

Hybrid Rocket Competition Operations Manual

Team 07

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1. Launch Items

1.1. Launch Pad

Step 1: Materials Check

Ensure you have all materials required to construct the launch pad. These include 3x PVC legs and 1x PVC joiner that is connected to 1x launch rail and 1x deflector, please see figure 1. If the deflector, launch rail and PVC joiner is not connected as one, assemble this first as shown in figure 1 now.

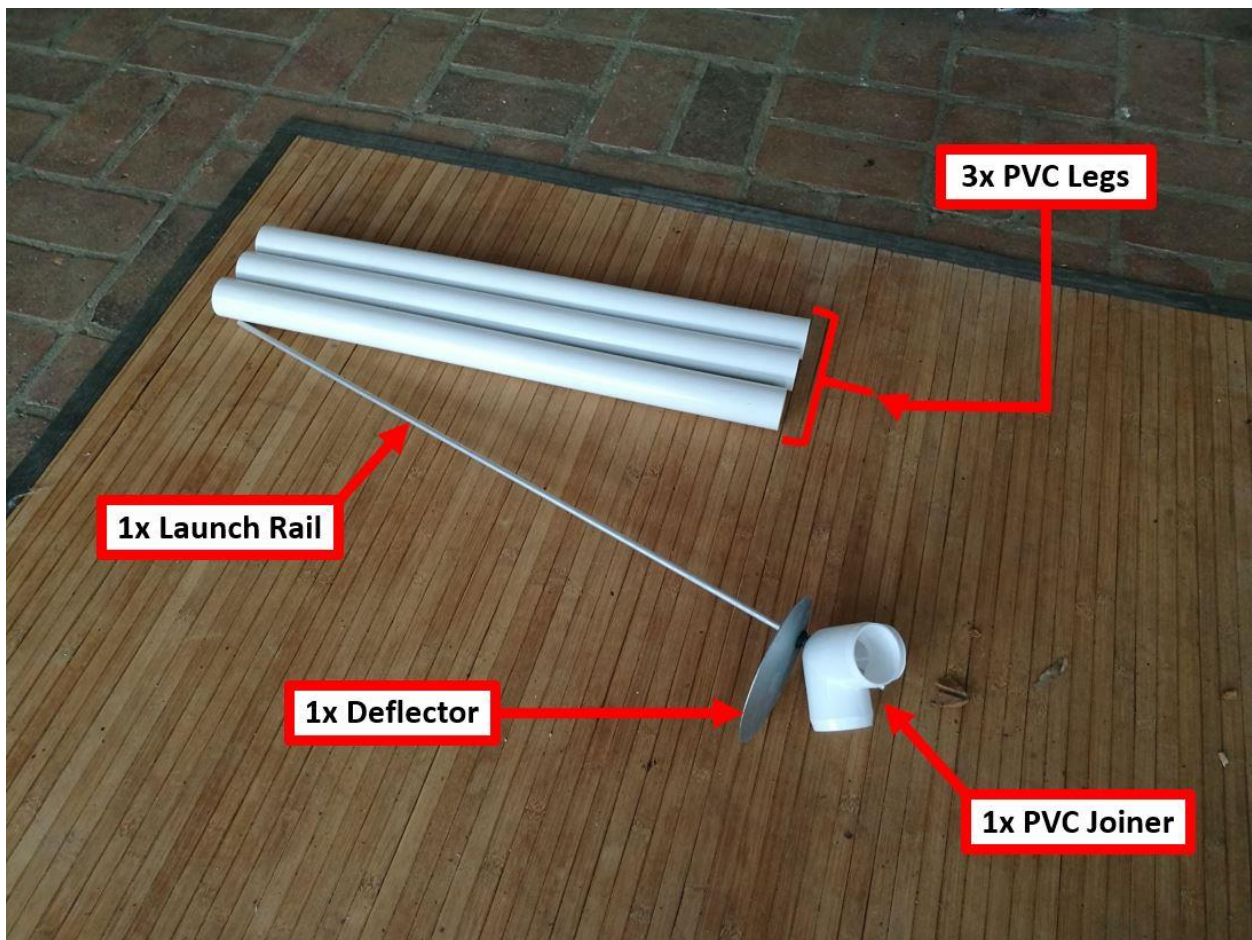


Figure 1. Display of all materials required to assemble and prepare launch pad.

Step 2: Assembly

Insert one PVC leg in to the PVC Joiner at a time. This is shown in figure 2.

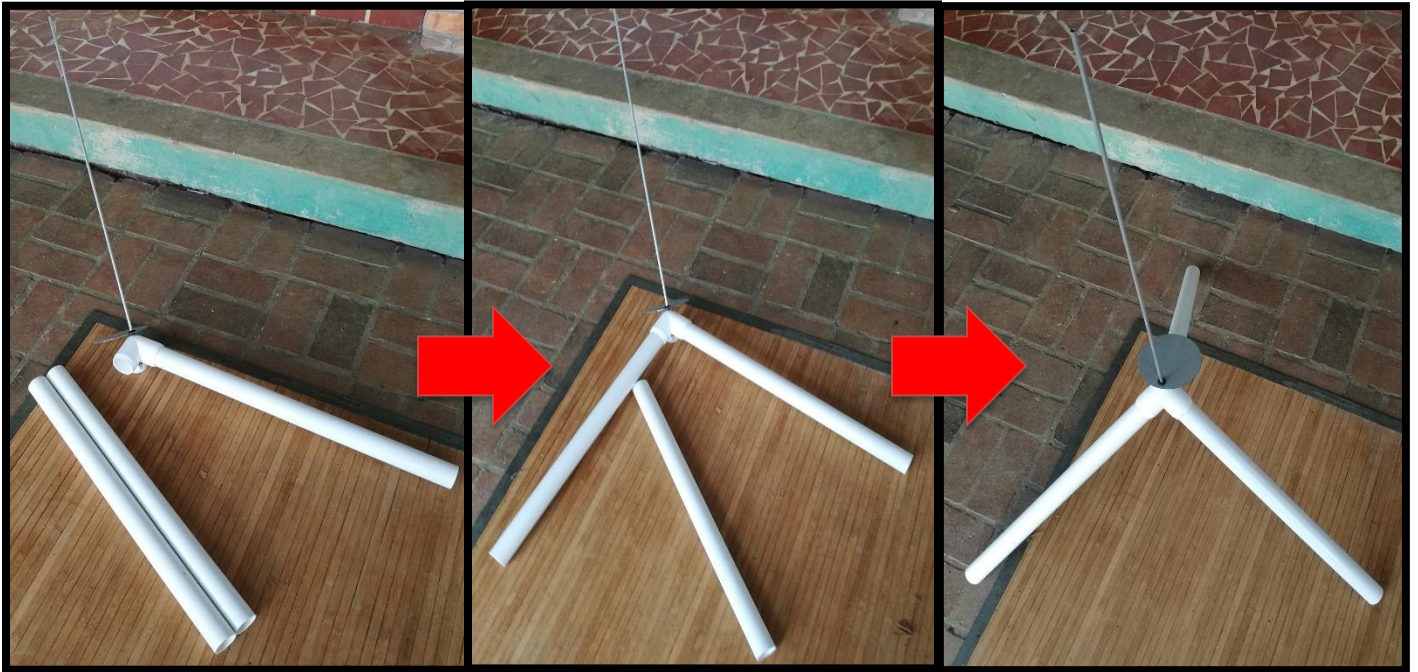
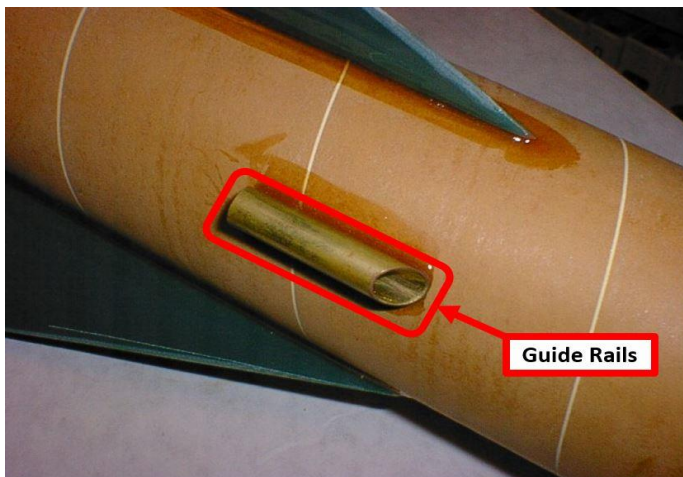


Figure 2. Step-by-step assembly of launch pad.

Step 3: Mounting

Mount the rocket on the launch pad. This is done by sliding the launch rail through the rocket's guide rails and allowing the rocket to fall comfortably to the bottom of the launch rail, see figure 3 for an example of a rocket's guide rails. Ensure that the deflector dish is located directly beneath the rocket motor to ensure the rest of the launch pad is undamaged during launch. See figure 4 for an example of a mounted rocket on a launch pad.



Figures 3. and 4. Example of a rocket's guide rails and an example of mounted rocket on a launch pad respectively.

1.2. Nitrous Oxide Setup

Step 1: Safety Check

One of the fuels for the motor is Nitrous Oxide. Ensure all safety guidelines and precautions are followed when handling the Nitrous Oxide. It is very important to follow all safety guidelines regarding this material and to correctly handle it. For more information in regards to the safety of Nitrous Oxide please see pages 12-23 for its data sheet. Most notably, Nitrous Oxide itself is not flammable but if exposed to a fire, the nitrous oxide can greatly increase the intensity of the flame. Additionally, Nitrous Oxide is kept in a highly pressurized container.

Step 2: Assembly of Fueling System

The pressurized container is used to fill the rocket with the oxidizer, Nitrous Oxide. This must be done from a distance of at least 100 feet from the rocket per motor manual. A standard brass valve is on the top of the pressurized container which will be connected to a pressure regulator. This regulator must be rated to appropriate pressures and must be connected to this valve to ensure the rocket motor is filled to the correct amount of pressure. This pressure regulator is then connected to the 100 feet of hosing with a barb and clamp connection. See figure 5 for a display of this set up. The other end of hose the hose must be connected to the single-use fill lines on the rocket motor.

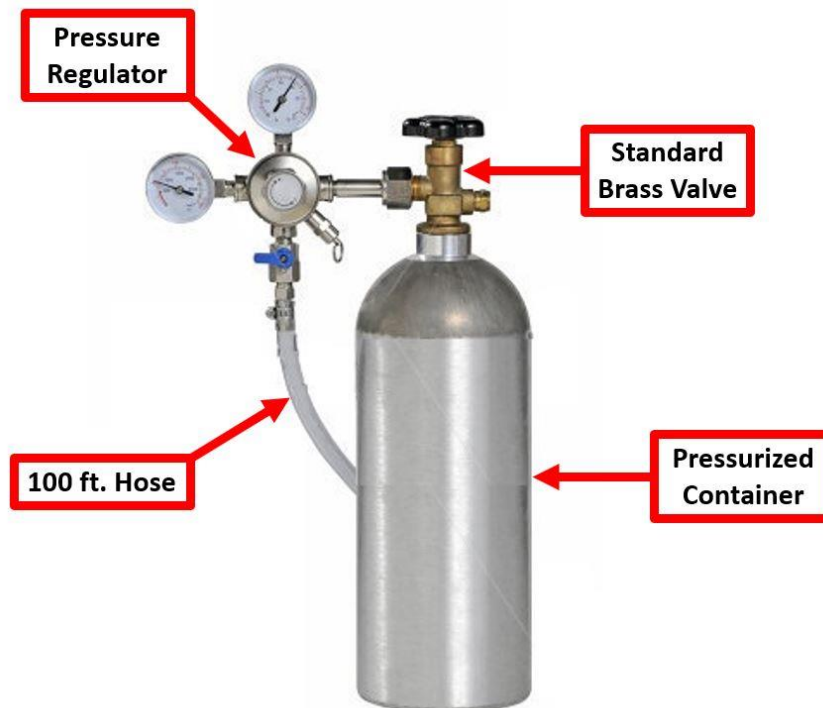


Figure 5. Display of assembled oxidizer (Nitrous Oxide) fueling system.

Step 3: Fueling

Before fueling, make sure the valve and regulators are fully closed and that all fittings and connections in the fueling system are tight and correctly fitted. Slowly turn the valve on top of the Nitrous Oxide cylinder to allow the gas to flow from the tank to the regulator. Next, slowly turn the regulator to allow the gas to flow from the tank through the regulator to the motor. Adjust the regulator to allow a pressure range of 550 to 900 psi in the motor per motor manual. It is recommended to fill the motor to roughly 750 psi. Read the pressure gauge on the regulator to know when the required pressure has been reached. Close the brass valve and then the regulator. Ensure these are fully closed. The rocket is now fueled and ready to be launched.

1.3. Ignition

Step 1: Igniter System Assembly

To ignite the motor, the igniter that lies in the motor must have a potential voltage applied to it. Ensure you have all components to the igniter system: 2x 300 feet of wiring, 1x 2-step switch and 3x 9 Volt batteries. Connect one end of each of the 300 feet long wires to the two wire leads at the end of the igniter. To keep a distance of 300 feet from the rocket when launching, as per Hybrid Rocket Competition Regulations, trail the two wires 300 feet away from the rocket. Connect a 2-step switch in the wire line near the end away from the rocket. Ensure that this switch is in the OFF position until ready to launch. See figure 6 for a diagram of this setup.

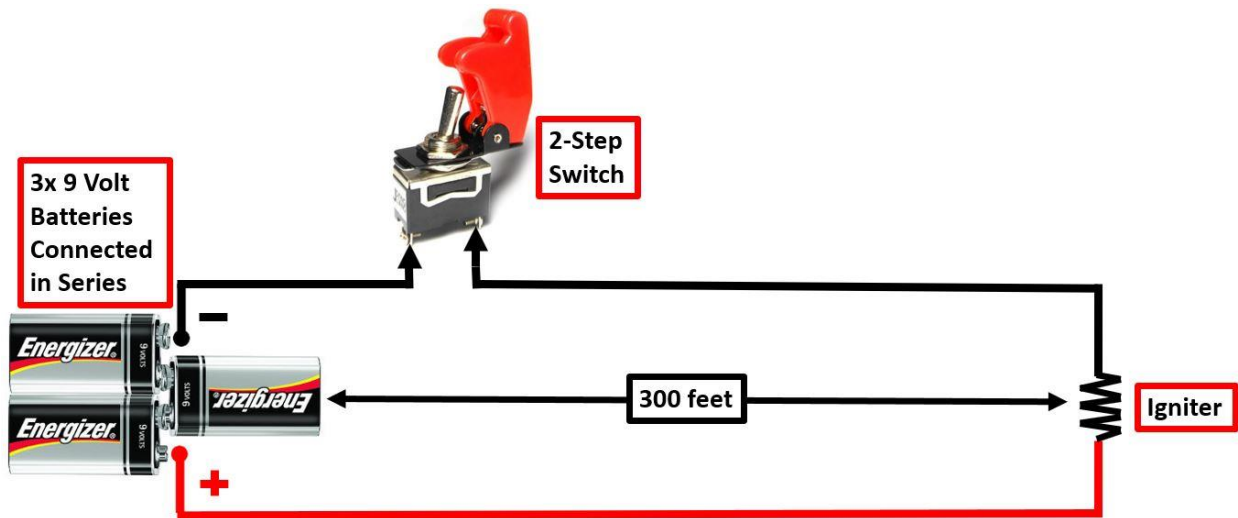


Figure 6. A diagram of the igniter assembly displaying its components and its arrangement.

Step 2: Ignition

When ready to launch the rocket, first turn the switch in line with one of the wires to the ON position. Connect the 3x 9 Volt batteries in series. Connect the two loose wire leads to each of the exposed terminals of the 9 Volt batteries. This will apply a voltage difference great enough to the igniter to ignite and start the motor.

2. Data analysis

Step 1: Software Acquisition

The data to be analyzed will be recorded during flight. In order to begin recording data, a connection between a computer and the Easy Mini must be made. After flight, the data will be analyzed by interfacing with the Easy Mini after it is removed from the electronics bay from the rocket. Download the AltosUi to have access to the device. The software is free and is compatible with both mac and windows.

Step 2: Connection

Connect the positive and negative ends of the 9 Volt battery pack to the positive and negative ends indicated on the Easy Mini. Attach a micro USB cable from the Easy Mini to your computer via a USB port.

Step 3: Data Recording (Pre-Flight)

After connection, a user interface will open; select “Monitor Flight” and click on the appropriate module to begin recording. See figure 7 for a display of the user interface.



Figure 7. User interface highlighting the “Monitor Flight” button.

Step 3: Data Analysis (Post-Flight)

After the flight occurs reconnect the Easy Mini to the rocket. The user interface will appear again. Click on the “Save Flight Data” button and the data will begin to import. Then, click on “Load Maps” and browse your computer to upload the flight data. After this, click on “Graph Data” to display the data gathered from the altimeter during the recording period. See figure 8 for an example of some graphed data.



Figure 8. Example of a graph displaying numerous data sets

Step 3: Apogee Display

If you wish to display the maximum height reached by your rocket (apogee), click on the “Flight Statistics” tab and it will appear on the graph. See figure 9 for a screenshot of the “Flight Statistics” tab.

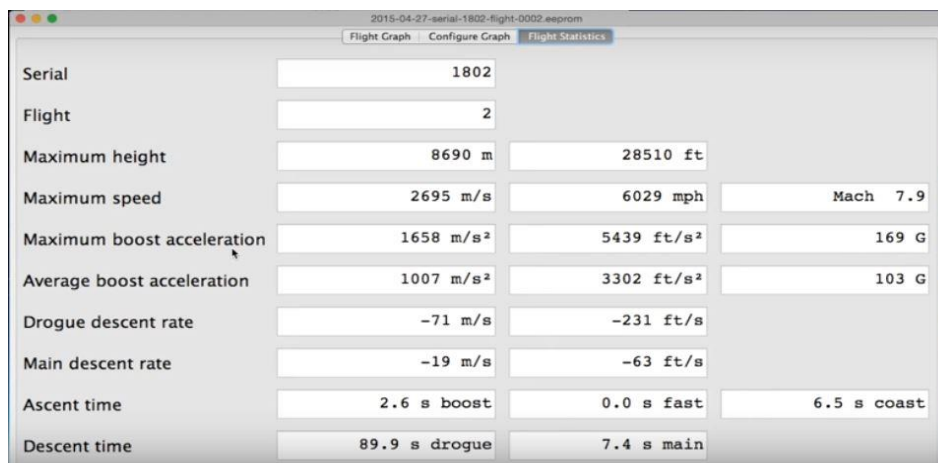


Figure 9. A screenshot of the “Flight Statistics” tab for a given example data set.

For more information regarding the software for the Easy Mini, please visit the following website: <https://www.apogeerockets.com/Electronics-Payloads/Dual-Deployment/EasyMini>.

3. Refueling and Replacement

3.1. Motor Refueling and Igniter Replacement

Step 1: Disassembly of Rocket

After a launch of the rocket, the motor requires its solid fuel grain, PVC, to be replaced. Please refer to the 38mm Hybrid Rocket Motor Reload Instruction Manual on pages 24-35 for details of the construction of the rocket to understand how to disassemble the motor.

Step 2: PVC Replacement

Replace the used PVC with a new PVC reload. Please refer to the 38mm Hybrid Rocket Motor Reload Instruction Manual on pages 24-35 for details on how to do this.

Step 3: Igniter Replacement

An igniter is a one-time-use only piece of equipment and will only spark ignition once and so must be replaced with each flight. Replace the used igniter with a new igniter. Please refer to the 38mm Hybrid Rocket Motor Reload Instruction Manual for details on how to do this.

3.2. Ejector Cap Replacement

Step 1: Ejector Cap Cleaning

For a successful ejection from the rocket of the drogue and parachute, ejector caps that store black powder are ignited. This black powder is used to pressurize the cabins, but is used up in the process. See figure 10 for a view of the ejector caps. To prepare the rocket for launch again these need to be replaced. remove the remnants of the previous ejection canisters and thoroughly clean the surface of the bulkhead. This ensures that future installations will not be jeopardized due to debris or improper mounting. If the ejector caps have not already been rigidly attached to the bulkhead of the coupler from before, instructions for this attachment is described in step 2.



Figure 10: A display of empty ejector caps, mounting screws and their mounting nuts.

Step 2: Attachment of Ejector Caps to Coupler

Bore the center of each ejector cap with a #51 drill bit. This ensures that the mounting screw will fit snugly and will not allow for any slack once the canister is mounted. Next, thread the mounting screw through both the ejection cap and the bulkhead of the coupler with the open face of the cap facing outwards. This will allow the gases to expand out into the body of the rocket. After the screw is completely through, use the included nut to secure the cap to the bulkhead. Apply epoxy onto the screw where the nut is fastened to prevent it from coming undone, see figure 11. Once the epoxy has dried up the ejection cap will be ready to be loaded with the black powder and primed for launch.

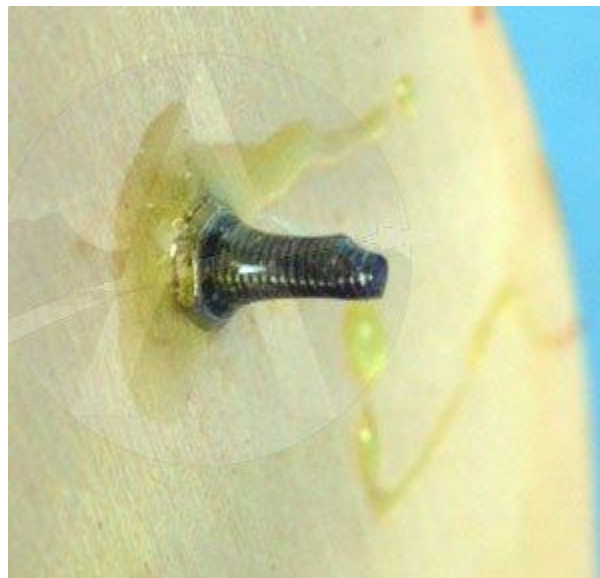


Figure 11: Epoxy applied onto the screw

Step 3: Ejector Cap Refill

Ensure the ejector caps are empty and then pour black powder in the caps until they are full. To prevent black powder from spilling out of the caps, simply seal/cover them with a piece of masking tape.

4. References

- https://www.apogeerockets.com/Launch_Accessories/Launch_Pads/Pro_Series_II_Launch_Pad?zenid=5ng2jocug3f1np591odkpa9905
- <http://simpletruths.me.uk/?p=23>
- <https://www.shutterstock.com/editor/image/pressure-tank-regulator-gauges-isolated-on-133995494>
- http://www.aircommandrockets.com/rocket_launcher.htm
- <https://www.aliexpress.com/item/Joying-Liang-Car-Switch-Racing-Car-Switch-with-Protective-Cover-12V-24V-110V-220V-2-feet/32822726897.html>
- https://www.apogeerockets.com/Ejection_Systems/Ejection_Canisters/Ejection_Canister_Caps_2_pk
- <http://www.contrailrockets.com/documents.htm>
- <http://www.praxair.com/-/media/documents/sds/medipure-liquid-nitrous-oxide-n2o-safety-data-sheet-sds-p6226.pdf?la=en>

SAFETY DATA SHEET

Nitrous Oxide

Section 1. Identification

GHS product identifier	: Nitrous Oxide
Chemical name	: Nitrous Oxide
Other means of identification	: Nitrogen oxide; Nitrous oxide; Laughing gas; Hyponitrous acid anhydride; Dinitrogen monoxide; NITROGEN OXIDE (N2O); Nitrogen monoxide; Hyponitrous oxide
Product type	: Gas.
Product use	: Synthetic/Analytical chemistry.
Synonym	: Nitrogen oxide; Nitrous oxide; Laughing gas; Hyponitrous acid anhydride; Dinitrogen monoxide; NITROGEN OXIDE (N2O); Nitrogen monoxide; Hyponitrous oxide
SDS #	: 001042
Supplier's details	: Airgas USA, LLC and its affiliates 259 North Radnor-Chester Road Suite 100 Radnor, PA 19087-5283 1-610-687-5253
24-hour telephone	: 1-866-734-3438

Section 2. Hazards identification

OSHA/HCS status	: This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).
Classification of the substance or mixture	: OXIDIZING GASES - Category 1 GASES UNDER PRESSURE - Liquefied gas SPECIFIC TARGET ORGAN TOXICITY (SINGLE EXPOSURE) (Narcotic effects) - Category 3

GHS label elements

Hazard pictograms



Signal word : Danger

Hazard statements : May cause or intensify fire; oxidizer.
Contains gas under pressure; may explode if heated.
May displace oxygen and cause rapid suffocation.
May cause drowsiness or dizziness.

Precautionary statements

General

: Read and follow all Safety Data Sheets (SDS'S) before use. Read label before use. Keep out of reach of children. If medical advice is needed, have product container or label at hand. Close valve after each use and when empty. Use equipment rated for cylinder pressure. Do not open valve until connected to equipment prepared for use. Use a back flow preventative device in the piping. Use only equipment of compatible materials of construction. Open valve slowly. Use only with equipment cleaned for Oxygen service. Always keep container in upright position.

Prevention

: Keep away from clothing, incompatible materials and combustible materials. Keep reduction valves, valves and fittings free from oil and grease. Use only outdoors or in a well-ventilated area. Avoid breathing gas.

Response

: In case of fire: Stop leak if safe to do so. IF INHALED: Remove person to fresh air and keep comfortable for breathing. Call a POISON CENTER or physician if you feel unwell.

Storage

: Store locked up. Protect from sunlight. Store in a well-ventilated place.

Section 2. Hazards identification

- Disposal** : Dispose of contents and container in accordance with all local, regional, national and international regulations.
- Hazards not otherwise classified** : In addition to any other important health or physical hazards, this product may displace oxygen and cause rapid suffocation.

Section 3. Composition/information on ingredients

- Substance/mixture** : Substance
- Chemical name** : Nitrous Oxide
- Other means of identification** : Nitrogen oxide; Nitrous oxide; Laughing gas; Hyponitrous acid anhydride; Dinitrogen monoxide; NITROGEN OXIDE (N₂O); Nitrogen monoxide; Hyponitrous oxide
- Product code** : 001042

CAS number/other identifiers

- CAS number** : 10024-97-2

Ingredient name	%	CAS number
nitrous oxide	100	10024-97-2

Any concentration shown as a range is to protect confidentiality or is due to batch variation.

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in Section 8.

Section 4. First aid measures

Description of necessary first aid measures

- Eye contact** : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Continue to rinse for at least 10 minutes. Get medical attention.
- Inhalation** : Remove victim to fresh air and keep at rest in a position comfortable for breathing. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Get medical attention. If necessary, call a poison center or physician. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband. In case of inhalation of decomposition products in a fire, symptoms may be delayed. The exposed person may need to be kept under medical surveillance for 48 hours.
- Skin contact** : Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. Get medical attention if symptoms occur. Wash clothing before reuse. Clean shoes thoroughly before reuse.
- Ingestion** : As this product is a gas, refer to the inhalation section.

Most important symptoms/effects, acute and delayed

Potential acute health effects

- Eye contact** : No known significant effects or critical hazards.
- Inhalation** : Can cause central nervous system (CNS) depression. May cause drowsiness or dizziness.
- Skin contact** : No known significant effects or critical hazards.
- Frostbite** : Try to warm up the frozen tissues and seek medical attention.
- Ingestion** : Can cause central nervous system (CNS) depression. As this product is a gas, refer to the inhalation section.

Over-exposure signs/symptoms

- Eye contact** : No specific data.

Section 4. First aid measures

- Inhalation** : Adverse symptoms may include the following: nausea or vomiting, headache, drowsiness/fatigue, dizziness/vertigo, unconsciousness
- Skin contact** : No specific data.
- Ingestion** : No specific data.

Indication of immediate medical attention and special treatment needed, if necessary

- Notes to physician** : In case of inhalation of decomposition products in a fire, symptoms may be delayed. The exposed person may need to be kept under medical surveillance for 48 hours.
- Specific treatments** : No specific treatment.
- Protection of first-aiders** : No action shall be taken involving any personal risk or without suitable training. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation.

See toxicological information (Section 11)

Section 5. Fire-fighting measures

Extinguishing media

- Suitable extinguishing media** : Use an extinguishing agent suitable for the surrounding fire.
- Unsuitable extinguishing media** : None known.

Specific hazards arising from the chemical : Contains gas under pressure. Oxidizing material. This material increases the risk of fire and may aid combustion. Contact with combustible material may cause fire. In a fire or if heated, a pressure increase will occur and the container may burst or explode.

Hazardous thermal decomposition products : Decomposition products may include the following materials:
nitrogen oxides

Special protective actions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training. Contact supplier immediately for specialist advice. Move containers from fire area if this can be done without risk. Use water spray to keep fire-exposed containers cool. If involved in fire, shut off flow immediately if it can be done without risk.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

- For non-emergency personnel** : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Shut off all ignition sources. No flares, smoking or flames in hazard area. Avoid breathing gas. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.
- For emergency responders** : If specialized clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

Environmental precautions : Ensure emergency procedures to deal with accidental gas releases are in place to avoid contamination of the environment. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Methods and materials for containment and cleaning up

- Small spill** : Immediately contact emergency personnel. Stop leak if without risk. Use spark-proof tools and explosion-proof equipment.

Section 6. Accidental release measures

- Large spill** : Immediately contact emergency personnel. Stop leak if without risk. Use spark-proof tools and explosion-proof equipment. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

Section 7. Handling and storage

Precautions for safe handling

- Protective measures** : Put on appropriate personal protective equipment (see Section 8). Contains gas under pressure. Avoid breathing gas. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Do not puncture or incinerate container. Use equipment rated for cylinder pressure. Close valve after each use and when empty. Protect cylinders from physical damage; do not drag, roll, slide, or drop. Use a suitable hand truck for cylinder movement.
Avoid contact with eyes, skin and clothing. Empty containers retain product residue and can be hazardous. Keep away from clothing, incompatible materials and combustible materials. Keep reduction valves free from grease and oil.

- Advice on general occupational hygiene** : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

- Conditions for safe storage, including any incompatibilities** : Store in accordance with local regulations. Store in a segregated and approved area. Store away from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10). Cylinders should be stored upright, with valve protection cap in place, and firmly secured to prevent falling or being knocked over. Cylinder temperatures should not exceed 52 °C (125 °F). Store locked up. Separate from reducing agents and combustible materials. Store away from grease and oil. Keep container tightly closed and sealed until ready for use. See Section 10 for incompatible materials before handling or use.

Section 8. Exposure controls/personal protection

Control parameters

Occupational exposure limits

Ingredient name	Exposure limits
nitrous oxide	ACGIH TLV (United States, 3/2017). TWA: 90 mg/m ³ 8 hours. TWA: 50 ppm 8 hours. NIOSH REL (United States, 10/2016). TWA: 46 mg/m ³ 10 hours. TWA: 25 ppm 10 hours.

- Appropriate engineering controls** : Use only with adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits.

- Environmental exposure controls** : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Individual protection measures

- Hygiene measures** : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Section 8. Exposure controls/personal protection

- Eye/face protection** : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists, gases or dusts. If contact is possible, the following protection should be worn, unless the assessment indicates a higher degree of protection: safety glasses with side-shields.
- Skin protection**
- Hand protection** : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.
- Body protection** : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.
- Other skin protection** : Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.
- Respiratory protection** : Based on the hazard and potential for exposure, select a respirator that meets the appropriate standard or certification. Respirators must be used according to a respiratory protection program to ensure proper fitting, training, and other important aspects of use. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

Section 9. Physical and chemical properties

Appearance

- Physical state** : Gas. [Compressed gas.]
- Color** : Colorless.
- Odor** : Characteristic.
- Odor threshold** : Not available.
- pH** : Not available.
- Melting point** : -90.8°C (-131.4°F)
- Boiling point** : -88.5°C (-127.3°F)
- Critical temperature** : 36.55°C (97.8°F)
- Flash point** : [Product does not sustain combustion.]
- Evaporation rate** : Not available.
- Flammability (solid, gas)** : Extremely flammable in the presence of the following materials or conditions: reducing materials and combustible materials.
- Lower and upper explosive (flammable) limits** : Not available.
- Vapor pressure** : 745 (psig)
- Vapor density** : 1.53 (Air = 1) Liquid Density@BP: 76.8 lb/ft³ (1230 kg/m³)
- Specific Volume (ft³/lb)** : 8.6957
- Gas Density (lb/ft³)** : 0.115
- Relative density** : Not applicable.
- Solubility** : Not available.
- Solubility in water** : 1.2 g/l
- Partition coefficient: n-octanol/water** : 0.36
- Auto-ignition temperature** : Not available.
- Decomposition temperature** : Not available.
- Viscosity** : Not applicable.
- Flow time (ISO 2431)** : Not available.

Section 9. Physical and chemical properties

Molecular weight : 44.01 g/mole

Section 10. Stability and reactivity

- Reactivity** : No specific test data related to reactivity available for this product or its ingredients.
- Chemical stability** : The product is stable.
- Possibility of hazardous reactions** : Hazardous reactions or instability may occur under certain conditions of storage or use.
Conditions may include the following:
contact with combustible materials
Reactions may include the following:
risk of causing fire
- Conditions to avoid** : No specific data.
- Incompatible materials** : Highly reactive or incompatible with the following materials:
combustible materials
reducing materials
grease
oil
- Hazardous decomposition products** : Under normal conditions of storage and use, hazardous decomposition products should not be produced.
- Hazardous polymerization** : Under normal conditions of storage and use, hazardous polymerization will not occur.

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity

Not available.

Irritation/Corrosion

Not available.

Sensitization

Not available.

Mutagenicity

Not available.

Carcinogenicity

Not available.

Classification

Product/ingredient name	OSHA	IARC	NTP
nitrous oxide	-	3	-

Reproductive toxicity

Not available.

Teratogenicity

Not available.

Specific target organ toxicity (single exposure)

Section 11. Toxicological information

Name	Category	Route of exposure	Target organs
nitrous oxide	Category 3	Not applicable.	Narcotic effects

Specific target organ toxicity (repeated exposure)

Not available.

Aspiration hazard

Not available.

Information on the likely routes of exposure : Not available.

Potential acute health effects

Eye contact : No known significant effects or critical hazards.

Inhalation : Can cause central nervous system (CNS) depression. May cause drowsiness or dizziness.

Skin contact : No known significant effects or critical hazards.

Ingestion : Can cause central nervous system (CNS) depression. As this product is a gas, refer to the inhalation section.

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact : No specific data.

Inhalation : Adverse symptoms may include the following: nausea or vomiting, headache, drowsiness/fatigue, dizziness/vertigo, unconsciousness

Skin contact : No specific data.

Ingestion : No specific data.

Delayed and immediate effects and also chronic effects from short and long term exposure

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Potential chronic health effects

Not available.

General : No known significant effects or critical hazards.

Carcinogenicity : No known significant effects or critical hazards.

Mutagenicity : No known significant effects or critical hazards.

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

Numerical measures of toxicity

Acute toxicity estimates

Not available.

Section 12. Ecological information

Toxicity

Not available.

Persistence and degradability

Not available.

Bioaccumulative potential

Product/ingredient name	LogP _{ow}	BCF	Potential
nitrous oxide	0.36	-	low

Mobility in soil



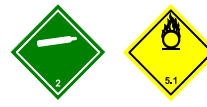
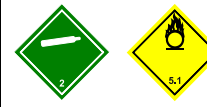
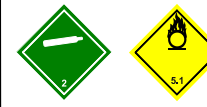
Soil/water partition coefficient (K_{oc}) : Not available.

Other adverse effects : No known significant effects or critical hazards.

Section 13. Disposal considerations

Disposal methods : The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Empty Airgas-owned pressure vessels should be returned to Airgas. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Empty containers or liners may retain some product residues. Do not puncture or incinerate container.

Section 14. Transport information

	DOT	TDG	Mexico	IMDG	IATA
UN number	UN1070	UN1070	UN1070	UN1070	UN1070
UN proper shipping name	NITROUS OXIDE	NITROUS OXIDE	NITROUS OXIDE	NITROUS OXIDE	NITROUS OXIDE
Transport hazard class(es)	2.2 (5.1) 	2.2 (5.1) 	2.2 (5.1) 	2.2 (5.1) 	2.2 (5.1) 
Packing group	-	-	-	-	-
Environmental hazards	No.	No.	No.	No.	No.

“Refer to CFR 49 (or authority having jurisdiction) to determine the information required for shipment of the product.”

Additional information

DOT Classification : **Limited quantity** Yes.
Quantity limitation Passenger aircraft/rail: 75 kg. Cargo aircraft: 150 kg.

Section 14. Transport information

- TDG Classification** : Product classified as per the following sections of the Transportation of Dangerous Goods Regulations: 2.13-2.17 (Class 2), 2.23-2.25 (Class 5).
Explosive Limit and Limited Quantity Index 0
ERAP Index 3000
Passenger Carrying Ship Index 450
Passenger Carrying Road or Rail Index 75
- IATA** : **Quantity limitation** Passenger and Cargo Aircraft: 75 kg. Cargo Aircraft Only: 150 kg.
- Special precautions for user** : **Transport within user's premises:** always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.
- Transport in bulk according to Annex II of MARPOL and the IBC Code** : Not available.

Section 15. Regulatory information

- U.S. Federal regulations** : **TSCA 8(a) CDR Exempt/Partial exemption:** Not determined

Clean Air Act Section 112 (b) Hazardous Air Pollutants (HAPs) : Not listed

Clean Air Act Section 602 Class I Substances : Not listed

Clean Air Act Section 602 Class II Substances : Not listed

DEA List I Chemicals (Precursor Chemicals) : Not listed

DEA List II Chemicals (Essential Chemicals) : Not listed

SARA 302/304

Composition/information on ingredients

No products were found.

SARA 304 RQ : Not applicable.

SARA 311/312

Classification : Refer to Section 2: Hazards Identification of this SDS for classification of substance.

State regulations

Massachusetts : This material is listed.

New York : This material is not listed.

New Jersey : This material is listed.

Pennsylvania : This material is listed.

California Prop. 65

⚠ WARNING: This product can expose you to Nitrous oxide, which is known to the State of California to cause birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov.

Ingredient name	No significant risk level	Maximum acceptable dosage level
Nitrous oxide	-	-

International regulations

Chemical Weapon Convention List Schedules I, II & III Chemicals

Section 15. Regulatory information

Not listed.

[Montreal Protocol \(Annexes A, B, C, E\)](#)

Not listed.

[Stockholm Convention on Persistent Organic Pollutants](#)

Not listed.

[Rotterdam Convention on Prior Informed Consent \(PIC\)](#)

Not listed.

[UNECE Aarhus Protocol on POPs and Heavy Metals](#)

Not listed.

[Inventory list](#)

Australia	: This material is listed or exempted.
Canada	: This material is listed or exempted.
China	: This material is listed or exempted.
Europe	: This material is listed or exempted.
Japan	: Japan inventory (ENCS) : This material is listed or exempted. Japan inventory (ISHL) : Not determined.
Malaysia	: Not determined.
New Zealand	: This material is listed or exempted.
Philippines	: This material is listed or exempted.
Republic of Korea	: This material is listed or exempted.
Taiwan	: This material is listed or exempted.
Thailand	: Not determined.
Turkey	: Not determined.
United States	: This material is listed or exempted.
Viet Nam	: Not determined.

Section 16. Other information

[Hazardous Material Information System \(U.S.A.\)](#)

Health	/	1
Flammability		0
Physical hazards		3

Caution: HMIS® ratings are based on a 0-4 rating scale, with 0 representing minimal hazards or risks, and 4 representing significant hazards or risks. Although HMIS® ratings and the associated label are not required on SDSs or products leaving a facility under 29 CFR 1910.1200, the preparer may choose to provide them. HMIS® ratings are to be used with a fully implemented HMIS® program. HMIS® is a registered trademark and service mark of the American Coatings Association, Inc.

The customer is responsible for determining the PPE code for this material. For more information on HMIS® Personal Protective Equipment (PPE) codes, consult the HMIS® Implementation Manual.

[National Fire Protection Association \(U.S.A.\)](#)



Section 16. Other information

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Copyright ©2001, National Fire Protection Association, Quincy, MA 02269. This warning system is intended to be interpreted and applied only by properly trained individuals to identify fire, health and reactivity hazards of chemicals. The user is referred to certain limited number of chemicals with recommended classifications in NFPA 49 and NFPA 325, which would be used as a guideline only. Whether the chemicals are classified by NFPA or not, anyone using the 704 systems to classify chemicals does so at their own risk.

Procedure used to derive the classification

Classification	Justification
OXIDIZING GASES - Category 1	Expert judgment
GASES UNDER PRESSURE - Liquefied gas	Expert judgment
SPECIFIC TARGET ORGAN TOXICITY (SINGLE EXPOSURE) (Narcotic effects) - Category 3	Expert judgment

History

Date of printing : 1/31/2018

Date of issue/Date of revision : 1/31/2018

Date of previous issue : 2/11/2016

Version : 0.04

Key to abbreviations :

- ATE = Acute Toxicity Estimate
- BCF = Bioconcentration Factor
- GHS = Globally Harmonized System of Classification and Labelling of Chemicals
- IATA = International Air Transport Association
- IBC = Intermediate Bulk Container
- IMDG = International Maritime Dangerous Goods
- LogPow = logarithm of the octanol/water partition coefficient
- MARPOL = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
- UN = United Nations

References : Not available.

☑ Indicates information that has changed from previously issued version.

Notice to reader

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.

Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.



Contrail Rockets

38mm Hybrid Rocket Motor

Reload

Instruction Manual

Congratulations on your purchase of a Contrail Rockets 38mm Hybrid Reload. The supplied motor reloads have been designed to operate in Contrail Rockets Hardware only. Before you begin assembly of this reload, please read through this manual and familiarize yourself with the steps. If you have any questions please contact Contrail Rockets.

Included With this Reload Package is:

Quantity	Item Name
3	Fuel Grains
3	Press-Lock Injectors (User Selected At Time of Purchase)
3	Igniters
3	Nylon Fill Lines (User Selected At Time of Purchase)
3	O-Rings (Size 215)
1	1/8 Inch Vent Line (Clear)
1	Instruction Manual

Not Included With this Reload Package is:

Snap Ring Pliers

Krytox™ Oxygen Safe Grease

Synthetic Type Grease (Mobile 1 Synthetic or Similar Recommended)

Pyrodex Pellets (Muzzle Loading Pellets)

Recommended and Approved Sizes are as listed in attached Chart.

Deep Wall Socket Set

7/16 Inch Socket for 1/8, and 3/16 Inch Injectors

1/2 Inch Socket for 1/4 Inch Injectors

9/16 Inch Socket for 5/16 Inch Injectors

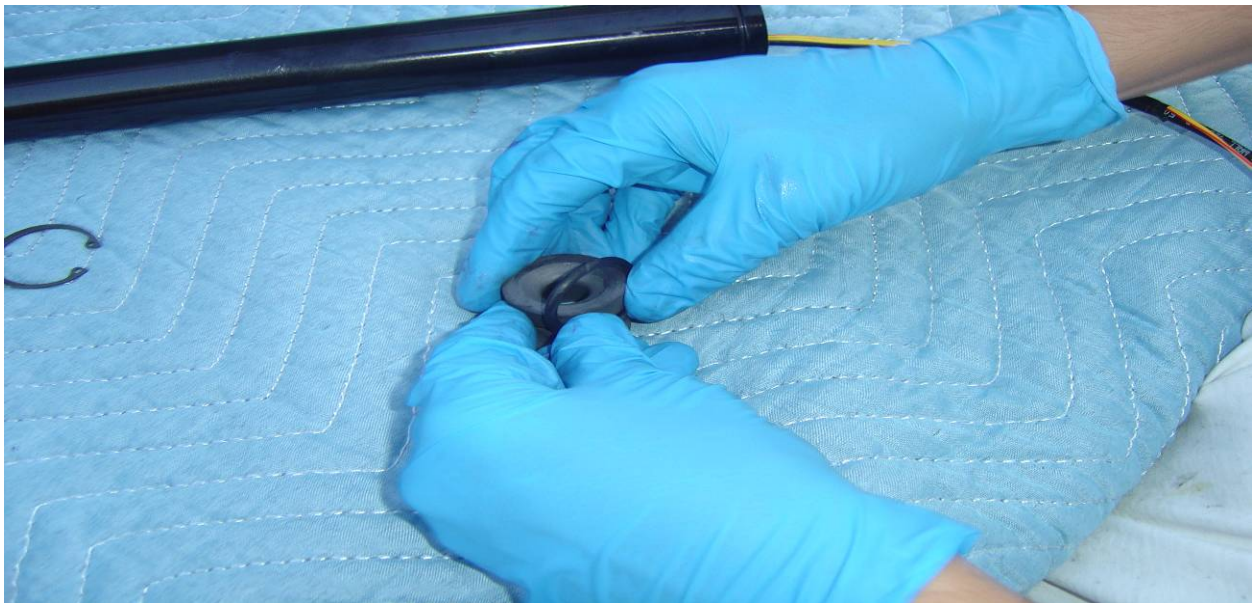
Good Pair of Cutters (Recommended: Radio Shack Coax Cable Cutters)

Roll of Electrical Tape

Motor Assembly Instructions



Step 1: Ensure that your motor hardware is clean and free from grease, oils, dirt and debris. Wipe the motor components with soap and water, to cut any residual grease from previous firings. Make sure you have all required tools and parts for motor assembly.



Step 2: Begin by installing all O-Rings onto Nozzle, Injector Baffle, and Bulkhead. All O-rings are Dash Number 215. O-Rings should be free from any cracks, burns or damage.



Step 3: Use Krytox™ grease on top Bulkhead O-rings. Smear Krytox™ over the entire outer cylindrical surface of the Bulkhead. This allows for an easy fit into the motor case. Krytox grease is available from Conrail Rockets and our Dealers.



Step 4: Slide top bulkhead into the top side of the motor case. (The top of the motor case does not have an external groove cut into it for a thrust washer). Once the bulkhead is pushed just below the snap ring groove, install the snap ring using snap ring pliers.

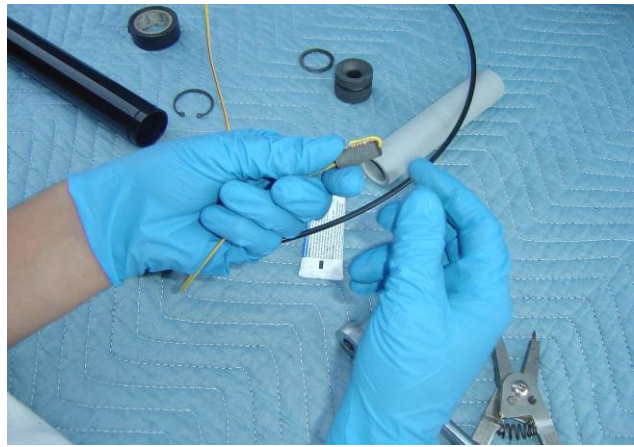
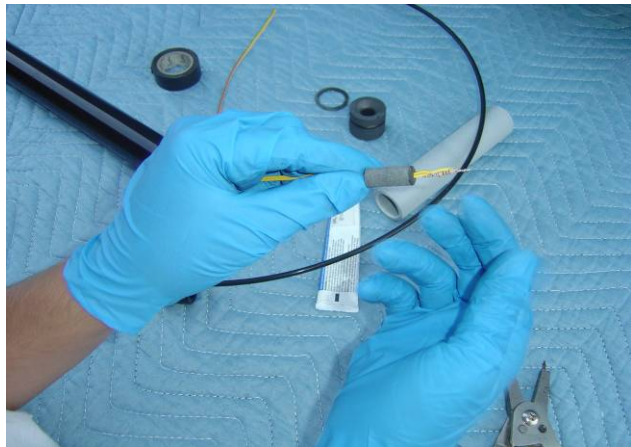
Step 5: Install Parker Press-Lock Fitting into the Floating Injector. (The Floating Injector is denoted by an “T” Stamped on the top face) This should be done with a deep wall socket set. Make sure the injector is tightened to ½ turn past snug. To verify injector speeds and Igniter requirements please view the attached chart.



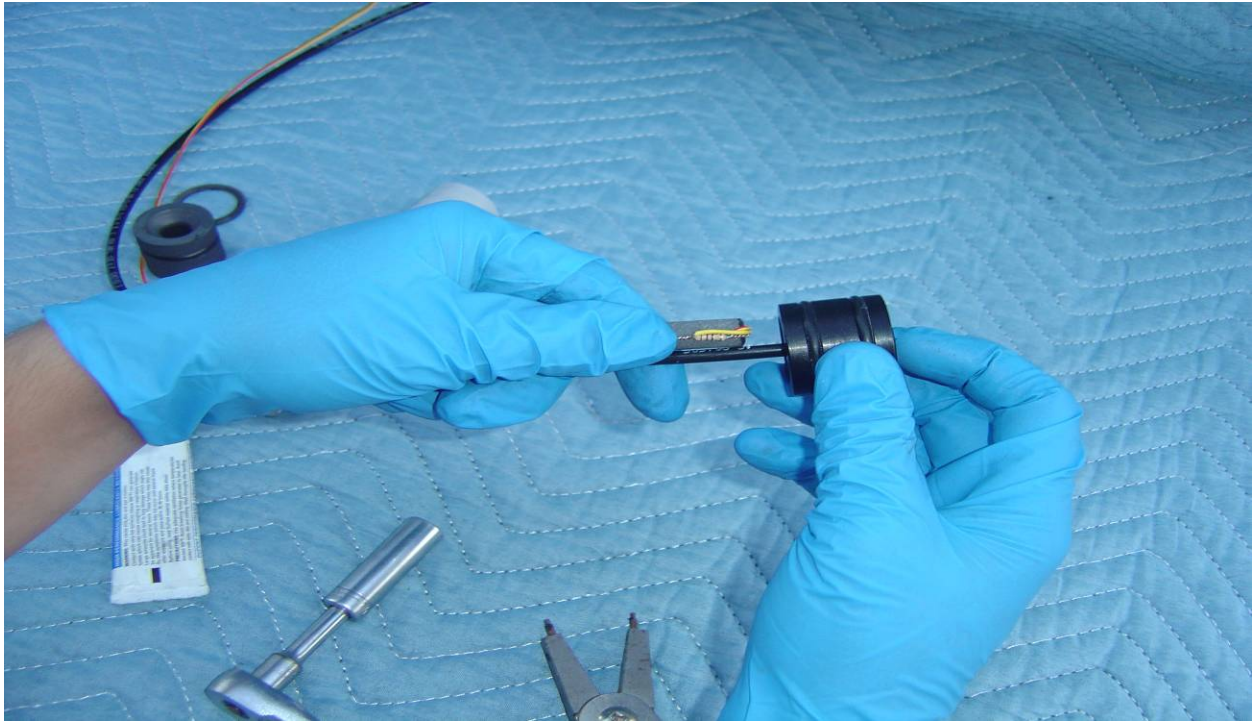
Step 6: Find the included Nylon Fill Line, and make sure the nylon line is cut square. If it is not, use a set of cutters to square off the end of the lines. Once the line is cut square, push the line into the Press Lock Fitting. Be sure that you feel the fitting go past an O-Ring seal and seat snugly onto the bottom of the fitting. Once Seated give a slight pull to ensure the fitting is locked in, and the fittings “Teeth” grab onto the line.

38mm Motor Pyrodex Pellet Ignition Grain Recommendations

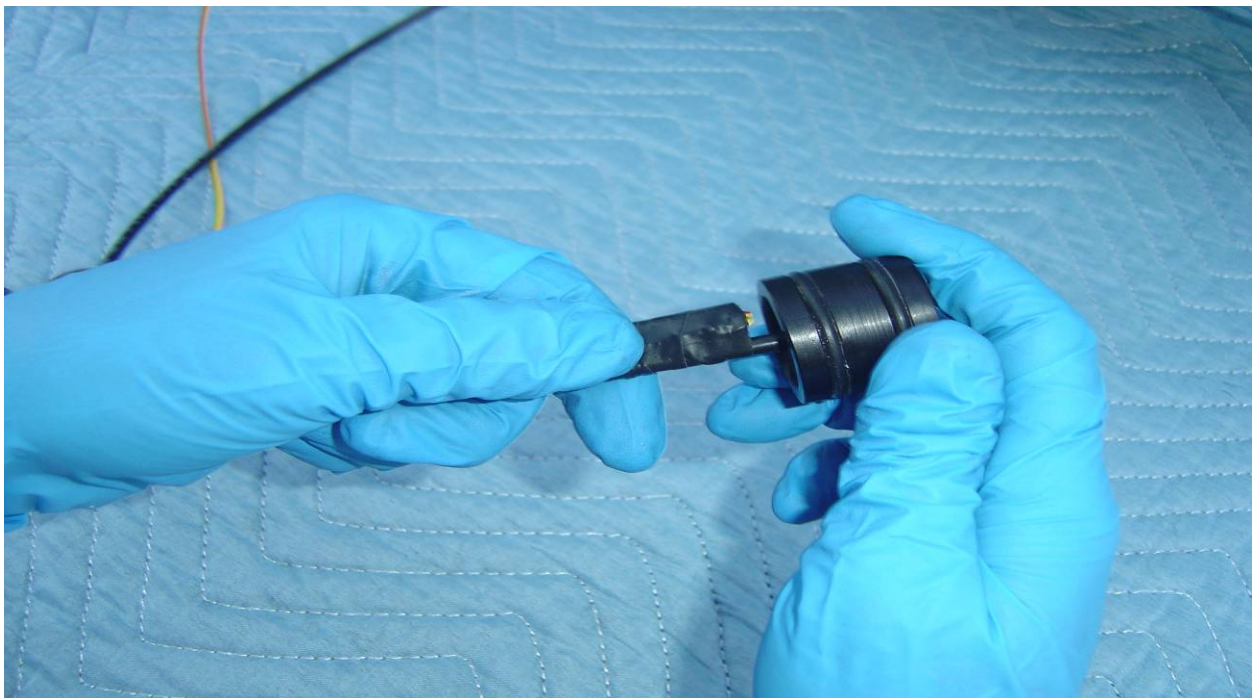
<i>Slow Motors</i>	<i>Medium Motors</i>	<i>Fast Motors</i>	<i>X-Fast Motors</i>
<i>(1) 44 Cal./30 Grain</i>	<i>(2) 44 Cal./30 Grain</i>	<i>(2) 44Cal./30 Grain</i>	<i>(2) 45 Cal./50 Grain</i>
<i>(2) 50 Cal./30 Grain</i>	<i>(2) 50 Cal./30 Grain</i>	<i>(2) 50 Cal./30 Grain</i>	<i>(2) 50 Cal./50 Grain</i>
<i>(1) 45 Cal./50 Grain</i>	<i>(1) 45 Cal./50 Grain</i>	<i>(1) 45 Cal./50 Grain</i>	
<i>(1) 50 Cal./50 Grain</i>	<i>(1) 50 Cal./50 Grain</i>	<i>(1) 50 Cal./50 Grain</i>	
<i>(1) 54 Cal./60 Grain</i>	<i>(1) 54 Cal./60 Grain</i>	<i>(1) 54 Cal./60 Grain</i>	



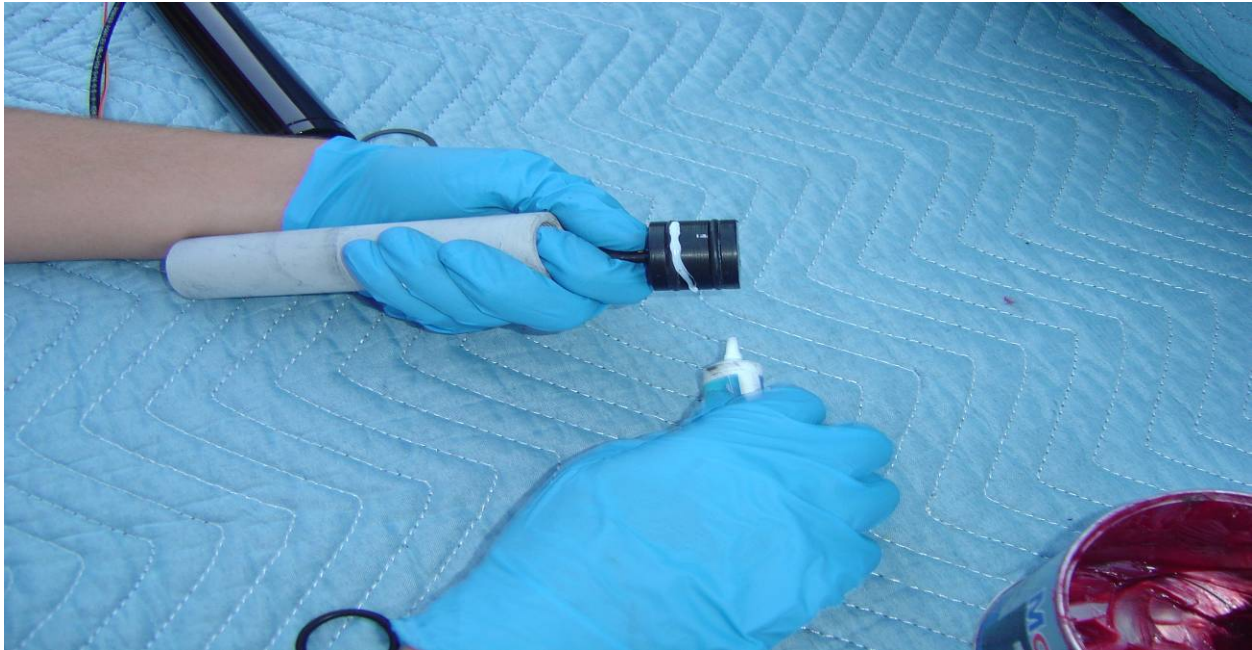
Step 7: Refer to the Igniter/Injector Chart to find out which size and number of Pyrodex Pellets is recommended for ignition. Verify that you have the correct size and number of Pyrodex Pellets for your reload and then slide the igniter wire through the center hole of the pellet. Bend the resistor to the side of the powder pellet as shown.



Step 8: Place the Igniter assembly next to the top of the Injector Face. Put the Resistor approximately 90 Degrees away from the fill tube. (Refer to Picture).



Step 9: After aligning the igniter into position, use electrical tape to tape the igniter to the fill line. 2 wraps of electrical tape over the entire igniter grain is recommended. This holds the heat of the Black Powder Pellets close to the Nylon Line.



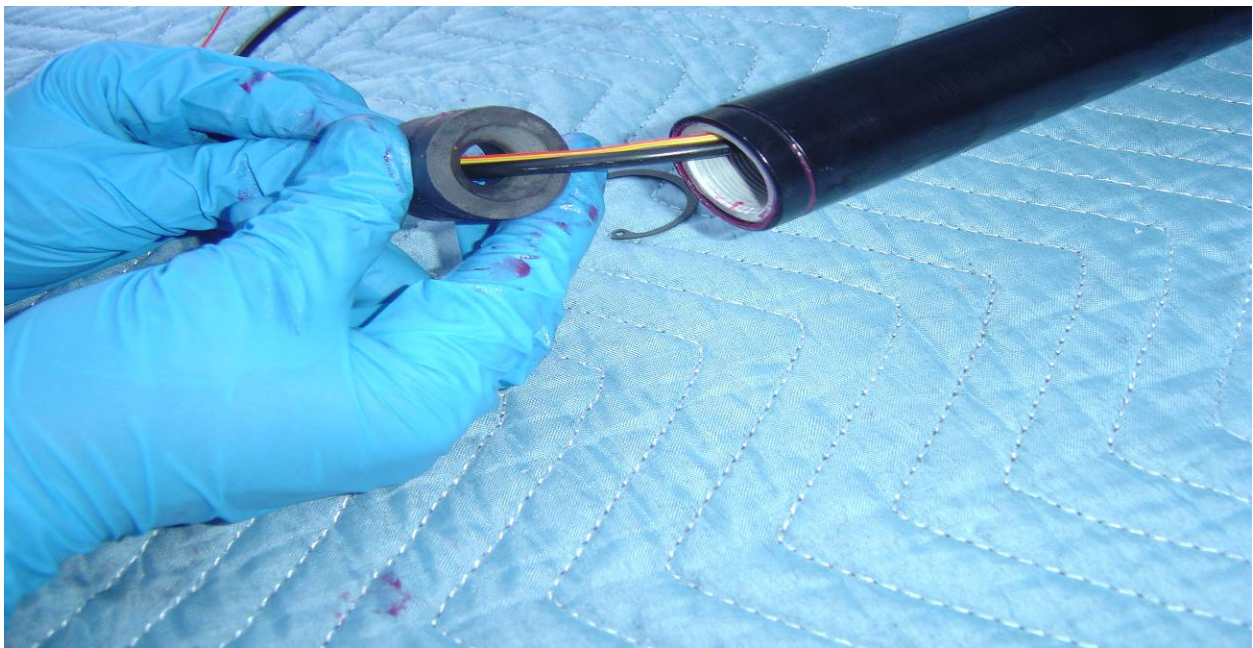
Step 10: Now that the Injector and Igniter assembly is put together, you will be greasing the Injector Assemble with Krytox™ Grease just as you did with the top bulkhead. Once the Injector is greased you will slide the assembly into the motor tube. Be sure to not slide the injector up to far, as you will use the grain to push the injector up the rest of the way into the case.



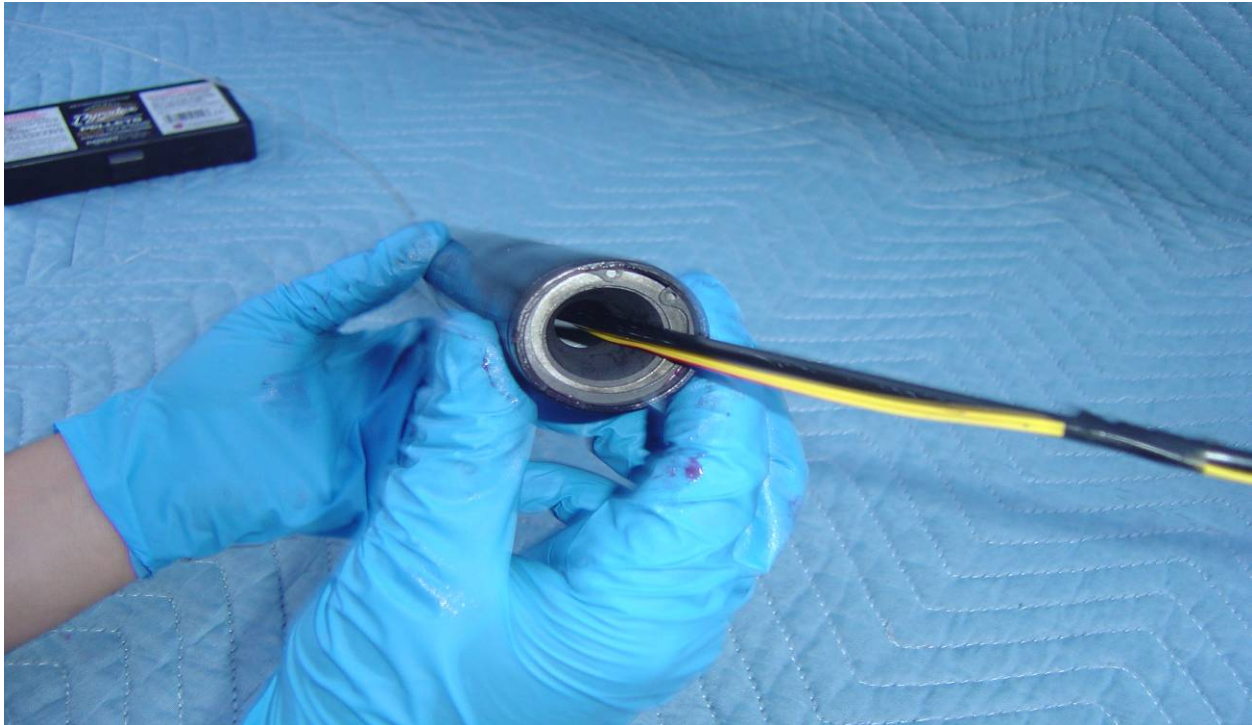
Step 11: Find the included Fuel Grain which came with the reload package. Grease the outside of this grain with a non-petroleum based grease. We recommend Mobile 1 Synthetic Grease. Completely cover the grain with grease before sliding the grain onto the fill line and igniter wire.



Step 12: Slide the Fuel grain into the motor case by pushing it down, which will also push the injector assembly into position as well. Wipe any excess grease off of the outside of the motor case.



Step 13: Find the graphite nozzle with O-ring and give a light coat of synthetic grease. You then want to slide the graphite nozzle into the motor case. Following the insertion of the nozzle into the motor case you will then place the nozzle washer onto the face of the nozzle.



Step 14: Be sure that the nozzle and nozzle washer are pressed slightly below (approx. 1/16th of an inch) the snap ring groove. Find the second snap ring, and insert the snap ring into the groove to complete motor assembly.

You're Now Done Assembling your Contrail Rockets Hybrid Rocket Motor.

Venting Instructions

The recommended procedure for venting Contrail Rockets Hybrid Motors is to drill the vent hole (1/8-3/16th hole) in the side of the rocket prior to motor installation.

Next, you will feed the clear vent line which is included with the reload package through the newly drilled hole, and down the motor mount tube.

You will then connect the clear vent to the Bulkhead Vent Assembly (The Vertical Press Lock Located in the Top Bulkhead)

Finally you feed the motor case and vent line back through and into the motor mount. You will then clip off any excess vent line which sticks out of the rocket body and you are ready to fly!

Launch Setup and Procedure

- In order to fire any Contrail Rockets Hybrid Motor you will need to have available a Hybrid Ground Support System. We recommend the Contrail Rockets Ground Support System, or the Pratt Hobbies Ground Support System. For More information on Ground Support Contact your favorite hybrid vendor. Pad Setup is Simple.
 - No Hybrid Motor should be operated when Nitrous Oxide Pressures are less than 550 psi or more than 900 psi.
 - It is required that you fill your Hybrid Motor from a Distance of no less than 100 Feet.
 - Manufactures of Hybrid Ground Support will be more able and willing to help assist you in the pre flight setup and procedures which go along with there equipment. If you are not familiar with there equipment, ask them prior to use.
-

Warnings

- Only Contrail Rockets Certified Reloads are to be used in Contrail Rockets Hardware. The use of any other manufactures reload in Contrail Rockets Hardware will void your warranty and will also render the assembled motor non-certified.
- Never Approach a Hybrid Motor when filling or while the motor has pressurized Nitrous Oxide in it.
- After Firing your motor, it may be hot, and should be handled with care.
- Always Wear Protective Eyewear, Gloves, and Clothing when working with Hybrid Motors, or Ground Support.
- Always follow the Tripoli Safety Code as well as the NFPA Safety Code for Mid and High Power Rocketry.
- Not heeding these warnings could result in injury of yourself or others.

Disposal and Cleanup

If for any reason you need to return or dispose of your reload, please contact Contrail Rockets LLC. for information on how to return the item. Appropriate shipping and handling, as well as packaging requirements may be necessary. Any used items should be disposed of in the proper trash receptacle.

Safety and First Aid

Conrail Rockets Hybrid Motor Reloads will not burn without the presence of a High Temp Heat Source, and strong oxidizer. If for some reason, any part of a reload is ingested, induce vomiting and seek medical attention.

Disclaimer

Conrail Rockets LLC. specifically disclaims any warranties with respect to any and all products sold or distributed by it, the safety or suitability thereof, or the result obtained, whether express or implied, including without limitation, any implied warranty of merchantability of fitness for a particular purpose and/or any other warranty. Buyers and users assume all risk, responsibility and liability whatsoever for any and all injuries (including death, losses, or damages to persons or property), including consequential damages arising from the use of any product or data, whether or not occasioned by seller's negligence or based on strict product liability or principles of indemnity or contribution. Conrail Rockets Neither assumes nor authorizes any person to assume for it any liability in connection with the use of any product or data.

Conrail Rockets LLC. Ensures that reasonable care during the design and manufacture process. Because we can not control the use or storage of our products, Conrail Rockets, can not be held responsible for any personal injury or property damage resulting from the handling, use or storage of its products. The Purchaser assumes and accepts all liabilities and risks associated by the handling or use of Conrail Rockets Products. By Purchasing a Conrail Rocket, LLC. product, you are hereby acknowledging the above disclaimer, and agreeing to not hold Conrail Rockets, LLC., its owners, employees, stock holders, partners, or subcontractors for any harm or blame caused by the use of our product, caused by the purchaser, and/or end user.

Warranty

Our Products are Warranted for a time period of one year, from the date of original purchase. The warranty expressed by Conrail Rockets LLC., covers defects in material or workmanship. There shall be no expressed or implied warranty, which covers any item damaged, through the use of a Conrail Rocket Motor. This includes the motor hardware, electronics, and

any other items which suffer from the misuse, neglect caused by the user. Contrail Rockets LLC. Reserves the right to alter the Warranty at any time, at their discretion.

Contact Information

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Suite #2

Lake Havasu City, AZ 86403

United States of America

Phone Number: 520-990-4721

Website: <http://www.contrailrockets.com>

Manufacture Date: