

# Technical Note

## TN-1



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## MODEL ROCKET ENGINES

### Engine Types and Classification

All engines sold by Estes Industries are stamped with a code designation which, when understood, will give the rocketeer important and useful data on the engine's performance capabilities. Here's how to read this coding: (refer to engine illustration).

#### Engine Coding for Quick-N-Easy Identification

1. **Label color indicates recommended use of the engine.**
  - a. Green - Single Stage Rockets
  - b. Purple - Upper stage or single stage for very light rockets.
  - c. Red - Booster and intermediate stages of multi-stage models.
2. **Code designation stamped on the engine gives useful and important information on its performance capabilities.**
  - a. This portion indicates total impulse or total power produced by the engine.
  - b. This portion shows the engine's average thrust in newtons and helps you choose the right engine for your rocket's flight.
  - c. This number gives you the delay in seconds between burnout and ejection charge. Lets you choose the engine with the delay time you want for any flight.



Igniters and complete instructions are included with Estes engines.

**HOW HIGH WILL YOUR MODEL GO?** The chart below shows the approximate altitudes that can be achieved with single stage rockets.

#### TOTAL IMPULSE CLASSIFICATION

| Code | pound-seconds    | newton-seconds     |
|------|------------------|--------------------|
| 1/4A |                  | <b>0.00-0.625</b>  |
| 1/2A | <b>0.14-0.28</b> | <b>0.625-1.25</b>  |
| A    | <b>0.28-0.56</b> | <b>1.25-2.50</b>   |
| B    | <b>0.56-1.12</b> | <b>2.50-5.00</b>   |
| C    | <b>1.12-2.24</b> | <b>5.00-10.00</b>  |
| D    | <b>2.24-5.00</b> | <b>10.00-20.00</b> |

| Engine Size | Altitude Range (depending on rocket size and weight) | Approximate Altitude in a typical 1 oz. model |
|-------------|--|---|
| 1/4A3-2     | 50' to 150'  | 100'  |
| 1/2A6-2     | 100' to 400'   | 190'  |
| A8-3        | 200' to 650'   | 450'  |
| B6-4        | 300' to 1000'  | 750'  |
| C6-5        | 350' to 1500'  | 1000'   |

(Some high performance models will reach higher altitudes than shown above.)

## MINI-ENGINE SELECTION CHART

| Cat. No. & Engine Type      | Total Impulse           |                        | Time Delay<br>(± 15%) | Maximum Lift-off Weight | Maximum Thrust | Thrust    | Initial Weight |     | Propellant Weight |      |
|-----------------------------|-------------------------|------------------------|-----------------------|-------------------------|----------------|-----------|----------------|-----|-------------------|------|
|                             | lb. - sec. <sup>1</sup> | n. - sec. <sup>2</sup> |                       |                         |                |           | oz.            | g.  | oz.               | g.   |
| <b>SINGLE STAGE ENGINES</b> |                         |                        |                       |                         |                |           |                |     |                   |      |
| 1/4A3-2T                    | 0.14                    | 0.625                  | 2 sec.                | 1 oz.                   | 23 oz.         | 0.18 sec. | 0.173          | 4.9 | 0.031             | 0.88 |
| 1/2A3-2T                    | 0.28                    | 1.25                   | 2 sec.                | 2 oz.                   | 28 oz.         | 0.36 sec. | 0.198          | 5.6 | 0.062             | 1.75 |
| A3-2T                       | 0.56                    | 2.50                   | 2 sec.                | 3 oz.                   | 28 oz.         | 0.86 sec. | 0.254          | 7.2 | 0.124             | 3.50 |
| A3-4T                       | 0.56                    | 2.50                   | 4 sec.                | 2 oz.                   | 28 oz.         | 0.86 sec. | 0.268          | 7.6 | 0.124             | 3.50 |
| A10-3T                      | 0.56                    | 2.50                   | 3 sec.                | 5 oz.                   | 48 oz.         | 0.26 sec. | 0.277          | 7.9 | 0.133             | 3.78 |
| <b>UPPER STAGE ENGINES*</b> |                         |                        |                       |                         |                |           |                |     |                   |      |
| 1/4A3-4T                    | 0.14                    | 0.625                  | 4 sec.                | 0.75 oz.                | 23 oz.         | 0.18 sec. | 0.187          | 5.3 | 0.031             | 0.88 |
| 1/2A3-4T                    | 0.28                    | 1.25                   | 4 sec.                | 1.00 oz.                | 28 oz.         | 0.36 sec. | 0.212          | 6.0 | 0.062             | 1.75 |
| A3-6T                       | 0.56                    | 2.50                   | 6 sec.                | 1.25 oz.                | 28 oz.         | 0.86 sec. | 0.282          | 6.0 | 0.124             | 3.50 |
| <b>BOOSTER ENGINES</b>      |                         |                        |                       |                         |                |           |                |     |                   |      |
| 1/2A3-0T                    | 0.28                    | 1.25                   | none                  | 3.50 oz.                | 28 oz.         | 0.36 sec. | 0.166          | 4.7 | 0.062             | 1.75 |
| A3-0T                       | 0.56                    | 2.50                   | none                  | 3.50 oz.                | 28 oz.         | 0.86 sec. | 0.226          | 6.4 | 0.124             | 3.50 |
| A10-0T                      | 0.56                    | 2.50                   | none                  | 5 oz.                   | 48 oz.         | 0.26 sec. | 0.235          | 6.7 | 0.133             | 3.78 |

Each pack of 4 engines includes 4 igniters. Designed for specific launch and flight functions, rocket engines are expendable — not reusable.

\*Or single stage engines if used in very light rockets. Shipping Wt. for mini-engine is 2½ oz. for a pack of 4. Mini-engines are 1.75 in. long and 0.500 in. dia.

## ROCKET ENGINE SELECTION CHART

| Cat. No. & Engine Type                 | Total Impulse           |                        | Time Delay<br>(± 15%) | Maximum Lift-off Weight<br>with Engine | Maximum Thrust | Thrust Duration | Initial Weight |      | Propellant Weight |       |
|--|-------------------------|------------------------|-----------------------|--|----------------|-----------------|----------------|------|-------------------|-------|
|  | lb. - sec. <sup>1</sup> | n. - sec. <sup>2</sup> |                       |  |                |                 | oz.            | g.   | oz.               | g.    |
| <b>SINGLE STAGE ENGINES</b>            |                         |                        |                       |  |                |                 |                |      |                   |       |
| <b>GREEN LABEL</b>                     |                         |                        |                       |  |                |                 |                |      |                   |       |
| 1/2A6-2                                | 0.28                    | 1.25                   | 2 sec.                | 2.5 oz.                                | 46 oz.         | 0.20 sec.       | 0.53           | 15.0 | 0.055             | 1.56  |
| A8-3                                   | 0.56                    | 2.50                   | 3 sec.                | 4.0 oz.                                | 48 oz.         | 0.32 sec.       | 0.57           | 16.2 | 0.110             | 3.12  |
| B4-2                                   | 1.12                    | 5.00                   | 2 sec.                | 4.0 oz.                                | 48 oz.         | 1.20 sec.       | 0.70           | 19.8 | 0.294             | 8.33  |
| B4-4                                   | 1.12                    | 5.00                   | 4 sec.                | 3.5 oz.                                | 48 oz.         | 1.20 sec.       | 0.74           | 21.0 | 0.294             | 8.33  |
| B6-2                                   | 1.12                    | 5.00                   | 2 sec.                | 4.5 oz.                                | 48 oz.         | 0.83 sec.       | 0.68           | 19.3 | 0.220             | 6.24  |
| B6-4                                   | 1.12                    | 5.00                   | 4 sec.                | 4.0 oz.                                | 48 oz.         | 0.83 sec.       | 0.71           | 20.1 | 0.220             | 6.24  |
| B8-5                                   | 1.12                    | 5.00                   | 5 sec.                | 5.0 oz.                                | 5 lb.          | 0.60 sec.       | 0.68           | 19.3 | 0.220             | 6.24  |
| C5-3                                   | 2.25                    | 10.00                  | 3 sec.                | 8.0 oz.                                | 5 lb.          | 2.10 sec.       | 0.90           | 25.5 | 0.450             | 12.70 |
| C6-3                                   | 2.25                    | 10.00                  | 3 sec.                | 4.0 oz.                                | 48 oz.         | 1.70 sec.       | 0.88           | 24.9 | 0.440             | 12.48 |
| C6-5                                   | 2.25                    | 10.00                  | 5 sec.                | 4.0 oz.                                | 48 oz.         | 1.70 sec.       | 0.91           | 25.8 | 0.440             | 12.48 |
| <b>UPPER STAGE ENGINES<sup>3</sup></b> |                         |                        |                       |  |                |                 |                |      |                   |       |
| <b>PURPLE OR BLUE LABEL</b>            |                         |                        |                       |  |                |                 |                |      |                   |       |
| 1/2A6-4                                | 0.28                    | 1.25                   | 4 sec.                | 1.0 oz.                                | 46 oz.         | 0.20 sec.       | 0.54           | 15.3 | 0.055             | 1.56  |
| A8-5                                   | 0.56                    | 2.50                   | 5 sec.                | 2.0 oz.                                | 48 oz.         | 0.32 sec.       | 0.62           | 17.6 | 0.110             | 3.12  |
| B4-6                                   | 1.12                    | 5.00                   | 6 sec.                | 1.5 oz.                                | 48 oz.         | 1.20 sec.       | 0.78           | 22.1 | 0.294             | 8.33  |
| B6-6                                   | 1.12                    | 5.00                   | 6 sec.                | 2.0 oz.                                | 48 oz.         | 0.83 sec.       | 0.78           | 22.1 | 0.220             | 6.24  |
| B8-7                                   | 1.12                    | 5.00                   | 7 sec.                | 2.5 oz.                                | 5 lb.          | 0.60 sec.       | 0.72           | 20.4 | 0.220             | 6.24  |
| C6-7                                   | 2.25                    | 10.00                  | 7 sec.                | 2.5 oz.                                | 48 oz.         | 1.70 sec.       | 0.95           | 26.9 | 0.440             | 12.48 |
| <b>BOOSTER ENGINES</b>                 |                         |                        |                       |  |                |                 |                |      |                   |       |
| <b>RED LABEL</b>                       |                         |                        |                       |  |                |                 |                |      |                   |       |
| A8-0                                   | 0.56                    | 2.50                   | none                  | 4.0 oz.                                | 48 oz.         | 0.30 sec.       | 0.51           | 14.2 | 0.110             | 3.12  |
| B6-0                                   | 1.12                    | 5.00                   | none                  | 4.0 oz.                                | 48 oz.         | 0.80 sec.       | 0.58           | 16.4 | 0.220             | 6.24  |
| B8-0                                   | 1.12                    | 5.00                   | none                  | 6.0 oz.                                | 5 lb.          | 0.60 sec.       | 0.60           | 17.0 | 0.220             | 6.24  |
| C6-0                                   | 2.25                    | 10.00                  | none                  | 4.0 oz.                                | 48 oz.         | 1.68 sec.       | 0.80           | 22.7 | 0.440             | 12.48 |

Shipping wt. of each package is approximately 4 oz. Each package of 3 engines includes 3 igniters.

## MIGHTY "D" ENGINE SELECTION CHART

| Cat. No. & Engine Type | Total Impulse           |                        | Time Delay<br>(± 15%) | Maximum Lift-off Weight<br>with Engine | Maximum Thrust | Thrust Duration | Initial Weight |      | Propellant Weight |       | Recommended Use |
|------------------------|-------------------------|------------------------|-----------------------|--|----------------|-----------------|----------------|------|-------------------|-------|-----------------|
|                        | lb. - sec. <sup>1</sup> | n. - sec. <sup>2</sup> |                       |  |                |                 | oz.            | g.   | oz.               | g.    |                 |
| D12-0                  | 4.49                    | 20.00                  | none                  | 14.0 oz.                               | 6.3 lb.        | 1.70 sec.       | 1.44           | 40.9 | 0.879             | 24.93 | Booster Engine  |
| D12-3                  | 4.49                    | 20.00                  | 3 sec.                | 14.0 oz.                               | 6.3 lb.        | 1.70 sec.       | 1.49           | 42.2 | 0.879             | 24.93 | Single Stage    |
| D12-5                  | 4.49                    | 20.00                  | 5 sec.                | 10.0 oz.                               | 6.3 lb.        | 1.70 sec.       | 1.52           | 43.1 | 0.879             | 24.93 | Single Stage    |
| D12-7                  | 4.49                    | 20.00                  | 7 sec.                | 8.0 oz.                                | 6.3 lb.        | 1.70 sec.       | 1.55           | 44.0 | 0.879             | 24.93 | Single or Upper |

Shipping wt. of each engine is approximately 2-1/3 oz.

D engines are 2.75 in. long and 0.945 in. dia.

**NOTES:**

Complete instructions and igniters (2301) are included with each rocket engine ordered from Estes Industries.

Regular engines are 2.75 in. long and 0.690 in. diameter.

<sup>1</sup> pound-seconds. (Figures shown are maximum.)  
<sup>2</sup> newton-seconds (Figures shown are maximum.)

<sup>3</sup>OR Single stage engines if used in very light rockets.



# ROCKET ENGINE DESIGN

The Series 1 and Mini-engines (T Series) engines are a solid propellant type with a dual thrust level design. There is a slight center bore at the very tip of the nozzle end of the propellant grain which serves two purposes. First, it provides for easy ignition. Second, as you will note from the thrust curves, this special design produces a high initial thrust which accelerates the rocket to a suitable flying speed quickly. This is because the slight center bore provides a relatively large burning area, resulting in faster consumption of the fuel.

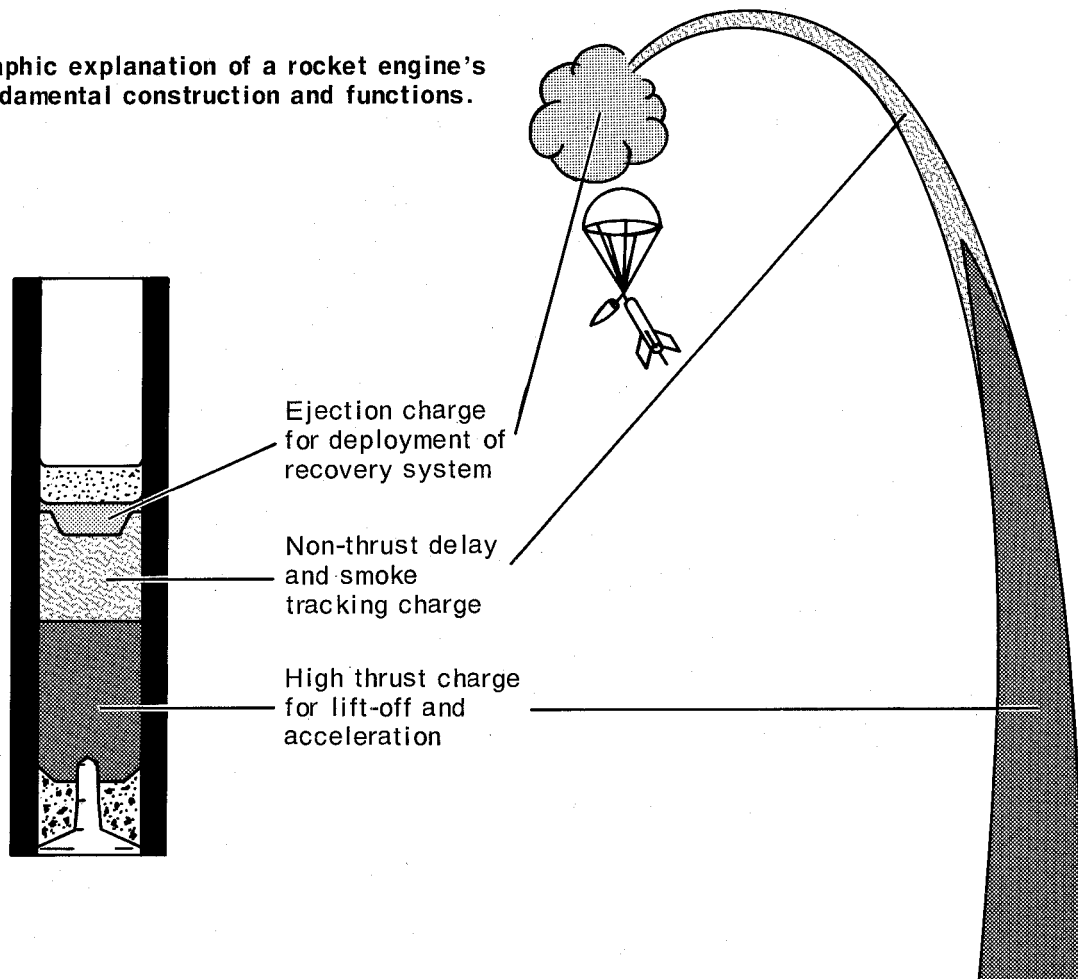
After this initial high thrust, a transition to an end burning grain is made, and the thrust drops to a sustained level (except on low total impulse engines which burn out by this time). Data from wind tunnel tests shows that dual thrust level to be the most effective design for rocket engines which are used to propel lightweight model rock-

ets at subsonic speeds.

The slow-burning delay and tracking charge is ignited at the burnout of the propellant grain. This slow-burning, smoke-producing charge provides no thrust, but permits the rocket to coast upward to its peak altitude. At the burnout of the delay charge a recovery system ejection charge is ignited which pressurizes the forward end of the rocket body tube, activating the recovery system. For further information, see the performance graphs and cutaway drawings.

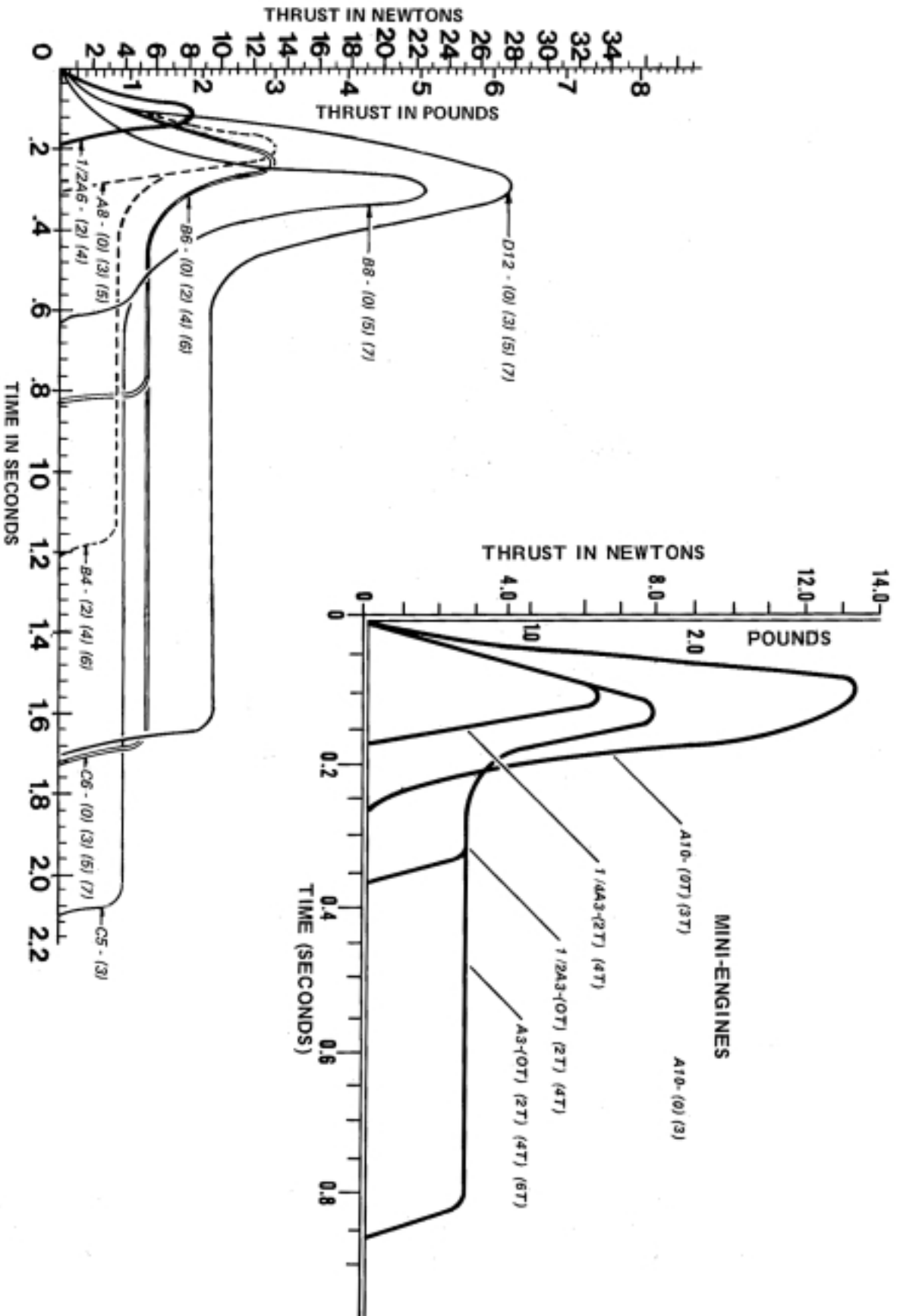
The B8- engines have a modified center-burning grain. This provides a greater propellant burning area than engines of the same total impulse but which are end burning. The larger burning area provides a higher initial thrust level but a short thrust duration. The B8- engines are especially useful for high acceleration studies, as boosters on heavier rockets and for drag races.

Graphic explanation of a rocket engine's fundamental construction and functions.





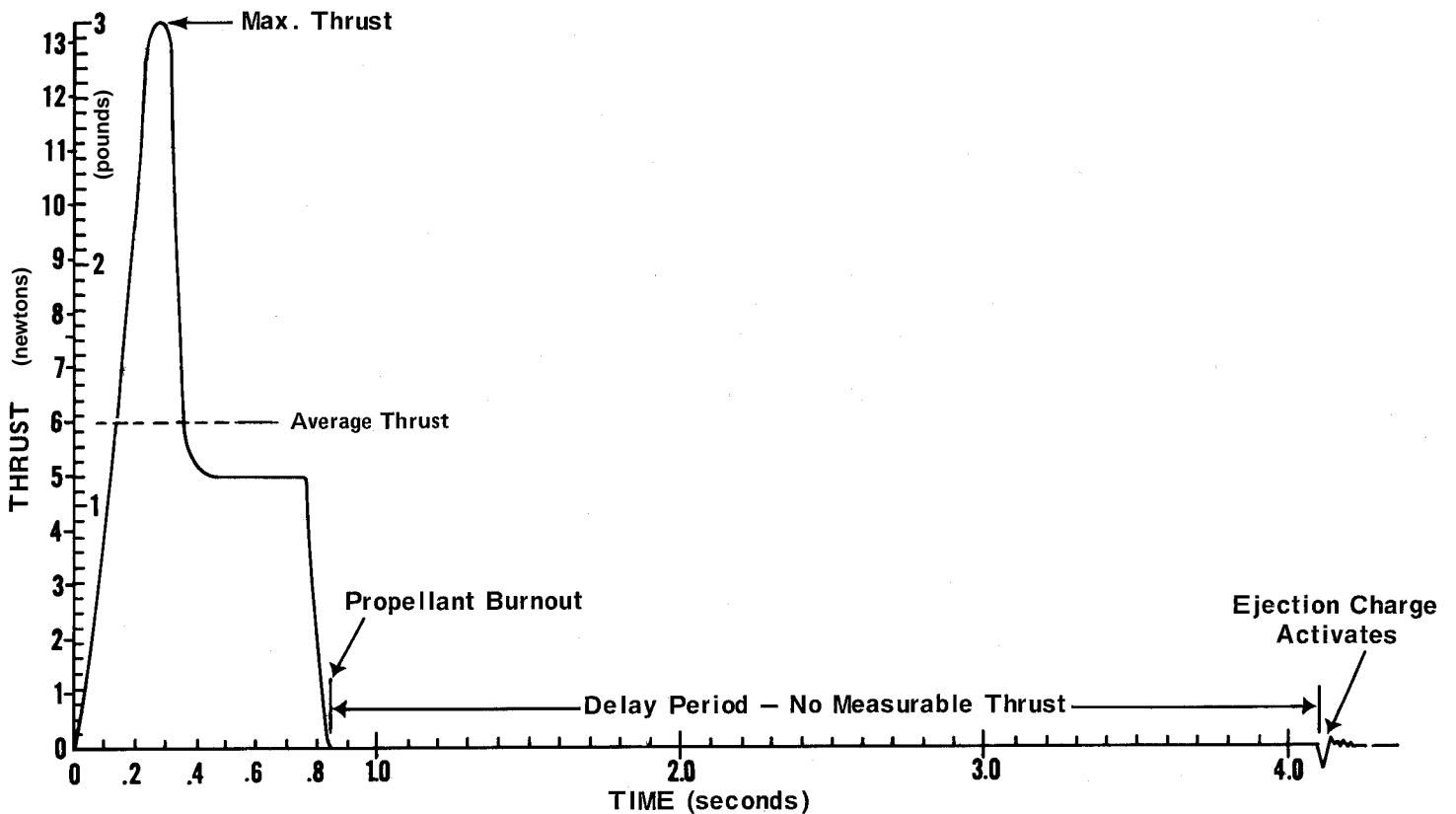
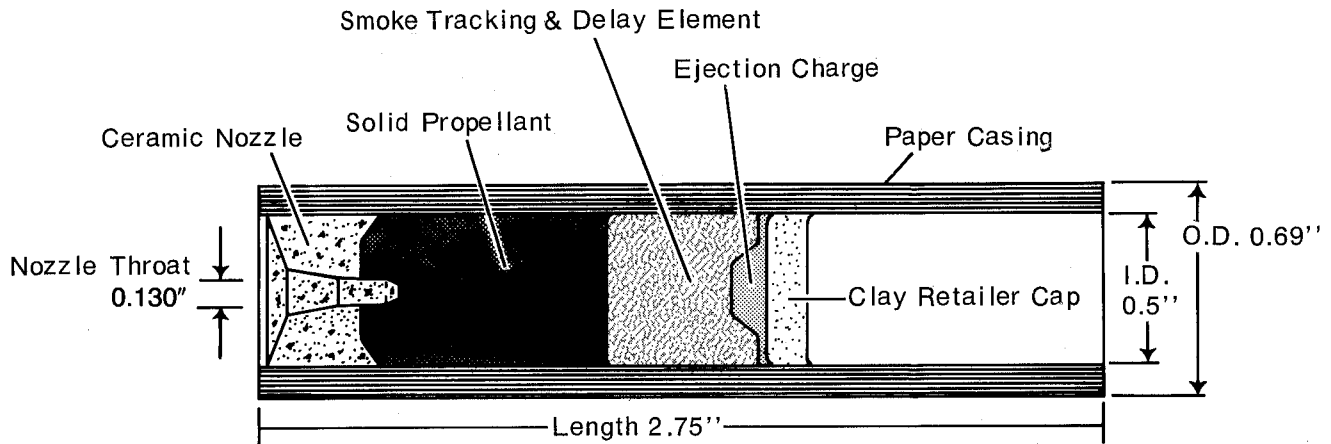
# COMPARATIVE TIME/THRUST CURVES





## TYPICAL TIME/THRUST CURVE OF B6-4 SERIES I

Specific Impulse – 80-83 lb.-sec. per lb.  
Exhaust Velocity – 2550-2650 ft./sec.





# TYPICAL TIME/THRUST CURVE

## B8-5 SERIES II

Exhaust Velocity — 2550-2650 ft./sec.  
Specific Impulse — 80-83 lb.-sec. per lb.

