ROUSE-TECH

CD3 INSTRUCTION MANUAL

INTRODUCTION

The ROUSE-TECH CD3 unit is designed for deploying parachutes and recovery items in high power and amateur rockets at any altitude. From sea level to space. The CD3 unit can be used in both "low altitude" and "high altitude" configurations. The low level application is for flights under 20,000 ft. where there are no problems with the burning of a pyrogen, in the case of the CD3 unit- black powder. For flights over 20,000 feet, the CD3 unit can be prepared for high altitude flights by "potting" the electric match heads with epoxy into the electric match holder and using Krytox lube to seal the o-rings. After the flight the epoxy is drilled out along with the spent e-match from the holder with a 1/4" bit.

Either configuration accepts the four different sized of CO2 cartridges available from your ROUSE-TECH dealers. 12, 16, 25 and 38 gram cartridges will satisfy most rocket sizes being launched today. A sizing chart prepared by John Rockdale is part of the manual for use in the initial determination of cartridge sizing.

As in any type of ejection and recovery system, only after ground testing to confirm desired results, should you proceed with the flight. Remember to always ground test the rocket to insure that the ejection of recovery items and separation of rocket components is adequate.

The use of the CD3 system eliminates the need for black powder or other pyrogen based ejection charges in rockets. These charges are dangerous and injury has occurred to people from the charges going off accidentally. Another benefit of the CD3 system is the elimination of Nomex protection parachute cloths and recovery line protection sleeves. These items often consume valuable recovery volume and never completely protect the recovery items from the burning of the pyrogen- black powder. Your expensive parachutes and recovery items can now be used many years with no damages.

A year of research and testing went into the CD3 unit. From the initial tests conducted to determine exactly what was happening at high altitudes we discovered that not even a Davey Fire electric match would completely burn at altitudes of 55,000 ft. and above. Pyrogens placed in contact with the matches would not completely burn either, with noticeable drop offs in burn rates starting at 20,000 ft..

Many different types of pyrogens were tested including nitro-cellulose based, black powder, Pyrodex, Igniter Man pyrogen, potassium based pyrogens, Clear Shot, Red Dot, Blue Dot and "777 brand" pyrogens. Each exhibited different characteristics in their burning and burn rates. However, the common denominator was that none worked in vacuums of 3" Hg and lower. (Roughly 55,000 ft..) All of these compounds are pressure dependent for their burn characteristics. The lower the pressure, the slower the burn. (Burn rate co-efficient). There was a significant drop off in gasses produced at approximately 20,000 ft. (13" Hg). Incomplete combustion occurs at an alarming rate above this.

After some assistance from NASA, the units design could be finalized to incorporate both the needs of low altitude flights and high altitude flyers. At high altitudes, NASA pointed out that there can be no burn in a vacuum due to the lack of air molecules needed to transfer heat to sustain burning. (Heat transfer in both convection and conduction. Radiation plays little in the role of sustaining combustion). Anything that burns must maintain its individual ignition temperature to sustain the burn. At these high altitudes, the ignition temperature is not maintained, nor can it be transferred due to the lack of a medium to transfer (conduct) temperature- air molecules.

Another factor that contributes to the high altitude burn problem is that of cooling gasses. As altitude increases, so does the cooling of the expanding gasses due to the pressure differential. The expanding combustion gasses expand so fast that they cool, like that of a CO2 cartridge or air hose. This cooling effects the burning of the pyrogen. At high altitudes, the cooling extinguishes the burn as the cooling and expansion of gasses lowers the ignition temperature to below that of the ignition temperature of the pyrogen.

The physical characteristics of the pyrogen are also critical to the burn. The powders used in rocketry are granular and when they burn they "spray" the adjoining grains out. At low altitudes, the flame front and ignition temperature keeps up with the moving particles and a complete burn is accomplished. These ejection containers fail prior to all the pyrogen being burnt, with particles burning out side the canister. Keeping the granules in a confined area to insure complete combustion by maintaining pressure, is whats needed to produce the gasses needed to separate the rockets components for these canister types of applications.

It is the burn rate of pyrogen (BP) and the physical properties of atmosphere that make the design of a deployment device difficult. For these reasons, ROUSE-TECH recommends 20,000 ft.. as the cut-off altitude for successful deployment of any pyrogen based ejection system. Over 20,000 ft.. the lack of air drastically effects any compounds ability to burn. There is no magical altitude where things "don't work" as it is far more complicated than that, when dealing with different pyrogens, containers, air pressure etc.

PRODUCT DISCLAIMER AND LIMIT OF LIABILITY

Rouse-Tech, Inc. has designed the CD3 system for rocket parachute deployment in hobby rockets only.
Other uses and applications where gas generation is needed, using the CD3 unit have not been identified.

Do not use this device in any other application. Never place more pyrogen in the unit than specified.

Purchaser and user agrees to hold harmless Rouse-Tech, Inc. for any and all claims, debits, liabilities, judgements, costs and attorneys costs arising, claimed on accouunt of, or other action arising from use of this product, for property damages, injuries and death.

Rocket launching activities are a dangerous activity and acknowledged as so by purchaser.

Rouse-Tech, Inc. products have not been tested by any agency, organization or entity for certification, approval,rating or qualification.

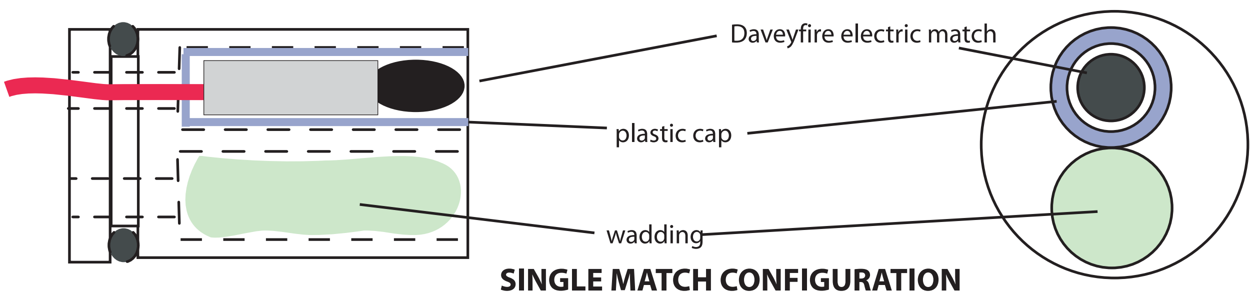
Extent of liability will be limited to the cost of the product.

LOW ALTITUDE USE - below 20,000 feet

STEP 1- Place a coating of Teflon lube (found at Radio Shack and other places) on the 2 o-rings and place a liberal amount inside the bore of the CD3 unit. Install the two o-rings on the plunger and electric match holder. Slide the plunger into the greased casing bore with the point of the plunger pointing inwards. You will feel a slight resistance when the o-ring reached the casing bore. Push into the casing about 1/8". (If you push the plunger into the casing farther than +- 1/8", the placement of pyrogen into the pyrogen cavity can be difficult). Place the pyrogen into the pyrogen cavity. For all sized cartridge uses, fill the pyrogen cavity 1/2 - 2/3 and no more. Set aside and keep vertical to insure the pyrogen does not spill.

STEP 2- Check the Ohms resistance of the Daveyfire electric match(s) you will be using in the flight. The CD3 unit is designed to accommodate the Daveyfires sold with the plastic cap on the tip covering the match head. If you are not using this type or another brand, you MUST cover the metallic soldered end of the match with tape or other item to prevent the match shorting out against the stainless steel body of the holder. Unwind the electric match wire leads and feed them through the large hole and into the small hole at the bottom of the e-match holder. Pull the wire on the Daveyfire through the holder until the plastic cap rests on the bottom of the cavity. There will be part of the plastic cap protruding from the end of the stainless steel holder. Trim off flush with holder with razor knife.

STEP 3- If using one e-match, the second cavity must be plugged with wadding or paper towel to prevent the pyrogen from spilling into the vacant cavity and to contain the combustion gas. Fill the second cavity fully with the wadding, etc. (See diagrams below)



SINGLE MATCH CONFIGURATION

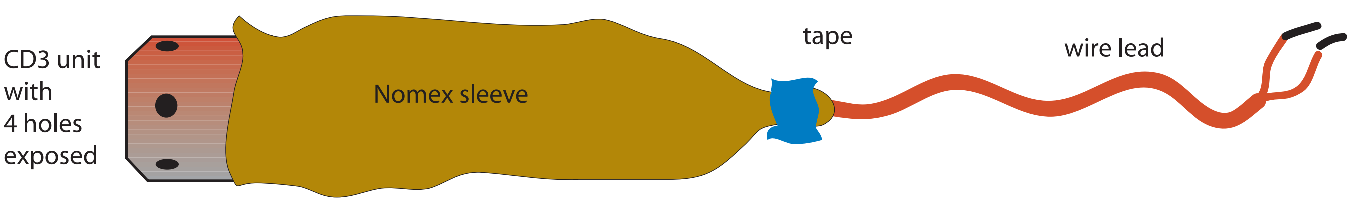
Step 4- Hold the casing with the installed plunger and pyrogen firmly with one hand, keep upright, and push the stainless steel electric match holder with the installed Daveyfire(s) into the casing. The plunger will also go into the casing further as the plunger slides in. You will again feel a slight resistance when the o-ring contacts the casing.

Step 5- Slide the red anodized, knurled cap over the wires and onto the now assembled casing. Screw onto the casing.

DO NOT OVER TIGHTEN!

Step 6- Slide the Nomex sleeve over the assembly and past the knurled cap.

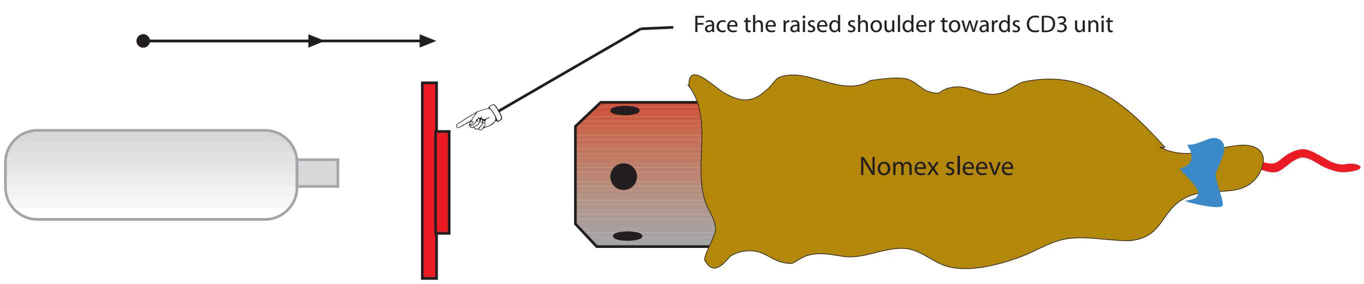
The 4 CO_2 gas escape holes will be exposed and the 2 pyrogen relief holes should be covered by the sleeve. Place masking tape to close the other end of the sleeve around the wires.



LOW ALTITUDE USE - below 20,000 feet

Step 7- Place the correct colored combination flange with the raised shoulder facing toward the CD3 unit and tightly screw the CO_2 cartridge into the CD3 unit .

Place the assembled unit into your rocket and secure with three 8/32 screws.



USE APPROPRIATE COMBINATION FLANGE - GOLD FLANGE FOR 12 AND 16 GRAM USES, RED FLANGE FOR 25 AND BLUE FOR BOTH 25 AND 38 GRAM USES

ROUSE-TECH

HIGH ALTITUDE FLIGHTS

- ABOVE 20,000 FEET

CD3

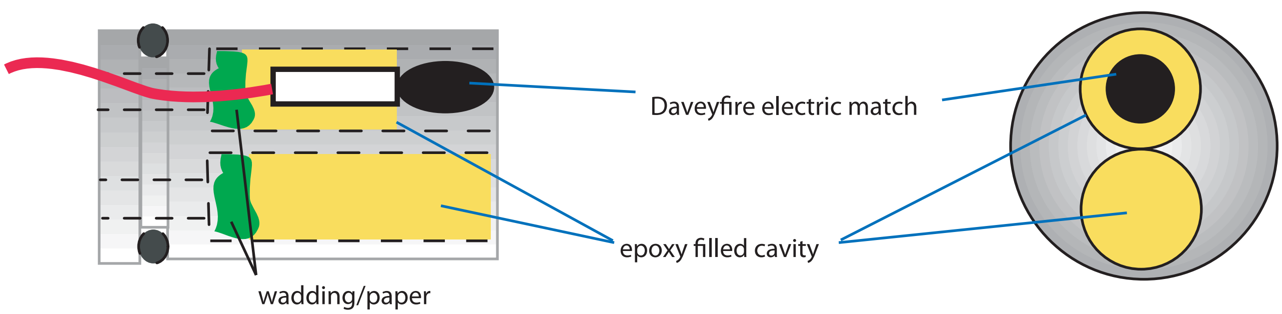
STEP 1- Place a generous coating of Krytox or Teflon grease on the two o-rings and inside the bore of the CD3 casing. The o-rings and the grease seal the cavity to keep the air inside. With no air or even a small amount of air, the pyrogen will not burn, even in the small cavity. Krytox will stay thick when it heats up, where the Teflon based grease gets runny as temperature goes up. This can be a concern to rocketeers launching in the summer when rockets are often on the launch pad and in the sun. You must fill the o-ring grooves in the plunger and holder with the sealant grease to insure a proper seal at the inside diameter of the o-ring too.
Install the o-rings. Slide the plunger into the casing bore approximately 1/8". You will feel a slight resistance when the o-ring contacts the casing.
Place the pyrogen inside the pyrogen cavity.

For all sizes of CO_2 cartridges, fill the pyrogen cavity only 1/2 - 2/3 full! The pyrogen cavity is the .440" dia. recess on top of the stainless steel plunger.

STEP 2- Check the Ohm's resistance of the Daveyfire. electric match(s) you will be using. Unwind the wire leads and remove all kinks. Remove the plastic cap from the head of the Daveyfire by sliding down the wire leads and discard. Push the wire leads into the electric match cavity and out the smaller hole on the bottom. Pull through all the way until only 1" of the match head is left sticking out of the end. Bend the wire over so you can pack wadding or paper towel into the hole around the wire at the bottom. Pack the bottom 3/16" of the cavity. This serves two purposes. First it keeps the epoxy from dripping out of the cavity when potting. Second, when drilling out the cavity after the flight, the paper allows the point of the drill bit to hit the paper before it hits the flat bottom of the cavity. You will know when you hit the paper with the drill. Still, be careful not to hit the bottom!

STEP 3- "POTTING THE ELECTRIC MATCH IN EPOXY". Mix a small amount of 5 minute epoxy and fill the cavity about 1/2 way. Straighten the match wire and pull the match head down into the cavity until its flush with the end of the stainless steel holder. Your epoxy should cover all of the electric match except the pyrogen dipped tip. (Usually black). Do not get epoxy on the tip. The goal here is to seal the cavity up to the match head and not get epoxy on the match head.

STEP 4- If using one match in the flight, place wadding or paper towel inside the other cavity about 1/2 way and fill the remainder with epoxy to seal the cavity.



SINGLE MATCH CONFIGURATION SHOWN

STEP 5-Place the casing on a flat surface in an upright position (the plunger and pyrogen already installed) and push the stainless steel electric match holder with the installed electric match(s) into the casing. You will feel a slight resistance when the o-ring contacts the casing. Push until flush.

STEP 6- Slide the red anodized CD3 holder cap over the wires and screw onto the casing. DO NOT OVER TIGHTEN.
STEP7-- Slide the Nomex sleeve over the assembly past the knurled cap. Continue to slide until the end of the sleeve is over the groove on the casing. Secure the Nomex with a zip tie.
The 4 CO_2 gas escape holes will be exposed and the two pyrogen escape holes will be covered by the Nomex. Place a piece of tape around the open end of the Nomex sleeve to close the other end around the wires.

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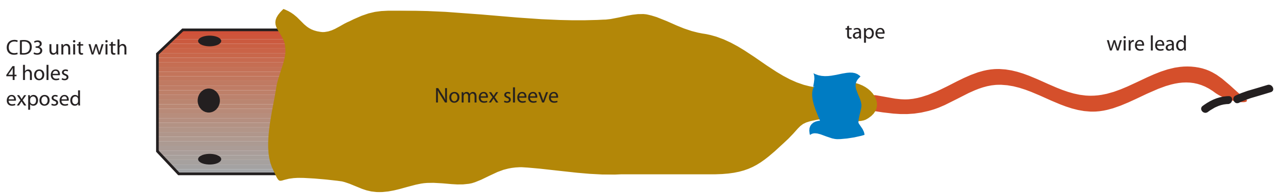
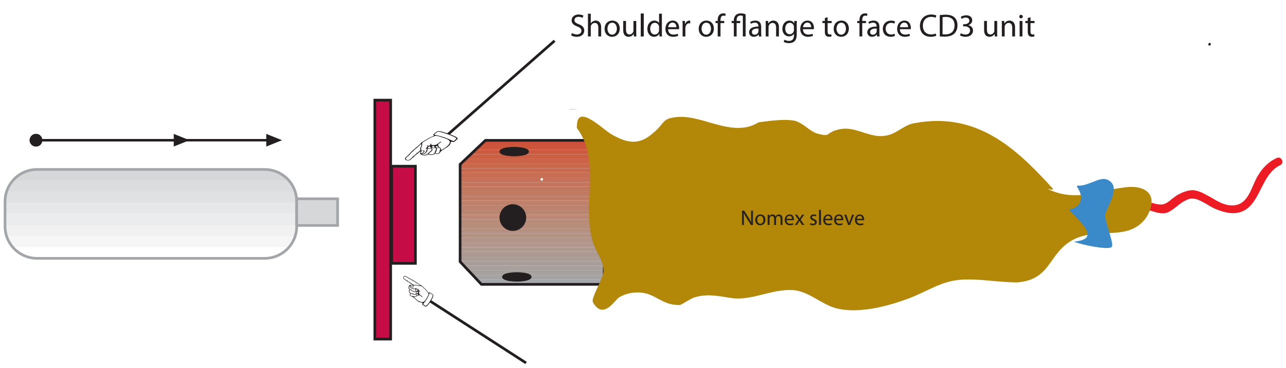
HIGH ALTITUDE FLIGHTS- con't -ABOVE 20,000 FEET

Continued

Your CD3 unit should now look like this-



Tghtly screw the CO2 cartridge into the CD3 unit using the appropriate combination flange. Place the shoulder of the flange facing toward the CD3 unit!!!



USE APPROPRIATE COMBINATION FLANGE - GOLD FLANGE FOR 12 AND 16 GRAM USES, RED FLANGE FOR 25 AND BLUE FLANGE FOR 25 AND 38 GRAM USES

When ready for flight, slide the finished assembly into the rocket and secure with your selection of screw type. 8/32 recommended.

NOTES-

IMPORTANT- FIll the pyrogen cavity 2/3 in 12 and 16 gram uses, fill to the top for 25 and 38 gram uses.

The CD3 unit should always be cleaned right after use. Black powder residue is harmful to aluminum and stainless steel if left uncleaned. Be careful not to use emery cloth or sandpaper to clean residue as these will scratch the protective anodizing inside bore of the unit.

In high altitude use, on the stainless steel electric match holder, the epoxy must be drilled out after use. Use a 1/4" bit (.250"), being careful not to drill too deep.

O-rings should be new when launching in high altitude use. O-rings can be re-used in low altitude use if no damage is evident.
Always take care when removing the plunger. Do not damage the point on the plunger. Push gently with a dowel or other object

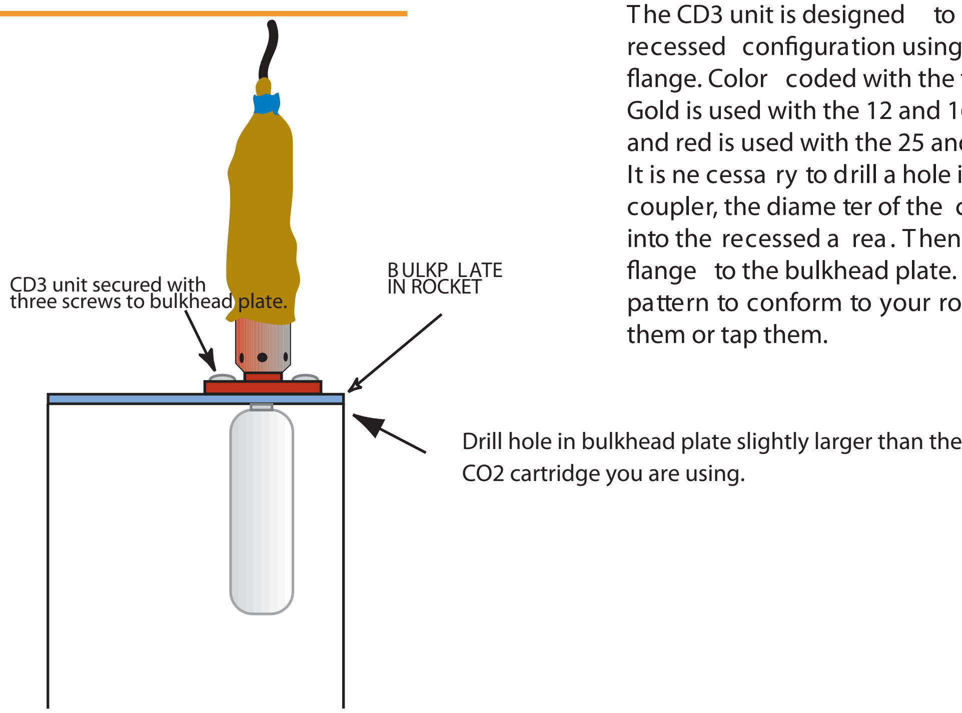
Always use Rouse-Tech CO2 cartridges. Other brands may use thicker caps or different thread dimensions! This can cause a failure due to an unacceptably small puncture size!!

MOUNTING DETAILS

Since there are so many different configurations of rockets and the way they separate at deployment, the CD3 combination flange was designed to have two methods of mounting in the rocket to accommodate as many design scenarios as possible. Like the black powder canister method, the CD3 should be placed below the recovery components- ie. parachute and recovery lines. Recovery components and parachutes should always be "above" the CD3 unit to insure they are pushed out by the gasses. Remember, using the CD3 eliminates the need for Nomex protection cloths, shock cord protection cloth and wadding. All components can be placed in the recovery area and rest against the CD3 unit without concern for damages from burning.

Make sure that all electric match wire leads are secure so they don't tangle with recovery components.

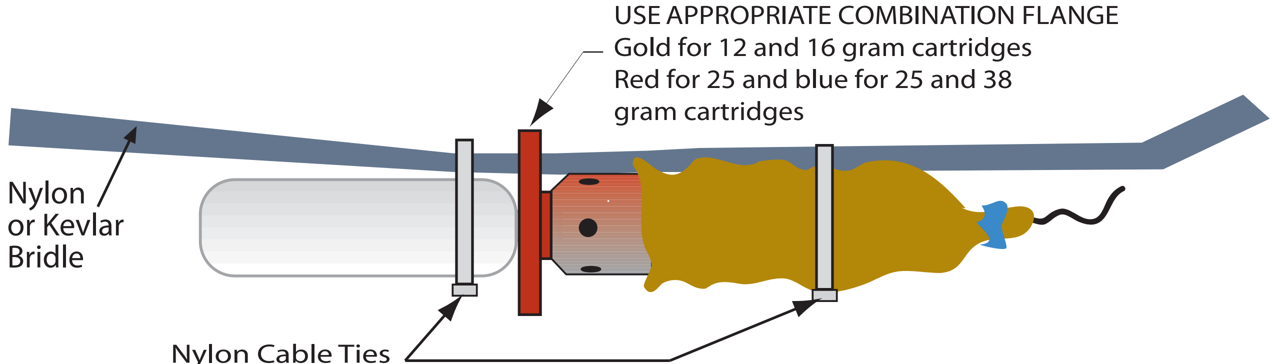
RECESSED MOUNT



The CD3 unit is designed to be mounted in a recessed configuration using the round, combination flange. Color coded with the following- Gold is used with the 12 and 16 gram cartridges, and red is used with the 25 and 38 gram cartridges. It is necessary to drill a hole in the bulkhead or coupler, the diameter of the cartridge so it can slide into the recessed area. Then, screw the combination flange to the bulkhead plate. Lay out the proper hole pattern to conform to your rocket, and either drill them or tap them.

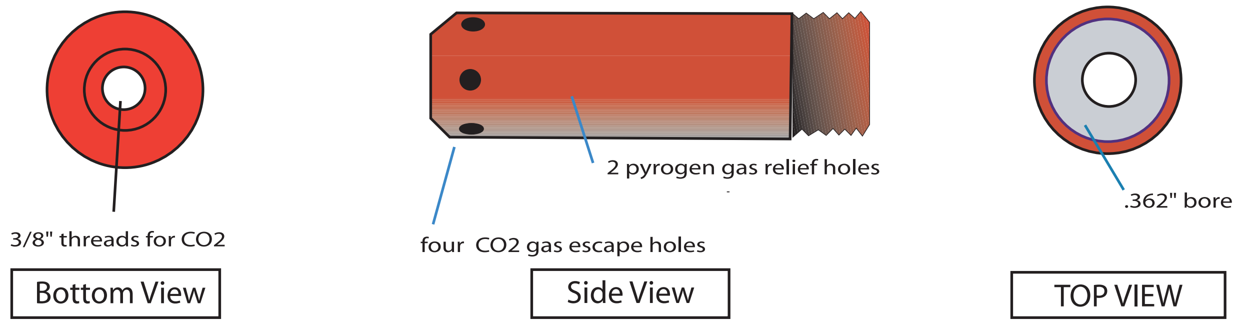
BRIDLE MOUNT

The CD3 unit can also be used by mounting it directly to the bridle using cable ties (zip ties) .

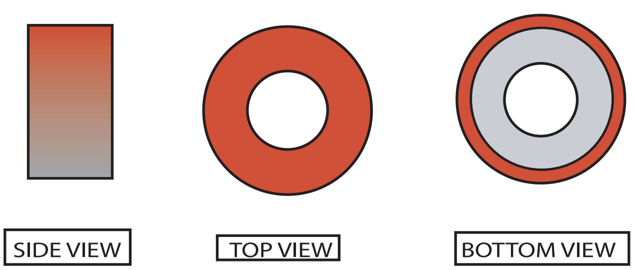


PARTS LIST

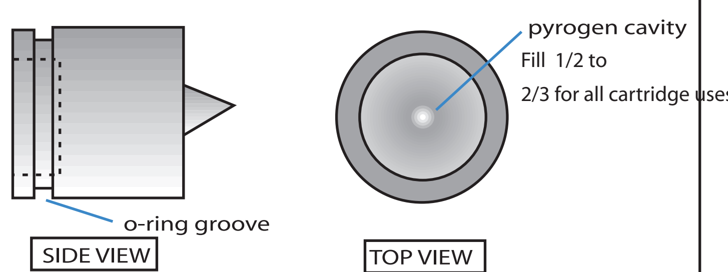
CASING- red anodized aluminum



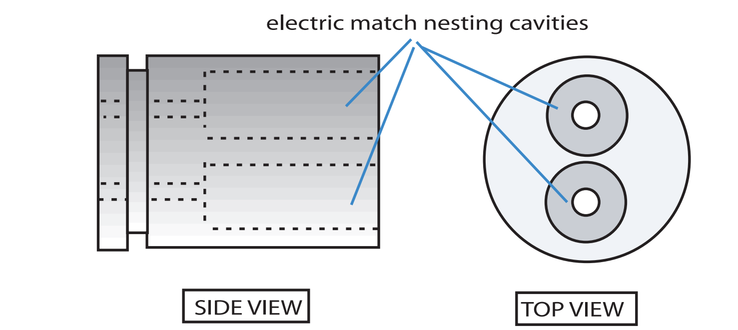
CAP- red anodized aluminum



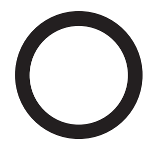
PLUNGER---stainless steel



ELECTRIC MATCH HOLDER- stainless steel

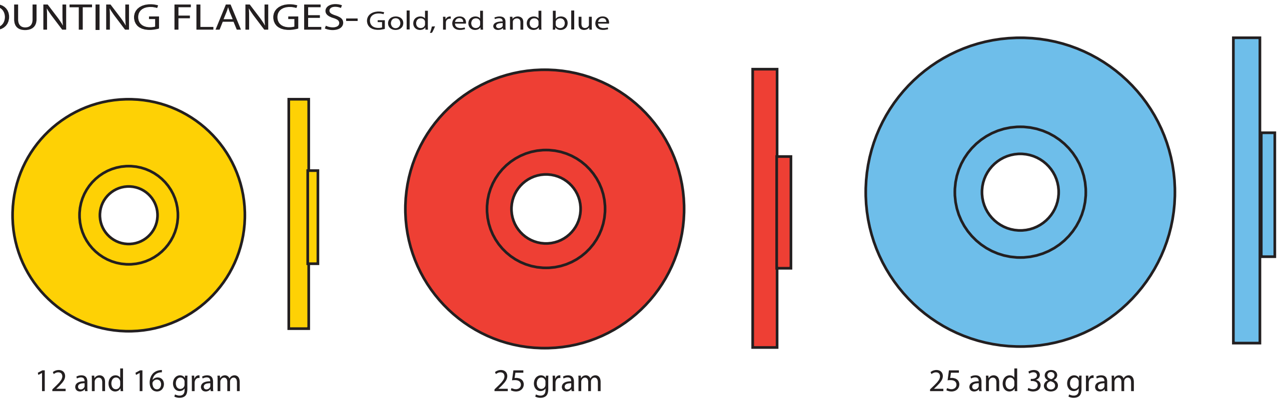


VITON O-RINGS (2)



NOMEX SLEEVE

MOUNTING FLANGES- Gold, red and blue



SIZING GUIDE

John Rockdale

Introduction

The Rouse-Tech CD3 CO_2 deployment system is designed to replace black powder deployment systems in amateur rockets. The CD3 system has two advantages over black powder systems:

- No residue to clean up after recovery, and no risk of a burned or melted parachute or streamer.
- No decrease in efficiency or reliability at extreme altitudes, i.e. > 40,000 feet. Black powder systems tend to fail at extreme altitudes due to poor heat transfer and combustion efficiency at low atmospheric pressures. The CD3 system is immune to this problem.

Optimally sizing an ejection system from a purely theoretical basis is a deceptively complicated matter. The mass of the two components to be separated, airframe material, shear pins, component coefficient of friction, and vent hole sizes all factor in to the problem. As with any "ejection charge calculator" or calculation, there is no substitute for ground testing your system, and we do not recommend flying any system for the first time without a ground test.
The CD3 system provides for four different CO_2 cartridge sizes: 12, 16, 25, and 38 grams.
We will present two methods for determining the optimal CO_2 cartridge size for your rocket, in ascending order of complexity. No matter which method you choose, remember that you should *always* ground test your system before flying it for the first time.

Method 1: Rough guidelines by compartment size
This method is based solely on typical charge sizes for typical rockets. It's a rough starting point for your ground testing. Simply use the table below to locate the recommended CO_2 cartridge size for the diameter and length of the recovery compartment.

Recommended Cartridge size by recovery compartment length and diameter (typical)

	Length (in)											
Diameter (in)	6"	10"	14"	18"	22"	26"	30"	34"	38"	42"	46"	50"
2"	12 g	12 g	12 g	12 g	12 g	12 g	12 g	12 g	12 g	16 g	16 g	16 g
3"	12 g	12 g	12 g	12 g	12 g	12 g	12 g	12 g	16 g	16 g	16 g	16 g
4"	12 g	12 g	12 g	12 g	12 g	16 g	16 g	16 g	25 g	25 g	25 g	25 g
5"	12 g	12 g	12 g	12 g	12 g	16 g	16 g	25 g	25 g	25 g	25 g	25 g
6"	12 g	12 g	12 g	12 g	16 g	16 g	25 g	25 g	25 g	25 g	38 g	38 g
8"	12 g	12 g	16 g	16 g	25 g	25 g	38 g	38 g	38 g	38 g	NR	NR
10"	12 g	12 g	16 g	25 g	25 g	38 g	38 g	38 g	NR	NR	NR	NR
12"	12 g	16 g	25 g	25 g	38 g	38 g	NR	NR	NR	NR	NR	NR

NR = Not recommended

Method 2: Sizing by Black Powder Equivalence

This method might be preferred for those experienced flyers who are comfortable with their own or published black powder "ejection charge calculators" or techniques. This method is also suitable for those retrofitting previously flown rockets with a successful base of experience.

Step 1: Determine the black powder charge (in grams) using the method you prefer. A widely used black powder charge calculator is available on the web at Rocketry Online's INFOcentral web page. Rocketry Online's URL is **www.rocketryonline.com**. You can find the calculator by going to the INFOcentral page and finding the "recovery" section. The "recovery" section's index has a "black powder use" page where the calculator resides. Note: There is no need to add in "extra" black powder charge for flights expected to exceed 20,000 feet.

Step 2: Multiply the black powder charge size (grams) by 5.0 to determine the amount of CO_2 (also in grams) required to achieve the same compartment pressure.

Step 3: Round *up* to the nearest sized CO_2 cartridge. Use this as the starting point for your ground testing.

Example: My previous rocket has flown and successfully deployed at 12,000 feet three times using a 2.5 gram black powder charge. What size CO_2 cartridge should I use to replace the black powder charge system?

2.5 x 5.0 = 12.5 grams CO_2. Round up to the nearest sized CO_2 cartridge: 16.0 grams.

Use a 16 gram CO_2 cartridge as the starting point for my ground testing.

Here's a brief description of the underpinnings of this "conversion factor" method (the black powder pressure calculation is borrowed from Ted Apke's "Ejection Charge Calculator" page on ROL's INFOcentral web page):

Quoting from Ted:

The ejection charge equation is:

$$Wp = dP*V/R*T$$

Where:

- dP is the ejection charge pressure in psi.
- R is the combustion gas constant, 22.16 (ft-lbf/lbm R) for FFFF black powder. (Multiply by 12 in/ft to get in terms of inches)
- T is the combustion gas temperature, 3307 degrees R for black powder
- V is the free volume in cubic inches. Volume of a cylinder is cross section area times length L, or from diameter D, $V=L*\pi*D^2/4$
- Wp is the charge weight (mass, actually) in pounds. (Multiply by 454 g/lb to get grams.)

Here's an example calculation. Suppose you want to generate 15 psi inside a 4" diameter rocket in a parachute compartment 18" long. That makes a volume of 226 in^3. The amount of powder you need will be:

$$Wp = 15*226(454)/12(22.16)\ 3307$$

$$Wp = 1.75 \text{ grams}$$

Continuing with the example provided by Ted Apke above, here's how to solve the same problem using CO2 instead of black powder:

Start with the ideal gas law: n= PV/RT

n= number of moles CO_2 required.
P= ejection pressure desired in atmospheres (1 atm = 14.7 psi)
V= volume of parachute compartment in liters (1 liter = 61 in^3)
R= universal gas constant (=0.08206)
T= Temperature of expelled CO_2 gas at deployment in degrees Kelvin (273K)

In this example:

P= 15psi = 1.02 atm
V= 226 in^3 = 3.70 liters
T= 273K

Number of moles CO_2 = (1.02*3.70)/(0.08206*273) = 0.168 moles.

Lastly, one mole of CO_2 = 44 grams, so 0.168 moles * 44g/mole = **7.41 grams CO_2**.

Thus, we have the result that 7.41 grams CO2 produces the same ejection pressure as 1.75 grams Black powder.

Dividing these results gives a ratio of 7.41 g CO2/1.75 g BP = 4.24. We recommend adding a safety factor of approximately 20%, resulting in a "conversion factor" of 5.0 grams CO_2 per gram of black powder.