



MiniSShot

ProtoSShot-M Mark III Rocket Motor

Assembly & Propellant Loading Manual

Rev. 2009/07/21

Introduction

This document describes the procedures required to assemble the *ProtoSShot-M Mark III* rocket motor and to load the propellant charges and igniter systems. Guidance is also provided with regard to pre-firing, firing, and post-firing procedures. The *ProtoSShot-M Mark III* motor incorporates design improvements over the *Mark I & Mark II* versions of the motor which were test-fired in April 2008 and November 2008, respectively.

The *ProtoSShot-M Mark III* 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
P1	1	Forward motor casing
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
P18	a/r	Lacquer thinner or acetone
P19	2	Pyrotechnic igniter (“electric match”)
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

Tools required

T1	Allen (hex) key, 9/64”
T2	Centre punch, tapered
T3	9/16” open end wrenches, 2 req’d

Documentation of Assembly

Effort should be made to video-document the assembly of the motor. The intent is to provide a record that could be reviewed at a later date to diagnose problems that may arise. As well, a review of the actual assembly process could be useful in uncovering areas of difficulty or discrepancy.

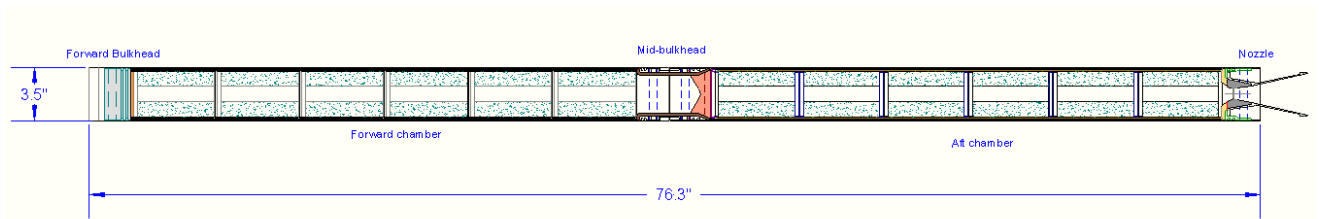


Figure 1 – Basic dimensions and components of the Mark III rocket motor assembly

I. Trial assembly

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 foil casing liner.
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 foil casing liner.
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 could have serious consequence, as o-rings have not been installed at this point.

II. Installation of Nozzle Assembly into Aft Casing

1. Fill Nozzle 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 of Aft Casing , 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 (see 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 of Forward Casing, 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.

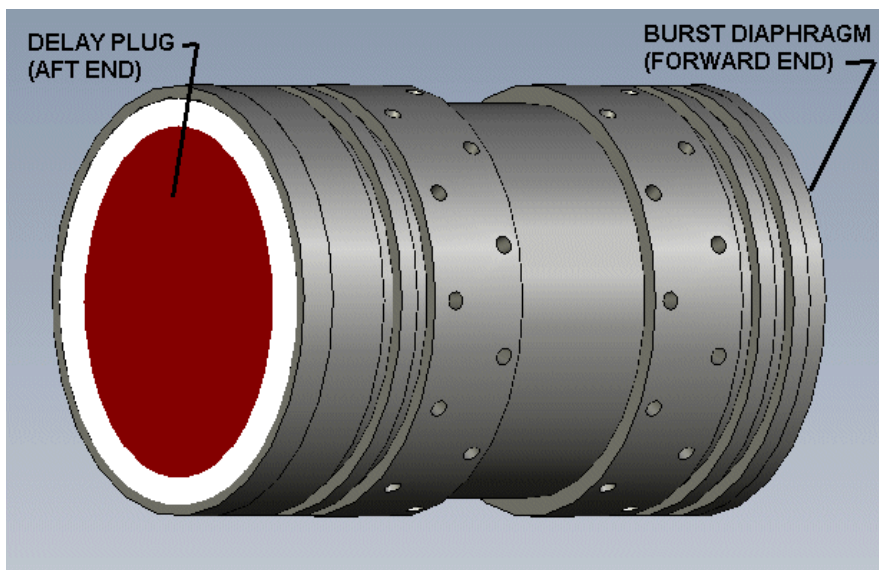


Figure 2 – Mid-bulkhead assembly, indicating Delay Plug (aft end) and Burst Diaphragm

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 foil 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. Lightly coat inside of Aft Casing with silicone grease.
5. Line up attachment holes in Mid-bulkhead with attachment holes in Aft Casing and firmly push Mid-bulkhead into Aft 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.

VI. Loading Propellant into Forward Motor Casing

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

VII. Igniter Installation in Forward Bulkhead

- 1. Prepare a 10 gram charge of Thermite (P21). See Parts Listing for preparation instructions.
- 2. Place thermite charge in poly bag together with Electric Match (P19) and seal. Diameter of filled bag must be less than 1” to allow it to fit into propellant core.
- 3. Perform continuity check of Electric Match.
- 4. Install Igniter Leads & Fitting assembly (P23) into Forward Bulkhead. Tighten snugly.
- 5. Connect the Electric Match leads to the igniter leads securely and tape each connection with Electrical tape (P24).
- 6. Shunt the other (bared) end of lead wire pair for safety.

VIII. Installation of Forward Bulkhead into loaded Forward Motor Casing

- 1. Fill the two o-ring grooves of the Forward Bulkhead 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. Apply a generous amount of silicone grease on the Bulkhead around the edge of the cork liner, as illustrated in Figure 3.
- 4. Lightly coat inside surface of Forward Casing with silicone grease (only that region not protected by painted foil barrier).
- 5. Line up attachment holes in Forward Bulkhead with attachment holes in Forward Casing and firmly push Bulkhead into casing. Push in far enough that holes are lined up as closely as possible. Take care to ensure igniter bag slides freely into propellant core and that leads do not snag.
- 6. Using centre punch (T2), align holes by inserting punch into hole and gently prying 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.

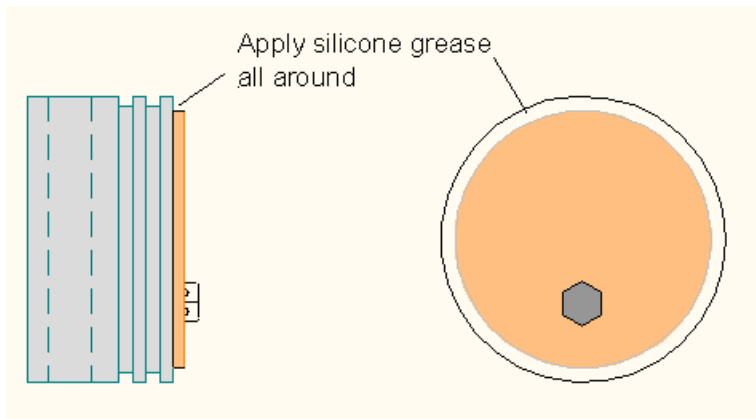


Figure 3 – Application of protective silicone grease on Forward Bulkhead perimeter.

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 near the top of the grain assembly (approximately 3” aft of the Delay Plug, ref. Figure 1).
3. Perform igniter continuity check.
4. Shunt the other end of bared lead wire pair for safety.

X. Interfacing of pressure sensor to Forward Bulkhead

Note: the Forward Bulkhead is shipped with the copper tubing/flare fitting assembly already firmly attached. It is only necessary to verify the connection to the bulkhead fitting has remained tight.

1. Connect copper tubing flare nut to pressure transducer assembly and tighten firmly.
IMPORTANT : use two wrenches (T3), one on the flare nut, the other on the brass fitting connected to the pressure transducer to ensure the connection is gas-tight.

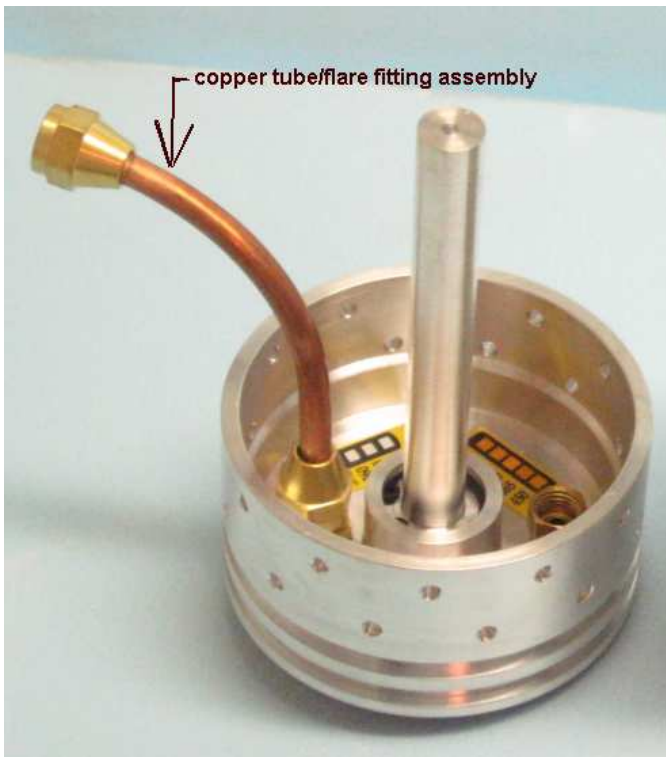


Figure 4 – Forward Bulkhead with interface to Pressure Transducer.

XI. Pre-firing, Firing and Post-firing Notes

- ✓ After completion of mounting motor on Test Platform, perform a continuity check of the 2nd phase igniter.
- ✓ Delay period between firing of the two phases is 10 seconds. This is the duration between 1st phase burnout and pressing of 2nd phase ignition button. First phase burnout is to be judged audibly by cessation of flow noise.
- ✓ Motor disassembly (Nozzle & Bulkhead removal) should be done as soon as possible after firing, to minimize seizure of components within the casings. Take great care to avoid damage to the casings as these are to be re-used. If excessive effort is needed, abandon disassembly & consult with Team Lead as to course of action to be taken.