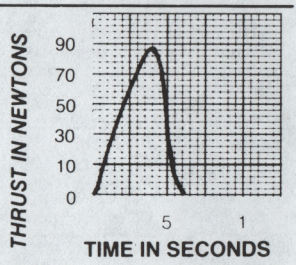


Motor Designation:..... E60
Total Imp.: 30 nt/sec., 6.6 lb/sec.
Maximum Thrust: ....9.06 Kg/20 lb.
Thrust Duration: ..... .6 sec.
Time Delays Available: . . . 0, 4, 6, 8

Initial Weight: .....80 grams
Propellant Weight: ..... 33.6 grams
Engine Casing Size: . .27 x 100 mm
Recommended Maximum
Lift Off Weight 448 grams

CATALOG NO.	ENGINE TYPE	DELAY
2041	E60	0
2042	E60	4
2043	E60	6
2044	E60	8

(Engines come 3 per package)

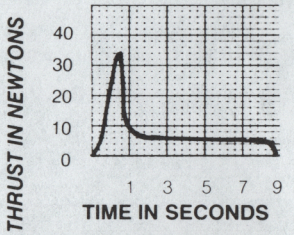


Motor Designation:.....F7
Total Impulse:60 nt/sec., 13.5 lb sec.
Maximum Thrust: .... 3.5 Kg 7.7 lb.
Thrust Duration: .....9 sec.
Time Delays Available: 4, 6

Initial Weight: .....110 grams
Propellant Weight: .....50 grams
Engine Casing Size: . .27 x 150 mm
Recommended Maximum
Lift Off Weight 200 grams

CATALOG NO.	ENGINE TYPE	DELAY
2051	F7	4
2052	F7	6

(Engines come 3 per package)

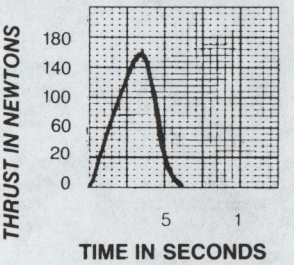


Motor Designation:.....F-100
Total Imp.: . .50 nt/sec., 11.3 lb/sec.
Maximum Thrust: .... 16 Kg 35 lbs.
Thrust Duration: .....5 sec.
Time Delays Available: 0, 4, 6, 8, 10

Initial Weight: .....110 grams
Propellant Weight: .....50 grams
Engine Casing Size: . .27 x 150 mm
Recommended Maximum
Lift Off Weight 500 grams

CATALOG NO.	ENGINE TYPE	DELAY
2053	F100	0
2054	F100	4
2055	F100	6
2056	F100	8
2057	F100	10

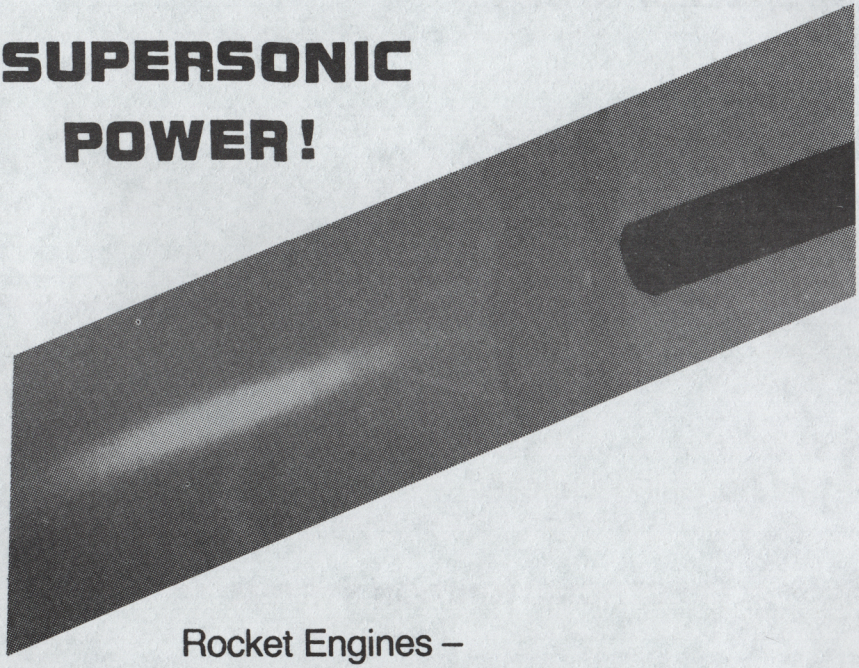
(Engines come 3 per package)



FLIGHT SYSTEMS, INC.

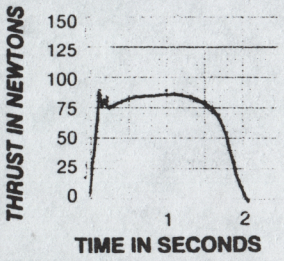
THE *THUNDERBOLTS* ARE HERE!

SUPERSONIC POWER!



Rocket Engines –
Typical Thrust VRS Time Curve

Motor Designation: G60		Initial Weight: ..... 110 grams	
Total Impulse: ..... 120 nt/sec.		Propellant Weight: ..... 60 grams	
Maximum Thrust: ..... 89 nts		Engine Casing Size: .. 1.00" x 5.25"	
Thrust Duration: ..... 2 sec.		Recommended Maximum	
Time Delays Available: 6, 8, 0		Lift Off Weight: ..... 2 lbs.	
CATALOG NO.	**ENGINE TYPE**	**DELAY**	
2061	G60	6	
2062	G60	8	
2063	G60	10	



FLIGHT SYSTEMS, INC.

Rocket Engine Ignitors:

For A, B, C, D, and E engines (except D-18) – 20 per pkg.
1A-10 Ignitors **Catalog No. 2101**

For D-18 and F7 engines – 16 per pkg.
1A-20 Ignitors **Catalog No. 2102**

For D20 engines – 12 per pkg.
1A-25 Ignitors **Catalog No. 2103**

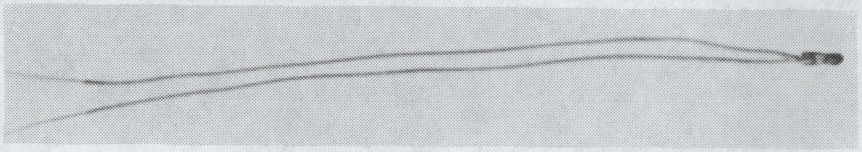
For F100 engines – 8 per pkg.
1A-30 Ignitors **Catalog No. 2105**

M-100 ELECTRIC MATCH

For quick, efficient iginition of E60, F100 and Thunderbolt engines.
12" Copper Leads **Catalog No. 2100**

M-20 ELECTRIC MATCH

For quick, efficient ignition of D20 Engines.
12" Copper Leads **Catalog No. 2104**



Launching Supplies

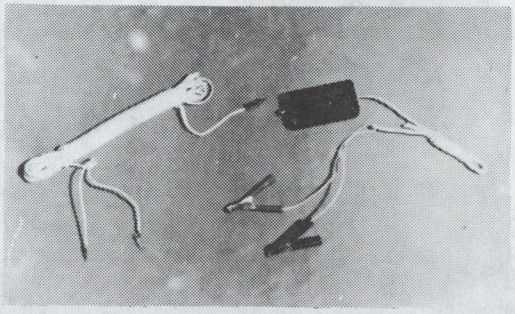
Proper launching equipment is very important for good model rocket flights.

EC-102 ELECTRONIC IGNITION SYSTEM

This model rocket ignition system is the latest innovation from Flight Systems, Inc., the leader in model rocket technology. The EC-102 System uses a light emitting diode (L.E.D.) with a line resistance to check continuity rather than the light bulb and the EC-102 will safely continuity check our M-100 Electric Match when used with a 6 or 12 volt battery.

This professional quality launch control has a removable firing line for complete safe disarming of the firing system. The firing line is 25' long and has plug and micro clips attached. The firing panel has a 5' power cord with battery clips attached. This launch system comes completely assembled. It can be used with any launcher.

Catalog No. 4001

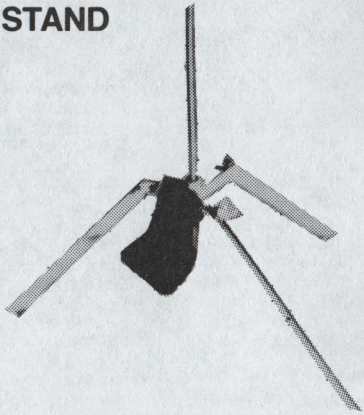


FLIGHT SYSTEMS, INC.

Launching Supplies

LP-1 ADJUSTABLE BASE LAUNCH STAND

The LP-1 is a professional type launcher featuring all metal construction. The legs are adjustable so that the launch rod can be positioned vertically on uneven ground or tipped for wind conditions. The two piece rod makes storage and handling easier. The lower rod is 1/8" in diameter and the upper rod is 1/16" in diameter. This launcher is not recommended for large model rockets. **Catalog No. 4002**



LP-2 ADJUSTABLE BASE LAUNCH STAND

The LP-2 is basically the same as the LP-1 except it is larger and features a 2 piece rod that has a lower rod 1/4" in diameter and an upper rod 3/16" in diameter. Larger models can be launched using this launcher. **Catalog No. 4003**

F.S.I. ROCKET NOT INCLUDED

LP-3 ADJUSTABLE BASE LAUNCH STAND

This launch stand is used by some of our commercial customers. It is ideal for use with larger model rockets. It has a 2 piece rod 42" long. The legs are adjustable so the launch rod can be positioned vertically on uneven ground or tipped for wind conditions. The legs can be staked down to assure launcher forms a very stable platform. This launcher is much larger and heavier than the LP-1 or the LP-2. The base measures about two feet high. **Catalog No. 4004**

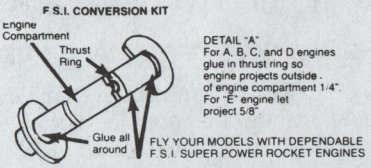
F.S.I. ROCKET NOT INCLUDED

FLIGHT SYSTEMS, INC.

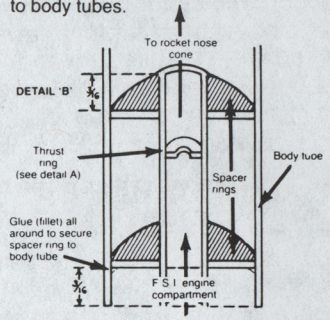
Engine Mounts

CAT. NO.	DESC.		I.D.
6901	C55	Fits Estes BT-55	1.283"
6902	C55F*	Fits Estes BT-55	1.283"
6903	C60	Fits Estes BT-60	1.595"
6904	C60F*	Fits Estes BT-60	1.595"
6905	C70	Fits Estes BT-70	2.175"
6906	C70F*	Fits Estes BT-70	2.175"
6907	C80	Fits Estes BT-80KD	2.175"
6908	C80F*	Fits Estes BT-80KD	2.175"
6909	C101F*	Fits Estes BT-101	3.896"
6919	C08	Fits FSI RT-8	.903"
6910	C10	Fits FSI RT-10	1.13"
6911	C12	Fits FSI RT-12	1.30"
6912	C12F*	Fits FSI RT-12	1.30"
6913	C15	Fits FSI RT-15	1.60"
6914	C15F*	Fits FSI RT-15	1.60"
6915	C17	Fits FSI RT-17	1.80"
6916	C17F*	Fits FSI RT-17	1.80"
6917	C19	Fits FSI RT-19	2.00"
6918	C19F*	Fits FSI RT-19	2.00"
6920	C22F*	Fits FSI RT-225	2.25"

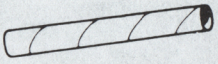
*For F Engines



Details for mounting F.S.I. conversion kits to body tubes.

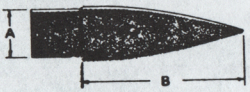


Rocket Body Tubes



CAT. NO.	DESCRIPTION	I.D.	O.D.	LENGTH	NET WEIGHT	SHIPPING WEIGHT
6006	RT-6	.175"	.755"	18"	.425 oz.	12 oz.
6008	RT-8	.903"	.921"	18"	.425 oz.	12 oz.
6010	RT-10	1.13"	1.17"	18"	.725 oz.	12 oz.
6012	RT-12	1.30"	1.34"	18"	.738 oz.	12 oz.
6015	RT-15	1.60"	1.64"	18"	.936 oz.	12 oz.
6017	RT-17	1.80"	1.84"	18"	.950 oz.	12 oz.
6019	RT-19	2.00"	2.04"	18"	1.184 oz.	14 oz.
6022	RT-22	2.25"	2.34"	22"	3 oz.	16 oz.

Nose Cones



Precision machined, lightweight balsa except as noted.

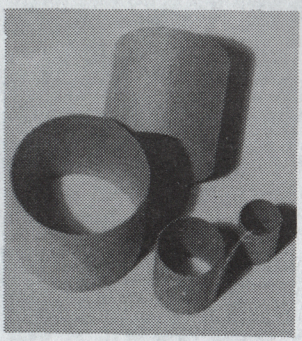
CAT. NO.	"A" FITS TUBE DESCRIPTION	"B" NOSE CONE I.D.	AVERAGE LENGTH	NET WEIGHT	SHIPPING WEIGHT
6171	NC-71	.175"	2.75"	.35 oz.	7 oz.
6181	*HNC-81	.903"	2.8"	.50 oz.	7 oz.
6101	*HNC-101	1.13"	3.5"	.50 oz.	7 oz.
6121	NC-121	1.30"	5.3"	.60 oz.	7 oz.
6152	NC-152	1.60"	6.0"	1.00 oz.	10 oz.
6191	NC-191	2.00"	10.0"	2.00 oz.	12 oz.
6171	NC-171	1.80"	4.00"	.50 oz.	12 oz.
6172	NC-172	1.80"	6.25"	1.50 oz.	12 oz.
6122	NC-122	1.30"	2.75"	.40 oz.	12 oz.
6192	NC-192	2.00"	4.00"	.50 oz.	12 oz.
6193	NC-193	2.00"	5.00"	.50 oz.	12 oz.
6125	NC-225	2.25"	6.25"	2.00 oz.	12 oz.

* Hardwood nose cones.

FLIGHT SYSTEMS, INC.

Stage Couplers

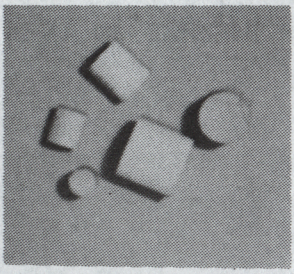
Connect same size body tubes either permanently or for staging.



CATALOG NO.	DESC.	CONNECTS TUBES WITH I.D. OF	AVERAGE WEIGHT	SHIPPING WEIGHT
6206	SC-6	.718"	0.10 oz.	.2 oz.
6208	SC-8	.903"	0.20 oz.	.2 oz.
6210	SC-10	1.130"	0.30 oz.	.2 oz.
6212	SC-12	1.300"	0.35 oz.	.2 oz.
6215	SC-15	1.60"	0.72 oz.	.2 oz.
6217	SC-17	1.80"	0.72 oz.	.2 oz.
6219	SC-19	2.00"	1.10 oz.	.3 oz.
6222	SC-22	2.25"	1.25 oz.	.3 oz.

Balsa Bulkheads

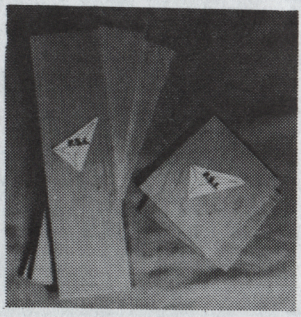
Connect body tubes of the same size. Build and connect payload sections.
Any application requiring complete blockage of tubes.



CATALOG NO.	DESC.	CONNECTS TUBES WITH I.D. OF	AVERAGE WEIGHT	SHIPPING WEIGHT
6306	BB-6	.718"	0.70 oz.	.2 oz.
6308	BB-8	.903"	0.90 oz.	.2 oz.
6310	BB-10	1.130"	1.25 oz.	.3 oz.
6312	BB-12	1.300"	1.40 oz.	.3 oz.
6315	BB-15	1.60"	1.85 oz.	.3 oz.
6317	BB-17	1.80"	2.03 oz.	.3 oz.
6319	BB-19	2.00"	2.88 oz.	.4 oz.
6322	BB-22	2.25"	3.26 oz.	.4 oz.

Fin Stock

Special selected balsa fin material.



CATALOG NO.	DESC.	SIZE	SHIPPING WEIGHT
6401	SB-1	3/32x3/12	.6 oz.
6402	SB-2	3/32x4/12	.6 oz.
6403	SB-3	1/8x3x12	.7 oz.
6404	SB-4	1/8x4/12	.7 oz.
6405	SB-5	1/4x4x12	.8 oz.

Select aircraft plywood fin material comes 1 sheet per package.

6501	PFM-1	1/16x6x6	.8 oz.

Transition Sections

CAT. NO.	DESC.	TUBE (X)	TUBE (Y)	NET WT.	SHIP WT.
6881	HTS-810*	.903"	1.130"	.18 oz.	.2 oz.
6812	TS-1215	1.300"	1.60"	.24 oz.	.4 oz.
6810	TS-1019	1.13"	2.00"	.28 oz.	.4 oz.
6615	TS-1519	1.60"	2.00"	.30 oz.	.4 oz.

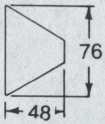
*Hardwood transition.

FLIGHT SYSTEMS, INC.

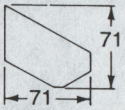
F.S.I. Fins

For replacement parts or building your own models.
Fins are precut and sanded. ALL DIMENSIONS IN MM.

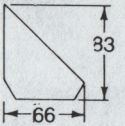
NOVA
Set of 3
1/16" Plywood
Cat. No.
8001



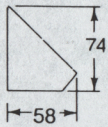
VOYAGER
Set of 3
1/16" Plywood
Cat. No.
8002



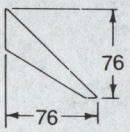
OSO
Set of 3
1/16" Plywood
Cat. No.
8003



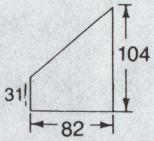
PENETRATOR
Set of 3
1/16" Plywood
Cat. No.
8004



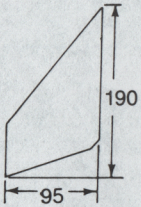
ORBIT
Set of 3
1/16" Plywood
Cat. No.
8005



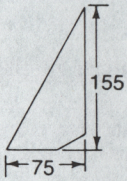
JAVELIN
Set of 4
3/16" Balsa
Cat. No.
8006



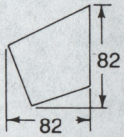
BLACK BRANT II
Set of 3
1/4" Balsa
Cat. No.
8007



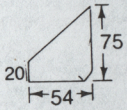
EOS
Set of 4
1/8" Balsa
Cat. No.
8008



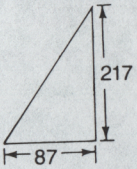
ECHO I
1/8" Balsa
Set of 4
Cat. No.
8009



MAVRICK
Set of 4
1/16" Plywood
Cat. No.
8010



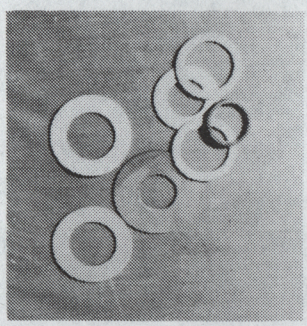
HERCULES
Set of 3
1/8" Plywood
Cat. No.
80011



Centering Rings

CAT. NO.	DESC.	CENTERS	I.D. TUBE IN	SHIP WT.
6668	CR-68*	.718"	.903"	.2 oz.
6610	CR-810*	.903"	1.13"	.2 oz.
6612	CR-812	.903"	1.30"	.2 oz.
6615	CR-815	.903"	1.60"	.2 oz.
6617	CR-817	.903"	1.80"	.2 oz.
6619	CR-819	.903"	2.00"	.2 oz.
6712	CR-1012*	1.13"	1.30"	.2 oz.
6715	CR-1015	1.13"	1.60"	.2 oz.
6717	CR-1017	1.13"	1.80"	.2 oz.
6719	CR-1019	1.13"	2.00"	.2 oz.
6722	CR-1022	1.13	2.25"	.2 oz.

*Heavy cardboard.



FLIGHT SYSTEMS, INC.

Miscellaneous Items

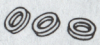
Cat. No.

THRUST RINGS (3 per pkg.)

7001 . . TR-1 for .903 dia. tube . . . . . .

7002 . . TR-2 for 1.130 dia. tube . . . . . .

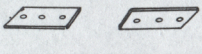
7003 . . TR-3 for .718 dia. tube . . . . . .



7011 . . **SHOCK CORD** (flame resistant covering) . . . . . (10 ft. per pkg.)

7012 . . **SHOCK CORD ANCHORS** (6 per pkg.) . . . . . .

7013 . . **SNAP SWIVELS** (6 per pkg.) . . . . . .



7014 . . **EYE SCREWS** (6 per pkg.) . . . . . .

7018 . . **FLAME RESISTANT WADDING** . . . . . .

STREAMER KITS

7112 . . S-12 3 streamers 2" wide 10' long with snap swivels

7113 . . S-13 2 streamers 3" wide 10' long with snap swivels

SELECT-A-CHUTE

7114 . . P-14 Plastic parachute comes with strings, glue, tabs and snap swivel

NYLON PARACHUTES

7120 . . NP-20 (20" dia.) . . . . . .

7122 . . NP-22 (22" dia.) . . . . . .

7124 . . NP-24 (24" dia.) . . . . . .

7126 . . NP-26 (26" dia.) . . . . . .

7130 . . NP-30 (30" dia.) . . . . . .

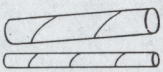
7136 . . NP-36 (36" dia.) . . . . . .

F.S.I.CHROME LABELS (4 per pkg.) CL-4 . . . . . .

7015 . . **LAUNCH LUGS**, 1/4" I.D. x 2 (Pkg. of 3) . . . . . .

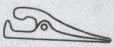
7016 . . **LAUNCH LUGS**, 1/8" I.D. x 3 (Pkg. of 6) . . . . . .

7017 . . **FIRING CLIPS** (Pkg. of 2)
Smooth nosed "MICRO-GATOR" clips . . . . . .

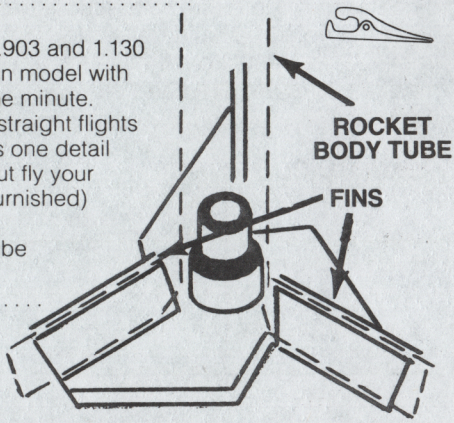


7060 . . **E-60 ENGINE ADAPTER**
Heavy duty phenolic sleeve fits into engine mount ahead of E60 casing. Makes use of E60 engines possible in rockets set up for F100 motors. Will not burn or deteriorate. . . . . .

FIN ALIGNMENT FIXTURE



7115 . . FA-101 Fin Alignment Fixture for .903 and 1.130 Body Tubes. Places fins on a 3 fin model with perfect alignment in less than one minute. Perfect alignment of fins means straight flights with less aerodynamic drag. This one detail in model building will help you out fly your friends. Snap clothes pins (not furnished) are used to hold fins to upright alignment supports. The body tube fits over a central spindle. . . . . .



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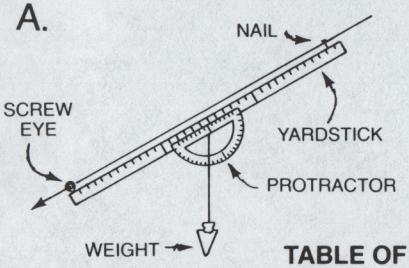
Tracking

A proven method of measuring altitude is by triangulation. A simple elevation tracking device can be made as in illustration A. It is a simple matter to determine approximate altitude if the distance between the tracker and launcher is known and the angle between the ground and the line of sight to the rocket is known. The tangent of the angle is found in a trigonometry table of tangents. The tangent is multiplied by the distance to the tracker to find the altitude. See example:



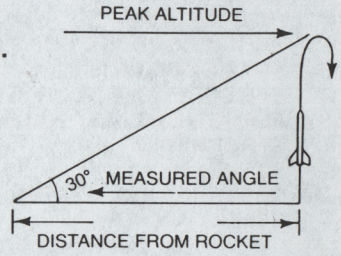
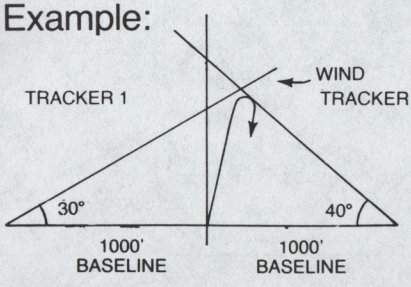


TABLE OF TANGENTS

ANGLE	TAN.	ANGLE	TAN.	ANGLE	TAN.	ANGLE	TAN.	ANGLE	TAN.	ANGLE	TAN.
1°	.02	15	.27	28°	.53	41	.87	54°	1.38	67	2.36
2	.03	16	.29	29	.55	42	.90	55	1.43	68	2.48
3	.05	17	.31	30	.58	43	.93	56	1.48	69	2.61
4	.07	18	.32	31	.60	44	.97	57	1.54	70	2.75
5	.09	19	.34	32	.62	45	1.00	58	1.60	71	2.90
6	.11	20	.36	33	.65	46	1.04	59	1.66	72	3.08
7	.12	21	.38	34	.67	47	1.07	60	1.73	73	3.27
8	.14	22	.40	35	.70	48	1.11	61	1.80	74	3.49
9	.16	23	.42	36	.73	49	1.15	62	1.88	75	3.73
10	.18	24	.45	37	.75	50	1.19	63	1.96	76	4.01
11	.19	25	.47	38	.78	51	1 23	64	2.05	77	4.33
12	.21	26	.49	39	.81	52	1.28	65	2.14	78	4.70
13	.23	27	.51	40	.84	53	1.33	66	2.25	79	5.14
14	.25									805.67	

Since wind will interfere with accuracy by causing the rocket to tilt into the wind, the tracker should be located 90° to the wind. The tracker should be from 500' to 1,000' from the launcher. Greater accuracy can be had if two or more trackers are used and the average of the two or more results are used (See example.)

Example:



TRACKER 1	TRACKER 2
1000' BASELINE	1000' BASELINE
.58 TAN. OF 20°	.84 TAN. OF 40°
8000	4000
5000	8000
580.00	840.00

580'
840'
1420

710' AVERAGE
2 ⟌1420 ALTITUDE
14

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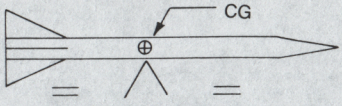
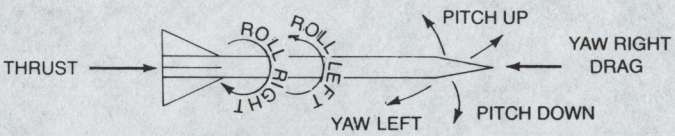
Stability

A rocket must be aerodynamically stable to fly. It is necessary to determine the CG (Center of Gravity) of a rocket in order to determine if it will be a stable vehicle. The CG is the balance point of a rocket.



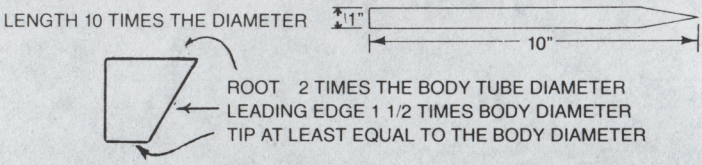
The main forces acting on a rocket are Thrust, Drag, Pitch Up, Pitch Down, Yaw Right, Yaw Left, Roll Left, and Roll Right.



As long as forces acting on the fins of a rocket are great enough to offset forces trying to turn rocket, it will fly straight. There is little side force on the fins or nose of a rocket that is flying straight. Any disturbing forces will try to turn the rocket, thus increasing side forces on the nose and tail. In a properly designed rocket the fins will overpower the nose and swing the rocket back on its intended flight path.

The following are a few simple rules the beginning rocketeer should follow in designing a stable rocket:

1. The length of a body tube should be 8 to 10 times the diameter.
2. Fins should be fairly large. The foot should be about twice the diameter of the body tube. The leading edge should be 1-1/2 times the body tube diameter and the tip of the fin should be at least equal to the diameter.
3. The fins should be placed as far back on the rocket as possible (fins should never be placed ahead of the CG)
4. The rocket should balance at least 1/8 of its length ahead of the fins.



ALWAYS CHECK ROCKETS FOR STABILITY BEFORE LAUNCHING.

Models may be tested for stability as follows:

1. Take an 8 to 10 foot string. Tie a loop in end of string. Place loop around rocket body tube and slide until a balance point (CG) is established. Tape loop to body tube at this point.

2. Swing rocket overhead in a circular motion. A very stable rocket will point forward. It may be necessary to start rocket forward by hand if so questionable stability exists. Slide string back until rocket nose tilts down at about 10° repeat test. If rocket proves unstable, this condition can usually be corrected by moving the CG forward by adding weight to the nose or increasing the size of the fins.

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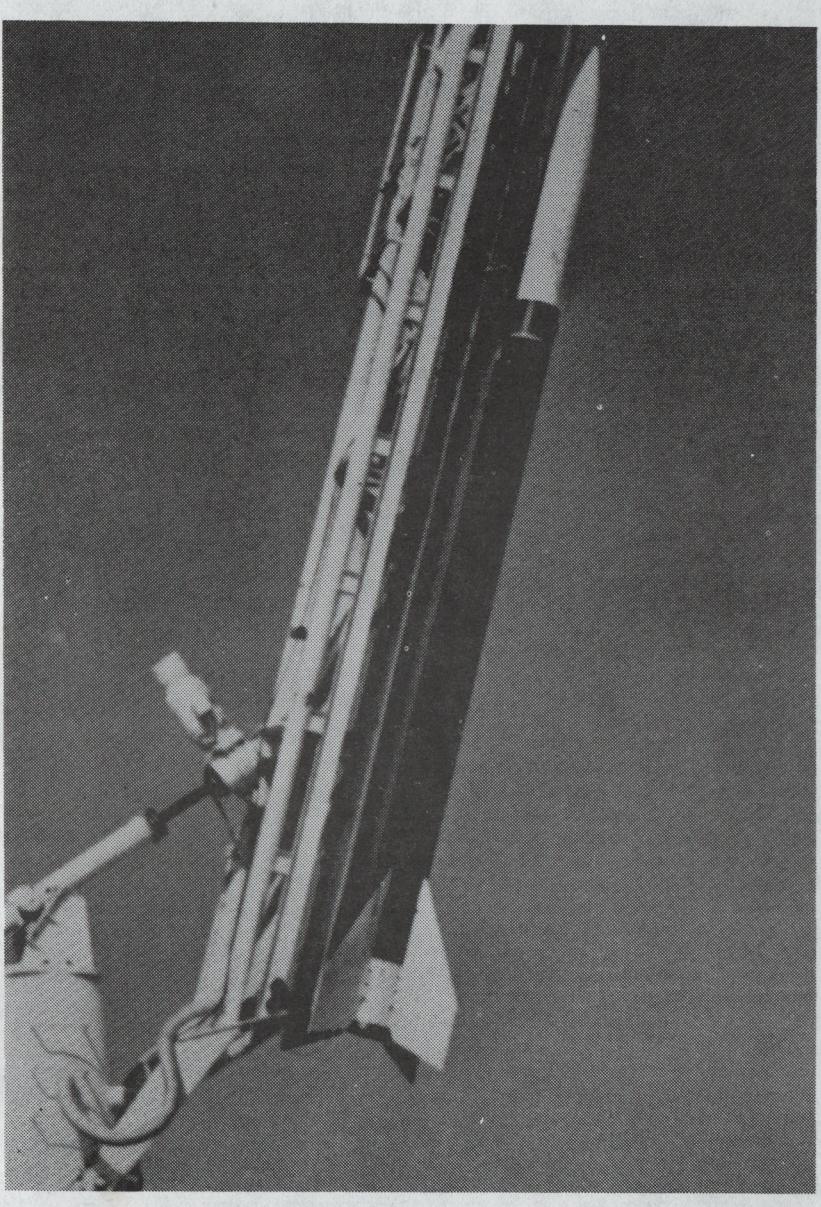

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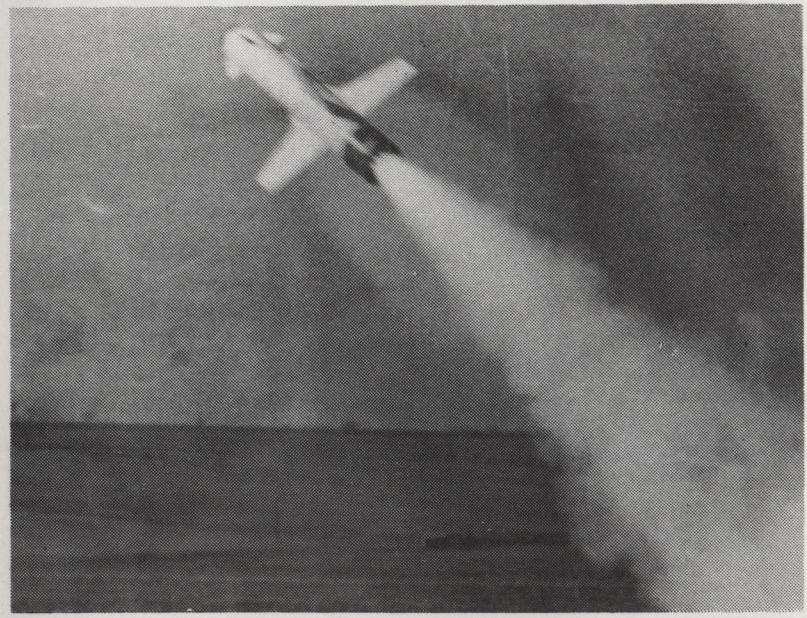

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