



MiniSShot

ProtoSShot-M Mark III Rocket Motor

Propellant Casting & Grain Assembly Guide for use with Ablative Casting Tubes

Rev. 2009/07/13

General information

This document is intended to serve as a guide for casting propellant for the *ProtoSShot-M Mark III* rocket motor. Instructions are also provided detailing assembly of the individual grain segments into a monolithic grain assembly

Pre-casting setup & tasks

1. Pre-blend KN/sorbitol to proportions shown in Table 1.
2. Apply PVC electrician tape around top end of casting tubes to protect flange lip from contamination.
3. Mark serial number on each casting tube to identify. Accurately weigh all casting tubes individually and use Table 2 to record data (*note this step may have been completed prior to shipment*).
4. Prepare Coring Rod, Top Cap and Bottom Plug by applying a light coat of suitable mould release, allow to dry completely.
5. Assemble casting apparatus for propellant loading shown in Figure 1. Use a 1” wide strip of aluminum foil tape to secure casting tube to the Support Disc.

Note regarding Step 6:

This step is necessary as casting tubes are not all the same length.

SN2 to SN5 are equal length.

SN7 to SN12 are equal length

SN1 & SN2 both have unique lengths.

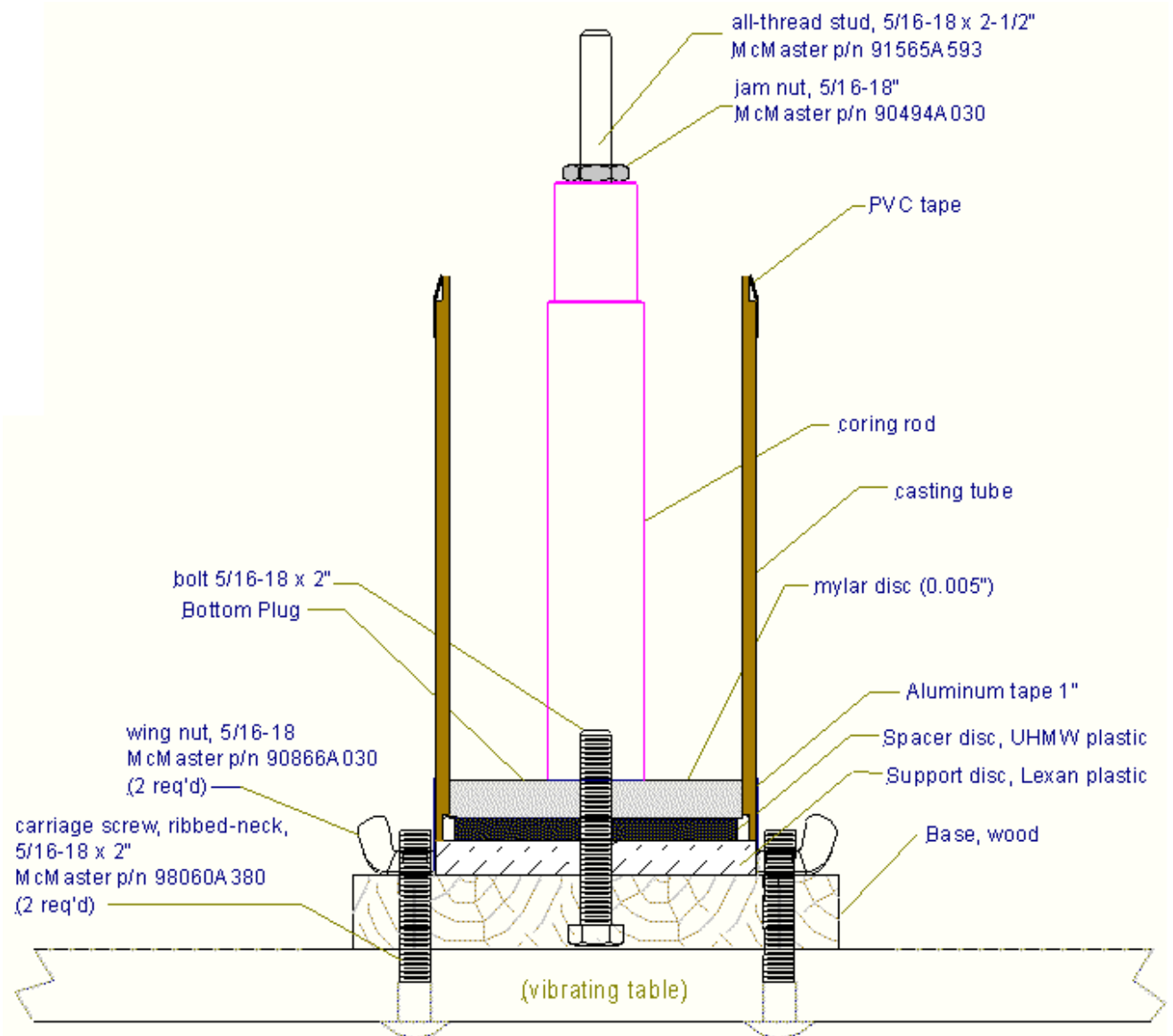


Figure 1 – Setup for propellant loading operation.

Propellant casting preparations and procedure

6. Slip Top Cap over coring rod and lower until bottom surface is even with the shoulder. Make note of how far it protrudes, as illustrated in Figure 2. Remove Top Cap and set aside.
7. Preheat vessel to temperature range of 250°F (120°C) to 295°F (145°C). Do not allow temperature of propellant to exceed 300°F (150°C) for extended duration.
8. Weigh out enough powdered mixture for one or more segments (Table 1) and add to heating vessel a little at a time. Allow melted slurry to reach desired casting temperature 265°F (130°C) to 285°F (140°C).
9. Power up the vibrating table.
10. Pour & scoop slurry, with use of the spatula, into casting mould. Fill level flush to the top of the casting tube.
11. Allow vibrating table to run for a minimum duration of five minutes before powering off.
12. Slip Teflon disc into place over coring rod and onto surface of propellant.
13. Slide Top Cap into place over coring rod and press down gently until it is submerged just past shoulder, as determined in Step 6.
14. As is shown in Figure 3, place steel shim, spring and spacer over coring rod. Loosely install washer and wing nut.

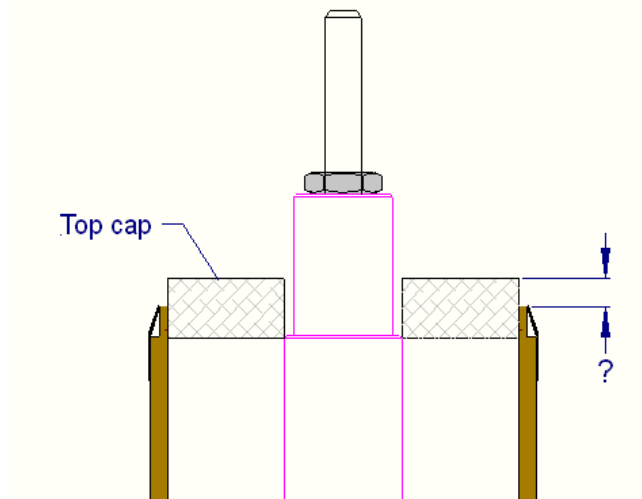


Figure 2 – Submersion of Top Cap

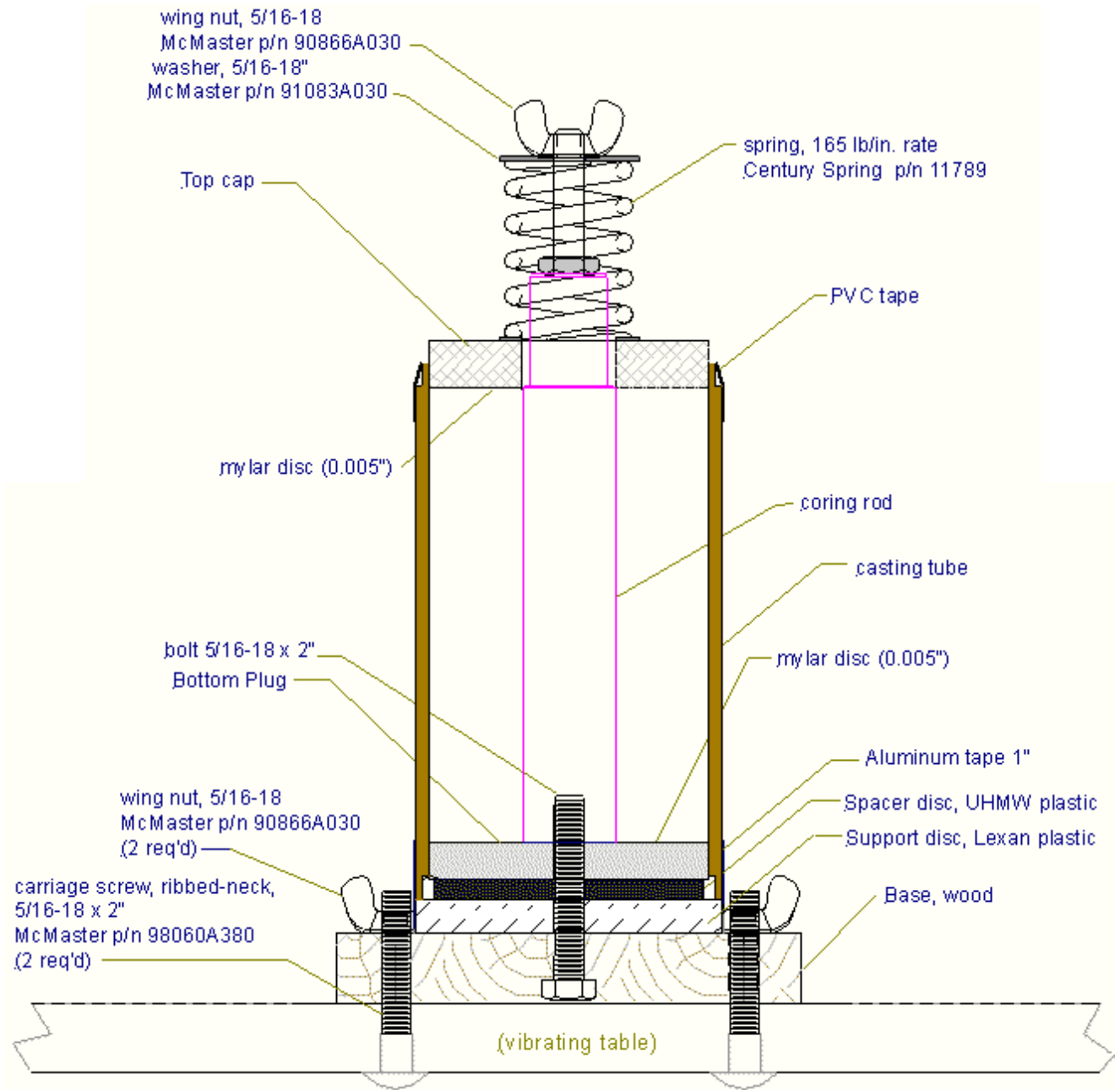


Figure 3 – Casting mould arrangement.

15. Slowly tighten wing nut to compress spring. Continue tightening, however
- a) stop if propellant begins to ooze out of mould
 - b) stop if Top Cap sinks down more than approximately 1/8"
 - c) stop if spring fully compresses
16. Allow to cool, then tighten wing nut to fully compress spring.

Disassembly and post-casting procedures.

- 17. Allow propellant to fully harden prior to releasing spring pressure (minimum 24 hours from time of casting).
- 18. Remove vinyl tape and aluminum tape from casting tube.
- 19. Disassemble casting setup. Top Cap is removed by using the Cap Removal Tool. A 3/4" or 1/2" diameter wooden dowel may be used to aid removal of the Bottom Plug. After inserting dowel into core, use a mallet to gently tap on top end of the dowel.
- 20. Clean the exterior surface of each casting tube to remove all traces of propellant. Use hot water to aid removal if necessary (water is not harmful to the ablative tube material).
- 21. Weigh each grain segment and record individual weights using Table 2. Measure and record depths of each recessed end, and casting tube lengths.
- 22. Store finished grains in sealed containers or poly bags, in a secure location or locations.

Priming of Propellant Segments

- 23. Prepare Ignition Primer slurry and paint onto both ends of all 12 propellant grain segments, using small paint brush. The Primer is a blend of finely pulverized mixture of potassium nitrate and charcoal, to the mass ratio of 80/20. Slurry consistency should be that of thick paint.

Optional: paint core to within 1" of each end.

Assembly of Aft Chamber Grain Segments

- 24. Prior to assembling, trial fit each individual grain (S/N 1 to S/N 6) separately in the Aft Chamber to verify that the fit is free without binding or excessive friction. Insert grain aft end first and take care not to snag edge of steel foil casing liner.
- 25. Clean mating surfaces (flanges) of all casting tubes with lacquer thinner.
- 26. Prepare a batch of well-blended, quality epoxy adhesive.
- 27. Starting with aft-most tube (S/N 1), sparingly apply a coat of epoxy over entire female flange surface of tube, as illustrated in Figure 4.
- 28. With tube lying upright on a firm, flat surface, fully press next tube in place (do not apply adhesive on the mating flange of this tube).
- 29. Wipe off excess adhesive on outside surface of joint.
- 30. Repeat process (steps 27-29) for remaining tubes.

- 31. Place 3.25" x 3.25" wooden plate onto top of assembled grains. Place a compact 5 lb weight onto plate.
- 32. Using lacquer thinner or acetone, wipe all joints to remove all traces of adhesive on exterior surface.
- 33. Allow adhesive to fully cure before removing weight.

Assembly of Forward Chamber Grain Segments

- 34. Prior to assembling, trial fit each individual grain (S/N 7 to S/N 12) separately in the Forward Chamber to verify that the fit is free without binding or excessive friction. Insert grain aft end first and take care not to snag edge of steel foil casing liner.
- 35. Clean mating surfaces (flanges) of all casting tubes with lacquer thinner or acetone.
- 36. Prepare a batch of well-blended, quality epoxy adhesive.
- 37. Starting with aft-most tube (S/N 7), sparingly apply a coat of epoxy over entire female flange surface of tube, as illustrated in Figure 4.
- 38. With tube lying upright on a firm, flat surface, fully press next tube in place. Do not apply adhesive on the mating (male) flange of this tube.
- 39. Wipe off excess adhesive on outside surface of joint.
- 40. Repeat process (steps 37-39) for remaining tubes.
- 41. Place 3.25" x 3.25" wooden plate onto top of assembled grains. Place a compact 5 lb weight onto plate.
- 42. Using lacquer thinner or acetone, wipe all joints to remove all traces of adhesive on exterior surface.
- 43. Allow adhesive to fully cure before removing weight.

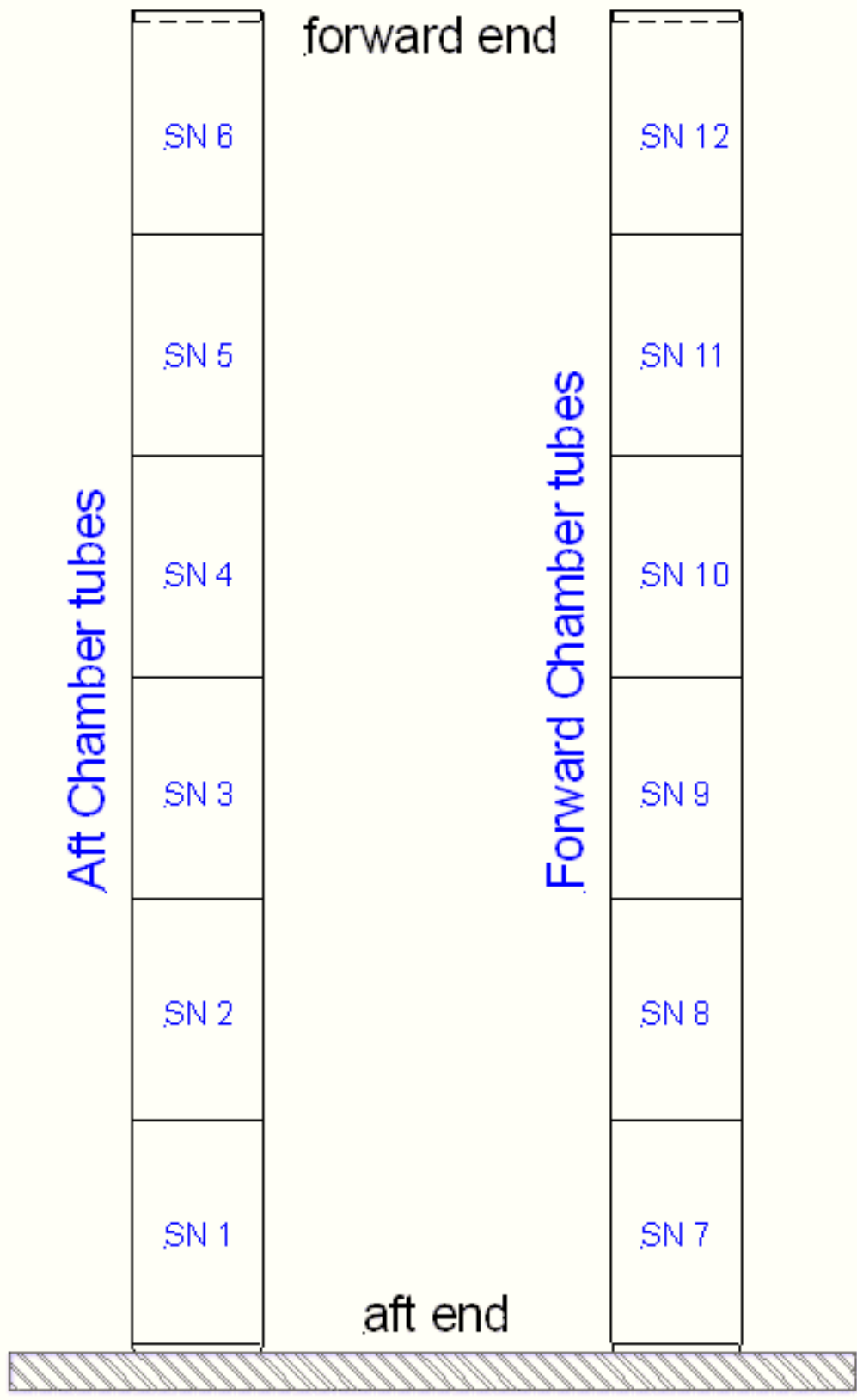


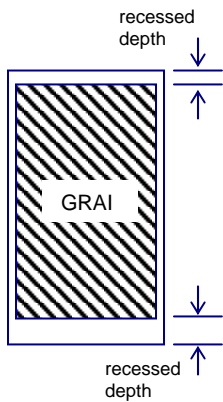
Figure 4 – Assembling grains

IMPORTANT NOTE: The scope of this document does not include complete information on safety precautions that must be followed. Refer to other sources for such information. Recommended safety wear, as a minimum, are protective glasses, clear faceshield, leather gloves, and leather or heavy jacket (long sleeves).

	Basic formula KNSB	Amount per segment *
KN	65%	635 grams
Sorbitol	35%	342 grams
	100%	977 grams

* includes 70 grams for wastage

Table 1 – Propellant formulas and constituent masses required per segment.



Grain s/n	Mass of casting tube (grams)	Mass of casting tube + propellant (grams)	Length of casting tube (mm)	Recessed depth Top (mm)	Recessed depth Bottom (mm)
	1				
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					

* S/N 1 is nearest nozzle; S/N increases toward forward end, with S/N 12 being nearest the Forward Bulkhead.

Table 2 – Recording sheet for grain masses and dimensions.