

RMS/HYBRID™ 54/300-900 MOTOR ASSEMBLY AND OPERATION INSTRUCTIONS

READ THIS BEFORE YOU BEGIN:

• Study the illustrations and sequence of assembly. **THE SEQUENCE OF ASSEMBLY IS EXTREMELY IMPORTANT. READ ALL INSTRUCTIONS BEFORE USE. USE RMS/HYBRID™ MOTORS ONLY IN ACCORDANCE WITH ALL INSTRUCTIONS.** Review the parts list and become familiar with all parts before assembly. **IF ANY PARTS ARE MISSING OR DAMAGED, CONTACT AEROTECH™ AT 1-702-641-2301.**

• **DO NOT USE ANY PARTS OF THE RMS/HYBRID™ SYSTEM THAT ARE DAMAGED IN ANY WAY, ESPECIALLY THE FLIGHT CYLINDER PIN VALVE.** If in doubt, contact AeroTech™ at the number above for assistance.

• **DO NOT MODIFY THE MOTOR IN ANY WAY.** Modification of the motor, flight cylinder or reload kit parts could result in motor failure, lead to the destruction of both your rocket and motor and may cause personal injury, death and/or property damage. Modification of the motor, flight cylinder or reload kit in any way will invalidate your motor warranty.

• **DO NOT USE ORDINARY "PAINTBALL" CYLINDERS AND VALVES IN THE RMS/HYBRID™ MOTOR SYSTEM.** Commonly-available "paintball" cylinders are designed for use with carbon dioxide (CO₂) and are **not** suitable for use with N₂O. Cylinders intended for N₂O service must be certified as "oxygen clean" to prevent ignition of contaminants. "Paintball" cylinder valves use combustible valve sealing components which have been shown to ignite in the presence of flowing liquid N₂O, and are not able to deliver sufficient quantities of N₂O into the combustion chamber to produce designed motor thrust levels.

• **NEVER USE PETROLEUM-BASED GREASES OR OILS ON THE FLIGHT CYLINDER, CYLINDER VALVE ASSEMBLY, CYLINDER FILLING ADAPTER AND FITTINGS OR ON ANY INSIDE SURFACES OF THE RMS/HYBRID™ PYROVALVE™/FORWARD CLOSURE ASSEMBLY.** Use only Krytox™ or other fully-fluorinated grease specifically designed for use in oxygen systems in these areas. Ordinary greases are susceptible to spontaneous ignition and/or explosion when exposed to pressurized nitrous oxide (N₂O). The only exception to this is that petroleum-based grease is acceptable for use in the N₂O preheater charge well of the RMS/Hybrid™ forward closure.

• **DO NOT ATTEMPT TO REMOVE THE PIN VALVE ASSEMBLY FROM THE FLIGHT CYLINDER. DO NOT TAMPER WITH OR REMOVE THE PRESSURE RELIEF VALVE ON THE CYLINDER VALVE ASSEMBLY.** Tampering with or removal of these parts could lead to a dangerous condition, possibly resulting in serious injury or death.

• **DO NOT FILL THE FLIGHT CYLINDER BEYOND THE RATED CAPACITY OF THE CYLINDER.** Overfilled cylinders can rupture the relief valve or burst violently without warning at certain elevated temperatures.

• **USE ONLY AEROTECH™ RMS/HYBRID™ RELOAD KITS AND MOTOR PARTS TO REFURBISH YOUR RMS/HYBRID™ MOTOR.** The AeroTech™ RMS/Hybrid™ reload kits have been designed specifically for use in your particular AeroTech™ RMS/Hybrid™ motor. Use of imitation components may destroy your motor, rocket and payload and will invalidate your motor warranty. Only use AeroTech™ RMS/Hybrid™ reload kits intended for your specific AeroTech™ RMS/Hybrid™ motor. **DO NOT INTERCHANGE PARTS!** Do not use AeroTech™ RMS/Hybrid™ reload kits or motor components for any other purpose than to refurbish an AeroTech™ RMS/Hybrid™ motor.

• **DO NOT REUSE ANY OF THE DISPOSABLE PARTS OF THE RMS/HYBRID™ RELOAD KIT.** This includes the fuel grains, liner, nozzle and o-rings. These components have been designed for one use only and must be discarded after firing. Reuse can result in motor failure during subsequent operation and will invalidate your motor warranty.

• Motors are hot after firing. Although the reloadable RMS/Hybrid™ motor operates at a lower temperature than most single-use solid propellant motors, the high thermal conductivity of the aluminum motor parts may make it seem otherwise. If necessary to handle a motor before it has cooled down, use a rag or similar means.

• Read and follow the safety code of the Tripoli Rocketry Association (TRA) and comply with all federal, state and local laws, regulations and ordinances in all activities involving high power rockets.

PARTS:

RMS/HYBRID™ 54/300-900 RELOADABLE HYBRID MOTOR SYSTEM™:

RMS™-54 aft closure	1
RMS™-54/1280 case	1
RMS/Hybrid™ forward closure with injector plate assembly & jet plugs	1
150, 300 or 440cc flight cylinder with valve assembly	1
Pyrovalve™ retainer screw	1

RMS/HYBRID™ RELOADABLE HYBRID MOTOR SYSTEM™ ACCESSORIES:

Pyrovalve™ retainer hex key wrench (3/8")	1
Injector plate jet plug hex key wrench (.050")	1
N ₂ O cylinder filling adapter & transfer hose assembly	1
Krytox™ fluorocarbon grease (syringe or 2 oz tube)	1
Ohaus® #LS5000 5000 gram electronic balance	1
Ohaus® #51055-00 500 gram calibration weight	1

RMS/HYBRID™ 2, 3 or 4-JET RELOAD KIT:

Nozzle (Large black plastic part)	1
Forward hybrid fuel grain (short 7/8" I.D. paper tube)	1
Aft hybrid fuel grain (longer 1-3/8" I.D. paper tube)	1
Liner (2" O.D. X 1-7/8" I.D. orange paper tube)	1
Fwd & aft o-rings (1/8" thick X 2" O.D.)	2

Pyrovalve™ teflon separator (5/8" O.D. white disk)	1
Pyrovalve™ o-ring (3/32" thick X 5/8" O.D.)	1
Pyrovalve™ element (short solid pellet)	1
Pyrovalve™ back-up washer (5/8" O.D. X 1/6" thick)	1
Nitrous oxide preheater charge (1" O.D. X 1" long propellant grain)	1
Nitrous oxide preheater insulator (1-1/8" O.D. X 1" long tube)	1
Nitrous oxide preheater forward insulator (1-1/8" O.D. fiber washer)	1
Forward insulator (2" O.D. phenolic washer)	1
Electric match igniter	1
Nozzle cap igniter holder (1-1/4" I.D. red cap)	1
Igniter guide (1/4" O.D. X 13" long tube)	1

ITEMS NEEDED FOR USE:

Nitrous oxide supply bottle (5 - 64 lb.) and valve with male CGA 660 outlet threads
CGA 660 bottle nut with teflon washer and male 4AN outlet fitting
Supply bottle pressure gauge (optional)
9/16" open-end or adjustable wrench
Petroleum jelly or similar petroleum-based grease
Masking tape
Hobby knife
Wet wipes or damp paper towels
"Chore Boy™" - type steel wool pad
Black powder

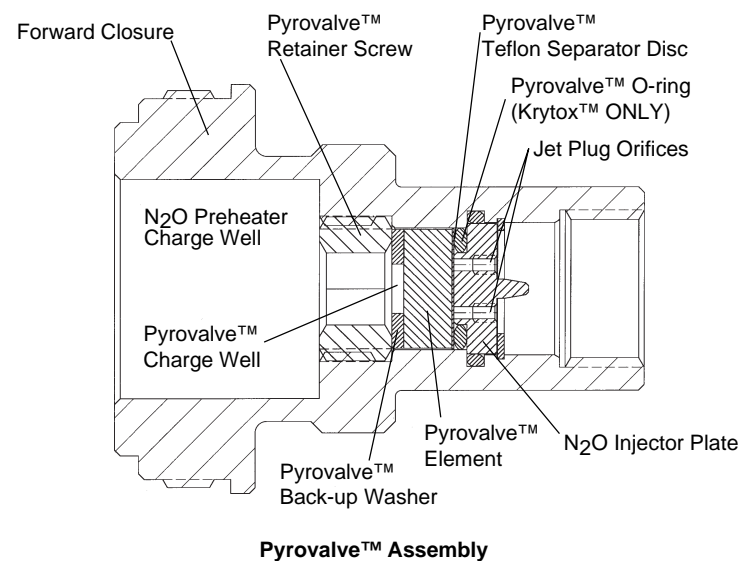
PERSONAL PROTECTIVE EQUIPMENT REQUIRED:

Leather gloves
Approved eye protection (such as safety glasses)

SAVE THE RELOAD KIT PLASTIC BAG FOR THE USED RELOAD PARTS. DISPOSE OF BAG AND PARTS PROPERLY.

NOTE: These abbreviated instructions are for field reference use only. For detailed instructions, including flight cylinder loading procedures, please refer to the RMS/Hybrid™ Assembly and Operations Manual that accompanied your RMS/Hybrid™ motor or upgrade package.

Chapter 2. Pyrovalve™/Forward Closure Preparation



2-1. Check the forward closure to ensure that the proper number of jet plugs (3-48 set screws) are installed in the forward closure N₂O injector plate corresponding to the reload kit being used (2, 3 or 4-jet) and the maximum thrust level desired. Using the .050" jet plug hex key wrench, remove or install one or two jet plugs in the injector plate as necessary. Store any removed jet plugs in the plug "parking spots" located in the injector plate or another secure location.

2-2. Apply a light coat of Krytox™ grease to the Pyrovalve™ (3/32" X 5/8" O.D.) o-ring. Place the o-ring in the groove in the bottom of the Pyrovalve™ charge well of the RMS/Hybrid™ forward closure.

WARNING: DO NOT use petroleum grease on the Pyrovalve™ o-ring or any **inside** threads or surfaces of the RMS/Hybrid™ forward closure. Ordinary greases used in these areas are susceptible to spontaneous ignition and/or explosion when exposed to pressurized nitrous oxide.

2-3. Inspect the Pyrovalve™ teflon separator disk (white disk 5/8" O.D. X .010" thick) for any holes, cuts or other defects.

CAUTION: Do not use a Pyrovalve™ teflon separator disk with any visible defects.

Install the separator disk into the Pyrovalve™ charge well, seated against the Pyrovalve™ o-ring.

2-4. Inspect the Pyrovalve™ element (short, solid black pellet, 5/8" O.D. X 1/4" thick) for chips, cracks or other defects. Check the structural integrity of the Pyrovalve™ element by grasping with the thumb and forefingers of both hands and flexing the element back and forth with moderate force.

CAUTION: Do not use a Pyrovalve™ element with any visible defects.

Install the Pyrovalve™ element in the Pyrovalve™ charge well of the RMS/Hybrid™ forward closure, seated against the teflon separator disk.

2-5. Insert the Pyrovalve™ back-up washer (5/8" O.D. X 1/16" thick stainless steel washer) into the Pyrovalve™ charge well until it is seated against the Pyrovalve™ element.

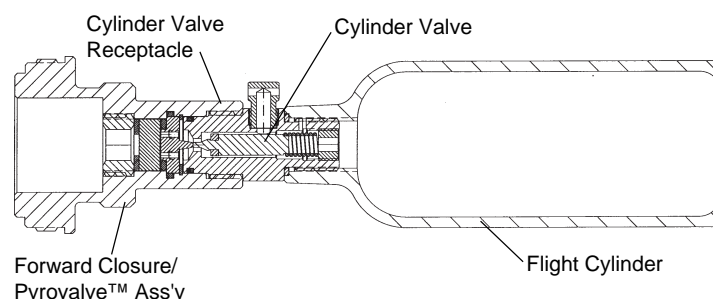
2-6. Drop the Pyrovalve™ retainer screw onto the Pyrovalve™ charge well. Using the Pyrovalve™ retainer hex key wrench, gently tighten the retainer screw against the Pyrovalve™ back-up washer until the retainer screw is flush with the end of the Pyrovalve™ charge well and a dramatic increase in threading resistance is noted.

CAUTION: Do not over tighten the Pyrovalve™ retainer screw. Over tightening the screw could crack the Pyrovalve™ element resulting in a leak and/or possible spontaneous ignition of the element when the flight cylinder is threaded into the RMS/Hybrid™ forward closure.

2-7. Leak Check.

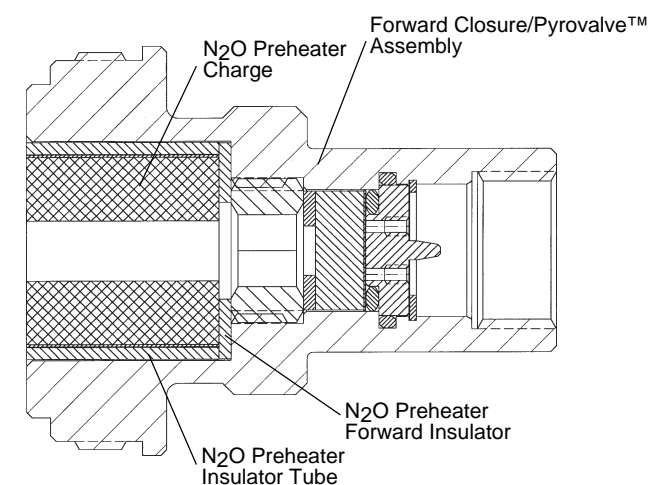
CAUTION: Perform step 2-7 outdoors ONLY. Wear leather gloves and approved eye protection during this operation.

WARNING: DO NOT at any time look directly into the Pyrovalve™ end of the RMS/Hybrid™ forward closure during this operation.



Leak Check Assembly

Using a partially or fully-filled flight cylinder at or above room temperature, and pointing the aft (Pyrovalve™) end of the RMS/Hybrid™ forward closure away from people, animals, buildings and flammable materials, slowly thread the cylinder valve fitting into the cylinder valve receptacle of the forward closure until a dramatic increase in threading resistance is felt. This increase signals the opening of the cylinder valve and the pressurizing of the forward closure cavities with nitrous oxide. If no leaks are heard or otherwise noted, unthread the cylinder from the forward closure and continue with the forward closure assembly. If a leak is detected, unthread the cylinder, remove the Pyrovalve™ components and carefully repeat steps 2-2 through 2-6 above before performing this leak check again. **NOTE: A small burst of N₂O gas will escape from the forward closure cylinder valve receptacle as the cylinder is unthreaded from the closure.**



Forward Closure Assembly (Complete)

2-8. Apply a liberal coat of petroleum-based grease to the inside surface of the nitrous oxide preheater well of the RMS/Hybrid™ forward closure. Install the nitrous oxide preheater forward insulator (1-1/8" O.D. X 1/16" thick fiber washer) into the nitrous oxide preheater well until it is seated against the forward end of the well.

2-9. Apply a liberal coat of petroleum-based grease to the outside of the nitrous oxide preheater insulator (1-1/8" O.D. X 1" I.D. X 1" long tube). Install the insulator into the nitrous oxide preheater well until it is seated against the nitrous oxide preheater forward insulator.

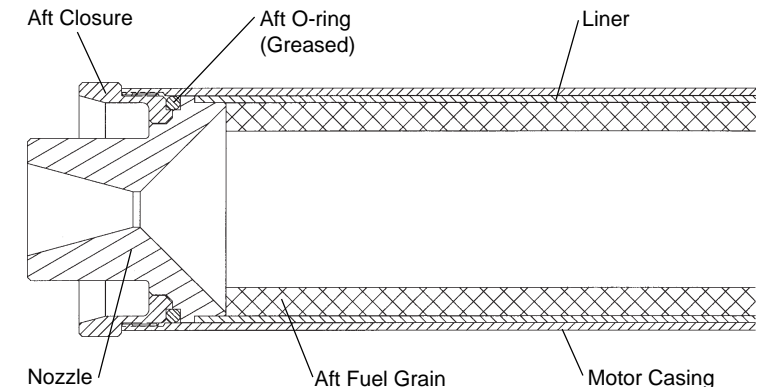
2-10. Insert the nitrous oxide preheater charge (1" O.D. X 1" long propellant grain) into the nitrous oxide preheater insulator tube until it is seated against the nitrous oxide preheater forward insulator. Set the completed RMS/Hybrid™ forward closure assembly aside.

Chapter 3. Combustion Chamber Assembly

3-1. Apply a light coat of petroleum-based grease to all casing threads and closure **outer** threads and both forward and aft o-rings. This will

facilitate assembly and prevents the threads from seizing.

3-2. Using your fingernail or other blunt object, remove the burr (rough, raised edge) from both inside ends of the liner tube (2" O.D. X 1-7/8" I.D. orange paper tube).



Aft End Motor Assembly

3-3. Apply a medium coat of Krytox™ grease to one end of the liner tube to a depth of approximately 3/8". **NOTE: The Krytox™ grease prevents the nozzle end of the liner from overheating and burning.**

3-4. Insert the larger-diameter end of the nozzle (large black plastic part) into the Krytox™-greased end of the liner tube until the nozzle flange is seated against the liner.

3-5. Install the aft (long, 1-3/8" I.D.) fuel grain into the liner tube, seated against the nozzle. If necessary, wrap the aft fuel grain with a layer or two of masking tape to insure a snug fit in the liner tube.

3-6. Install the forward (short, 7/8" I.D.) fuel grain into the liner tube and push it in until it is slightly below flush with the end of the liner tube and is seated against the aft fuel grain. If necessary, wrap the forward fuel grain with a layer or two of masking tape to insure a snug fit in the liner tube.

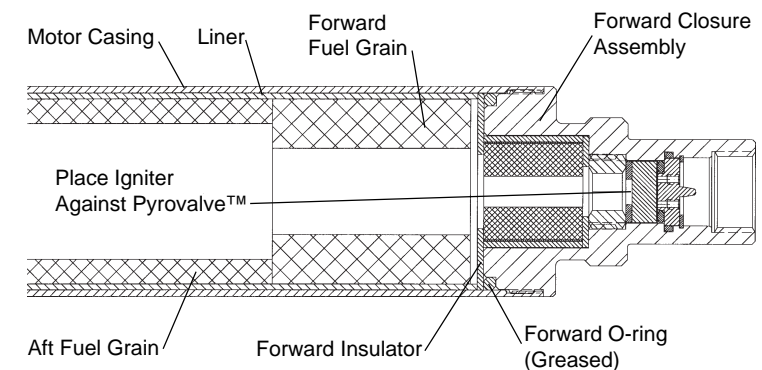
3-7. Push the liner assembly, nozzle end first, into the motor case until the nozzle protrudes from the case about 7/8". **NOTE: A liberal coat of petroleum-based grease applied to the outside surface of the liner (especially on the forward end) will facilitate installation and casing cleanup after motor firing.**

3-8. Place the greased aft (1/8" thick X 2" O.D.) o-ring into the groove in the nozzle insert.

3-9. Thread the aft (gold) closure into the motor case by hand until about 1/16" gap remains between the case and the closure. **NOTE: Final tightening will be done after the other motor components are loaded into the case.**

3-10. Using a hobby knife, slice a 1/8" vent hole in the edge of the nozzle cap igniter holder (1-1/4" I.D. red plastic cap). Set the vented nozzle cap igniter holder aside.

3-11. Wrap a short piece of 1" masking tape around the head of the electric match, forming a "tube" about 1/4" in diameter. Fill this tube about 1/8" from the end with black powder. Pinch the top of this tube together with your fingers to prevent the black powder from leaking out.



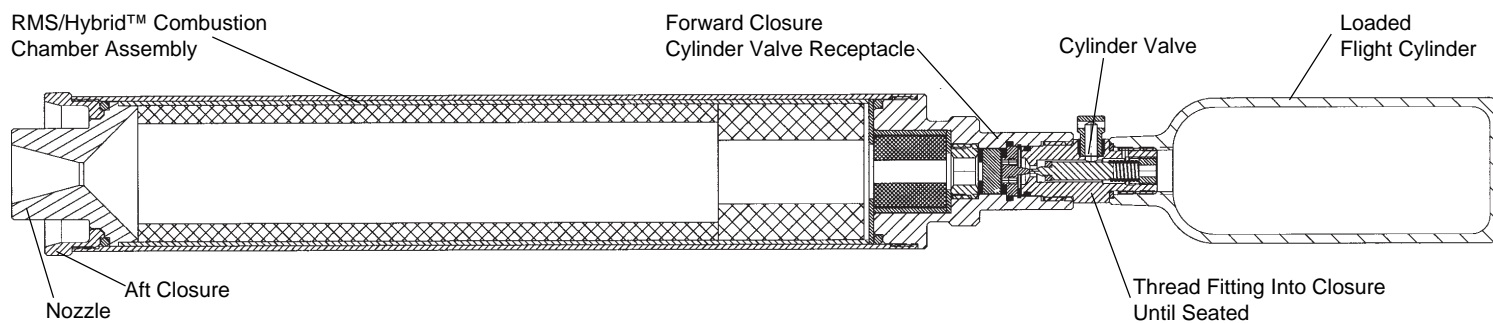
Forward End Motor Assembly

Igniter Installation. NOTE: If necessary, the igniter can be inserted after the motor has been installed in the rocket. This may be performed by slipping a 1/4" diameter or smaller straw over the igniter leads as a support to help guide the igniter to position against the Pyrovalve™ charge. For reference purposes, the distance between the end of the nozzle and the surface of the Pyrovalve™ charge is 13-3/8".

3-12. NOTE: Perform steps 3-12 through 3-15 with the motor held in a horizontal position. Thread the electric match ignition assembly through the nozzle throat until it protrudes beyond the forward end of the motor casing for a distance of about 2 inches.

3-13. Insert the forward insulator (2" O.D. phenolic washer) into the motor case, threaded around the electric match, until it is seated against the end of the liner.

3-14. Place the greased forward (1/8" thick X 2" O.D.) o-ring into the case, threaded around the electric match, seated against the forward insulator.



RMS/Hybrid™ 54/300-900 Motor Assembly With 150cc Flight Cylinder Attached

- 3-15. With the motor case and the previously-completed RMS/Hybrid™ forward closure assembly held facing each other, place the head end of the electric match ignition assembly through the hole in the nitrous oxide preheater charge, through the opening in the Pyrovalve™ retainer screw and against the exposed portion of the Pyrovalve™ charge. A small piece of masking tape or other similar means may be used to hold the igniter in this position if necessary.
- 3-16. Carefully raise the motor to a nozzle-up orientation and slowly thread the forward closure assembly into the open end of the motor case by hand until it is seated against the case. **NOTE:** Ensure that the electric match ignition assembly remains positioned against the Pyrovalve™ charge during this operation.
- 3-17. Continue holding the motor vertically with the nozzle pointing up. Push the vented nozzle cap igniter holder over the nozzle to secure the electric match to the motor.
- 3-18. Finish tightening the aft (gold) closure by hand until it is seated against the case. **NOTE:** There will be moderate resistance to threading in the closure during the last 1/32" to 1/16" of travel. It is normal if a slight gap remains between the closure and the case after tightening.

Chapter 4. Final Motor Assembly & Flight Preparation

NOTE: It is recommended that final motor assembly be performed at the launch pad, immediately prior to flight. The flight cylinder should be at 75 deg. F. +/- 20 deg. F. for best performance and proper motor operation. Use a thermal insulated cooler to store your flight cylinders during extreme temperature situations. Leave the flight cylinders in the cooler until just before you are ready to attach to the motor and install in your rocket. Above 97 deg. F. nitrous oxide transitions to the gas phase regardless of pressure and may result in surging or variable thrust during burn. During cold weather delivered total impulse can be adversely affected. Obtain priority status to launch your rocket within 15 minutes of installation on the launch pad during hot or cold weather conditions.

- 4-1. **CAUTION:** Perform step 4-1 outdoors **ONLY**. Wear leather gloves and approved eye protection during this operation. Pointing the nozzle end of the RMS/Hybrid™ motor away from people, animals, buildings and flammable materials, slowly thread the cylinder valve fitting into the cylinder valve receptacle of the forward closure until a dramatic increase in threading resistance is felt. This increase signals the opening of the cylinder valve and the pressurizing of the forward closure cavities with nitrous oxide. Continue threading the cylinder valve fitting into the RMS/Hybrid™ forward closure cylinder valve receptacle until the valve fitting bottoms out against the forward closure.
- 4-2. Install the RMS/Hybrid™ motor in the rocket's motor mount tube. Ensure that the motor is securely retained in the rocket by using tape around the motor mount tube/aft closure flange joint, a motor hook or other means to prevent it from being ejected during recovery system deployment.
- 4-3. Place the rocket on the launcher and make any other preparations required before hooking up the igniter. Attach the igniter clips to the leads of the electric match ignition assembly and launch the rocket in the approved manner in accordance with the Tripoli safety code

Chapter 5. Misfires

- 5-1. If a misfire occurs and a loaded RMS/Hybrid™ motor does not ignite for any reason within five seconds of pressing the launch button, release the launch button and remove the safety key from the electrical launch controller. **WAIT ONE MINUTE** before approaching or allowing anyone else to approach the vehicle. **CAUTION:** Wear leather gloves and approved eye protection during this operation. Keep your fingers and hands out from underneath the vehicle and away from the possible path of the motor exhaust jet. Do not place any part of your body in front of the vehicle. Disconnect the igniter clip(s) from the electric match or other ignition means. Carefully remove the RMS/Hybrid™ motor from the rocket while still on the launch pad, if possible. Otherwise, remove the rocket from the launch pad and keep it pointed in a safe direction. Keeping the motor nozzle and flight cylinder pointed away from your face and body - and away from any other person's face or body - unthread the flight cylinder from the motor combustion chamber. Remove the igniter, unscrew the RMS/Hybrid™ forward closure, and repeat the motor preparation and launching process.

Chapter 6. Post-Flight Motor Cleanup

NOTE: Perform motor clean-up as soon as possible after motor firing. Fuel combustion residues become difficult to remove after 24 hours and can lead to corrosion of the metal parts. Place the spent motor components in the reload kit plastic bag and dispose of properly.

- 6-1. After the motor has cooled down, remove the flight cylinder and the forward and aft closures. Replace the cylinder valve cap (13/16" I.D.

- red plastic cap) over the cylinder valve fitting. Leave the cap in place until you are ready to load the cylinder for another flight. Store the flight cylinder in a safe place.
- 6-2. Remove the liner, nozzle and forward insulator assembly from the casing by pushing on the nozzle end and discard. Remove and discard the forward and aft o-rings. Using wet wipes or damp paper towels, wipe the inside of the casing to remove all combustion residues.
- 6-3. Remove the nitrous oxide preheater insulator tube and forward insulator washer from the forward closure and discard. Using the Pyrovalve™ hex key wrench, remove the Pyrovalve™ retainer screw from the Pyrovalve™ charge well of the forward closure and set aside. Remove the Pyrovalve™ back-up ring and Pyrovalve™ o-ring from the forward closure and discard. Using wet wipes, damp paper towels and/or a "Chore Boy™" steel wool pad, remove all combustion residue from the forward and aft closures and the Pyrovalve™ retainer screw.
- 6-4. Apply a light coat of petroleum-based grease to casing threads, outer forward and aft closure threads **only** and the inside of the motor case. Reassemble metal parts and store motor in a dry place.

Chapter 7. First Aid

For a minor burn, apply a burn ointment. For a severe burn, immerse the burned area in ice water at once and see a physician as quickly as possible. In the unlikely event of oral ingestion of the igniter propellant or Pyrovalve™ element, induce vomiting and see a physician as quickly as possible. The AeroTech RMS/Hybrid™ N₂O/fuel preheater composite propellant contains ammonium perchlorate and a rubber like plastic elastomer. The Pyrovalve™ pellet consists of black powder.

Chapter 8. Disposal

Damaged or defective reload kits should be returned to AeroTech™.

Chapter 9. Fire Safety

Tests show that the pyrotechnic ignition components of RMS/Hybrid™ reload kits will not explode in fires and normally will not ignite unless subjected to direct flame and then will burn slowly. Use water to fight fires in which AeroTech™ RMS/Hybrid™ reload kit pyrotechnic components may become involved: direct the water at the AeroTech™ RMS/Hybrid™ reload kit pyrotechnic components to keep them below their 550 deg. F autoignition temperature. Foam and carbon dioxide fire extinguishers will NOT extinguish burning propellants of the type used in AeroTech™ RMS/Hybrid™ reload kit pyrotechnic components. Keep filled nitrous oxide cylinders away from flames, sources of heat and flammable materials.

Disclaimer and Warranty

NOTICE: AeroTech™ certifies that it has exercised reasonable care in the design and manufacture of its products. As we cannot control the storage and use of our products, once sold we cannot assume any responsibility for product storage, transportation or usage. AeroTech™ shall not be held responsible for any personal injury or property damage resulting from the handling, storage or use of our product. The buyer assumes all risks and liabilities therefrom and accepts and uses AeroTech™ products on these conditions. No warranty either expressed or implied is made regarding AeroTech™ products, except for replacement or repair, at AeroTech's™ option, of those products which are proven to be defective in manufacture within one year from the date of original purchase. For repair or replacement under this warranty, please contact AeroTech™. Proof of purchase will be required. Note: Your state may provide additional rights not covered by this warranty.



AeroTech™, Inc. Las Vegas, NV 89104

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Premier Edition

RMS/HYBRID™

HIGH-POWER Reloadable Motor System™ Products

RMS/HYBRID™ 54mm Igniter Parts Kit Assembly and Operation Instructions



THIS PACKAGE CONTAINS ONE IGNITER PARTS KIT FOR ALL RMS/HYBRID™ 54MM MOTORS

This igniter parts kit is intended **ONLY** for use in AeroTech RMS/Hybrid™ 54mm High-Power motors.

Contains 1 each Pyrovalve™ element, Pyrovalve™ o-ring, Pyrovalve™ teflon separator disk, Pyrovalve™ back-up washer, N₂O preheater charge, N₂O preheater forward insulator, N₂O preheater insulator and electric match initiator.

NOTICE: RMS/HYBRID™ MOTORS DO NOT INCLUDE A DELAY OR EJECTION CHARGE. RMS/HYBRID™ MOTORS MUST BE USED IN CONJUNCTION WITH A TIMER, ALTIMETER OR RADIO ACTUATED RECOVERY SYSTEM.

NOTE: SALE TO PERSONS UNDER 18 YEARS OF AGE PROHIBITED BY FEDERAL LAW. WARNING-FLAMMABLE: Read Instructions Before Use. KEEP OUT OF REACH OF CHILDREN. FOR USE ONLY BY CERTIFIED HIGH-POWER USERS 18 YEARS OF AGE OR OLDER. DO NOT SMOKE when loading these motors or use in the vicinity of open flames.