D-REGION TOMAHAWK
by Howard Kuhn

The "D"-Region Tomahawk is a medium performance member of the Tomahawk Sounding Rocket family designed by Astro-Met of Thiokol Chemical Corporation. The single-stage Tomahawk is fin stabilized, uses the basic TE-M-416 Tomahawk solid propellant motor and attains its special performance characteristics through a controlled drag design. Normal trajectory data are based on a sea level launch at an initial launch angle of 80 degrees and a gross payload weight of 80 pounds.

The basic medium performance (MP) Tomahawk is designed for the specific capability of delivering an 80 pound gross payload to an apogee altitude of 110 kilometers. However, a simple configuration change from a 3:1 ogive nose cone to a low drag shape such as a 5:1 ogive nose cone would result in an altitude increase of approximately 70,000 feet, or conversely, would permit achieving the nominal apogee altitude with an increase in payload weight of 35 to 40 pounds, thus providing a significant payload growth capability for a 100 kilometer altitude range. A reduction in apogee altitude of approximately 1,800 feet will occur for each additional pound of system weight, and a 42,000 foot reduction in altitude will occur for each 10 percent increase in drag.

NASA D-REGION TOMAHAWK

The "D"-region Tomahawk, NASA Flight No. 1208 GT, was primarily a test flight to demonstrate vehicle flight characteristics before acceptance by NASA as a standard NASA sounding rocket. The object of the test flight was to determine vehicle performance and establish the payload environment during flight. To accomplish these objectives, the payload carried three accelerometers, two vibration transducers, one stable platform to measure vehicle attitude, ten temperature transducers to measure temperature environment of the payload, one pressure transducer to measure chamber pressure on the TE-M-416 rocket motor, and associated electronics designed to transmit data to a ground station.

Vehicle No. 1208 GT was launched from Wallops Island, Virginia, at 1900 Z 5 February 1966, and reached a peak altitude of 115,5 KM (389,927 feet) in 160,0 seconds. An altitude of 380,000 feet was predicted. Burnout occurred 9.5 seconds after lift-off at an altitude of 27,458 feet and a velocity of 6,067 feet/second. Impact was 318,185 feet at an azimuth of 110 degrees from the launch site after a flight of 5 minutes and 27 seconds. The launcher was set at an effective angle of 116.50 degrees azimuth from true north and 80.4 degrees wind velocity.
degrees elevation above horizontal. The vehicle performed as predicted with all instrumentation operating to impact. The rocket was recommended for acceptance in the NASA sounding rocket stable.

DESCRIPTION

The D-Region Tomahawk was a single-stage rocket based on the Thiokol Chemical Corporation TE-M-416 solid propellant rocket motor. Vehicle stabilization was provided by four fixed incidence fins each having an area of 222 square inches. The payload weighed 82.25 pounds and was an ogive-cylinder configuration. Both the motor and payload were 9 inches in diameter. The launch weight was 622.3 pounds. The weight after burnout was 223.1 pounds. The TE-M-416 motor utilized solid propellant with a sea level impulse of 93,840 pounds/second. It was ignited by two pyrogen-type igniter squibs located at the head of the motor. The ignition leads extended from the igniter through the perforated solid propellant grain and out the nozzle to the firing circuit in the blockhouse. These leads burn up after motor ignition.

The tail fins were from 6061-T6 aluminum sheet. The fin structure was protected from high aerodynamic heating by an asbestos phenolic leading edge cove and silicone rubber surface coating. The fins were retained to the support shroud over the entire fin root by a locking bracket and sixteen No. 10 bolts. The leading edge was swept 55 degrees and the fin had a total of 222 square inches.

The fin-to-motor attach shroud was a solid aluminum shell structure having a minimum wall thickness of .10 inch. The fins were attached, preset, to this unit at the factory. The shroud with fins attached was shipped over the motor at the nozzle end and was retained by twenty-eight 7/8 inch flat head allen bolts.

The payload consisted of diagnostic instrumentation required to obtain data relative to acceleration, vibration, angular position and rate, motor pressure, and payload temperature. The total length was 52 inches with a maximum diameter of 9 inches. The overall configuration consisted of a 3:1 ogive which is attached to a cylindrical housing having a length of 24.50 inches. The nose had an asbestos phenolic nose tip epoxied to a S/C fused silica 3:1 ogive nose cone which in turn is epoxied to an asbestos phenolic attitude gryo cover. This assembly is attached to a splice ring on the telemetry housing by 12 7/8 inch flat head allen bolts.

Rear view of the partially assembled D-Region in the shop. The shape of the fin shroud is clearly shown. In this photo the shroud attachment bolts have not yet been painted. (NASA Photo W68-14)

Left side view of NASA Flight 12.08GT prior to installation of the payload section. Note that the bolt heads on the fin shroud have been painted white. The color version of this photograph clearly shows that the trailing edge of each fin is painted red. (NASA Photo W-68-16)
This ring is then attached to the aluminum telemetry housing by 12 ½ inch flat head alien bolts. This housing attaches directly to the forward part of the aluminum antenna housing with 12 ½ inch flat head alien bolts. A special aluminum splice ring attaches the antenna housing to the rocket motor with two sets of 24 each ½ inch flat head alien bolts.

The rocket motor was a Thiokol TE-M-416 solid propellant type PBAA with a total impulse of 93,846 pounds/seconds. The nozzle was constructed of graphite and silica phenolic. The motor casing was made from 7075-T6 aluminum with a diameter of 9 inches and overall casing length of 141.085 inches.

The rocket was launched from a special zero length launcher attached to the beam of a standard Wallops Island launcher with 3/8 inch diameter bolts. Basically, the zero length launcher consists of a ring with mounting flanges on one side and an I beam to support the rocket diametrically opposite on the other side. The rear of the motor casing slips into an opening in the ring at the same time the launch lug on the rocket shroud slips into an attachment on the I beam. This supports the entire rocket from the rear. To insure a good fit into the ring the rocket motor casing from the rear of the shroud is unpainted. The exhaust gasses blow through the opening in the launch ring upon ignition to minimize damage to the launcher.

**FLIGHT INFORMATION SUMMARY**

**NASA FLIGHT NO. 12.08 GT**

**Weights:**
- Launch Weight: 622.3 lbs.
- Payload Weight: 82.25 lbs.
- Burnout Weight: 223.1 lbs.

**Performance:**
- Burnout Altitude: 27,456 ft.
- Burnout Velocity: 6,067 ft/sec.
- Burnout Time: 9.5 sec.
- Apogee Altitude: 397,927 ft.
- Apogee Time: 160.0 sec.
- Impact Range: 318,185 ft.
- Impact Time: 337 sec.

**Color Data:**
- Nose Tip: Flat Phenolic Brown
- Nose Cone: Flat White
- Attitude Gyro Cover: Flat Phenolic Brown
- Telemetry Housing: Flat Bright Red
- Small Ring: Natural Aluminum
- Antenna Housing Cover: Flat White
- Rocket Motor:
  - 1" from top: Flat Bright Red
  - Body: Flat White
  - Rear of Shroud: Natural Aluminum
  - Shroud and Launch Lug: Flat White
  - Fin Locking Bracket: Flat White
  - 3 Fins: Flat Black
  - 1 Fin: Flat Bright Red
  - Rear of Fins: Flat Bright Red

**DATA SOURCE**

Thiokol Chemical Corporation, Contract No. NASS-10444
NASA Flight requirements Plan.NASA 12.08 GT
NASA Sounding Rocket Post Flight Summary, NASA 12.08 GT
NASA report of Sounding Rocket Launching, Vehicle No. 12.08 GT
Thiokol Chemical Corporation Drawings: D00763, D00764, D00765, D00788, R00528, R00529, R00 548, R00790, C00746.

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### WEIGHT TABLE

<table>
<thead>
<tr>
<th>Description</th>
<th>Weight</th>
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</thead>
<tbody>
<tr>
<td>Launch Weight</td>
<td>622.3 LBS.</td>
</tr>
<tr>
<td>Weight After Tomahawk Burnout</td>
<td>223.1 LBS.</td>
</tr>
<tr>
<td>Gross Payload Weight</td>
<td>80.0 LBS.</td>
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**D-REGION TOMAHAWK**
D-REGION TOMAHAWK
WITH DIAGNOSTIC PAYLOAD

Figure 6B