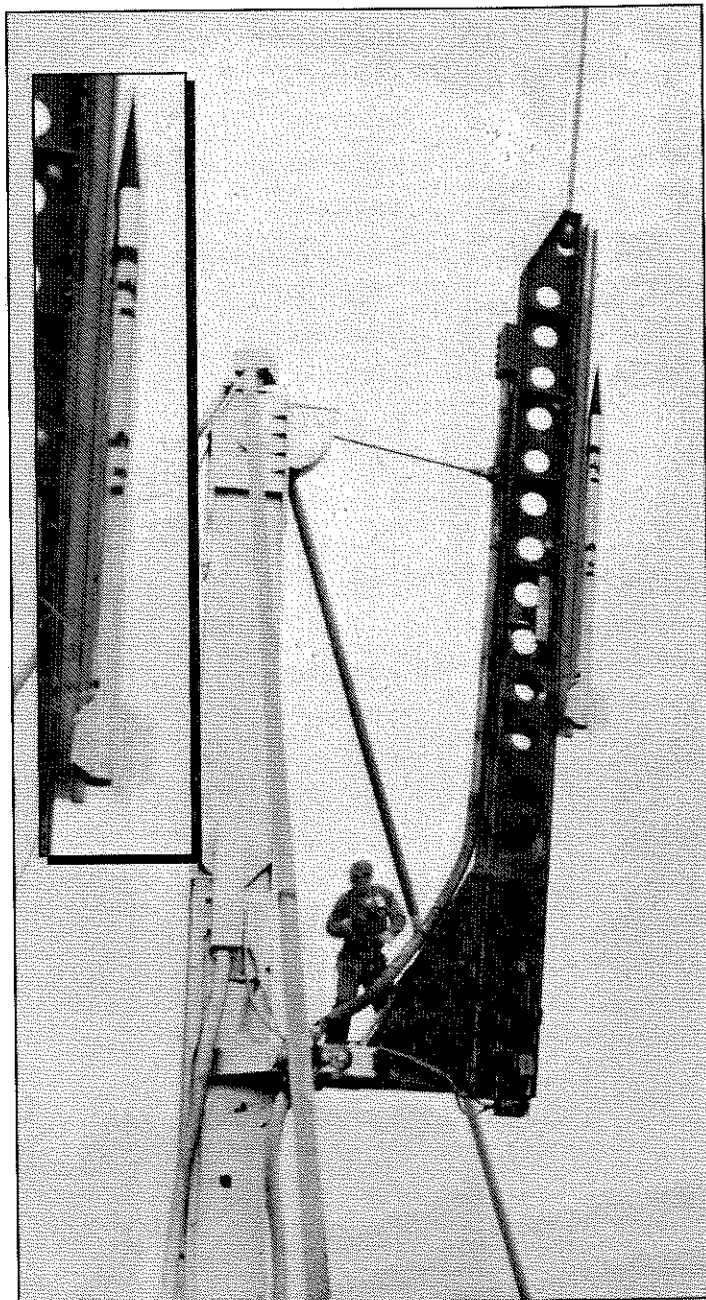


### 3. SIROCCO SOUNDING VEHICLE

## H Historical Background



In 1963, under the Special Projects Division, Missile Electronic Warfare technical Area, Electronic Warfare Laboratory at White Sands, New Mexico, Space Data received a contract under the Defense Atomic Support Agency (DASA) to design, develop, and flight test a family of 11 solid-propellant sounding rocket vehicles. One of these vehicles was the Sirocco. Space Data Corporation used six basic rocket motors in various combinations to generate the 11 vehicle systems. They were: Honest John (M-6), Nike (M-5),

**SIROCCO Sounding Vehicle**  
**Photo Courtesy of Marshall Cartledge**

**Coloring: fins-natural; motor-natural; payload-natural; nosecone-black; markings on motor-red tape.**

Hydac II, Javelin III, Apache, and Sirocco. A building-block technique was used in order to standardize and streamline the readiness of these systems. When possible, standard flight hardware such as fin sets, interstage couplings, payload structures and launching lugs were employed on these vehicles.<sup>130</sup>

▶▶ 130. SDC (Final Report No. 3), 1966.

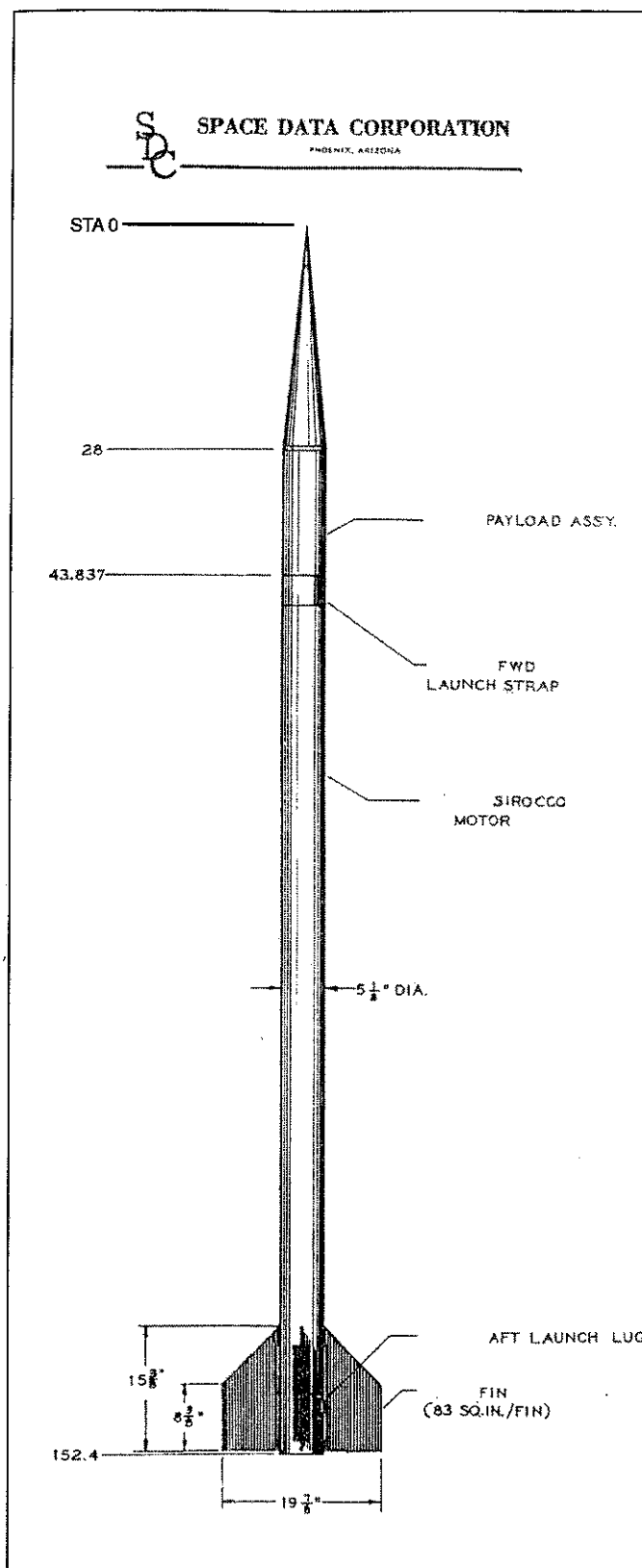
### Sirocco Sounding Vehicle

The Sirocco Sounding Vehicle was a single-stage solid propellant sounding rocket. The vehicle was 152.4 inches in length, a motor diameter of either 4.5 or 5.5 inches (depending on its application), and a fin span of 19.875 inches. It had a launch weight of 152 lbs. and a burnout weight of 46 lbs. It used an aft launch lug and a snap away forward launch strap. This vehicle was successfully flown with gross payloads ranging between 15 and 18 pounds. Sirocco was easily accommodated to various launchers available at the United States-operated launch facilities. Sirocco was fin-stabilized in the effective atmosphere, and in certain instances spin stabilization was added for launches out of the atmosphere. The vehicle could be spun at a desired roll rate by canting the fins. The fin surface area was 83 sq. in./fin.<sup>131</sup>

#### SIROCCO Sounding Vehicle

#### Sirocco Motor

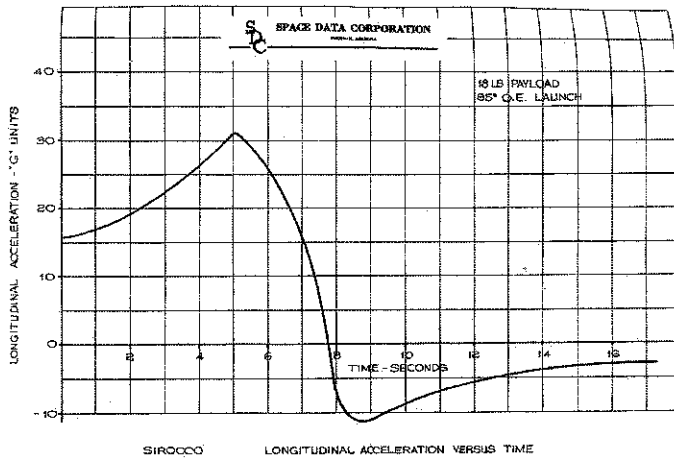
The Sirocco motor was manufactured and loaded by Lockheed Propulsion Company (formerly GCR) in Redlands, California. The motor had a length of 109 inches and a diameter of 4.5 or 5.5 inches (depending on which payload was used). The motor was an internal burning star design which according to Bob Walker was developed at SDC to compete with the Arcas in the early days of Space Data. Several flight tests were made at White Sands with reasonable success, but the instrumented Loki system eliminated the need for the Sirocco as it did for the Arcas.<sup>132</sup>



►► 131. SDC (TM 60), 1965.

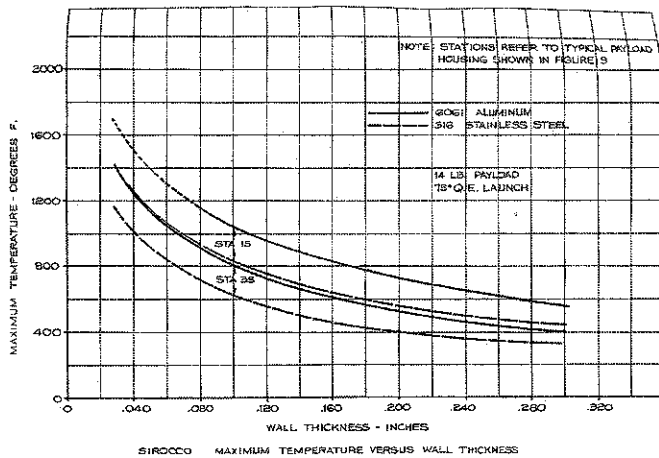
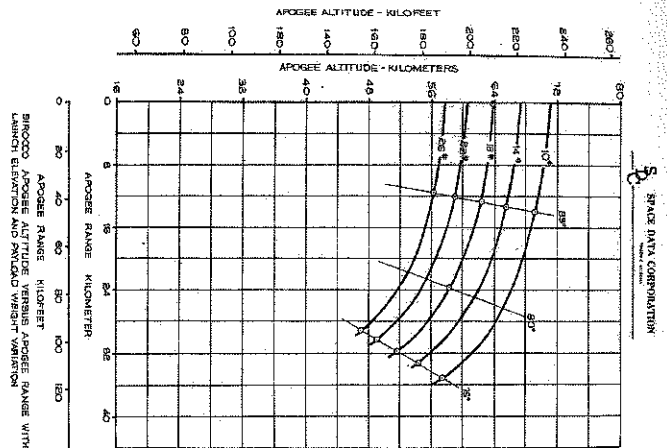
132. Walker (Correspondence), 1998.

## STATUS OF THE SIROCCO PROGRAM THRU JANUARY 1965



### STATIC FIRING 2 Motor LW-1

All hardware was of production type and the propellant grain was perfect. This motor was fired on May 22, 1964 and failed at the nozzle end at .050 seconds. Although the motor case melted down, the nozzle was recovered and from that it was determined that the nozzle retainer failed in the weld spots. This area was subsequently



### STATIC FIRING 1

The first Sirocco motor was made from a heavy wall tube and employed a threaded retainer for the nozzle. Igniter, forward closure, and insulation were of production type. Although the grain had a large number of voids, propellant bonding to the insulation was good. This motor was successfully fired on May 15, 1964.

redesigned to incorporate a ring of roll-pins to retain the nozzle.

### STATIC FIRING 3 Motor LW-2

This motor was one of three cast at one time and had severe separation of the propellant and insulation. The motor was static-fired on July 2, 1964 and performed satisfactorily although the flame did flash behind the propellant at about 7 seconds. The case showed no hot spots.

‡ **FLIGHT 1**      **Motor LW-4**

LW-4, the best of the three motors in this lot, had moderate separation on both ends and was assembled for flight test. The unit was flown on July 15, 1964 and looked good until the motor burned through at the head end at 8.5 seconds. Peak altitude was about 30,000 feet. This unit was flown with a low roll rate (predicted about 2.0 rps at burnout). The failure was attributed to a burn-through due to the propellant separation at the forward end.

‡ **FLIGHT 2**      **Motor LW-5**

LW-5 was flown on July 31, 1964. The flight looked good until the vehicle was obscured by clouds. Maximum altitude was 18,000 feet. No cause of failure was established.

‡ **FLIGHT 3**      **Motor LW-6**

LW-6 was flight/rather than static-tested since it was undetermined whether Flight 2 was a motor or vehicle failure. The unit was flown on August 6, 1964 and the motor failed through the forward closure at 1 to 1.5 seconds. From this, it was deduced that Flight 2 had failed in a similar manner. The forward closure and forward seal were redesigned and the case insulation thickness was increased at this time to allow motors with slight separations at both ends to be flown. (Testers were having difficulty in getting the propellant to bond to the insulation at the ends of the grain.) The forward closure redesign was pressure-tested to the allowable case pressure (3000) without yielding.

‡ **FLIGHT 4**      **Motor LW-10**

LW-10 was flown on September 16, 1964 and looked good until 8 seconds when the payload cylinder failed at the spot-welded joint. Motor performance was satisfactory and the motor was recovered. Predicted roll rate was 8-9 rps at burnout. Payload weight was 21.5 lbs.

‡ **FLIGHT 5**      **Motor LW-9**

LW-9 was flown on September 28, 1964. An SDC fabricated payload cylinder was flown with a payload weight of 24.8 lbs. Maximum altitude was estimated at about 193,000 feet (radar tracking was lost at 185,000 feet). Maximum roll rate was predicted to be 13-14 rps, and was measured at 14 rps maximum.

### 🚀 **FLIGHT 6**      **Motor LW-13**

LW-13 was flown on October 8, 1964. A bad spiral was noted at burnout, and maximum altitude was 177,000 feet. The fins were thermolagged and recovered hardware looked very good. Maximum roll rate was 9.2 rps, and payload weight was 20 lbs.

### 🚀 **FLIGHT 7**      **Motor LW-14**

LW-14 was flown on October 9, 1964. From the results of Flight 6, payload weight was increased to 32.5 lbs. This vehicle started spiraling about half way through burning and reached only 77,000 feet. Maximum roll rate was 9.1 rps.

### 🚀 **FLIGHT 8**      **Motor LW-12**

Due to the apparent aerodynamic problems with LW-13 and LW-14, a thorough investigation of the available data was undertaken at this time. It was decided to fly the next unit at a considerably higher roll rate of 18-20 rps at burnout. LW-12 was flown on November 4, 1964 and the motor failed at the aft end. Upon recovery of the hardware, it was apparent that the nozzle retainer had failed through the roll pins.

At this time the problem with the processing of the propellant was investigated. Due to the fact that the rejection rate for the polyurethane motors had been high, a switch was made to a Polycarbutene propellant.

With the same grain configuration, some slight degradation in performance was anticipated due to the shorter burn time. This problem was not considered serious however, as the grain design could easily be modified in the future to gain a sizeable performance increase.

### 🚀 **STATIC FIRING 4LW-18**

LW-18, a product of the above modifications was static-fired on November 15, 1964 and proved successful. This first polycarbutene motor and grain were perfect.

🚀 <b>FLIGHT 1</b>	<b>Motor LW-4</b>
🚀 <b>FLIGHT 2</b>	<b>Motor LW-5</b>
🚀 <b>FLIGHT 3</b>	<b>Motor LW-6</b>
🚀 <b>FLIGHT 4</b>	<b>Motor LW-10</b>
🚀 <b>FLIGHT 5</b>	<b>Motor LW-9</b>
🚀 <b>FLIGHT 6</b>	<b>Motor LW-13</b>
🚀 <b>FLIGHT 7</b>	<b>Motor LW-14</b>
🚀 <b>FLIGHT 8</b>	<b>Motor LW-12</b>

**FLIGHT 9      Motor LW-19**

LW-19 was flown on December 4, 1964 to an altitude of 183,500 feet. Payload weight was slightly over 20 lbs. Performance on this round was lower than predicted although the flight looked very good. Roll rate was measured at 18.7 rps maximum.

**FLIGHT 10      Motor LW-21**

Due to the low performance of LW-19, an attempt was made at drag reduction on this flight. A steel nose cone and a fairing for the adapter section were fabricated to improve performance. LW-21 was flown on December 17, 1965 and reached an altitude of 221,000 feet. Payload weight was 17.7 lbs.

**FLIGHT 11      Motor LW-22**

LW-22 was flown on December 17, 1964 to an altitude of 198,000 feet. Payload weight was 18.2 lbs and an Arcas-type nose cone was used. The same fairing was used on this flight as was used on Flight 10.

**FLIGHT 12      Motor LW-27 (Case 23)**

At this time, two casting mandrels for the motor were machined down to increase the amount of propellant in the motor, furnishing a net gain of about 5 lbs. LW-27, one of these modified motors, was flown on January 19, 1965. A steel nose cone was used and total payload weight was 17.3 lbs. Apogee altitude was 242,000 feet.

**FLIGHT 13      Motor LW-20**

(This flight was erroneously labeled LW-19. The manufacturing number on the case was 19, but the LW number was 20.) LW-20 was flown on January 21, 1965. Payload weight was 14.6 lbs. No instrumentation was flown. The motor (apparently) failed at the aft end at about 7 seconds. Some hardware was recovered, but no indication of mode of failure was apparent from it, so no conclusions were reached at that time, although the most likely possibility seems to have been a failure of the roll pin joint at the nozzle end.

**SUMMARY:**

- ❶ The change to polycarburene propellant eliminated the problems with motor casting. All motors cast (10 to date) after the change have had good grains with the worst imperfections being very small voids.
- ❷ The aerodynamic integrity of the system was demonstrated in the last 5 flights. With the change in fin angle to produce high roll rates, all tendency to spiral was eliminated.
- ❸ The area of mechanical design of motor components was one area under investigation at that time. Some weakness was apparent at the nozzle attachment in the aft end of the motor. That aft end was redesigned before the next motors were cast.
- ❹ Another change being considered for the next unit was the removal of approximately 3 lbs of liner, adding approximately 3 lbs of propellant. Recovered hardware indicated insulation thickness was double what was required. With removal of the insulation, the resulting increase in altitude was approximately 20,000 feet giving the rocket a performance capability of 260,000 feet., with a 17 lb. payload.
- ❺ The area of zero spin rate was investigated as new hardware was built. No problems were anticipated although flight test proof was certainly needed before manufacturing large quantities at zero roll.<sup>132</sup>

**LAUNCH DATES:**

- Flight #1**      **March 31, 1965**, Eglin AFB, Experiment 18, Agency (DASA). *The flight was successful*
- Flight #2**      **July 13, 1965**, WSMR experiment 18, Agency DASA. *Unsuccessful— vehicle successful, nosecone failure.*
- Flight #3**      **July 26, 1965**, WSMR experiment 18, Agency DASA. *Unsuccessful— vehicle successful, nosecone failure.*
- Flight #4**      **October 28, 1965**, EGLIN experiment 18, Agency DASA. *Successful*<sup>133</sup> †

▶▶ 132. Force (Sirocco program review), 1965.

133. Orbital Sciences Corporation (TM-3476J), 1998, A-3,4.