



*MiniSShot*

Rocket Motor

Assembly & Propellant Loading Manual

Rev. 2010/03/10

## Introduction

This document describes the procedures to assemble the *MiniSShot* rocket motor and to load the propellant charges and igniter systems. The *MiniSShot* motor is basically identical to the *ProtoSShot-M Mark III* rocket motor which was successfully static fired on July 25<sup>th</sup>, 2009. The *MiniSShot* motor will be used to propel the *MiniSShot* flight vehicle.

Certain modifications to the motor compared to the *ProtoSShot-M Mark III* were made to improve thermal resistance or to reduce mass, and are as follows:

- Garolite (0.005") replaces stainless steel foil (0.002") thermal barrier in both chambers
- Thrust stand-off fitting truncated
- Pressure sensor fitting modified and copper pipe eliminated
- Nozzle Ring shaved in non-structural areas to remove mass
- Nozzle ablative composition modified slightly to increase erosion resistance
- Forward Chamber casting tube composition modified to reduce mass
- Forward Casing modified by addition of eight coupler attachment holes

The *MiniSShot* motor is illustrated in Figure 1.

**Instructions** -- Check off the box on the left side upon completion of each step.

Parts listing:

<u>P/N</u>	<u>Qty.</u>	<u>Description</u>
P0	1	Aft motor casing with Garolite lining
P1	1	Forward motor casing with Garolite lining
P3	1	Nozzle assembly
P4	1	Mid-bulkhead/Delay Plug/Burst Diaphragm assembly
P5	1	Forward Bulkhead
P6A	1	Propellant grain assembly, aft chamber
P6B	1	Propellant grain assembly, forward chamber
P14	8	O-ring, -234, nitrile (Buna-N)
P15	96	#8-32x1/4 custom shoulder screw
P16	a/r	Silicone grease, Dow Corning 111 or equivalent
P19	2	Pyrotechnic igniter ("electric match" p/n M-TEK1 )
P21	2	Primary Igniter charge containing 10 grams of CuO/Mg or CuO/Al thermite 8.2 grams CuO & 1.8 grams Aluminum, <u>blend thoroughly</u> or 7.7 grams CuO & 2.3 grams Magnesium, <u>blend thoroughly</u>
P22	1	Wooden dowel, 1/4" diameter x 3' (min.)
P23	1	Igniter Leads and Fitting Assembly
P24	a/r	Electrical (PVC) tape
P24	1	Electrical Safety Shunt (banana plug type)

**Tools required**

- T1 Allen (hex) key, 9/64"
- T2 Centre punch, tapered
- T3 Wrenches (sizes as required)

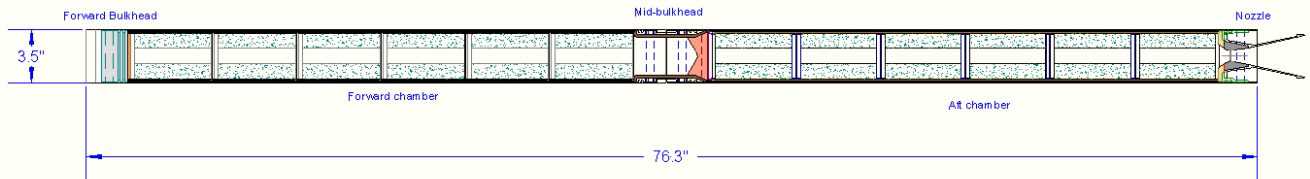


Figure 1 – Basic dimensions and components of the *MiniSShot* motor assembly

**I. Trial assembly (optional but highly recommended)**

- 1. Insert Nozzle Assembly, without o-rings, into Aft Casing and attach with 2 or 3 screws.
- 2. Insert Aft Grain Assembly into Aft Casing (grain S/N 1 nearest Nozzle). Take care not to snag Garolite casing liner. IF FIT IS SNUG, STOP. REFER TO REWORK INSTRUCTIONS, APPENDIX A.
- 3. Insert Mid-bulkhead Assembly, without o-rings, into Aft casing (Delay Plug end first). Attachment screw holes should line up. It is not necessary to install any screws unless to verify alignment of holes.
- 4. Remove Mid-bulkhead from Aft Casing and insert Mid-bulkhead Assembly, without o-rings, into Forward casing. Install Burst Diaphragm end first, and attach with 2 or 3 screws.
- 5. Insert Forward Grain Assembly into Forward Casing (grain S/N 7 nearest Mid-bulkhead). Take care not to snag Garolite casing liner. IF FIT IS SNUG, STOP. REFER TO REWORK INSTRUCTIONS, APPENDIX A
- 6. Insert Forward Bulkhead, without o-rings, and verify attachment holes line up. It is not necessary to install any screws unless to verify holes line up.
- 7. Remove Nozzle and Grain Assembly from Aft Casing.
- 8. Remove Mid-bulkhead and Grain Assembly from Forward Casing
- 9. Remove Forward Bulkhead from Forward Casing (if installed).

**It is imperative that steps 7 to 9 be accomplished, as failure to disassemble will have serious consequence, as o-rings have not been installed at this point.**

## II. Installation of Nozzle Assembly into Aft Casing

1. Fill Nozzle (P3) o-ring grooves with silicone grease (P16) using a craft stick (T3). Coat two o-rings (P14) with silicone grease.
2. Install both o-rings into grooves.
3. Lightly coat inside end of Aft Casing (P0), aft end, with silicone grease.
4. Line up attachment holes in nozzle with attachment holes in casing and firmly push nozzle into casing. Push in far enough that holes are lined up as closely as possible.
5. Using centre punch (T2), align holes by inserting punch into hole and gently prying nozzle into aligned position. Do not use excessive force.
6. Install, but do not tighten, 24 screws (P15), using hex key (T1). DO NOT USE POWER DRIVER
7. Tighten all screws, one by one, until firmly seated. Finish by torquing hand-tight. Do not over-tighten. Order of tightening is not important.

## III. Installation of Mid-bulkhead Assembly into Forward Motor Casing.

1. Remove protective cover and poly wrap from Burst Diaphragm end of Mid-bulkhead. Leave protective poly wrap in place over Delay Plug (ref. Figure 2).
2. Fill the two forward o-ring grooves (nearest the burst diaphragm) with silicone grease (P16) using a craft stick (T3). Coat two o-rings (P14) with silicone grease.
3. Install both o-rings into grooves.
4. Lightly coat inside end of Forward Casing (P1), aft end, with silicone grease.
5. Line up attachment holes in Mid-bulkhead with attachment holes in casing and firmly push Mid-bulkhead into casing. Push in far enough that holes are lined up as closely as possible.
6. Using centre punch (T2), align holes by inserting punch into hole and gently prying Mid-bulkhead into aligned position. Do not use excessive force.
7. Install, but do not tighten, 24 screws (P15), using hex key (T1). DO NOT USE POWER DRIVER
8. Tighten all screws, one by one, until firmly seated. Finish by torquing hand-tight. Do not over-tighten. Order of tightening is not important.

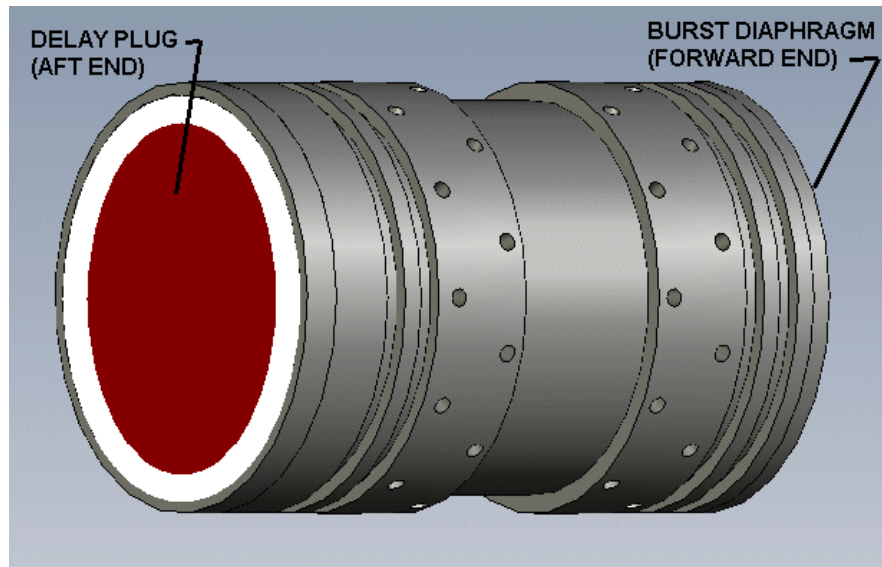


Figure 2 – Mid-bulkhead assembly, indicating Delay Plug (aft end) and Burst Diaphragm

#### IV. Loading Propellant Grain into Aft Motor Casing

- 1. Insert Aft Grain Assembly into Aft Casing (grain S/N 1 nearest Nozzle). Take care not to snag Garolite casing liner.

#### V. Installation of Mid-bulkhead/Forward Casing Assembly into loaded Aft Casing

- 1. Remove protective poly wrap from Burst Diaphragm end of Mid-bulkhead.
- 2. Fill the two o-ring grooves of Mid-bulkhead with silicone grease (P16) using a craft stick (T3). Coat two o-rings (P14) with silicone grease.
- 3. Install both o-rings into grooves.
- 4. Apply a generous amount of silicone grease in the ablative “step” at the perimeter of the burst diaphragm.
- 5. Lightly coat inside end of Aft Casing with silicone grease.
- 6. Line up attachment holes in Mid-bulkhead with attachment holes in casing and firmly push Mid-bulkhead into Aft Casing. Push in far enough that holes are lined up as closely as possible.
- 7. Using centre punch (T2), align holes by inserting punch into hole and gently prying Mid-bulkhead into aligned position. Do not use excessive force.
- 8. Install, but do not tighten, 24 screws (P15), using hex key (T1). DO NOT USE POWER DRIVER

- 9. Tighten all screws, one by one, until firmly seated. Finish by torquing hand-tight. Do not over-tighten. Order of tightening is not important.

## **VI. Loading Propellant into Forward Motor Casing**

- 1. Insert Forward Grain Assembly into Forward Casing (grain S/N 7 nearest Mid-bulkhead). Take care not to snag Garolite casing liner.

## **VII. Igniter Installation in Forward Bulkhead**

- 1. Prepare a 10 gram charge of Thermites (P21). See Parts Listing for preparation instructions.
- 2. Place thermites charge in poly bag together with electric match M-TEK1 (P19) and seal.
- 3. Perform continuity check of electric match.
- 4. Install Igniter Fitting assembly (P23) into Forward Bulkhead. Tighten snugly.
- 5. Connect the electric match leads to the igniter leads and insulate each connection with Electrical tape (P24).
- 6. Place bag within metal "U" holder (attached to bulkhead) and secure with tape or wire.

## **VIII. Installation of Forward Bulkhead into loaded Forward Motor Casing**

- 1. Confirm that pressure port fitting is installed in bulkhead and tightly fastened (ref. Fig.3)
- 2. Fill the two o-ring grooves of the Forward Bulkhead (P5) with silicone grease (P16) using a craft stick (T3). Coat two o-rings (P14) with silicone grease.
- 3. Install both o-rings into grooves.
- 4. Apply a generous amount of silicone grease on the bulkhead around the edge of the cork liner, as illustrated in Figure 3.
- 5. Lightly coat inside end of Forward Casing with silicone grease.
- 6. Line up attachment holes in Forward Bulkhead with attachment holes in casing and firmly push bulkhead into casing. Push in far enough that holes are lined up as closely as possible.

- 7. Using centre punch (T2), align holes by inserting punch into hole and gently prying bulkhead into aligned position. Do not use excessive force.
- 8. Install, but do not tighten, 24 screws (P15), using hex key (T1). DO NOT USE POWER DRIVER
- 9. Tighten all screws, one by one, until firmly seated. Finish by torquing hand-tight. Do not over-tighten. Order of tightening is not important.
- 10. Apply double layer of Teflon tape onto threads of Pressure Transducer. Screw Pressure Transducer firmly into pressure fitting.

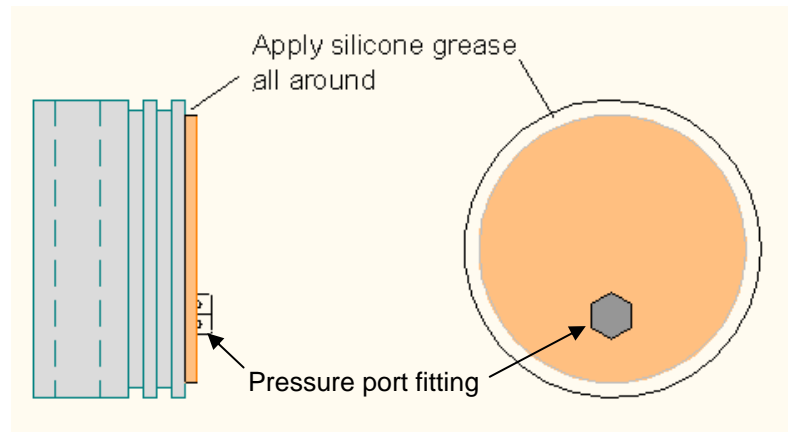


Figure 3 – Application of protective silicone grease on Forward Bulkhead

### IX. Installation of Igniter into Aft Motor Casing

- 1. Stretch out igniter (P19) leads and attach to tip of wooden dowel (P22) with tape.
- 2. Insert through nozzle opening and secure in position.
- 3. Perform igniter continuity check.
- 4. Shunt the two bared ends of the igniter leads for safety.

## **Appendix A – Rework Instructions to relieve snug fit of Grain Assembly**

A snug fit could be a result of a number of factors. The following rework provides some relief that should mitigate a snug fit caused by the overlapping seam of the Garolite liner.

Using a file or sanding block, remove approximately 0.020" (0.5 mm) along the entire length of the casting tube assembly (to create a "flat spot"), as shown in Figure 4

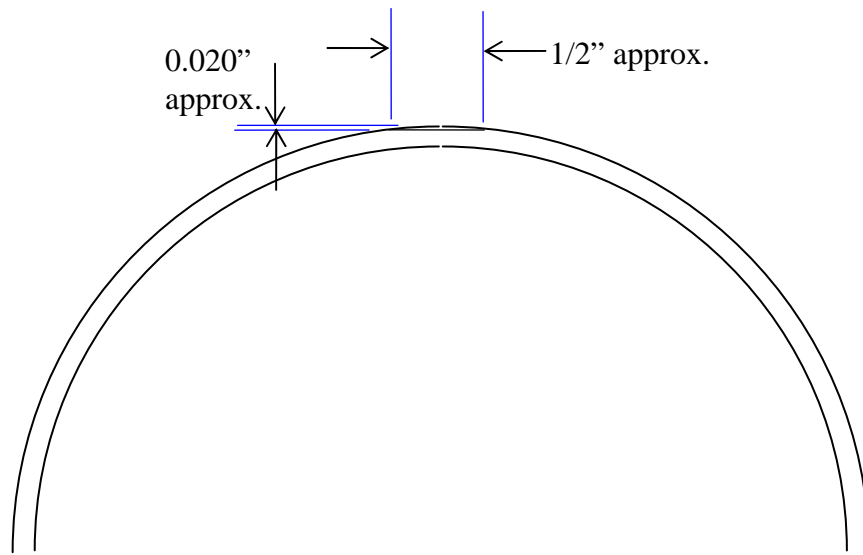


Figure 4 – Rework to alleviate snug fit

Insert the Grain Assembly into the motor, aligning the flat spot with the lap joint of the Garolite casing liner.